Volume 13, Supplement 1 March 2017

INTERNATIONAL JOURNAL OF CENTRAL BANKING
Volume 13, Supplement 1 March 2017

INTERNATIONAL JOURNAL OF CENTRAL BANKING

Special Issue on International Prudential Policy Spillovers: Evidence from the International Banking Research Network

Introduction

Cross-Border Prudential Policy Spillovers: How Much? How Important? Evidence from the International Banking Research Network
Claudia M. Buch and Linda S. Goldberg

International Banking and Cross-Border Effects of Regulation: Lessons from Canada, Switzerland, Chile, Germany, France, Hong Kong, Italy, Mexico, Korea, the Netherlands, Poland, Portugal, Turkey, the United Kingdom, and the United States
H. Evren Damar and Adi Mordel; Simone Auer, Maja Ganarin, and Pascal Towbin; Alejandro Jara and Luis Cabezas; Jana Ohls, Marcus Pramor, and Lena Tonzer; Matthieu Bussière, Julia Schmidt, and Frédéric Vinas; Kelvin Ho, Eric Wong, and Edward Tan; Marianna Caccavaio, Luisa Carpinelli, and Giuseppe Marinelli; Gabriel Levin-Konigsberg, Calixto López, Fabrizio López-Gallo, and Serafín Martínez-Jaramillo; Hyunggeun Park and Jungyeoun Lee; Jan Frost, Jakob de Haan, and Neeltje van Horen; Krzysztof Gajewski and Oskar Krzesicki; Diana Bonfim and Sónia Costa; Yusuf Soner Başkaya, Mahir Binici, and Turalay Kenç; Robert Hills, Dennis Reinhardt, Rhiannon Sowerbutts, and Tomasz Wieladek; Jose M. Berrospide, Ricardo Correa, Linda S. Goldberg, and Friederike Niepmann

Changes in Prudential Policy Instruments—A New Cross-Country Database
Eugenio Cerutti, Ricardo Correa, Elisabetta Fiorentino, and Esther Segalla

International Prudential Policy Spillovers: A Global Perspective
Stefan Avdjiev, Cathérine Koch, Patrick McGuire, and Goetz von Peter

International Journal of Central Banking

Volume 13, Supplement 1 March 2017

Special Issue on International Prudential Policy Spillovers: Evidence from the International Banking Research Network

Introduction 1

Cross-Border Prudential Policy Spillovers: How Much? How Important? Evidence from the International Banking Research Network 5
Claudia M. Buch and Linda S. Goldberg

International Banking and Cross-Border Effects of Regulation: Lessons from Canada 35
H. Evren Damar and Adi Mordel

International Banking and Cross-Border Effects of Regulation: Lessons from Switzerland 65
Simone Auer, Maja Ganarin, and Pascal Towbin

International Banking and Cross-Border Effects of Regulation: Lessons from Chile 95
Alejandro Jara and Luis Cabezas

International Banking and Cross-Border Effects of Regulation: Lessons from Germany 129
Jana Ohls, Marcus Pramor, and Lena Tonzer

International Banking and Cross-Border Effects of Regulation: Lessons from France 163
Matthieu Bussière, Julia Schmidt, and Frédéric Vinas

International Banking and Cross-Border Effects of Regulation: Lessons from Hong Kong 195
Kelvin Ho, Eric Wong, and Edward Tan

International Banking and Cross-Border Effects of Regulation: Lessons from Italy 223
Marianna Caccavaio, Luisa Carpinelli, and Giuseppe Marinelli

International Banking and Cross-Border Effects of Regulation: Lessons from Mexico 249
Gabriel Levin-Konigsberg, Calixto López, Fabrizio López-Gallo, and Serafín Martínez-Jaramillo

International Banking and Cross-Border Effects of Regulation: Lessons from Korea 273
Hyunggeun Park and Jungyeoun Lee

International Banking and Cross-Border Effects of Regulation: Lessons from the Netherlands 293
Jan Frost, Jakob de Haan, and Neeltje van Horen

International Banking and Cross-Border Effects of Regulation: Lessons from Poland 315
Krzysztof Gajewski and Oskar Krzesicki

International Banking and Cross-Border Effects of Regulation: Lessons from Portugal 341
Diana Bonfim and Sónia Costa

International Banking and Cross-Border Effects of Regulation: Lessons from Turkey 379
Yusuf Soner Başkaya, Mahir Binici, and Turalay Kenç

International Banking and Cross-Border Effects of Regulation: Lessons from the United Kingdom 405
Robert Hills, Dennis Reinhardt, Rhiannon Sowerbutts, and Tomasz Wieladek

International Banking and Cross-Border Effects of Regulation: Lessons from the United States 435
Jose M. Berrospide, Ricardo Correa, Linda S. Goldberg, and Friederike Niepmann

Changes in Prudential Policy Instruments—A New Cross-Country Database 477
Eugenio Cerutti, Ricardo Correa, Elisabetta Fiorentino, and Esther Segalla

International Prudential Policy Spillovers: A Global Perspective 505
Stefan Avdjiev, Cathérine Koch, Patrick McGuire, and Goetz von Peter

The contents of this journal, together with additional materials provided by article authors, are available without charge at ***www.ijcb.org****.*

ISSN: 1815-4654

International Prudential Policy Spillovers: Evidence from the International Banking Research Network

Introduction to a Special Issue of the International Journal of Central Banking

Claudia M. Buch,[a] Matthieu Bussière,[b] and Linda Goldberg[c]
Co-editors of the Special Issue
[a]Deutsche Bundesbank
[b]Banque de France
[c]Federal Reserve Bank of New York[1]

The global financial crisis has affected almost all countries worldwide. Its epicenter has been in the core of the advanced economies. After the crisis, deleveraging has been slow while the structure of capital flows has changed from debt- to equity-type instruments. The decline in cross-border bank lending, particularly bank-to-bank flows, has been a key driver of these developments. The crisis has triggered substantive policy responses: fiscal and monetary policy measures have been used actively, stress testing and rules governing recovery and resolution regimes for financial institutions have been further developed, microprudential rules and in particular capital requirements have been tightened, and macroprudential toolkits have been assembled.

While progress is under way since the introduction of macroprudential policy instruments, experience with and lessons from these new instruments remain tentative. Assessing the impacts of the changes in policy and the effects on the real economy is a challenging task.

Among the effects on the real economy are the spillovers of prudential policy measures across borders. In this special issue of the *International Journal of Central Banking* we present a recent cross-country and cross-institution initiative by the International Banking Research Network (IBRN) that has explored responses of lending

[1]The views expressed are solely those of the authors and should not be interpreted as reflecting the views of the Deutsche Bundesbank, the Banque de France, the Federal Reserve Bank of New York, or the Federal Reserve System.

by globally active banks to changes in prudential regulations, distinguishing adjustment across modes of entry and types of policy instruments, and exploring heterogeneity across banks.

The IBRN was founded in 2012 to inform the academic and the policy debate on current issues related to international banking. It is a multi-country initiative,[2] currently bringing together research teams from more than twenty-five central banks and two international financial institutions—the International Monetary Fund (IMF) and the Bank for International Settlements (BIS). Most teams have access to confidential bank-level data on domestic and cross-border banking activities.

In this special issue, fifteen country studies and one cross-country study examine international spillovers of prudential instruments through credit provision by banks. Spillovers are defined very generally and do not necessarily reflect regulatory arbitrage or policy leakages. The studies focus on two main questions. First, does lending of internationally active banks respond to prudential policies implemented in home and foreign markets, and what are the channels for policy spillovers? Second, to what extent are the responses to prudential policies shaped by characteristics of banks and by macroeconomic factors?

The analysis conducted here used a coordinated approach to research whereby the same methodological framework and consistent data since the early 2000s—both bank specific and in terms of prudential instruments—is applied in each study. Taken together, the initiative generates broadly relevant insights, going well beyond the single-country case studies and capturing the types of insights that can most effectively be gleaned from work using micro-banking data. In a baseline model, all country teams use the same regression models analyzing inward or outward transmission of prudential policies. In addition to the baseline model, country teams address issues that are relevant for their countries, given the structure of their banks, their banking systems, and the available micro-banking data. These data cover lending activity, bank ownership, and balance sheet characteristics such as capitalization, deposit shares, total assets, and the share of illiquid assets. The micro-banking data used

[2]The current list of participating central banks and institutions as well as country studies are available at http://www.newyorkfed.org/IBRN/index.html.

in these studies help teams solve the identification problem which otherwise beleaguers impact assessment studies based on aggregate data.

To facilitate this analysis, the IBRN collaborated with the IMF and regulatory bodies in the individual countries in order to utilize and extend the Global Macroprudential Policy Instruments (GMPI) survey, which the IMF conducted in 2013. The collaboration resulted in a new cross-country and quarterly time series database for prudential instruments spanning sixty-four countries and the period from 2000 to 2014. The instruments covered include general capital requirements, sector-specific capital requirements, interbank exposure limits, concentration limits, loan-to-value ratio limits, and changes in (minimum) reserve requirements. The database is available at https://www.newyorkfed.org/ibrn.

Within this special issue, the paper by Claudia Buch and Linda Goldberg provides an overview of the full initiative, including its methodological and database contributions, and a meta-analysis that reveals key cross-country results. By design, the empirical studies summarized are very homogenous because all teams use the same baseline regression model. Hence, publication biases that can affect meta-analyses that draw on only published research are not an issue here. The new database on prudential instruments is described in the paper by Eugenio Cerutti, Ricardo Correa, Elisabetta Fiorentino, and Esther Segalla. The remainder of the special issue contains a cross-country analysis conducted by the Bank for International Settlements (Stefan Avdjiev, Cathérine Koch, Patrick McGuire, and Goetz von Peter) and then fifteen country-specific studies that highlight the inward and outward transmission of prudential policies and specific mechanisms as observed in detailed micro-data case studies. Countries represented are Canada, Chile, France, Germany, Hong Kong, Italy, Korea, Mexico, Netherlands, Poland, Portugal, Switzerland, Turkey, United Kingdom, and United States.

Overall, the main conclusions of this initiative are as follows: *First, there is evidence that prudential instruments sometimes spill over across borders through bank lending.* Spillovers are most likely to occur via the affiliates of foreign banks hosted in a country, although some evidence exists of inward transmission through home-country global banks.

Second, international spillovers vary across prudential instruments and are heterogeneous across banks. Bank-specific factors like balance sheet conditions and business models drive both the amplitude and the direction of spillovers to lending growth rates. Spillovers into lending growth from prudential tightening are positive in some cases and negative in others. There is some evidence that prudential policy change is associated with market share repositioning of banks internationally, with some foreign banks expanding activity in markets when local banks face tighter balance sheet constraints.

Third, international spillovers of prudential policy on loan growth rates have not been large on average, but have the potential to grow with broader use of macroprudential instruments. The quantitative size of international spillovers has thus far been viewed as small across country studies.

Having said that, the results of this project may underestimate the full impact of regulations on cross-border banking activities to date and the scope for effects in the future. Three considerations should be underlined. First, during the period of study, few country-specific macroprudential instruments were activated in the large countries that are home and hosts of global banks. Instead, increased capital requirements were enforced worldwide, which limits the scope for regulatory arbitrage. To the extent that macroprudential instruments will be used at a national level to an increasing degree, the potential for international spillovers is likely to increase as well. Second, the analyses focus on the effects of macroprudential policy along the intensive margin; implications for the entry and exit of financial institutions into foreign markets (i.e., adjustment along the extensive margin) have not been considered. Finally, while imposing a common methodology across countries has the advantage of making results comparable and performing an unbiased meta-analysis, it may cloud interesting and important country-specific features of the adjustment process.

Cross-Border Prudential Policy Spillovers: How Much? How Important? Evidence from the International Banking Research Network*

Claudia M. Buch[a] and Linda S. Goldberg[b]
[a]Deutsche Bundesbank
[b]Federal Reserve Bank of New York

The development of macroprudential policy tools has been one of the most significant changes in banking regulation in recent years. In this multi-study initiative of the International Banking Research Network, researchers from fifteen central banks and two international organizations use micro-banking data in conjunction with a novel data set of prudential instruments to study international spillovers of prudential policy changes and their effects on bank lending growth. The collective analysis has three main findings. First, the effects of prudential instruments sometimes spill over borders through bank lending. Second, international spillovers vary across prudential instruments and are heterogeneous across banks. Bank-specific factors like balance sheet conditions and business models drive

*The authors thank participants of the International Banking Research Network, in particular Matthieu Bussière, Jana Ohls, and Dennis Reinhardt, for many thoughtful exchanges and contributions. Special thanks go to the teams that prepared the IBRN Prudential Instruments Database (Eugenio Cerutti, Ricardo Correa, Elisabetta Fiorentino, and Esther Segalla) in collaboration with the International Monetary Fund and to all country teams providing the input for the meta-analysis. Simone Auer, Stijn Claessens, Ricardo Correa, Ralph De Haas, John Driscoll, Martial Dupaigne, Peter Egger, Alexander Guembel, Galina Hale, Robert Hills, Christian Hellwig, Augustin Landier, Ouarda Merrouche, Camelia Minoiu, Gianmarco Ottaviano, Alexander Popov, Rhiannon Sowerbutts, and Phil Strahan provided valuable comments on an earlier draft of this paper. Excellent research assistance was provided by Jacob Conway and Guzel Valitova. The views expressed in this paper are solely those of the authors and should not be interpreted as reflecting the view of the Federal Reserve Bank of New York, the Federal Reserve System, or the Deutsche Bundesbank. All errors are our own. Corresponding author (Goldberg): Federal Reserve Bank of New York, 33 Liberty Street, New York, NY 10045, Tel.: (212) 720-2836, e-mail: linda.goldberg@ny.frb.org. (Buch): claudia.buch@bundesbank.de.

the amplitude and direction of spillovers to lending growth rates. Third, the effects of international spillovers of prudential policy on loan growth rates have not been large on average. However, our results tend to underestimate the full effect by focusing on adjustment along the intensive margin and by analyzing a period in which relatively few countries implemented country-specific macroprudential policies.

JEL Codes: F34, G01, G21.

1. Introduction

The development of macroprudential policy tools is one of the most significant policy changes in the past decade. Macroprudential policies aim at mitigating systemic risks in financial markets. Macroprudential tools are often explicitly applied to banks and are mostly implemented at the national level. Examples of such tools are bank capital requirements, counterparty concentration limits, interbank exposure limits, loan-to-value ratios, and reserve requirements. The desired targets might be bank lending growth, the resilience of banks to shocks, or asset markets that are deemed to be frothy or mispriced.

The effectiveness of these tools is a key consideration. Analysis of early experiences with macroprudential instruments shows that some tools can reduce banks' asset growth within countries (Claessens, Ghosh, and Mihet 2014). However, effectiveness may be weakened when risky or excessive lending moves outside of the regulatory perimeter to non-covered entities or activities (Aiyar, Calomiris, and Wieladek 2014; Bengui and Bianchi 2014; Reinhardt and Sowerbutts 2015) or to other geographic regions (Houston, Lin, and Ma 2012).

The international financial openness of countries and the global nature of financial institutions present added challenges (Obstfeld 2014).[1] International spillovers through banks matter for instrument effectiveness within a country's borders and are relevant for the broader issues of policy frameworks, externalities, reciprocity, and welfare. Yet, there is little systematic evidence that establishes whether spillovers are common, important, and support or hinder

[1]For a more detailed discussion of macroprudential toolkits, see Arregui et al. (2013), Claessens, Ghosh, and Mihet (2014), or Ostry et al. (2011).

the attainment of policy goals. The gap in knowledge is particularly acute when it comes to evidence drawn from and relevant for a broad range of countries. Providing this evidence on prudential policy effects and international spillovers is the subject of this multi-study initiative of the International Banking Research Network (IBRN).[2] Fifteen country teams examine domestic effects and international spillovers of prudential instruments using detailed confidential micro-banking data. In addition, researchers from the Bank for International Settlements (BIS) and from the European Central Bank (ECB) provide cross-country perspectives. The analyses focus on evidence for international policy spillovers through multiple channels: *inward* transmission addresses how *foreign* regulations affect the *domestic* activities of domestic banks or foreign affiliates (bank branches or subsidiaries) located in the host country; *outward* transmission to foreign economies addresses the effects of foreign policies on the *foreign* activities of a reporting country's global banks. All country teams implement the same baseline regression models for analyzing inward or outward transmission. In addition, country teams address issues specific to their banking markets or banks' business models. In some cases, teams differentiate adjustment of lending by their global banks' branches (which are subject to the capital requirements of their parents) versus subsidiaries (which are, in addition, subject to regulations in the host country).

This paper provides an overview of the full initiative, including its methodological and database contributions, and it presents a meta-analysis that generates key cross-country results. By design, the empirical studies we summarize are very homogenous because all teams used the same baseline regression model. Hence, publication biases that can affect meta-analyses that draw on only published research are not an issue here. Also, largely due to data availability, previous studies of international spillovers are more restricted, as they consider fewer or less precisely dated policy instruments or

[2]The IBRN was founded in 2012 to analyze issues pertinent to internationally active banks. The current list of participating central banks and institutions is available at http://www.newyorkfed.org/IBRN/index.html. Most central bank teams have access to confidential bank-level data on domestic and cross-border banking activities. In a previous project, the IBRN analyzed the transmission of liquidity risk domestically and internationally through the activities of global banks, with a meta-analysis (Buch and Goldberg 2015) and eleven country studies published in the *IMF Economic Review* (volume 63, number 3, 2015).

countries, or as they cannot account for differences across banks or channels of policy transmission internationally.[3]

The IBRN has worked toward closing several gaps that have limited prior analyses. The IBRN provides cross-country evidence on regulatory spillovers using the same methodological framework and consistent data—both bank specific and in terms of prudential instruments—across countries. As researchers apply a common research methodology, the IBRN's broadly relevant insights go well beyond the single-country case studies. In order to identify effects of prudential policies, the project uses micro data, and it exploits variation in prudential instruments across countries, bank balance sheet characteristics, and the location of foreign affiliates. Micro data help in solving the identification problem which beleaguers impact assessment studies based on aggregate data. Identification using heterogeneity and in the international context is greatly aided by the degree of granularity of the data involved. To facilitate results which are comparable across countries, the IBRN and International Monetary Fund (IMF) developed a new database that contains more precise measures of prudential regulation than were available to prior researchers. Described in Cerutti et al. (2017), the quarterly database spans sixty-four countries and the period from 2000 to 2014. The instruments covered include different types of prudential regulations: capital requirements, concentration limits, interbank exposure limits, loan-to-value ratio limits, and changes in reserve requirements.[4]

Based on the meta-analysis of fifteen country studies and the findings of two cross-country studies, here we highlight three key observations about prudential spillovers that are immediately of interest from analytical and policy perspectives.

[3]Most available studies cover the domestic consequences of domestic prudential policies. Examples include Bruno and Shin (2014), International Monetary Fund (2011), Jiménez et al. (2012), and Vandenbussche, Vogel, and Detragiache (2015).

[4]To construct this database, the IBRN and IMF collaboratively worked with regulatory sources in the individual countries, and extended and utilized the Global Macroprudential Policy Instruments (GMPI) survey that the IMF conducted in 2013. Note that stress tests, which may give incentives for banks to adjust their foreign exposures, are not covered in this project. Changes in reserve requirements are included, as they are sometimes used explicitly by countries for prudential purposes instead of as monetary policy instruments.

First, some countries observe that prudential instruments spill over internationally and through banks via lending growth. Specifications that focus on international spillovers along the intensive margin and over a time horizon of several quarters detect significant international spillovers in about one-third of the specifications. The baseline specifications provide a lower bound of regulatory spillover effects. As the analyses exclude large bank-specific outliers, they do not capture potentially large adjustments along the extensive margin, representing entry and withdrawal of banks from foreign markets. Moreover, as the meta-analysis summarizes results from a common empirical approach imposed across countries, the identified spillovers also exclude other potentially important country- and sector-specific dynamics that individual country analyses document.

Second, heterogeneity in spillovers through lending is common. This heterogeneity is at the bank level, where prudential instrument effects on lending can each differ with the balance sheet characteristics and business models of the banks participating in international lending. For example, illiquid asset shares and reliance on deposit funding differentiate the degree of loan growth responses of hosted affiliates to loan-to-value ratio limits and sector-specific capital buffer changes in the foreign parent location. Degrees of internal liquidity management via internal capital markets can matter too, significantly differentiating across these hosted affiliates in terms of how general capital requirements imposed in the parent's country spill over into lending in the host market. These same characteristics do not appear to be as important for the inward transmission of foreign policies into the domestic lending of global banks.

Cyclical considerations do not appear as important for the spillovers of regulations to international lending activity. Most countries do not find strong evidence that international spillovers of prudential policy *differ* across the business or financial cycle.

Third, the economic magnitudes of international spillovers of policy thus far have not been large on average. However, the pattern of results highlights the potential for larger and more consequential spillovers as the use of macroprudential instruments increases. Changes in capital requirements, for instance, have largely been implemented in many countries during similar time frames, potentially limiting some of the first-mover advantages for countries that had banks with higher initial capital ratios. Even with this limitation, in some cases, banks with higher initial capital were

poised to increase lending internationally, sometimes pivoting from domestic loan growth, when foreign countries tightened their capital requirements. Changes in some prudential instruments may thus spur market share repositioning across banks and foreign countries.

Overall, based on the evidence provided from a range of country experiences with international spillovers of prudential instruments through bank lending growth, we conclude that there is not a one-size-fits-all channel or even direction of transmission that dominates spillovers. While most of the countries in the IBRN initiative are advanced economies, we do not observe that results are systematically different between these countries and participating emerging market countries. Simple arguments about regulatory arbitrage do not characterize the diversity of experiences across countries. Almost all prudential instruments have been associated with both positive and negative spillovers, within and across transmission channels. The effects through specific banking institutions can depend on their balance sheet characteristics and business models. All of these observations raise complex questions: How can countries insulate themselves from international spillover? Are there trade-offs between microprudential and macroprudential policy? What if the goals of macroprudential instruments are made more difficult to attain if, at the same time, the microprudential conditions locally are changing with the market share adjustments across domestic and foreign banks? What might policy reciprocity achieve?

The rest of this paper is organized as follows. Related literature and conceptual arguments are presented in section 2, and hypothesis testing and empirical models are in section 3. Data are discussed in section 4, with more detail in appendix 2. Key findings are presented in section 5, both through a meta-analysis study of the patterns of international spillovers identified in the baseline empirical models explored by fifteen countries and through highlighting the idiosyncratic specifications run by countries. Section 6 provides a short summary of results.

2. Prudential Spillovers: What Do We Know? What Do We Expect?

The terms "regulatory arbitrage," "leakages," and "spillovers" are sometimes used interchangeably. All three terms have been invoked

to describe when regulations in one market have consequences for other markets or other institutions. But spillovers do not necessarily reflect regulatory arbitrage or policy leakages. Spillovers can occur as a natural response to changing supply or demand for credit in particular locations and by particular institutions. As spillovers have less of a loaded connotation than "leakages," we use this language. In general, we cannot identify whether banks adjust to regulations in an intentional way with the explicit aim to circumvent regulation or whether policy is ineffective because global banks adjust their international activities. In describing the prior literature and moving forward with the exposition of the IBRN initiative, we apply our broad definition to comprise the respective concepts. In general we analyze the effects of particular policy instruments—for example, loan-to-value ratios or capital requirements—to inform the consequences of prudential policy.

2.1 Prior Empirical Studies

Previous empirical studies of prudential instrument effects either follow a cross-country approach—for example, using BIS international banking statistics combined with a cross-country database on regulations—or focus on the effects of prudential instruments for a specific country. Most studies focus on domestic effects of instruments within the country applying the regulatory changes.

Using detailed data on prudential instruments similar to that within the IBRN database, other studies provide cross-country lessons for domestic macroeconomic and financial-sector aggregates. A number of studies use aggregate credit data. IMF (2011) uses a 2010 survey on the use of macroprudential instruments for forty-nine countries and finds that most macroprudential instruments (DTI, LTV, dynamic provisioning, reserve requirements, and credit growth ceilings) are effective at reducing the cyclicality of credit growth, but that this effectiveness is sensitive to the type of shock considered. Akinci and Olmstead-Rumsey (2015) use data covering 2000–13 of changes in macroprudential policy instruments affecting the housing market such as loan-to-value ratios (LTVs) and debt-service-to-income (DTI) ratios. They find that overall real domestic bank credit declines if prudential measures are tightened. Mortgage lending and house prices are affected only by macroprudential

instruments related to the housing market. Kuttner and Shim (2013) find a similar result in that only DTI ratios significantly affect housing credit growth. Bruno, Shim, and Shin (2015) document the role of macroprudential policies and capital controls in mitigating credit growth in twelve Asian economies.

Cerutti et al. (2017) use the 2013 GMPI IMF survey to create a database of macroprudential policy stances in 119 countries, and find that domestic credit growth in emerging markets is weaker when prudential policy stances are more restrictive. They also find that macroprudential instrument effects are weaker in countries that are more open, suggesting evidence of leakages.

Claessens, Ghosh, and Mihet (2014) are the only authors to use bank data rather than aggregate credit. They use annual data collected through an internal IMF survey of country desk economists and a sample of banks in thirty-five countries over the years 2000 to 2010 and find that caps on certain activities—and particularly measures aimed at borrowers—may have a stronger impact on banks' asset growth than general capital buffers. The effectiveness of these tools was not found to vary by the intensity of the credit cycle.

Several studies look at prudential policy leakages from the perspective of a specific country and focus on domestic lending. Aiyar, Calomiris, and Wieladek (2014) focus on the leakages that arise when an instrument covers domestic banks but is not applied to the branches of foreign banks operating in the domestic market. The study concludes that leakages weaken policy effectiveness in the United Kingdom. Aiyar et al. (2014) exploit exogenous changes in the capital ratios of U.K. banks to investigate whether these regulatory shocks are transmitted abroad. As the regulatory changes were imposed at the unconsolidated level, the authors argue that cross-border lending responds more than lending by affiliates abroad.

After the financial crisis, some global banks have retrenched from foreign markets. There is hardly consistent cross-country evidence analyzing the drivers of this retrenchment. One prudential policy database commonly used in previous studies and compiled by Barth, Caprio, and Levine (2013) has indexes constructed based on survey responses to reflect the broad stance of regulation and supervision. The three-year survey intervals are not ideal for studies using higher-frequency data and focusing on the identification and assignment of effects to particular instruments. Houston, Lin, and Ma (2012) use

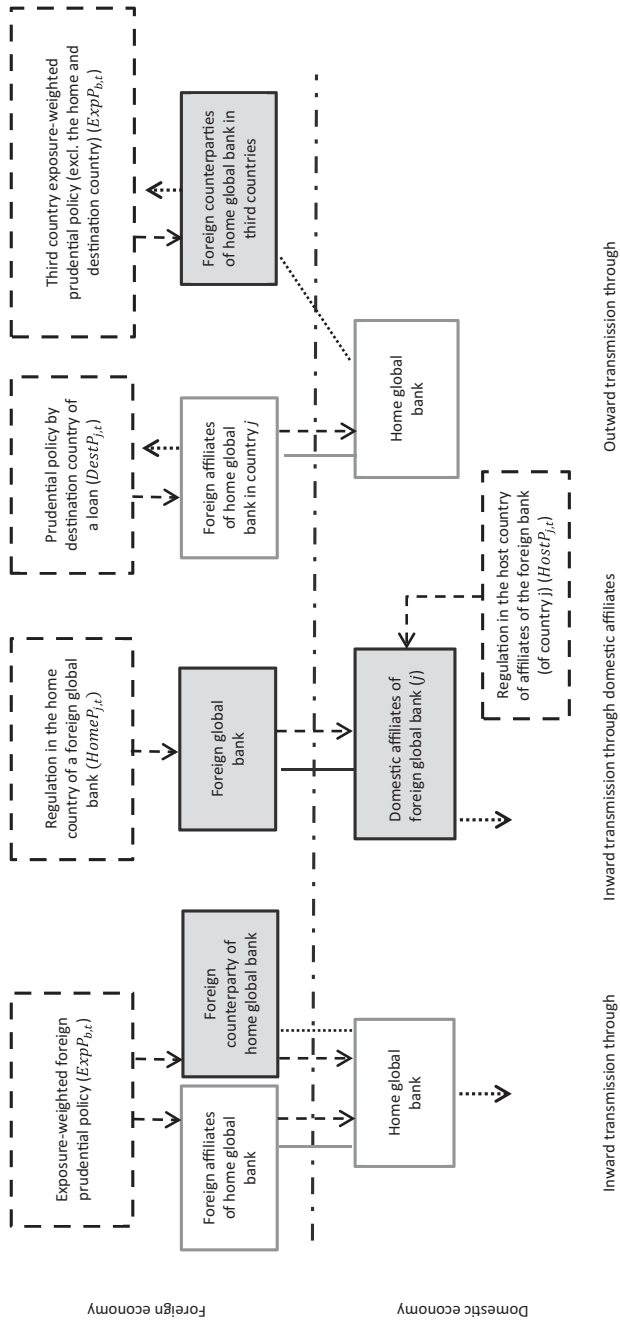
these data and find that banks lend more in markets with fewer regulations when there is an effort by domestic regulators to limit bank risk taking. Bremus and Fratzscher (2015) combine these data with the BIS international banking data and show that cross-border bank outflows appear to be driven by expansionary monetary policies, with some flows mitigated by tighter regulation. Reinhardt and Sowerbutts (2015) construct a database of macroprudential instruments for sixty countries and find that countries increase aggregate borrowing from abroad after an increase in capital requirements but not after an increase in lending standards, attributing these outcomes to the coverage of these instruments. As we observe in our initiative and discuss in section 5, some of the specific dynamics in global bank reactions to policy instruments depend on their ex ante balance conditions, which are not generally observable or used in studies of aggregate data.

2.2 Expected Effects of Specific Instruments

Previous work reviewed above provides a mixed picture of the effects of prudential instruments. While most studies find a decline in domestic lending following a domestic regulatory tightening, effects differ across banks, countries, and instruments. In terms of international spillovers, no single theoretical model captures the range of possible international transmission channels and bank-level responses to the different prudential policy instruments—capital requirements, exposure limits, concentration limits, loan-to-value ratio limits, and minimum reserve requirements—examined by teams participating in the IBRN initiative. Figure 1 details possible routes for inward and outward policy transmission, whether through global banks directly or through their affiliates around the world.

To illustrate the distinct channels of outward and inward policy transmission internationally, consider a global bank from the United States (U.S.) which owns an affiliated bank in Germany and another in the United Kingdom (U.K.). Suppose that the affiliate within Germany lends only in that host country, while the U.K. affiliate lends both in the United Kingdom and elsewhere throughout Europe. The global bank can move funds across both affiliates and its U.S. operations as part of a consolidated operational strategy. The bank's lending in Germany could depend on U.S. regulations,

Figure 1. Transmission Channels of Regulatory Policies



Notes: Dashed boxes represent changes in a prudential instrument, with dashed arrows representing the direction of policy transmission. Solid boxes denote banks, with unshaded and shaded boxes representing domestic and foreign-owned banks, respectively. Solid and dotted lines denote intragroup and cross-border lending, respectively. Dotted arrows denote the direction of lending influenced by the respective prudential policy. The horizontal dash-dot line separates domestic and foreign markets. The letters b, j, and t denote a bank b lending in country j at time t.

German regulations, and regulations in the United Kingdom. If the United Kingdom implements a prudential policy change and this influences U.S. bank lending in the United Kingdom and possibly Germany, we refer to this adjustment as the *outward transmission channel*.[5] If the U.K. prudential policy influences lending by the U.S. bank in its home (U.S.) market, this is an *inward transmission channel*.

As an example of expected effects, consider the possible implications of capital requirements in the domestic market. In the longer term, higher capital requirements make bank lending less cyclical, albeit at a marginally lower level. In the short run, the costs of raising capital may be high and banks at home may reduce the supply of credit if capital constraints become more binding. This response should be related to bank-specific capital ratios and overall balance sheet composition in terms of risks and funding structures. The response will also differ whether the capital requirement is set at the consolidated level or whether it applies to a particular domestic sector (SCR)—in which case there may be a relative price effect when lending abroad. Some *domestic* banks may increase international activities by moving to less regulated markets if the regulation does not bind or is not applied on a consolidated level. Alternatively, tighter regulations may induce banks to lower their foreign market activities if their global balance sheet constraints become more binding. How domestic banks are affected by regulatory policies will thus depend not only on how the policy is applied but also on the strength of their balance sheet and on their international business model. The response of *foreign* banks to the domestic regulation can depend on their own relative capital position and profitability. For example, if the foreign banks start out with a relatively strong capital position, they can be well situated to expand lending in a location where the domestic banks have retracted loan supply due to tighter standards. These foreign banks may respond differently if their affiliates in the domestic market are subsidiaries that are subject to the tighter capital requirements, instead of affiliates established as overseas branches, which are not.

[5] Alternatively, there could be an outward reallocation between the United Kingdom, Germany, and other foreign markets.

The effects of tighter capital requirements may also change over time, as banks can raise additional external equity or retain profits. Any negative impact effect might thus be mitigated over time, and capital requirements become less binding. Careful analysis of the timing of effects is warranted. Capital regulations are more likely to bind when the cost of raising equity is high—in other words, at the bottom of the output and financial cycles, when profitable opportunities are rare and capital markets are less exuberant. Another noteworthy feature of changes in capital requirements is that many have been implemented following international agreements. As such, their impact is likely to be more global than the effects of prudential regulations for which there is more national discretion with regard to implementation. At the same time, spillover effects might be more limited to the extent that changes in regulation are coordinated internationally and applied at the consolidated level.

Consider next the mechanisms for international spillovers from changes in loan-to-value ratios which limit the amount of borrowing a debtor can have on a particular transaction as a fraction of the underlying asset value. Use of these instruments is typically not coordinated internationally. Such limits work on credit demand rather than credit supply, and studies such as Claessens, Ghosh, and Mihet (2014) have concluded that these instruments may be most impactful on credit outcomes. A priori, international spillovers may be weaker, and bank-specific characteristics, such as the degree of capitalization, may be less relevant for identifying the effects of these instruments. If a foreign country changes LTV caps on mortgage lending, there may be a limited inward spillover if domestic credit demand is unchanged. However, LTV limits also limit the risk that a bank is able to take in its home market. Hence, banks affected by the regulation might change the composition of their credit supply by substituting away from mortgage lending at home toward lending into other sectors or internationally.

Reserve requirements or interbank exposure limits are instruments that may induce spillovers, as these instruments serve as funding restrictions.[6] Generally, higher reserve requirements make either

[6]Policymakers may tighten reserve requirements in order to dampen credit growth and thus have an (implicit or explicit) financial stability goal in mind. This may be the case, for example, if the legal basis for the use of other macroprudential

domestic-currency deposits or foreign-currency deposits scarcer depending on the specific application of this instrument. With higher reserve requirements in place, the cost of funding rises. Banks cannot lever up this funding to the same degree as previously, thus favoring other sources of funding. The return offered to depositors would be lower, which may reduce funding and lending. Restrictions on interbank exposures can lead to spillovers from or to banking systems and possibly have concentrated effects on banks that depend more on interbank funding. For global banks, restrictions also may constrain the scale of borrowing from related parties through internal capital markets, generating funding reallocations.

The IBRN analysis of international spillovers does not consider the *reasons* why policymakers vary prudential instruments. Macroprudential policies differ in intent from microprudential policies which aim at stabilizing individual financial institutions, differ from capital controls which target the cross-border movement of capital, and differ from monetary policy which targets a combination of macroeconomic goals such as low price inflation and full employment.[7] We focus on the prudential policy changes more broadly, regardless of whether stated as explicitly macroprudential or microprudential. Changes in interbank exposure limits may be triggered by microprudential concerns, whereas changes in LTV caps typically aim at preventing an overheating of the housing market and thus have a macroprudential motivation. For example, a prudential policy instrument like exposure limits applied to banks is intended to reduce risks due to the concentration of lending on the balance sheets of the targeted institutions. This policy may be effective at achieving those goals for domestic entities, while at the same time other foreign institutions pick up the customers squeezed from those institutions for which the exposure limits bind. If the intent of policy was microprudential, such a redistribution of activity may be the desired outcome: demand for credit is satisfied by reallocating borrowers to institutions with stronger capital ratios and more liquid assets which may have more capacity to safely engage in domestic

instruments is inadequate or if the institutional mechanisms to activate those instruments are comparatively restrictive.

[7]See the discussions of the standard Tinbergen assignment problem by Fischer (2011) and Obstfeld (2014).

lending. However, if the policy was implemented for macroprudential reasons, the spillover might be less desirable and can be interpreted as leakages that undermine the intent of the original policy. Likewise, if exposure limits constrain lending to particular domestic counterparts, institutions might shift activity to other economies or those counterparties unconstrained by the exposure limits. Such spillovers may not be attempts to circumvent regulation or even leakages, but instead are a result of an intended reallocation of bank activities.

3. Hypothesis Testing and Empirical Models

Fifteen IBRN country teams, as well as cross-country studies conducted by the BIS and ECB, examine whether bank lending responds to changes in prudential regulation, and whether these responses are shaped by characteristics of the banks or the state of the financial cycle.[8] For both dimensions—the lending response and the prudential instruments—we consider the home and the foreign markets. From figure 1, we consider four types of banks for each country pair ij: domestic banks in i that operate in i and not in j (but may lend cross-border); domestic banks in i that have affiliates in j; banks headquartered in j that have affiliates in i; and banks that operate in j and i but are headquartered in k. While the specific features of the data in the inward and outward transmission exercises determine some modeling choices, a number of specification features pertain to all models. In the methodological discussion, we focus specifically on the common empirical methods applied by country.

[8]The studies included in this IBRN initiative on the impact of prudential instrument changes on the activities of global banks include Auer, Ganarin, and Towbin (2017) for Switzerland; Avdjiev et al. (2017) using international data; Başkaya, Binici, and Kenç (2017) for Turkey; Berrospide et al. (2017) for the United States; Bonfim and Costa (2017) for Portugal; Bussière, Schmidt, and Vinas (2017) for France; Caccavaio, Carpinelli, and Marinelli (2017) for Italy; Damar and Mordel (2017) for Canada; Frost, de Haan, and van Horen (2017) for the Netherlands; Gajewski and Krzesicki (2017) for Poland; Hills et al. (2017) for the United Kingdom; Ho, Wong, and Tan (2017) for Hong Kong; Jara and Cabezas (2017) for Chile; Levin-Konigsberg et al. (2017) for Mexico; Nocciola, Żochowski and Franch (2016) using international data; Ohls, Pramor, and Tonzer (2017) for Germany; and Park and Lee (2017) for Korea.

3.1 General Specification Features

3.1.1 Dependent Variables

Bank lending as the key transmission channel running from banks to the real economy is the dependent variable. Using changes in loans as the dependent variable has the added advantage that loan data are readily available and relatively comparable across banks and countries. These data will be considered in comparable baseline specifications implemented by all country teams. The observations on the loan data accord with the perspective of the specification studied by the researcher, so they may represent domestic loans, cross-border loans, or local claims. If available, in their respective additional analysis some country teams have also used claims and more refined sectoral breakdowns of loans.[9]

Because we are interested in the responses of lending to *changes* in prudential instruments, the baseline model uses log changes in stocks as the dependent variable.[10] The advantage of using log changes is that the data are smoothed while conserving the ranking of the values. This approach implies that changes in prudential instruments may have temporary growth effects rather than permanent level effects, following the approach of Henry (2007) for changes in capital controls.

3.1.2 Prudential Instruments and Specifications

Prudential instruments could be introduced into the empirical specification simultaneously or individually, with lags, and as levels or in changes. Some instrument changes might have been implemented simultaneously, making it difficult to attribute possible effects to a *specific* instrument. Also, prudential instruments target different balance sheet items of banks and operate through different transmission

[9] These data have been used in many previous studies. For details, see the International Banking Library, hosted at the Halle Institute for Economic Research (http://www.bankinglibrary.com).

[10] In appendix 2, we describe the common methodology used for dealing with outliers. In addition, log changes of stocks do not inform about changes in loans relative to banks' balance sheets. Country teams thus use different scaling options in robustness exercises.

channels. In the baseline model, instruments are included in separate specifications and in one additional specification that simultaneously includes all instruments. Moreover, teams examine spillovers using an index *PruC* that captures the change of *any* regulation and which is conceptually more comparable to the approach in studies that utilized the lower-frequency (three-year survey) data of Barth, Caprio, and Levine (2013).

The international dimension of prudential regulations is captured in four ways (figure 1):

- Home (i.e., parent-bank) country regulation ($HomeP_{j,t}$): The home country is the country of the parent bank. For the outward transmission exercise, the home country is the country that conducts the study. Typically, regulation in the home country does not vary across banks. For the inward transmission case, the home country may vary across banks if the IBRN country hosts affiliates of foreign banks.
- Destination-country regulation ($DestP_{j,t}$): The destination country is the economy to which a loan has been granted. This is mainly relevant for the outward transmission case. This economy does not need to be the host country of the bank because cross-border loans are considered as well and those might be granted to third countries.
- Host-country regulation ($HomeP_{j,t}$): The host country is the country where the affiliate of a bank is hosted. This is relevant mainly for the inward transmission case. In this case, the host country is the IBRN country that conducts the study. Recall that the destination country and the host country might be different. In our previous example, a U.S. global bank owns a U.K. affiliate that lends to France and Germany. In this case, the United States is the home country, the United Kingdom is the host country, and France is the destination country.
- Foreign-exposure-weighted regulation ($ExpP_{b,t}$): Banks can be subject to regulations in several countries, and teams create a composite measure of such regulations. In the outward transmission through global banks exercise, teams weight regulations with the foreign exposures outside the home country

and destination countries.[11] For the inward transmission case, domestic global banks that are active in several foreign countries are exposed to the regulations of those countries. Teams weight regulations with the bank-specific foreign exposures outside the home country. The exposure weights are based on exposures over the previous four quarters. They are calculated based on the sum of foreign assets (on an immediate borrower basis) and liabilities in a given market.[12]

The spillover effects of prudential policy should depend on whether policies are applied at a consolidated or unconsolidated level. Most of the home prudential policies apply to the consolidated entity, to domestic parents and their foreign branches (consolidated or unconsolidated). Foreign bank subsidiaries are generally subject to host-country regulations. Regarding the foreign affiliates in the home country, the same logic applies. The spillover effects also depend on the type of regulation. For example, capital regulation is likely applied on a consolidated basis to domestic banks and to the domestic subsidiaries of foreign banks. Other instruments, including reserve requirements, may only apply to specific entities within the organization. Moreover, sectoral capital requirements likely will be country specific.

Tests for inward spillovers of foreign policy instruments take two broad formats, depending on whether through global bank foreign exposures or through hosted affiliates of foreign banks. Tests of outward spillovers of foreign policy instruments consider how global banks adjust total positions externally or how these global banks reallocate activity across foreign locations.

[11] These exposure-weighted prudential instruments share some similarities with price indexes in Melitz-type models (Melitz 2003), although we do not derive the indexes from an explicit optimization problem. Note that the weights can be considered exogenous as long as the patterns of banks' international activities are sufficiently persistent and do not vary at the same frequency as the prudential instruments.

[12] This summing of assets and liabilities follows the international trade and finance literature, in which openness to foreign trade is often measured through the sum of exports and imports (Leamer 1988). In some country cases, data availability constraints necessitate using variants of the recommended weighting approach.

Formally, log changes in the stock of (domestic) loans ($\Delta Y_{b,t}$) are linked to prudential changes, bank-level controls ($X_{b,t-1}$), and bank and time fixed effects (f_b, f_t):

$$\begin{aligned}\Delta Y_{b,t} = \alpha_0 &+ (\alpha_1 PP_{b,t} + \alpha_2 PP_{b,t-1} + \alpha_3 PP_{b,t-2}) + \alpha_4 X_{b,t-1} \\ &+ (\beta_1 PP_{b,t} \cdot X_{b,t-1} + \beta_2 PP_{b,t-1} \cdot X_{b,t-1} + \beta_3 PP_{b,t-2} \cdot X_{b,t-1}) \\ &+ f_b + f_t + \epsilon_{b,t}, \end{aligned} \tag{1}$$

where $PP_{b,t}$ is a policy measure appropriate for the international transmission exercise conducted. Time fixed effects capture changes in prudential instruments on the home market. Multiplying our interaction coefficients by the mean values of the corresponding balance sheet variables ($\bar{X}_{b,t-1}$), the F-test $\sum_{i=1}^{3}(\alpha_i + \beta_i \cdot \bar{X}_{b,t-1}) = 0$ considers whether the cumulative impact of regulations on lending growth over a time horizon of three quarters is statistically significant for the average bank.

An additional specification examined by teams allows for the effect of the foreign prudential instrument to vary over the home financial or business cycle. The resulting specification is

$$\begin{aligned}\Delta Y_{b,t} = \alpha_0 &+ \alpha_1 PP_{cum,b,t-1} + \alpha_2 X_{b,t-1} + \alpha_3 PP_{cum,b,t-1} \cdot Z_t \\ &+ f_b + f_t + \epsilon_{b,t}, \end{aligned} \tag{2}$$

where Z_t is the credit-to-GDP or output gap in the home market. In order to measure the effect of the financial cycle, we use a cumulative regulatory measure ($PP_{cum,b,t-1}$). Using mean values of our cycle variables ($\bar{Z}_{j,t}$), prudential instrument net effects on lending growth for the average bank are analogously defined as $(\alpha_1 + \alpha_3 \cdot \bar{Z}_{j,t})$ with a corresponding F-test of significance. Additional baseline specifications do not include interaction terms or include multiple prudential instruments simultaneously. A comprehensive discussion of the specific international transmission test and regression specifications is provided in appendix 1.

3.1.3 Identification

Identification of causal effects of policy instruments is helped by the use of micro- or bank-level data. The project exploits the joint effects

of two features of the data to facilitate identifying effects of policy instruments.

This first identification feature is that prudential instrument changes are considered exogenous for the individual bank behavior, as opposed to aggregate credit measures, and in a cross-country environment. In this sense, our models take a partial equilibrium perspective: decisions on changes in prudential instruments are assumed to not be driven by the specific individual banks. But assuming this exogeneity is not sufficient. If all banks in the same country were to face the same prudential instrument changes, then instrument changes and common shocks could not be identified separately. Prudential variables would thus be tantamount to country-time effects. Our identification strategy depends on *differences* in prudential instruments affecting banks domiciled in the *same* country. These differences arise when banks are active in different countries and have heterogeneous exposures.

The second feature is that business models of banks are heterogeneous so that banks are expected to respond to the same policy measure in different ways. Some banks conduct cross-border activities, others maintain branches and subsidiaries, and borrowing and lending patterns are differently concentrated across countries. Adjustment along the extensive margin, with exit and entry from locations, is assumed to take place with a much lower frequency than changes in the lending and prudential policies.

3.1.4 Other Specification Issues

Whenever appropriate, country teams include within empirical specifications bank, country, and time fixed effects to account for time-invariant heterogeneity at the bank and country level as well as common shocks affecting all banks in period t. As in Khwaja and Mian (2008), demand effects in country j can be captured by introducing borrower-time fixed effects to account for changes in credit demand.[13] While in the baseline specification clustering of residuals by country has been used, country teams have been advised to cluster as appropriate.

[13]Some papers follow a similar route but include country-time fixed effects instead. In this case, the country-level regulatory measure can be included in the interaction terms only.

4. Data and Descriptive Statistics

Section 4.1 provides a high-level overview of the patterns of use and changes in prudential instruments over time and across countries included in the IBRN Prudential Instruments Database. Section 4.2 introduces the specifics of the bank-level balance sheet data examined by country teams. Section 4.3 provides details on the other variables used in the specifications, including credit cycles, output gaps, and country characteristics.

4.1 Prudential Data

The IBRN and IMF collaboration, the Prudential Instruments Database, includes rich quarterly information on the announcement and implementation of policy changes for 2000 through 2014 for sixty-four countries, as described in in Cerutti et al. (2017). Seven prudential and regulatory instruments are included: general capital requirements, sector-specific capital requirements (split into real estate credit, consumer credit, and other), interbank exposure limits, concentration limits, loan-to-value ratio limits, and reserve requirements (in local and in foreign currency).[14] Generally, we do not explicitly distinguish whether prudential instruments have been activated for microprudential or macroprudential reasons, because the channels for generating cross-border spillovers are similar, regardless of the reason for instrument use.

For a tightening (loosening) of an instrument, the index is coded as 1 (–1) in the quarter when a change in the policy takes effect.[15] Indexes are presented in two ways. The first type of index records the *changes* in each quarter when a policy is modified, with a *zero*

[14]Information on capital controls is not included in the regulatory data set. This information currently is not available on a *quarterly* basis, as in Schindler (2009) and follow-up studies using the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions. In the IBRN studies, differences in capital controls across countries or variations over time are assumed to be absorbed in the country and time fixed effects.

[15]For some indexes, changes in a given quarter may be greater (lower) than 1 to account for the intensity in the change of the instrument that the index is capturing. For example, if a change in the reserve requirement in a quarter is double the change in the next quarter, this would be captured by a coding of 2 in the index for the first quarter and 1 in the second.

in those quarters when no change occurs. The second type of index is a *cumulative index*. In each quarter, the index is the sum, since the first quarter of 2000, of all changes in that policy instrument recorded prior to and during the quarter of interest. The purpose of this cumulative index is to capture the level of overall "tightness" change of an instrument at a given point in time. If a particular instrument has never been introduced in a given country, the raw data are set to zero. While some of the prudential instruments have information on the overall level (tightness), this information is not used in the analysis of the IBRN initiative because of difficulties of constructing useful metrics similarly defined across countries and over time.

Table 1 provides insights into the variation observed in the full database, by prudential instrument, for the years 2000 through 2014. The table provides counts of the number of countries that report a change in each instrument, the number of overall changes in the instrument, and the breakdown between tightening (>0) and loosening (<0) events. The left panel of the table provides this information across all sixty-four countries in the database out of a total of 3,840 country-time observations; the right panel shows incidence across six countries—Germany, France, Japan, Switzerland, the United Kingdom, and the United States—that have a number of large globally active banks. These countries are highlighted for their potential importance in generating international spillovers through prudential instrument changes.

Changes in general capital requirements and reserve requirements have been more relevant than changes in other instruments. For example, interbank exposure limits have been changed less frequently. In the right panel, only general capital requirements are well populated across these six countries and with multiple events; two countries changed reserve requirements on local-currency deposits and two countries changed interbank exposure limits.

Time-series variation in instruments also is important for the econometric exercise, since the instrument effects need to be separated from the time fixed effects used to control for omitted variables such as changes in aggregate demand. Instruments that have changes well distributed over time include concentration limits, loan-to-value ratios, reserve requirements, and sector-specific capital

Table 1. Variation of Prudential Instruments

Prudential Instrument	Full Sample				Restricted Sample			
	No. Countries	No. Changes	No. Tightening	No. Loosening	No. Countries	No. Changes	No. Tightening	No. Loosening
General Capital Requirements	55	100	100	0	6	12	12	0
Sector-Specific Capital Buffer	29	73	54	19	1	3	3	0
Loan-to-Value Ratio Limits	36	97	72	25	0	0	0	0
Reserve Requirements: Foreign	21	141	90	51	0	0	0	0
Reserve Requirements: Local	46	297	131	166	2	4	0	4
Interbank Exposure Limit	14	25	24	1	3	8	8	0
Concentration Ratio	22	34	32	2	1	4	4	0

Notes:. This table summarizes the changes in prudential instruments, based on the database which is described in more detail in Cerutti et al. (2017). The table gives the number of countries that changed regulations within the sample period (2000–14) and the number of such quarterly changes, broken down into policy tightening and loosening. The entries distinguish the total from a restricted sample including the United States, the United Kingdom, Japan, Germany, France, and Switzerland. The following are the sixty-four countries in the Prudential Instruments Database: Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, China, Colombia, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Kuwait, Latvia, Lebanon, Lithuania, Luxembourg, Malaysia, Malta, Mexico, Mongolia, Netherlands, New Zealand, Nigeria, Norway, Peru, Philippines, Poland, Portugal, Romania, Russia, Saudi Arabia, Serbia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, Ukraine, United Kingdom, United States, Uruguay, and Vietnam.

requirements. Capital requirement changes are concentrated over time. Nonetheless, although international agreements such as Basel II or Basel III set a common framework for these regulations, there is still a sufficiently high degree of variability with regard to the implementation and activation of instruments across countries to perform meaningful analyses.[16]

4.2 Balance Sheet Data for Banks

The data used by country teams are collected as part of financial supervision and regulatory reporting, with banks in each country providing confidential quarterly balance sheet data and data on international positions. The choice of bank-level characteristics in baseline empirical specifications is guided both by theoretical priors on which balance sheet and bank characteristics might matter for international transmission and by data availability.

The baseline specification's dependent variable ($Y_{b,t}$) is based on total loan data for the reporting bank or global bank affiliate as relevant for the international spillover examined. The balance sheet characteristics ($X_{b,t-1}$) included as explanatory variables capture the structure of banks' assets and liabilities, their profitability, and their degree of internationalization. Bank size is the log of total assets ($LogTotalAssets_{b,t-1}$); liquidity is measured as the fraction of a bank's portfolio of assets that is illiquid ($IlliquidAssetsRatio_{b,t-1}$); the deposit ratio is the fraction of the banking organization's balance sheet financed with core deposits ($CoreDeposits_{b,t-1}$); and the capital ratio is the banking organization's regulatory tier 1 risk-based capital-to-asset ratio ($Tier1Ratio_{b,t-1}$).[17] The bank's degree of internationalization is generally measured through the difference between "net due to" and "net due from" of the head office as a measure of internal capital market positions of the entity, relative to assets ($NetDueTF_{b,t-1}$), and by foreign assets plus foreign liabilities, relative to total assets plus total liabilities ($InternationalRatio_{b,t-1}$). More

[16] See Kalemli-Ozcan, Papaioannou, and Peydro (2013) for an overview of the timing of implementation of financial regulations across European countries.

[17] Ratios are in percent (multiplied by 100). Some country teams use the balance sheet ratio of equity over total assets instead of regulatory tier 1 capital.

detailed information regarding data preparation, including variable definitions and cleaning procedures, may be found in appendix 2.

4.3 Credit Cycles, Output Gaps, and Other Country Characteristics

To test for potential differences in prudential instrument effects over the (aggregate) credit cycle, some specifications include credit-to-GDP gap data. As in Drehmann, Borio, and Tsatsaronis (2011), the credit-to-GDP gap is defined as the difference of credit to GDP from its long-run trend in percentage points.[18] The credit component draws on total credit to the non-financial private sector available at the BIS.[19] If total credit is not available, data on domestic credit are taken from the IMF's International Financial Statistics. Financial cycles for the home country are included in the inward transmission models, and financial cycles for the host country are included in the outward transmission models. In addition, some specifications use domestic credit growth by country, with the time series on credit to the private non-financial sector available for a broader group of countries than the credit data, or output gap measures constructed following BIS methods (BIS 2014).

5. Do Prudential Policies Affect International Bank Lending?

Fifteen country teams studied a combination of inward and outward transmission exercises. Sections 5.1 and 5.2 summarize results only from the baseline models for inward and outward transmission implemented by countries. Individual country papers provide more detailed and nuanced analyses of inward and outward prudential

[18]Prior studies show that financial cycles can be key indicators of emerging risks (Borio 2012; Claessens, Kose, and Terrones 2011). As such, cyclical developments may ultimately be triggers for macroprudential policies such as the countercyclical capital buffer.

[19]This long-run time trend in turn is calculated with a one-sided Hodrick-Prescott filter using a smoothing factor of 400,000. Data by country are available as the BIS's long series on credit to the private non-financial sector: http://www.bis.org/statistics/credtopriv.htm, http://www.bis.org/statistics/credtopriv/documentation.pdf.

Table 2. Types of Specification by Country

	Inward Transmission of . . .		Outward Transmission of . . .	
	Exposure-Weighted Regulation	**Home Prudential Policy via Affiliates**	**Destination-Country Policy***	**Total**
Canada			✓	33
Chile	✓	✓		53
France			✓	35
Germany	✓	✓	✓	84
Hong Kong		✓		25
Italy			✓	32
Mexico	✓	✓		52
Netherlands			✓	35
Poland		✓		28
Portugal	✓	✓		49
South Korea		✓		35
Switzerland	✓			24
Turkey	✓	✓		48
United Kingdom	✓	✓		56
United States	✓	✓	✓	86
Total	199	281	195	675

Notes: This table summarizes the transmission channels studied by particular country teams, along with the total number of regressions by country (row) and channel (column). The specifications differ in transmission channel (exposure-weighted inward transmission, inward transmission of home policy via affiliates, outward transmission) and in the inclusion of bank variable interactions and business and financial cycles. *The outward transmission channel looks primarily at effects on lending from destination-country policy. Third-country exposure-weighted effects are included in addition to destination-country policy in one exercise.

policy transmission through bank lending. Cross-country analyses conducted by the BIS and ECB provide additional insights.

5.1 Which Transmission Channels and Instruments Have Been Analyzed?

The international spillover exercises explored by the country teams are summarized in table 2. Eleven of the fifteen countries study inward transmission of foreign prudential policy changes. Eight countries explore inward transmission through their own global

banks that maintain foreign operations. Ten countries consider transmission into their country through the operations of the affiliates of hosted foreign banks. The next column shows that six of the fifteen countries study external adjustments in lending by their own global banks, i.e., the outward transmission channel. Among these, most specifications address the effects of foreign prudential policies on the external lending of global banks. A smaller number of specifications explore foreign lending reallocation through global banks via cross-border flows and foreign affiliates. As country teams focus only on those prudential instruments that show sufficient variation and on specific transmission channels, the total number of empirical specifications by channel thus differs across countries.

5.2 Meta-Analysis of the Fifteen Country Studies

We perform a meta-analysis to extract relevant and robust lessons on international spillovers from the fifteen country studies. Meta-analyses summarize the key outcomes of empirical exercises, and then explore which features of an empirical model are drivers of different empirical outcomes. A strength of the approach is that the empirical studies we summarize are designed to be homogenous, by using the same baseline regression model and variable definitions. Moreover, by summarizing the results of all the analyses, we are not subject to criticisms of publication biases that can affect meta-analyses that draw on only published research. By design, as we seek robust lessons on international spillovers, we use conservative criteria for significance.

Our measure of statistical significance is the 10 percent significance of the summed effect on lending growth over linear combinations of all regression terms that include each specific prudential instrument. For example, in exercises that introduce prudential instrument interactions with bank balance sheet characteristics, the relevant test result reported is over $\sum_{i=1}^{3}(\alpha_i + \beta_i \cdot \bar{X}_{b,t-1})$ and $(\alpha_1 + \beta_1 \cdot \bar{X}_{b,t-1})$, which utilizes the mean level of each balance sheet characteristic for the banking entities in each regression sample. In specifications in which there are interactions of the prudential instrument with business or financial cycles, the relevant metric for an effect on lending growth is the test result over the

sum $(\alpha_1 + \alpha_3 \cdot \bar{Z}_{j,t})$ or $(\alpha_1 + \alpha_4 \cdot \bar{Z}_{j,t})$. This type of test requiring the summed net effect of a prudential measure on lending is a more conservative threshold for significance than a test of statistical significance at any single quarter. As a conservative threshold, the exercise will tend to provide a lower bound on the incidence of international spillovers of prudential policies through bank lending. As exposited within the country papers, teams frequently observe statistically significant international spillovers when not netting over three quarters.

Table 3 shows the number of regression specifications and number of countries by prudential instrument and exercise that are used in the meta-analysis. The largest numbers of regression specifications across the collection of studies are for inward transmission of home prudential policies into host markets through hosted affiliates of global banks. Ten countries explore the spillover effects of changes in general capital requirements, sector-specific capital buffers, loan-to-value ratios, and local reserve requirements. Fewer countries examine inward spillovers through hosted bank affiliates of the changes in foreign reserve requirements, interbank exposure limits, or concentration ratios. Eight countries examine inward transmission of foreign policies through the exposures of their own global banks. Six countries examine how their global banks reallocate lending internationally when foreign affiliate locations have changes in respective prudential instruments.

5.2.1 What Is the Direction of Prudential Instrument Spillovers through Global Banks?

Table 4 considers the sign pattern of significant international spillovers, showing—by specific prudential instrument (rows) and by transmission channel—the share of empirical specifications that register statistically insignificant spillovers (column a), positively signed significant spillovers (column b), and negatively signed significant spillovers (column c). "Positive" spillovers indicate that a tightening of a prudential measure in one location is associated with an *increase* in lending growth in another location. As baseline studies do not consider asymmetric effects of prudential policy tightening or loosening, the discussion of results assumes symmetry in spillovers even as the actual language of our discussion refers to tightening.

Table 3. Counts of Countries and Models Included in the Meta-Analysis

	Total Number		Inward Transmission of . . .				Outward Transmission of . . .	
			Exposure-Weighted Regulation		Home Policy via Affiliates		Destination-Country Policy*	
	No. Countries	No. Models	No. Countries	No. Models	No. Countries	No. Models	No. Countries	No. Models
General Capital Requirements	15	113	8	32	10	51	6	30
Sector-Specific Capital Buffer	15	110	8	32	10	48	6	30
Loan-to-Value Ratio Limits	15	110	8	32	10	49	6	29
Reserve Requirements: Foreign	12	76	7	27	4	19	6	30
Reserve Requirements: Local	14	106	7	28	10	48	6	30
Interbank Exposure Limit	12	68	5	20	6	25	5	23
Concentration Ratio	14	92	7	28	9	41	5	23

Notes: This table summarizes the number of countries and regression specifications for each combination of prudential instrument (rows) and channel (columns), preceded by the number of regressions reported in total across all channels. The specifications differ in transmission channel (exposure-weighted inward transmission, inward transmission of home policy via affiliates, outward transmission) and in the inclusion of bank variable interactions and business and financial cycles. Countries included are Canada, Chile, France, Germany, Hong Kong, Italy, South Korea, Mexico, Netherlands, Poland, Portugal, Switzerland, Turkey, the United Kingdom, and the United States. *The outward transmission channel looks primarily at effects on lending from destination-country policy. Third-country exposure-weighted effects are included in addition to destination-country policy in one exercise.

Table 4. Effects of Prudential Instruments on Lending Growth

	Inward Transmission of . . .						Outward Transmission of . . .		
	Exposure-Weighted Regulation			Home Policy via Affiliates			Destination-Country Policy*		
	(a) **0**	(b) +	(c) −	(a) **0**	(b) +	(c) −	(a) **0**	(b) +	(c) −
General Capital Requirements	75	19	6	92	0	8	70	23	7
Sector-Specific Capital Buffer	94	6	0	73	15	13	77	20	3
Loan-to-Value Ratio Limits	72	19	9	69	18	12	93	7	0
Reserve Requirements: Foreign	74	15	11	74	11	16	67	27	7
Reserve Requirements: Local	89	4	7	75	19	6	33	47	20
Interbank Exposure Limit	80	5	15	76	8	16	70	4	26
Concentration Ratio	79	11	11	66	22	12	87	9	4

Notes: This table details—by instrument, channel, and sign—the percentage of prudential instrument net effects significant at the 10 percent level. Net effects are calculated as the sum of all instrument coefficients in a given regression, multiplying interaction coefficients by the mean of their interacted control. $0 \equiv$ insignificant, $+ \equiv$ positive, and $- \equiv$ negative. An F-test is used to test whether this linear combination of coefficients is non-zero. *For the outward transmission exercise in which both destination-country and third-country exposure-weighted policy instruments were considered simultaneously, if either of these two current-lagged coefficient sums were statistically significant, the net effect for this regression is considered significant.

Examination of table 4 shows that the majority of these baseline regression specifications do *not* exhibit statistically significant international spillovers of prudential instruments. For example, when foreign general capital requirements are adjusted, the domestic lending of home global banks with affiliates in foreign locations does not significantly change in 75 percent of the specifications examined across country teams. However, significant international spillovers of this instrument are still often observed.[20] In the specifications covering home global banks, when foreign capital requirements tighten, these banks significantly increase domestic lending growth in 19 percent of cases (column b) and reduce domestic loan growth in the remaining 6 percent of cases (column c). Similar patterns are observed in the outward spillovers of these policies.

The last columns of table 4 show that global banks reallocate lending externally when local reserve requirements change. Foreign reserve requirement tightening on local deposits is more often associated with global bank expansion of lending growth abroad than with lending growth contractions. While the literature reviewed in section 2.1 tended to find that lending declines when regulations tighten, this evidence drawn from a broad sample of countries using micro-banking data shows a mixed pattern of responses to most policy instruments. Interestingly, the columns summarizing inward transmission of policy through hosted affiliates of foreign banks show that general capital requirements are least likely to be associated with significant inward lending transmission, while home reserve requirements, LTV caps, and concentration limits have significant spillovers into host loan growth in one-quarter to one-third of the regression specifications.

Table 5 complements these results by showing which countries' experiences drive the patterns of significant instrument spillovers just described. When foreign countries tightened general capital requirements, positive spillovers to home loan growth by global banks were observed across U.S., German, and Chilean banks, while

[20]This significance is beyond the level that likely could be attributed to type I errors: under the hypothesis of "no spillovers," about 10 percent of specifications are expected to be significant at the 10 percent level.

Table 5. Country Breakdown of Prudential Instrument Significance by Instrument and Channel

	Inward Transmission of . . .						Outward Transmission of . . .		
	Exposure-Weighted Regulation			Home Policy via Affiliates			Destination-Country Policy*		
Prudential Instrument	**(a) 0**	**(b) +**	**(c) −**	**(a) 0**	**(b) +**	**(c) −**	**(a) 0**	**(b) +**	**(c) −**
General Capital Requirements	MX, PT, TR	CL, DE, US	CH, UK	CL, DE, KR, MX, TR, UK, US		HK, PL, PT	FR, IT	CA, NL, US	DE, US
Sector-Specific Capital Buffer	CH, CL, DE, TR, UK, US	MX, PT		MX, PL, UK	CL, PT, TR, US	DE, HK, KR, TR	DE	CA, FR, IT, NL	US
Loan-to-Value Ratio Limits	CL, UK, US	CH, DE, TR	MX, PT	CL, KR, MX, PL	PT, TR, UK, US	DE, HK, TR	CA, DE, FR, US	IT, NL	
Reserve Requirements: Foreign	CH, US	CL, PT, UK	DE, MX	UK	CL, DE	KR	DE	CA, FR, IT, NL	NL, US
Reserve Requirements: Local	CL, DE, MX, US	UK	PT, TR	CL, UK	DE, HK, PL, PT, TR, US	HK, KR, MX		CA, FR, IT, NL	DE, US
Interbank Exposure Limit	UK	TR	CH, MX, US	HK, PL, UK	MX, TR	KR, TR	CA, IT, US	NL	FR, NL
Concentration Ratio	CH, CL, DE	MX, PT, TR	MX, UK	HK, PL	CL, DE, PT, TR	KR, MX, UK	CA, DE	FR, IT	NL

Notes:. This table reports the *country teams* which found a 10 percent significant net effect on lending by instrument, channel, and sign, adding a country dimension to the results of table 4. Also reported are countries that ran exercises for a given instrument and channel, but that found no significant net effects. 0 ≡ insignificant, + ≡ positive, and − ≡ negative. Note that it is possible for a country to find both positive and negative net effects across exercises within a channel, and to therefore appear in both columns b and c. Countries included are Canada (CA), Chile (CL), France (FR), Germany (DE), Hong Kong (HK), Italy (IT), South Korea (KR), Mexico (MX), Netherlands (NL), Poland (PL), Portugal (PT), Switzerland (CH), Turkey (TR), the United Kingdom (UK), and the United States (US). *For the outward transmission exercise in which both destination-country and third-country exposure-weighted policy instruments were considered simultaneously, if either of these two current-lagged coefficient sums were statistically significant, the net effect for this regression is considered significant.

German global banks had significantly reduced loan growth outwardly and U.S. global banks had mixed directional effects depending on the regression specification. Negative inward spillovers were observed for U.K. and Swiss global banks. The German global banks also expanded home loan growth when foreign loan-to-value limits tightened, without significant outward transmission from the LTV ratios. Tighter local reserve requirements influenced outward transmission by global banks in all of the countries that studied this channel. Global banks from Canada, France, Italy, and the Netherlands increased lending growth externally, while U.S. and German banks contracted loan growth abroad without increasing loan growth back home. This directional heterogeneity, with the incidence differing across instruments and transmission channels, is important for understanding the intended and unintended effects for a range of prudential instruments.

All country teams tested to see whether bank-level balance sheet characteristics were important drivers of identified heterogeneity in the international spillovers through the respective channels. Table 6 summarizes which countries identified a significant role for particular balance sheet characteristics. In inward transmission of general capital requirements by global banks into domestic loan growth, core deposit ratios of banks were important for four countries; net due ratios and tier 1 capital ratios were important features in transmission through hosted affiliates of foreign banks. Within a country, heterogeneity in loan growth spillovers from the loan-to-value ratio changes in the home countries of hosted foreign banks were often associated with bank-specific illiquid asset ratios, asset size, and core deposit ratios. Tier 1 capital ratios also differentiated global banks in the spillover of exposure-weighted reserve requirements on foreign deposits and concentration ratios into domestic lending growth. Overall, these findings are consistent with the prior that a tightening of prudential regulations induces a reallocation of market shares away from weaker banks toward banks with stronger balance sheets. Changes of prudential instruments therefore are observed to have influence on the global pattern of international lending, with potential implications for competition, bank-level risk, and financial stability.

Table 6. Heterogeneity of Effects across Banks by Instrument, Channel, and Balance Sheet Characteristic

	Countries with Significant Heterogeneity by Bank Characteristic														
	Inward Transmission of . . .										Outward Transmission of . . .				
	Exposure-Weighted Regulation					Home Policy via Affiliates					Destination-Country Policy*				
	Total Assets	Tier 1	Illiquid Assets†	Net Due†	Core Deposits	Total Assets	Tier 1	Illiquid Assets†	Net Due†	Core Deposits	Total Assets	Tier 1	Illiquid Assets†	Net Due†	Core Deposits
General Capital Requirements	CL, PT, TR	CL, PT	CH, TR	PT	CH, PT, UK, US	HK, KR	CL, HK, US	CL, PL	DE, PL, PT, US	CL	DE, FR	DE, US	FR		
Sector-Specific Capital Buffer		UK	PT, US		PT	TR	HK, KR, US	DE, KR, PT, UK, US	KR	DE, KR, UK	DE, IT	NL		CA	CA, NL
Loan-to-Value Ratio Limits	CH, CL, PT	CL, MX		PT	CL, PT	HK, KR, TR, US	HK, PT, UK	CL, HK, MX, PL, PT, UK	DE, PT	DE, HK, KR, MX, PT,TR	CA	NL	CA	DE	NL
Reserve Requirements: Foreign‡	MX, PT	CH, DE, MX, PT	PT, UK	CL, DE, PT	US	KR, UK	UK			KR, UK	NL, US	CA, NL, US	DE		DE, US
Reserve Requirements: Local‡	TR	TR	DE, TR	CL	US	DE, KR, TR	DE, KR	DE, HK, PL	HK, US	HK, KR, TR	US	CA, NL	CA, DE	DE	
Interbank Exposure Limit‡		TR	TR, US	US	TR, UK	KR, TR	KR	KR, PL, TR	HK, KR	KR, TR	CA, NL		FR	CA, FR	
Concentration Ratio‡	CL, MX	DE, MX, PT, TR	PT, TR	DE	CL, MX, PT	HK, MX, TR	MX, TR	MX, PT, TR	PL, PT	DE, MX, PT	IT, NL	NL	CA		CA, IT
Countries Reporting	CH, CL, DE, MX, PT, TR, UK, US					CL, DE, HK, KR, MX, PL, PT, TR, UK, US					CA, DE, FR, IT, NL, US				

Notes: This table shows the countries that found particular balance sheet characteristics to be important in differentiating the impacts of prudential regulations on bank lending growth, defined as having found instrument-bank interaction sums ($\beta_1 + \beta_2 + \beta_3$) to be significant at the 10 percent level using an F-test. Countries included are Canada (CA), Chile (CL), France (FR), Germany (DE), Hong Kong (HK), Italy (IT), South Korea (KR), Mexico (MX), Netherlands (NL), Poland (PL), Portugal (PT), Switzerland (CH), Turkey (TR), the United Kingdom (UK), and the United States (US). All countries running a bank interaction regression in a given channel are listed in the final row, with the following exceptions: †Due to data availability, CH, IT, MX, NL, TR, and the U.K. do not include net due variables, while NL also does not include an illiquid assets ratio. ‡Due to insufficient variation, foreign reserve requirements are excluded by TR, local reserve requirements by CH, concentration ratios by US, and interbank exposure limits by CL, DE, and PT in all channels. In the via affiliates channel, foreign reserve requirements are similarly excluded by HK, MX, PL, PT, TR, and US, with interbank exposure limits also excluded by US in this channel.

5.2.2 Which Specification Features Drive the Likelihood of Observing International Spillovers?

As a complement to these summary tables, we perform a formal meta-analysis using probit regressions to explore which spillover regression features and data sample characteristics are associated with a higher or lower likelihood of significant international spillovers for each prudential instrument. These probit regressions consider whether the likelihood of identifying a significant spillover varies across advanced and emerging markets;[21] across the type of prudential transmission exercise (inward spillovers through hosted affiliates versus through global banks, versus outward through global banks); across specifications that include only recent changes in prudential instruments versus including cumulative changes; or across transmission specifications that include versus exclude bank-specific balance sheet characteristics, that control for financial and business cycles, or that simultaneously introduce the effects of multiple prudential instruments.[22] The dummy variable is *PP*bank* for models with interactions between the prudential policy instrument and bank-specific balance sheet characteristics, and *PP*cycle* for models with interactions with cycle indicators and including cumulative policy changes. Finally, the specifications include a continuous variable reflecting the percent of instrument changes that represent tightenings as opposed to loosenings; the specifications also include the share of foreign banks in the banking system studied, which may matter for the aggregated transmission of spillovers through foreign banks and for market share considerations. The dummy variables are further described in appendix 2.

[21] An emerging market dummy captures potential differences in spillovers between emerging market and advanced economies, although emerging markets only explored inward transmission exercises.

[22] A dummy indicating whether all prudential instruments are included in the specification simultaneously, versus one at a time, is potentially important, as the simultaneous instrument specifications reduce the degrees of freedom in the regressions and may raise the difficulty of identifying a significant set of regression coefficients. However, such specifications avoid omitted variable bias that might occur when prudential instruments are changed by a country at the same time, potentially causing a single instrument to mistakenly pick up the effect of another instrument not included.

Each row of table 7 represents an individual probit regression.[23] Three probit regressions are presented for each prudential instrument. The "All" row has the dependent variable take the value of 1 if a specification reported by a country team indicates a statistically significant international spillover of the prudential instrument, where significance is defined as summed over three quarters and at the 10 percent level. The "Positive" row keeps a value of 1 only if the prudential instrument tightening is associated with spillovers of stronger loan growth externally. The "Negative" row explores whether prudential instrument tightening is associated with reduced international loan growth. The columns of the table show the roles of the respective specification or country characteristics in differentiating the probability of significance relative to the base case of the probit. The base case is the probability of a significant effect of the prudential instrument on lending growth for an advanced economy through hosted affiliates of foreign banks, in a specification that includes only one prudential instrument and without cycle or bank-characteristic interactions. The rightmost columns of table 7 provide the total number of regression observations by instrument and the pseudo-R^2 of the specification. The pseudo-R^2 indicates the relative power of the full group of right-hand-side variables in describing the pattern of observed significant spillovers of the respective prudential instruments into lending.

From table 7, observe that countries classified as emerging markets (Mexico, Poland, Chile, Turkey) have a lower probability of significant inward transmission of foreign prudential policies, except for inward spillovers of interbank exposure limits and concentration ratios, where the probability is higher. For these latter two instruments, inward transmission through hosted foreign affiliates is more likely to be associated with spillovers than transmission through global banks. The columns for inward transmission through global banks and for outward transmission together show that the probability of tighter general capital requirements being associated with higher international lending growth is greater for global banks

[23] While table 7 compares probits on any significance versus by sign of significance, other probits have been explored using different weighting approaches applied to regression observations (for example, country weights, banking system size weights). Results are available on request.

Table 7. Probit Regression Analysis of Significance by Prudential Instrument

	Direction of Significance	Emerging Market	Inward Exposure Weighted	Outward Transmission	PP*Cycle Indicator	PP*Bank Indicator	All PP Indicator	% Tightening	% Foreign Bank Ownership	Obs.	R^2
General Capital Requirements	(All)	−0.64	1.25**	2.24***	0.23	−0.18	−0.20	0.02**	0.03***	113	0.22
	(Positive)	−0.04	7.84***	9.65***	0.05	−0.32	0.29	0.02	0.02	113	0.36
	(Negative)	−0.92***	0.26	0.16	0.23	−0.07	−4.89***	0.01	0.03***	113	0.21
Sector-Specific Capital Buffer	(All)	−0.49**	−0.95**	0.12	−0.62	−0.06	−0.92**	0.03**	−0.01**	110	0.16
	(Positive)	−0.25	−0.48	0.52	−0.58	−0.11	−0.96**	0.02	−0.01	110	0.11
	(Negative)	−0.86	−5.05***	−0.51	−0.29	0.07	−0.36	0.03	−0.01	110	0.21
Loan-to-Value Ratio Limits	(All)	−0.17	−0.21	−0.99	−0.09	0.43	0.43	−0.00	−0.02	110	0.12
	(Positive)	−0.17	−0.03	−0.54	0.29	0.23	0.48	−0.01	−0.01	110	0.08
	(Negative)	0.03	−0.13	−5.20***	−4.88***	0.61	0.16	0.06**	−0.02	110	0.31
Reserve Requirements: Foreign	(All)	−0.19	0.49	1.03*	−0.42	−0.44	−0.47	0.02**	−0.01	76	0.08
	(Positive)	0.10	0.22	0.92***	−0.20	−0.31	−1.05**	−0.01	−0.01	76	0.10
	(Negative)	−5.34	12.40	12.37	−0.67	−0.67	0.45	0.38	−0.01	76	0.38
Reserve Requirements: Local	(All)	−0.06	−0.45	1.20***	−0.33	−0.60	−0.32	−0.00	0.01*	106	0.21
	(Positive)	−0.71	−0.90*	1.51**	−0.45	−1.04**	−0.20	−0.01	0.02*	106	0.25
	(Negative)	0.59	0.16	−0.64	0.18	−0.18	−0.60*	0.01	−0.00	106	0.17
Interbank Exposure Limit	(All)	1.87***	−0.43	1.15	−1.14*	0.13	0.69	−0.05***	−0.07***	68	0.36
	(Positive)†	17.42	−11.78	81.82	−4.91	−6.03*	52.92***	1.17***		68	0.91
	(Negative)	1.28**	−0.20	0.27	−0.89	0.18	−0.31	−0.05***	−0.06**	68	0.24
Concentration Ratio	(All)	0.08	−0.50	−0.35	0.28	0.06	0.88***	−0.00	−0.00	92	0.10
	(Positive)	0.76*	−0.62	0.51	0.97*	0.54	0.62	−0.00	−0.03**	92	0.25
	(Negative	−0.44	−0.04	−2.94*	−5.25***	−0.67***	0.95**	−0.05*	0.02	92	0.37

Notes: This table shows the features of regressions yielding significant impacts of prudential regulations on bank lending. The cells of the table present probit regression coefficients, produced separately by prudential instrument and net effect direction (rows). The dependent variable in each probit is an indicator variable for whether the prudential instrument net effect associated with a regression was significant at the 10 percent level. In the latter two rows for each instrument, this net effect is further required to be *positively* or *negatively* significant, respectively. This indicator is regressed on the characteristics of the country running this exercise, along with indicator variables detailing the specifications of this exercise (columns). The rightmost rows of the table show the number of regression coefficients considered in each respective probit, as well as the pseudo-R^2 of the specification. Explanatory variables are defined in the appendix. Standard errors are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively. †Due to unstable coefficient estimates in the full model, % foreign bank ownership was dropped as a control in the analysis of positively significant interbank exposure limit effects.

than for hosted foreign affiliates. Global banks are more likely to be associated with declines in loan growth internationally from foreign tightening of loan-to-value limits and concentration ratio limits.

The table column for the *PP*cycle* indicator shows that this variable is usually insignificant or significant and negative in sign. The interpretation of this finding is that country teams did not have a higher probability of finding significant international spillovers in specifications that consider cumulative tightening or loosening of instruments, or in which these effects were interacted with the state of the financial cycle or business cycle. This is an interesting result, as prudential limits might be expected to bind more and spill over to a greater degree at times when the banks are more extended through the financial cycle. Of course, as the sample period of the underlying analysis in general was short (2000 through 2014), increased experience with prudential instruments over multiple cycles would make this observation more robust.

The table column for the *PP*bank* indicator considers whether the specifications that include interactions between prudential measures and bank-specific balance sheet characteristics have higher or lower probability of finding significant international spillovers. While it was observed (table 6) that bank-specific balance sheet characteristics are important in the cross-sectional responses of banks to prudential instrument changes, in general such characteristics did not raise the probability of finding international spillovers. This inclusion reduces the degrees of freedom in the regressions and may raise the difficulty of identifying a significant set of regression coefficients, possibly explaining some of the negative coefficients observed in the associated column within table 7. The specifications that simultaneously include all prudential instruments, indicated by *All PP*, likewise can reduce the degrees of freedom in the regressions while helping identify the role of a particular instrument, especially when other instruments have also been changing and could elicit the international spillovers. This type of specification increases the probability of finding significant spillovers from concentration ratios, and lowers the probability of some of the specific directional findings from other instruments.

Finally, the probits consider whether those regression specifications that had more unidirectional changes in direction for an

instrument were more likely to be able to identify the international spillovers from that instrument. This finding is supported in the case of general and sector-specific capital requirements, and for foreign reserve requirements. Foreign ownership share in the local banking system, the last column of the table, did not systematically change the direction or likelihood of spillovers in some robust way across all prudential instruments.

5.3 What Other Broad Observations Arise from the IBRN Studies?

So far, we have summarized results from the baseline regression that were designed for maximal comparability across countries and the meta-analysis. These key findings are set against a high threshold for identifying consistent effects across transmission exercises. The common baseline model did not consider the specificities that were clearly identified in more idiosyncratic explorations present in the broader range of country studies of the full IBRN initiative. Beyond these baselines, individual country papers and cross-country papers (without micro-banking data) provide more in-depth and nuanced analyses that generate additional insights on international spillovers of prudential instruments. While the reader is referred to those studies, here we highlight examples of some additional findings from across those papers.

Two countries—Germany and the United States—analyze both *inward and outward transmission* of prudential policies through loan growth of global banks, and contrast inward transmission through domestic global banks and hosted foreign affiliates (Berrospide et al. 2017; Ohls, Pramor, and Tonzer 2017). When foreign capital requirements tightened, in both cases global banks expanded loan growth at home. German global banks tended to contract loan growth externally, while U.S. bank directions of outward transmission depended on the regression specifications studied. Interestingly, neither the United States nor Germany experienced significant changes in domestic lending by their hosted affiliates of related foreign banks when parent-country capital requirements tightened. Global banks from both countries contracted foreign loan growth in localities that raised local reserve requirements, while not changing lending back at home. Foreign changes in loan-to-value ratios and

concentrations ratios did not lead to significant outward retrenchment in loan growth by the respective global banks.

A few of the country studies suggest that market share repositioning across global and domestic banks may be a significant implication of prudential instruments changes. The *outward transmission* channel analyzed by Canada, France, Italy, and the Netherlands confirms a positive prudential spillover effect: as prudential instruments tightened, foreign lending growth tended to increase (Bussière, Schmidt, and Vinas 2017; Caccavaio, Carpinelli, and Marinelli 2017; Damar and Mordel 2017; Frost, de Haan, and van Horen 2017). This finding is consistent with foreign banks acquiring market share during a country's tightening episode, either because they are not directly affected by the tighter regulations or because the regulations are less binding. For example, well-capitalized banks may have been poised to expand their international presence when other countries increased capital ratios and constrained the activities of their own local firms. Some of the positioning and tendencies might be sensitive to the organizational form of country global bank exposures to foreign locations.

German and Italian teams also explored differences in prudential spillover responses across *branches versus subsidiaries* of foreign banks. Outward lending by hosted subsidiaries of foreign banks in Germany was rather unresponsive to changes in prudential instruments affecting parent banks, whereas cross-border lending and lending by hosted branches reacted more strongly to changes in regulations. In the case of Italy, inward transmission through hosted branches was observed specifically in response to changes in local reserve requirements and sector-specific capital buffers.

Some of the studies by teams also underscore how the unit of observation—total loans—of the baseline work used in the meta-analysis is likely to understate some important international spillovers of prudential policies. For example, results for the United Kingdom emphasize the importance of using sectorally disaggregated data (Hills et al. 2017). As an illustration, tightening in LTV ratios in the home market of parents outside the United Kingdom leads to an increase in lending to private non-financials and households in the United Kingdom. When the home country tightens foreign reserve requirements, lending to both financials and private non-financials decreases.

Other considerations that are potentially important for detecting significant spillovers are other policy measures such as capital controls, more of a focus on regional linkages, and asymmetric effects of tighter or looser policies. In Korea, inward spillover effects were viewed as relatively weak because foreign banks are not very active on the retail market and because regulations of cross-border *capital flows* matter (Park and Lee 2017). Accounting for the intensity of *bilateral linkages* by, for example, using weighted regressions was found to be a better measure of the economic effects of spillovers in the study by Mexico. When the main banks from the United States and Canada were explored, the Mexico analysis picked up more significant spillovers of prudential policies into domestic retail lending (Levin-Konigsberg et al. 2017).

The econometric methods that assume the tightening and loosening episodes have symmetric effects on loan growth may be inappropriate in the future for some instruments. Symmetric effects would not be expected for instruments like capital requirements, which were exclusively tightening episodes in the period studied, or sector-specific capital buffers, which exhibited both tightening and loosening episodes. When the Netherlands considered such *asymmetries,* they concluded that Dutch banks increased lending in countries that tightened prudential regulation and decreased lending when regulation is relaxed, but to different degrees. The effects were more significant in larger banks, in lending to advanced economies, and in the post-crisis period.

Reinforcing how the common empirical approach will not pick up all potential international spillovers, the United States also provided a difference-in-difference analysis of the international lending done by two types of U.S. global banks: those banks subject to or not subject to the Comprehensive Capital Analysis and Review (CCAR). This type of review was applied to systemically important institutions. The loan growth comparison across global banks showed that the affected banks subject to enhanced capital analysis reduced loan growth to foreign residents relative to the loan growth of the comparison group. The magnitude of difference in loan growth effects depended on the balance sheet characteristics of the banks, again reinforcing our broader observation of heterogeneity in the effects of prudential instruments across banks, and vis-à-vis international counterparties.

An additional scope for international spillovers of prudential instruments comes from expanding the analysis beyond just the lending of banks, and taking into account the *funding side* of bank balance sheets. Turkey finds that prudential spillovers occur both on lending and borrowing (Başkaya, Binici, and Kenç 2017): prudential tightening abroad led to higher cross-border borrowing by banks in Turkey for the case of lower LTV limits.

Finally, while the individual country studies provide many advantages in terms of identification of effects and heterogeneity of responses to prudential instruments, they do not provide a full view of the reallocation of international financial flows through banks in response to prudential policies. This latter goal is accomplished in the *cross-country analysis* using country aggregates by Avdjiev et al. (2017) from the BIS, which uses panel data for banks from sixteen home countries active in fifty-three destination countries. Among the seven instruments analyzed, loan-to-value limits and local-currency reserve requirements have the most significant impact on international bank lending. The estimated international spillovers of the prudential tightening tend to be positive, so that tightening in one country is more likely to be associated with expanded loan growth elsewhere. Analysis of cross-country propagation in the euro area through 248 banks from sixteen euro-area countries by Nocciola, Żochowski, and Franch (2016) of the ECB conclude that inward spillovers of foreign prudential policies were present. Generally, instruments directed to specific borrowers, such as loan-to-value limits or sector-specific requirements, were most prone to spillovers, while the tightening of *capital requirements* tended to be associated with a decrease in lending.

Balance sheet characteristics of banking systems sometimes influenced the magnitudes of spillovers. Consistent with the country studies that suggested the potential for market share reallocations in response to changes in prudential regulations, the BIS team cross-country work found that better-capitalized banking systems, those with more liquid assets, and those less reliant on core deposit funding had stronger loan growth externally when prudential instruments were more restricted at home—for example, from tighter loan-to-value ratios. The BIS team found that institution-based prudential instruments (capital requirements or local-currency reserve requirements) affected more the local lending of foreign affiliates, whereas

activity-based instruments (loan-to-value ratios) primarily affected cross-border lending. Bank characteristics such as size, capitalization, and liquidity play a role in determining the magnitude of cross-border spillovers.

6. Summary

Macroprudential policies have been established as a key line of defense in preventing and mitigating the consequences of systemic financial crises. In recent years, the legal framework for macroprudential policy instruments has been defined, institutions have been further tasked with the surveillance and regulation of financial stability risks, and terms for applying macroprudential policy tools and for monitoring consequences have been specified. Given the urgency of addressing financial stability risks, policymakers moved forward with this toolbox before having comprehensive empirical and theoretical evidence on the expected effects, on possible spillovers, and on the effectiveness of macroprudential policies.

This paper and the overall IBRN initiative provide evidence relevant for discussion of the international spillover effects of prudential policies used in a broad set of countries. The use of a common research methodology allows for comparability of results across countries and for drawing lessons from those country studies. Overall, the results of this prudential spillover work demonstrate the importance of incorporating considerations on the international spillovers of prudential instruments into discussions and frameworks around macroprudential policy, including the role and potential for reciprocity.

Key findings are, first, that prudential instruments spill over across borders through international bank lending. The sign of spillovers onto lending can be positive or negative, indicating that different constraints are binding for different types of banks and that banks substitute between different types of activities. Second, bank balance sheet conditions and business models in fact affect the intensity of spillovers. Evidence from some countries suggests that some global banks with strong balance sheets responded to tightening foreign regulations by expanding their market shares abroad as local banks presumably contract their balance sheets. Spillovers of foreign regulations into home lending are more likely to arise through hosted

affiliates of foreign banks. Third, significant international spillovers of policy on loan growth have mostly not been large. One reason for this is that the analysis focuses on adjustment in loan growth along the intensive margin, excluding analysis of adjustment along the extensive margin through entry and exit into foreign markets and mergers and acquisitions. Moreover, countries have tested for prudential spillovers in the context of the relatively infrequent and newer use of some instruments. To the extent that domestic activation of macroprudential instruments increases, the scope for international spillovers of prudential instruments might thus increase in the future.

Overall, the results of this prudential spillover work demonstrate the importance of incorporating considerations on the international spillovers of prudential instruments into discussions and frameworks around macroprudential policy, including the role and potential for reciprocity. While spillovers do not always occur through lending, they do occur frequently enough to have consequences for countries interlinked through international banking.

Appendix 1. Specific Regression Models by Transmission Channel

Inward Transmission through Home Global Banks

The analysis of the inward transmission channel begins with a specification focused on changes in the domestic lending behavior of a domestic bank with activities in multiple foreign countries. This global bank is exposed to *foreign* prudential instruments through its exposure to foreign markets. Lending behavior *at home* may be affected. For example, as discussed in section 2.1, if foreign regulations tighten, lending on the home market is, ceteris paribus, more attractive.

Formally, log changes in the stock of (domestic) loans ($\Delta Y_{b,t}$) are linked to prudential changes weighted by a bank's lagged foreign exposures ($ExpP_{b,t-1}$), bank-level controls ($X_{b,t-1}$), and bank and time fixed effects (f_b, f_t):

$$\begin{aligned}\Delta Y_{b,t} = \alpha_0 + (\alpha_1 ExpP_{b,t} + \alpha_2 ExpP_{b,t-1} + \alpha_3 ExpP_{b,t-2}) \\ + \alpha_4 X_{b,t-1} + f_b + f_t + \epsilon_{b,t}. \qquad (3)\end{aligned}$$

Time fixed effects capture changes in prudential instruments on the home market. In order to test whether policies have a significant impact on lending growth, the F-test $\alpha_1 + \alpha_2 + \alpha_3 = 0$ considers whether the cumulative impact of regulations over a time horizon of three quarters is statistically significant.

In a second step, the prudential measures are interacted with bank-level variables to test whether the banks' business models influence the lending response to regulatory changes:

$$\Delta Y_{b,t} = \alpha_0 + (\alpha_1 ExpP_{b,t} + \alpha_2 ExpP_{b,t-1} + \alpha_3 ExpP_{b,t-2}) + \alpha_4 X_{b,t-1} + (\beta_1 ExpP_{b,t} \cdot X_{b,t-1} + \beta_2 ExpP_{b,t-1} \cdot X_{b,t-1} + \beta_3 ExpP_{b,t-2} \cdot X_{b,t-1}) + f_b + f_t + \epsilon_{b,t}. \quad (4)$$

The corresponding F-tests are $\alpha_1 + \alpha_2 + \alpha_3 = 0$, $\beta_1 + \beta_2 + \beta_3 = 0$, $\sum_{i=1}^{3}(\alpha_i + \beta_i \cdot \bar{X}_{b,t-1})$, and $(\alpha_1 + \beta_1 \cdot \bar{X}_{b,t-1})$. The country team analyses allow effects of the bank-level variables to depend on the specific prudential measure considered. Take the case of prudential instruments aiming at increasing the capital buffers of banks. For well-capitalized banks with large capital buffers in excess of the regulatory minimum, higher capital requirements abroad should have little impact on domestic lending. For weakly capitalized banks with foreign subsidiaries, additional capital requirements may well be the relevant constraint, hence these banks may have to cut back foreign lending and possibly domestic lending in the short run. Therefore, the expected sign of the interaction term between capital-based prudential changes and bank capital is negative in this inward transmission exercise.

An additional specification examined by teams allows for the effect of the foreign prudential instrument to vary over the home financial or business cycle. The resulting specification is

$$\Delta Y_{b,t} = \alpha_0 + \alpha_1 ExpP_{cum,b,t-1} + \alpha_2 X_{b,t-1} + \alpha_3 ExpP_{cum,b,t-1} \cdot Z_t + f_b + f_t + \epsilon_{b,t}, \quad (5)$$

where Z_t is the credit-to-GDP or output gap in the home market. In order to measure the effect of the financial cycle, we use a cumulative regulatory measure ($ExpP_{cum,b,t-1}$). The cumulative index captures not only contemporaneous changes in the policy but also previous changes that may affect current lending, surfacing at

specific stages of the financial or business cycle, as in Akinci and Olmstead-Rumsey (2015) or Cerutti, Claessens, and Laeven (2015). Results are summarized in table 8.

Inward Transmission through Affiliates of Foreign Banks

Inward transmission of prudential instruments can arise through the lending behavior of home prudential policy via affiliates of foreign banks that are active in the domestic market. Rather than weighting foreign policy changes by the exposure of each domestic bank abroad, we now have a direct measure of the home policy changes of each foreign affiliate, depending on where the parent of this affiliate resides. Equation (1) thus becomes

$$\begin{aligned}\Delta Y_{b,j,t} = \alpha_0 + (\alpha_1 HomeP_{j,t} + \alpha_2 HomeP_{j,t-1} + \alpha_3 HomeP_{j,t-2}) \\ + \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + f_b + f_t + \epsilon_{b,j,t}, \qquad (6)\end{aligned}$$

where $HomeP_{j,t}$ is the regulation in the home country j of an affiliate with a parent in j. Time fixed effects absorb changes in the regulation of the domestic market. Due to data limitations, it is usually not possible to control for the international loan portfolio of these banks through an exposure-weighted index similar to the first inward transmission specification. Instead, a net intragroup position term in some specifications controls for the degree of ex ante reallocation of resources within the banking group. Also, bank fixed effects may capture structural differences in banks' business models. All other tests remain the same.

Outward Transmission through Home Global Banks

The general structure of the outward transmission exercise is very similar to the structure of the inward transmission model. An initial specification starts with a given bank residing in country i that has claims on several foreign countries j. To test how lending in these countries is affected by destination-country regulatory policies implemented in each country $j(DestP_{j,t})$, formally the following empirical model is used:

$$\begin{aligned}\Delta Y_{b,j,t} = \alpha_0 + (\alpha_1 DestP_{j,t} + \alpha_2 DestP_{j,t-1} + \alpha_3 DestP_{j,t-2}) \\ + \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + f_j + f_t + f_b + \epsilon_{b,j,t}. \qquad (7)\end{aligned}$$

Table 8. Heterogeneity of Effects across Cycles by Instrument and Channel

	Countries with Significant Heterogeneity by Business and Financial Cycle											
	Inward Transmission of . . .								Outward Transmission of . . .			
Channel →	Exposure-Weighted Regulation				HomePolicy via Affiliates				Destination-Country Policy*			
Interaction →	Business Cycle		Financial Cycle		Business Cycle		Financial Cycle		Business Cycle		Financial Cycle	
Sign of Interaction →	+	−	+	−	+	−	+	−	+	−	+	−
General Capital Requirements		CH			KR, MX	TR		HK	DE	US		FR
Sector-Specific Capital Buffer	PT	TR			KR, PL, US	UK		PT, US		DE	IT	
Loan-to-Value Ratio Limits		CL, DE		TR			KR, PT, TR					
Reserve Requirements: Foreign‡	MX		DE, PT			DE	KR			DE	CA	
Reserve Requirements: Local‡	MX	CL, PT			CL, TR		KR, PT, TR	DE		NL		
Interbank Exposure Limit‡		TR	TR		KR	UK	KR	TR				
Concentration Ratio‡	PT			TR	TR	KR, MX, PL, PT	TR	DE		NL	CA	
Countries Reporting	CH, CL, DE, MX, PT, TR, UK, US				CL, DE, HK, KR, MX, PL, PT, TR, UK, US				CA, DE, FR, IT, NL, US			

Notes: This table shows which countries found business and financial cycles to be important in differentiating the significant impacts of prudential regulations on bank lending, defined as having found instrument-cycle interactions that were significant at the 10 percent level. Cycle variables are those of the host country, home country, and destination country, respectively, in the three transmission channels below. Regressions involving cycle interactions use cumulative macroprudential instrument measures. Countries included are Canada (CA), Chile (CL), France (FR), Germany (DE), Hong Kong (HK), Italy (IT), South Korea (KR), Mexico (MX), Netherlands (NL), Poland (PL), Portugal (PT), Switzerland (CH), Turkey (TR), the United Kingdom (UK), and the United States (US). All countries running a bank interaction regression in a given channel are listed in the final row. ‡Due to insufficient variation, foreign reserve requirements are excluded by TR, local reserve requirements by CH, concentration ratios by US, and interbank exposure limits by CL, DE, and PT in all channels. In the via affiliates channel, foreign reserve requirements are similarly excluded by HK, MX, PL, PT, TR, and US, with interbank exposure limits also excluded by US in this channel.

All variables are defined as previously, except that the business or financial cycle variables $Z_{j,t}$ are now for the destination country j. The F-tests as well as interaction terms with bank-level variables and the cycle are conducted analogously.

The outward transmission exercise has a baseline specification that refers to prudential policies in the destination country. Another specification is similar to the inward transmission case in which teams consider exposure-weighted regulations in foreign countries that are not the home or destination country. Consider, for instance, the foreign affiliate of the domestic bank located in a specific host market—say the United Kingdom—but with many foreign markets being serviced from that location. In that case, prudential changes imposed in those third-country locations might affect the lending in the specific host market, and these prudential changes are included in the model through a composite index *ExpP*:

$$\begin{aligned}\Delta Y_{b,j,t} = \alpha_0 &+ (\alpha_1 DestP_{j,t} + \alpha_2 DestP_{j,t-1} + \alpha_3 DestP_{j,t-2}) \\ &+ \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + (\beta_1 ExpP_{b,t} + \beta_2 ExpP_{b,t-1} \\ &+ \beta_3 ExpP_{b,t-2}) + f_j + f_t + f_b + \epsilon_{b,j,t}. \qquad (8)\end{aligned}$$

The corresponding F-test analyzes whether either destination-country regulations or foreign-exposure-weighted regulations in third countries have a significant impact over a horizon of three quarters on lending in a given destination market: $\alpha_1 + \alpha_2 + \alpha_3 = 0$; $\beta_1 + \beta_2 + \beta_3 = 0$.

Appendix 2. Data Cleaning and Variable Definitions

Data Details and Cleaning

Data availability, the length of time series, and the types of relevant banking groups vary across countries. As general guidance, country teams use quarterly data from the first quarter of 2000 through the fourth quarter of 2013. The largest meaningful set of banks is included in the baseline model implemented by country teams. The outward transmission exercises generally exclude foreign-owned banks. Inward transmission exercises use data on domestic banks, foreign branches, and foreign subsidiaries.

Data have not been adjusted for exchange rate changes because not all country teams have information on the currency denomination of banks' cross-border assets. Whenever feasible and meaningful, positions adjusted for exchange rate changes were used for robustness specifications. Quarterly growth rates of lending are based on nominal rather than real data in order to avoid adding noise from quarterly price changes.

A key consideration in understanding channels of transmission is the use of consolidated versus unconsolidated data, in particular for those banking organizations that maintain extensive international networks of affiliates. Consolidated data refer to the group level, reflecting balance sheet items for all individual banks that are within the organization. Unconsolidated data cover specific entities so that balance sheet items are at the level of an individual bank which is part of a larger bank holding company or banking group. Consolidation complicates an analysis of the international dimension of prudential spillovers, as the geographical split of a bank's assets or liabilities by destination/country may be excluded. In baseline specifications, country teams generally use data that have been consolidated across parents and branches as relevant for the transmission exercise, but not for the entire bank holding company. If that option is not available, data that have been consolidated at the group level (parent, branches, and subsidiaries) are used. For those countries where neither option is available and country teams instead resort to locational data, group-level variables are included as bank-level controls.

Teams impose screens on the bank-level data to account for merger-induced changes and to correct errors in the data: (i) Log changes that exceed –100/+100 percent have been dropped. Compared with the winsorization of data at standard levels, this has the advantage of giving an approximately normal distribution of growth rates while keeping most observations in the sample. Country teams additionally use standard winsorization techniques to check robustness. (ii) Generally, zeros representing missing bank-level observations are dropped. (iii) Strings that did not include at least two years of consecutive observations generally are dropped.

These data-cleaning steps follow standard procedures in the literature by focusing on variation in bank-specific observations along the intensive margin and by eliminating large outliers. But there is

also the possibility that some large extensive margin adjustments in response to prudential instruments are inadvertently excluded from the analysis. These steps, along with baseline specifications' instructions designed to deliver maximum commonalities across country results on specific transmission channels, imply that the meta-analysis results provide a conservative, lower bound for international transmission of prudential instruments through banks.

Construction of Regressors Used in Probit Meta-Analysis

Indicator Variables:

- *Emerging Market:* Equals one if the country team running a given regression is classified as an emerging market economy (as opposed to an advanced economy), and zero otherwise.
- *Inward Exposure Weighted:* Equals one if the regression studies the inward transmission of foreign prudential regulation through domestic global banks, and zero otherwise.
- *Outward Transmission:* Equals one if the regression studies the outward transmission of policy through the international activities of domestically owned banks, and zero otherwise.
- *PP*Cycle Indicator:* Equals one if the regression includes prudential instruments interacted with business and financial cycle variables, and zero otherwise. Note that these specifications are also exactly the specifications that use a cumulative prudential instrument measure.
- *PP*Bank Indicator*: Equals one if the regression includes prudential instruments interacted with bank-level balance sheet variables, and zero otherwise.
- *All PP Indicator*: Equals one if the regression specification simultaneously includes all prudential instruments showing sufficient variation, and zero otherwise.

Non-Indicator Variables:

- *% Foreign Bank Ownership:* Indicates the share of banks operating in the regression country in 2013 which are foreign owned as derived from the Claessens and van Horen database (2015).

- *% Tightening:* Indicates the share of prudential instrument changes which represent tightenings (as opposed to loosenings), for a given country team, channel, and specific instrument.
- *Log Observations (not shown):* The log number of observations included in a regression specification.
- *Constant Term (not shown)*

References

Aiyar, S., C. Calomiris, J. Hooley, Y. Korniyenko, and T. Wieladek. 2014. "The International Transmission of Bank Capital Requirements: Evidence from the United Kingdom." *Journal of Financial Economics* 113 (3): 368–82.

Aiyar, S., C. Calomiris, and T. Wieladek. 2014. "Does Macro-Prudential Regulation Leak? Evidence from a UK Policy Experiment." *Journal of Money, Credit and Banking* 46 (s1): 181–214.

Akinci, O., and J. Olmstead-Rumsey. 2015. "How Effective Are Macroprudential Policies? An Empirical Investigation." International Finance Discussion Paper No. 1136, Board of Governors of the Federal Reserve System.

Arregui, N., J. Beneš, I. Krznar, S. Mitra, and A. Oliveira Santos. 2013. "Evaluating the Net Benefits of Macroprudential Policy: A Cookbook." IMF Working Paper No. 13/167.

Auer, S., M. Ganarin, and P. Towbin. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Switzerland." *International Journal of Central Banking* 13 (S1).

Avdjiev, S., C. Koch, P. McGuire, and G. von Peter. 2017. "International Prudential Policy Spillovers: A Global Perspective." *International Journal of Central Banking* 13 (S1).

Bank for International Settlements. 2014. "Debt and the Financial Cycle: Domestic and Global." In *84th Annual Report*, 65–84 (chapter IV). Basel, Switzerland: Bank for International Settlements.

Barth, J. R., G. Caprio, and R. Levine. 2013. "Bank Regulation and Supervision in 180 Countries from 1999 to 2011." *Journal of Financial Economic Policy* 5 (2): 111–219.

Başkaya, Y. S., M. Binici, and T. Kenç. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Turkey." *International Journal of Central Banking* 13 (S1).

Bengui, J., and J. Bianchi. 2014. "Capital Flow Management when Capital Controls Leak." Manuscript.

Berrospide, J., R. Correa, L. Goldberg, and F. Niepmann. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from the United States." *International Journal of Central Banking* 13 (S1).

Bonfim, D., and S. Costa. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Portugal." *International Journal of Central Banking* 13 (S1).

Borio, C. 2012. "The Financial Cycle and Macroeconomics. What Have We Learnt?" BIS Working Paper No. 395 (December).

Bremus, F., and M. Fratzscher. 2015. "Drivers of Structural Change in Cross-Border Banking since the Global Financial Crisis." *Journal of International Money and Finance* 52: 32–59.

Bruno, V., I. Shim, and H. S. Shin. 2015. "Effectiveness of Macroprudential and Capital Flow Measures in Asia and the Pacific." *BIS Papers* 82: 185–92.

Bruno, V., and H. S. Shin. 2014. "Assessing Macroprudential Policies: Case of Korea." *Scandinavian Journal of Economics* 116 (1): 128–57.

Buch, C. M., and L. S. Goldberg. 2015. "International Banking and Liquidity Risk Transmission: Lessons from Across Countries." *IMF Economic Review* 63 (3): 377–410.

Bussière, M., J. Schmidt, and F. Vinas. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from France." *International Journal of Central Banking* 13 (S1).

Caccavaio, M., L. Carpinelli, and G. Marinelli. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Italy." *International Journal of Central Banking* 13 (S1).

Cerutti, E., S. Claessens, and L. Laeven. 2015. "The Use and Effectiveness of Macroprudential Policies: New Evidence." Forthcoming in *Journal of Financial Stability.*

Cerutti, E., R. Correa, E. Fiorentino, and E. Segalla. 2017. "Changes in Prudential Policy Instruments:—A New Cross-Country Database." *International Journal of Central Banking* 13 (S1).

Claessens, S., S. R. Ghosh, and R. Mihet. 2014. "Macro-Prudential Policies to Mitigate Financial System Vulnerabilities." IMF Working Paper No. 14/155.

Claessens, S., M. A. Kose, and M. E. Terrones. 2011. "Financial Cycles: What? How? When?" IMF Working Paper No. 11/76.

Claessens, S., and N. van Horen. 2015. "The Impact of the Global Financial Crisis on Banking Globalization." *IMF Economic Review* 63 (4): 868–918.

Damar, H. E., and A. Mordel. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Canada." *International Journal of Central Banking* 13 (S1).

Drehmann, M., C. Borio, and K. Tsatsaronis. 2011. "Anchoring Countercyclical Capital Buffers: The Role of Credit Aggregates." *International Journal of Central Banking* 7 (4): 189–240.

Fischer, S. 2011. "Central Bank Lessons from the Global Crisis." Lecture at the Bank of Israel conference on "Lessons of the Global Crisis," Jerusalem, March 31.

Frost, J., J. de Haan, and N. van Horen. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from the Netherlands." *International Journal of Central Banking* 13 (S1).

Gajewski, K., and O. Krzesicki. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Poland." *International Journal of Central Banking* 13 (S1).

Henry, P. B. 2007. "Capital Account Liberalization: Theory, Evidence, and Speculation." *Journal of Economic Literature* 45 (4): 887–935.

Hills, R., D. Reinhardt, R. Sowerbutts, and T. Wieladek. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from the United Kingdom." *International Journal of Central Banking* 13 (S1).

Ho, K., E. Wong, and E. Tan. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Hong Kong." *International Journal of Central Banking* 13 (S1).

Houston, J. F., C. Lin, and Y. Ma. 2012. "Regulatory Arbitrage and International Bank Flows." *Journal of Finance* 67 (5): 1845–95.

International Monetary Fund (IMF). 2011. "Macroprudential Policy: What Instruments and How to Use Them? Lessons from Country Experiences." IMF Working Paper No. 11/238.

Jara, A., and L. Cabezas. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Chile." *International Journal of Central Banking* 13 (S1).

Jiménez, G., S. Ongena, J.-L. Peydro, and J. Saurina Salas. 2012. "Macroprudential Policy, Countercyclical Bank Capital Buffers and Credit Supply: Evidence from the Spanish Dynamic Provisioning Experiments." Working Paper No. 231, National Bank of Belgium.

Kalemli-Ozcan, S., E. Papaioannou, and J.-L. Peydro. 2013. "Financial Regulation, Financial Globalization and the Synchronization of Economic Activity." *Journal of Finance* 68 (3): 1179–1228.

Khwaja, A. I., and A. Mian. 2008. "Tracing the Impact of Bank Liquidity Shocks: Evidence from an Emerging Market." *American Economic Review* 98 (4): 1413–42.

Kuttner, K., and I. Shim. 2013. "Can Non-interest Rate Policies Stabilize Housing Markets? Evidence from a Panel of 57 Economies." NBER Working Paper No. 19723.

Leamer, E. E. 1988. "Measures of Openness." In *Trade Policy Issues and Empirical Analysis*, ed. R. E. Baldwin, 147–204. Chicago and London: University of Chicago

Levin-Konigsberg, G., C. López, F. López-Gallo, and S. Martínez. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Mexico." *International Journal of Central Banking* 13 (S1).

Melitz, M. 2003. "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity." *Econometrica* 71 (6): 1695–1725.

Nocciola, L., D. Żochowski, and F. Franch. 2016. "International Banking and Cross-border Effects of Prudential Regulation: Lessons from the Euro Area." Working Paper, European Central Bank.

Obstfeld, M. 2014. "Trilemmas and Tradeoffs: Living with Financial Globalization." Paper for Asian Monetary Policy Forum, Singapore (May).

Ohls, J., M. Pramor, and L. Tonzer. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Germany." *International Journal of Central Banking* 13 (S1).

Ostry, J. D., A. R. Ghosh, K. Habermeier, L. Laeven, M. Chamon, M. S. Qureshi, and A. Kokenyne. 2011. "Managing Capital

Inflows: What Tools to Use?" IMF Staff Discussion Note No. 11/06.

Park, H., and J. Lee. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Korea." *International Journal of Central Banking* 13 (S1).

Reinhardt, D., and R. Sowerbutts. 2015. "Regulatory Arbitrage in Action: Evidence from Banking Flows and Macroprudential Policy." Staff Working Paper No. 546, Bank of England.

Schindler, M. 2009. "Measuring Financial Integration: A New Data Set" *IMF Staff Papers* 56 (1): 222–38.

Vandenbussche, J., U. Vogel, and E. Detragiache. 2015. "Macroprudential Policies and Housing Prices—A New Database and Empirical Evidence for Central, Eastern, and Southeastern Europe." *Journal of Money, Credit and Banking* 47 (S1): 343–77.

International Banking and Cross-Border Effects of Regulation: Lessons from Canada*

H. Evren Damar[a] and Adi Mordel[b]
[a]Hobart and William Smith Colleges
[b]Bank of Canada

We study how changes in prudential requirements affect cross-border lending of Canadian banks by utilizing an index that aggregates adjustments in key regulatory instruments across jurisdictions. We show that when a destination country tightens local prudential measures, Canadian banks increase the growth rate of lending to that jurisdiction, and the effect is particularly significant when capital requirements are tightened and weaker if banks lend mainly via affiliates. Our evidence also suggests that Canadian banks adjust foreign lending in response to domestic regulatory changes. The results confirm the presence of heterogeneous spillover effects of foreign prudential requirements.

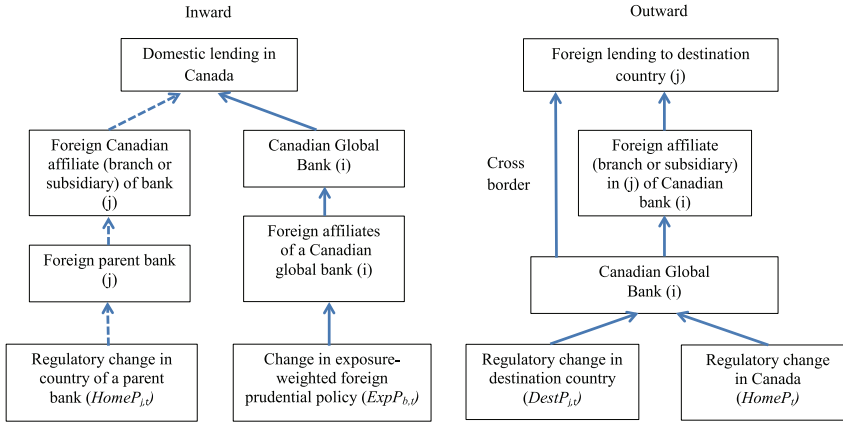
JEL Codes: F34, G01, G21.

1. Introduction

How do regulatory changes in prudential requirements affect cross-border banking activities? Does the effect depend on the regulatory instrument being adjusted, or on bank characteristics? And does it depend on the country of origin or the type of lending the bank is engaged with? In this project we take advantage of a unique database, as part of the International Banking Research Network (IBRN)

*The views expressed in this paper are those of the authors and do not necessarily reflect the views of the Bank of Canada. We thank Christian Friedrich, IBRN participants from Italy and the BIS, and one anonymous referee for thoughtful comments. Omar Abdelrahman provided excellent research assistance. Author contact: Damar: Hobart and William Smith Colleges, 300 Pulteney Street, Geneva, NY, USA; e-mail: damar@hws.edu. Mordel: Financial Stability Department, Bank of Canada, 234 Wellington Street, Ottawa, ON, Canada; e-mail: amordel@bankofcanada.ca.

Figure 1. Transmission Channels of Regulatory Policy Changes (relevant channels for Canada shown by the solid lines)



initiative, to investigate these questions using a sample of globally active Canadian banks, and study how they adjust the growth rate of lending when faced with prudential changes, either at home or abroad.

Canadian banks represent an interesting case to study the international spillover effects of prudential regulations, since they are relatively globally active. Furthermore, the banks traditionally operate with capital buffers above the minimum prescribed Basel requirements, which could play a role in their reaction to prudential policy changes in other countries.

The focus of the analysis is on the outward transmission channel, which is the most relevant for Canadian banks. The outward channel captures how Canadian lending to a specific destination country reacts to policy changes at that destination. This can take two forms: either via the Canadian banks' foreign affiliates lending or via the Canadian banks' headquarters (cross-border lending). We also study an extension of the outward channel, one that captures how changes to Canadian regulatory requirements affect foreign lending. Figure 1 provides a graphical representation of these respective channels. After examining the outward channel in detail, we extend the analysis by investigating the inward transmission channel, or

the effect of foreign regulatory changes on domestic lending (i.e., in Canada). This exercise investigates the degree to which domestic activities of Canadian banks are exposed to foreign regulations through their global operations.[1]

We find that when a destination country tightens requirements, Canadian banks react by increasing the lending growth rate to that jurisdiction, and this effect is strongest when capital, loan-to-value (LTV), or reserve requirements change. The economic magnitudes of tighter capital requirements can be significant: the average amount of new lending associated with a tightening is around Can$600 million (or approximately 10 percent of the average foreign lending in a given quarter). However, since such changes occur infrequently during the sample period, their overall impact is modest.[2]

We note that such an outcome is not necessarily undesirable if the Canadian banks that increase lending have more capital than their local competitors. Under this scenario, lending would have shifted toward better-capitalized institutions and increased overall resilience of the banking sector (which may have been the policy's intention in the first place). Although our data do not allow us to compare Canadian banks' capital ratios with those of their competitors in each destination country, two pieces of information may be indicative of this outcome. First, for most of our sample period, Canadian banks operated with capital requirements that exceeded Basel minimum requirements, so it is possible that their capital ratios exceeded those of their competitors, at least in some foreign jurisdictions. Second, we find that some bank characteristics, such as tier 1 capital, interact positively with the impact of regulatory changes in Canadian banks' foreign lending. Other important bank factors that support foreign lending are the size of the bank's international activities and its internal capital market, indicating that a developed intragroup

[1]A different inward channel that could potentially exist is through foreign affiliates operating in Canada. However, the economic magnitude of this channel is likely to be limited, since foreign affiliates have traditionally accounted for a very small share of domestic lending. Over the sample period, the average annual share of domestic lending by foreign subsidiaries and branches is only about 4.5 percent and 1.5 percent, respectively. As such, the inward analysis focuses only on the home global banks.

[2]For the prudential index, the magnitude is about Can$190 million of extra lending per tightening. If aggregated over thirteen years across all banks and actions, this translates into an increase in lending of about Can$40 billion.

market or presence across multiple jurisdictions is a key determinant of a bank's ability to redirect lending as prudential standards change at the destination.

Next we study how regulatory adjustments interact with global banks' business models. If in a certain destination a Canadian bank lends mainly via an affiliate, then the bank's ability to adjust lending, perhaps by substituting to cross-border loans, might be more limited. We show that under tighter LTV limits, the lending growth rate in such a destination country decreases if it is done mainly via affiliates. A similar slowdown in affiliate lending is observed for non-bank private loans when capital requirements are tightened.

As an extension to the outward transmission analysis, we also investigate how changes to domestic (i.e., Canadian) regulatory requirements affect foreign lending. We show that, in general, tighter home requirements push Canadian banks to lend abroad, but the effect differs across banks. For example, when domestic capital standards are tightened, we observe a reduction in foreign lending growth rates for banks that are more retail oriented (i.e., with higher levels of illiquid assets) and/or for banks that are more internationally active, but an increase in lending growth rates for banks that rely on core deposits. Finally, we complement the analysis by investigating the consequences of foreign regulatory changes on domestic Canadian lending, i.e., the inward channel. We find that the tightenings of foreign prudential policies are associated with a slowdown in the growth rate of domestic credit by global Canadian banks. Assuming a global bank has a fixed pool of funds, this finding is expected given the positive effects for the outward channel. It indicates that global banks optimize lending across jurisdictions (reducing in one, increasing in another).

2. Data and Stylized Facts for Canada

2.1 Bank-Level Data

Our data are obtained from the confidential regulatory returns filed by all federally chartered financial institutions in Canada.[3]

[3]Please see Chen et al. (2012) and Chapman and Damar (2015) for more details on our data sources. The actual forms and their filing instructions can be found at http://www.osfi-bsif.gc.ca/Eng/fi-if/rtn-rlv/fr-rf/dti-id/Pages/default.aspx.

Bank-time level data is globally consolidated at the parent level and is obtained from two forms: the quarterly "Basel Capital Adequacy Return" (for tier 1 capital ratio) and the monthly "Balance Sheet" return (for all other bank-level data).

In order to construct the foreign lending of globally active Canadian banks, we use data from two sources. The form "Geographic Assets and Liabilities Booked in Canada" contains information on the cross-border activities (claims and liabilities) at the bank-country-time level, while the "Geographic Assets and Liabilities Booked Outside of Canada" form provides claims and liabilities booked by foreign affiliates of Canadian banks. For the purposes of this study, we combine information from the two forms to create an aggregate "foreign lending" variable, without differentiating between cross-border loans and lending being done through affiliates. As part of the robustness tests, we extend the analysis by treating these two lending types separately (see section 3.3).

We perform a number of adjustments to the data. Given our primary focus on the outward transmission of regulatory policy changes, we first exclude all foreign banks and foreign bank branches from our sample. In addition, we exclude all domestic banks with assets less than Can$1 billion (in 2013:Q4 dollars) at any point during our sample period. To eliminate the possibility that the results are driven by banks with limited foreign lending activity, we drop any observations where the outstanding foreign lending by bank i in country j in time t is less than Can$100 million. We then limit our sample to series of bank-country-time observations with at least eight consecutive non-missing quarterly observations. This yields a final estimation sample of 2,885 observations.

There are six domestically owned Canadian banks in our sample, which are the "Big Six" banks that have traditionally dominated the federally chartered banking sector.[4] These six banks lend

[4]These banks are the Bank of Montreal, Bank of Nova Scotia, Canadian Imperial Bank of Commerce, National Bank of Canada, Royal Bank of Canada, and the Toronto Dominion Bank group. Among the federally chartered commercial banks (domestic and foreign subsidiaries), trust and loan companies, and foreign bank branches, these six banks hold approximately 90 percent of all assets. There are also a number of provincially chartered credit unions and cooperative credit institutions in Canada; however, we exclude such institutions from this study, as they do not file uniformly designed regulatory returns and have almost no foreign activities.

in thirty-five different foreign countries.[5] However, looking across individual banks, there is substantial variation in the scope of foreign lending. The number of countries that banks lend to varies between 3 and 29 (with an average of 16.8). Furthermore, there are only three countries where all six banks have substantial lending activities (China, the United Kingdom, and the United States). Meanwhile, our sample includes nine countries in which only one Canadian bank is active throughout the entire sample period (Belgium, Denmark, Finland, Greece, Malaysia, New Zealand, Peru, the Slovak Republic, and Thailand).

For the baseline empirical analysis, our dependent variable is defined as

$$\Delta Y_{b,j,t} = \text{Change in log loans by bank } b \text{ to counterparties in country } j \text{ at time } t.$$

We also use a narrower definition of lending as an extension of the baseline specification:

$$\Delta P_{b,j,t} = \text{Change in log private non-bank lending by bank } b \text{ in country } j \text{ at time } t.$$

This allows us to investigate if some regulatory policies affect certain types of lending but not others. Ideally, we would like a finer subcategorization of loans (mortgages versus unsecured consumer lending versus commercial loans, etc.). However, the regulatory forms only allow for the (relatively coarse) sub-categorization of "loans to banks," "loans to non-bank public entities," and "loans to non-bank private entities." We use the latter category in defining $\Delta P_{b,j,t}$.

Table 8 in the appendix reports the different control variables. These are the log of total assets ($LogTotalAssets_{b,t-1}$), the percentage of a bank's portfolio of assets that is illiquid ($IlliquidAsset-Ratio_{b,t-1}$),[6] the percentage of the bank's balance sheet financed

[5]These are countries for which prudential policy, business cycle, and financial cycle data are available. There are a few other countries (mainly in the Caribbean and South America) that would have otherwise met our sample inclusion criteria. Therefore, the real number of countries with substantial lending by Canadian banks is around forty.

[6]We limit illiquid assets only to loans due to data availability issues. Ideally, we would like to include other assets, such as held-to-maturity structured financial products, in our definition of illiquid assets. However, Canadian regulatory

with core deposits ($CoreDeposits_{b,t-1}$),[7] and the bank's regulatory tier 1 capital ratio ($Tier1Ratio_{b,t-1}$). We also include two variables related to the international aspects of Canadian banks' balance sheets. The first is the percentage of the bank's foreign assets plus foreign liabilities relative to total assets plus total liabilities ($InternationalRatio_{b,t-1}$). The second variable measures the size of the bank's "internal capital markets," capturing the bank's net claims on its foreign affiliates. Specifically, we include the percentage of the bank's net due to head office—net due from head office relative total liabilities ($NetIntragroupFunding_{b,t-1}$).

Since we would like to capture the exposure of globally active Canadian banks to changes in prudential measures, we construct two "prudential policy change" instruments according to their geographical specifications. Our first measure is "destination-country regulation" ($DestP_{j,t}$), which captures tightening or loosening of prudential measures in destination (or "host") country j and time t. This variable takes one of three possible values: +1 for a tightening, –1 for a loosening, and 0 for no change. In some of the empirical specifications, we use the contemporaneous value of this variable along with its first two lags ($DestP_{j,t-l}$, where $l = 0, 1, 2$). For the second measure, we use the "home-country regulation" ($Home_t$) in certain extensions of our empirical analysis. This allows us to investigate whether prudential policy changes in Canada affect Canadian banks' foreign lending. This variable is defined in a manner similar to $DestP_{j,t}$.

2.2 Stylized Facts

Summary statistics on the banks' characteristics are presented in table 1. While the banks are fairly similar in terms of size (given the small standard deviation for that variable), they exhibit greater diversity with regards to the level of capital, the share of international activity, and the reliance on parent funding (i.e., net intragroup funding) and on core deposits. Summary statistics

returns do not feature such a breakdown of banks' securities holdings during our sample period.

[7] Core deposits are defined as demand, notice, and time deposits owned by individuals.

Table 1. Summary Statistics on Foreign Lending and Bank Characteristics

Variable	Observations	All Banks (N = 6)		
		Mean	Median	SD
Dependent Variables:				
Δ Foreign Loans	2,885	0.086	0.099	25.750
Δ Foreign Private Non-bank Loans	2,589	−0.636	−0.267	26.968
Independent Variables:				
Log Total Assets	324	19.729	19.758	0.555
Tier 1 Ratio (%)	324	9.793	9.224	2.159
Illiquid Assets Ratio (%)	324	54.470	54.860	5.537
International Activity (%)	324	21.799	23.259	7.909
Net Intragroup Funding/Liabilities (%)	324	0.221	−0.025	1.125
Core Deposits Ratio (%)	324	26.886	25.661	5.041

Notes: This table provides summary statistics for bank balance sheet and lending data. Data are observed quarterly from 2000:Q1 to 2013:Q4. Banking dada come from the globally consolidated balance sheet and capital reporting forms and are reported at the parent level. Net intragroup funding measures from the perspective of a bank's head office total net internal lending (or borrowing) vis-à-vis all its related domestic and international offices. Given the globally consolidated nature of the independent variables, summary statistics are reported at the bank-quarter level. Meanwhile, the dependent variables are measured at the bank-country-time level and the summary statistics are reported accordingly.

on the outward transmission of destination-country policy changes ($DestP_{j,t}$) are reported in table 2. For the prudential index, there are a total of 223 changes reported by countries in which Canadian banks operate, and 73 percent of those are associated with tightening of prudential requirements. Considering the individual components of the index, we observe that 8 percent of the overall changes are to local reserve requirements, 4 percent are to the LTV limits, 3.6 percent are to foreign reserve requirements, and about 3 percent are capital related. Since interbank exposure limits and concentration ratios rarely change, we do not report regression results for these instruments.

There are a few characteristics unique to the Canadian system that makes it ideal to study the consequences of foreign regulatory spillover effects. First, globally active Canadian banks are relatively more internationally oriented than their peers and as such are exposed to changes in foreign regulation. For example, for Canadian

Table 2. Summary Statistics on Changes in Prudential Instruments

Outward Transmission of Policy to Destination Country					
	Policy Changes in Destination Country				
Instrument	**No. of Country-Time Changes**	**No. of Country-Time Changes (Tightening)**	**No. of Country-Time Changes (Loosening)**	**No. of Bank-Country-Time Changes**	**Proportion Base-MPP Non-zero**
Prudential Index	223	164	59	426	0.165
General Capital Requirements	39	39	0	86	0.029
Sector-Specific Capital Buffer	33	26	7	53	0.024
Loan-to-Value Ratio Limits	54	43	11	122	0.040
Reserve Requirements: Foreign	48	31	17	75	0.036
Reserve Requirements: Local	112	61	51	203	0.083
Interbank Exposure Limit	10	10	0	22	0.007
Concentration Ratios	12	12	0	20	0.009

Notes: This table shows summary statistics on changes in prudential instruments for banks located in Canada over the period 2000–13. Data on the instruments come from the IBRN Prudential Instruments Database described by Cerutti et al. (2017) and are quarterly. The number of changes in prudential instruments is reported on several dimensions, i.e., on the country-time level and on the bank-time level. The last column shows the share of prudential changes to total observations (i.e., the share of non-zero observations). The reported data are based on the regression sample.

banks the median *InternationalRatio* is about 20 percent, substantially larger than the one for U.S. or German banks, approximately at 5 percent and 3 percent, respectively (see Berrospide et al. 2017 and Ohls, Pramor, and Tonzer 2017). Furthermore, Canada has a history of federally regulated institutions operating with higher capital requirements. Between 1999 and 2013, the Office of the Superintendent of Financial Institutions (OSFI) required institutions to hold minimum tier 1 and total capital ratios of 7 percent and 10 percent, while the Basel II requirements were 4 percent and 8 percent. Effectively, Canadian banks maintained a time-invariant capital buffer of 3 percent for tier 1 capital and 2 percent for total capital. Finally, in recent years Canadian regulators have used loan-to-value (LTV) limits extensively (see table 9 in the appendix).[8] During the sample period domestic authorities also adjusted capital requirements.[9] Thus we limit the $Home_t$ indicator to capture only these two policies.

3. Empirical Method and Regression Results

3.1 Baseline Analysis of Outward Transmission of Prudential Policies

The analysis explores the effect of changes in regulation on banks' growth rate in outstanding foreign loans, following the approach described in Buch and Goldberg (2017). We begin with the following regression specification, which controls for the outward transmission of destination-country macroprudential policy:

$$\Delta Y_{b,j,t} = \alpha_0 + (\alpha_1 DestP_{j,t} + \alpha_2 DestP_{j,t-1} + \alpha_3 DestP_{j,t-2}) + \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + f_j + f_t + f_b + \varepsilon_{b,j,t}, \quad (1)$$

[8]In Canada, federally regulated lenders and most provincially regulated lenders are required by law to purchase insurance for mortgages that exceed 80 percent of the value of the residential property. Since the insurance is guaranteed by the government, it sets minimum qualifying standards for borrowers, and key among those is the LTV limit.

[9]Capital changes included the full adoption of Basel II in 2007:Q4, the implementation of Basel II.5 in 2012:Q1, and the Basel III implementation in 2013:Q1.

where $\Delta Y_{b,j,t}$ is the log change in destination-country j lending by a global Canadian bank b at time t. $DestP_{j,t}$ captures that country's prudential policy changes. $X_{b,t-1}$ is a vector of bank balance sheet control variables and $Z_{j,t}$ represents the financial and business cycle variables for country j (as defined by Drehmann, Borio, and Tsatsaronis 2011 and the Bank for International Settlements 2014). Finally, f_j, f_t, and f_b respectively represent country, time, and bank fixed effects.

We report results from this specification in table 3. First we note that Canadian banks' lending at the destination country is procyclical, as evident by the positive and significant business cycle coefficient. More importantly for our study, the positive and significant (at 5 percent) coefficient on the prudential index suggests that when a destination country tightens requirements, Canadian banks increase the lending growth rate in that jurisdiction. The coefficient of $DestP_{j,t}$ implies that for the average Canadian bank, a tightening of the prudential policy index is associated with roughly Can$190 million of new lending.[10]

Results from the individual components of the prudential index show that the effect is strongest for changes in capital requirements. The average amount of new lending associated with a tightening in capital requirements is around Can$600 million. The healthy balance sheets of Canadian banks during our sample period, and especially after the crisis (Chapman and Damar 2015), may have better positioned banks to increase lending under tighter requirements. Furthermore, until the implementation of Basel III toward the end of the sample period, Canadian banks were required to maintain capital ratios above the Basel minimum. According to Ratnovski and Huang (2009), such requirements lower Canadian banks' incentives for foreign expansion, "except in cases where they can have a distinct competitive advantage." Tighter capital requirements in

[10]Given that our dependent variable is the log change in foreign lending (multiplied by 100), a coefficient of 3.254 implies that on average (*foreign lending at time t/foreign lending at time* $t-1$*)* $= e^{(3.254/100)}$, which equals 1.033 if the prudential index is tightened by one unit at time t. Using the average value of foreign lending in our sample (Can$5.7 billion), we are able obtain an average increase of Can$188 million (5.7 billion * 0.033). Given that there were 204 net tightenings throughout our sample period (317 tightenings – 113 loosenings), a simple estimate of the cumulative effect is Can$40 billion.

Table 3. Outward Transmission of Policy to Destination Country

	DestP = Prudential IndexC	**DestP = Capital Requirements:**	**DestP = Sector-Specific Capital Buffer**	**DestP = LTV Ratio**	**DestP = Reserve Requirements: Foreign**	**DestP = Reserve Requirements: Local**
Destination-Country Regulation DestP_{t}	3.755**	9.985**	−0.279	1.834	−1.065	2.517*
	(1.463)	(4.333)	(1.550)	(3.517)	(1.010)	(1.415)
Destination-Country Regulation DestP_{t-1}	1.233	5.194	0.183	−1.535	1.714	1.882
	(1.521)	(3.868)	(1.412)	(1.677)	(2.228)	(2.279)
Destination-Country Regulation DestP_{t-2}	1.089	2.488	2.415	3.395**	0.763	1.036
	(1.340)	(4.799)	(2.458)	(1.600)	(1.436)	(1.347)
Log Total Assets_{t-1}	−8.228	−9.698	−8.544	−8.048	−8.548	−8.748
	(5.845)	(5.850)	(5.734)	(6.051)	(5.797)	(5.831)
Tier 1 Ratio_{t-1}	−0.600	−0.647	−0.589	−0.580	−0.593	−0.653
	(1.015)	(0.984)	(1.011)	(1.014)	(1.009)	(1.008)
Illiquid Assets Ratio_{t-1}	−0.135	−0.161	−0.162	−0.151	−0.150	−0.135
	(0.271)	(0.257)	(0.264)	(0.264)	(0.261)	(0.272)
International Activity_{t-1}	0.083	0.072	0.052	0.053	0.051	0.069
	(0.163)	(0.164)	(0.163)	(0.163)	(0.164)	(0.165)
Net Intragroup Funding_{t-1}	0.226	0.239	0.221	0.218	0.220	0.213
	(0.135)	(0.148)	(0.140)	(0.140)	(0.142)	(0.136)

(*continued*)

Table 3. (Continued)

	DestP = Prudential IndexC	DestP = Capital Requirement	DestP = Sector-Specific Capital Buffer	DestP = LTV Ratio	DestP = Reserve Requirements: Foreign	DestP = Reserve Requirements: Local
Core Deposits Ratio$_{t-1}$	0.071	0.066	0.069	0.070	0.061	0.070
	(0.352)	(0.354)	(0.358)	(0.352)	(0.356)	(0.355)
BIS Financial Cycle	0.017	0.018	0.018	0.015	0.019	0.019
(Destination Country)	(0.034)	(0.036)	(0.033)	(0.032)	(0.033)	(0.033)
BIS Business Cycle	0.551*	0.706**	0.710**	0.681**	0.705**	0.726**
(Destination Country)	(0.324)	(0.315)	(0.321)	(0.328)	(0.333)	(0.332)
Cumulative Effect DestP	6.076**	17.667*	2.319	3.694	1.412	5.435**
	(2.601)	(9.702)	(2.828)	(4.044)	(2.407)	(2.603)
Observations	2,885	2,885	2,885	2,885	2,885	2,885
Adjusted R^2	0.025	0.025	0.022	0.022	0.022	0.023
No. of Destination Countries	35	35	35	35	35	35
No. of Banks	6	6	6	6	6	6

Notes: This table reports the effects of changes in destination-country regulation and firm characteristics on log changes in total loans by destination country. The data are quarterly from 2000:Q1 to 2013:Q4 for a panel of bank holding companies and are globally consolidated at the parent level. DestP refers to the changes in regulation in the destination country of the loan. For more details on the variables, see table 8 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include bank, country, and time fixed effects. Standard errors (in parentheses) are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

certain foreign jurisdictions may have provided such competitive advantages; while domestic banks are adjusting to the new capital requirements by curbing credit growth, Canadian banks (that already operate under relatively strict capital levels) could have more easily adjusted lending and increased market share.

Our findings also indicate that the lending growth rate in a destination country increases under tighter local reserve requirements (cumulative effect) and stricter LTV limits (second lag of the policy). Surprisingly, this suggests that LTV limits, a product-level regulation that often targets borrower demand, may also affect credit supply. There could be two possibilities for this positive outcome. Recall that our data do not distinguish lending by entity type. This might be important in cases where the limits apply to a specific group of institutions, which does not include the Canadian affiliates. That would allow them to maintain (or increase) lending. Alternatively, it is possible that Canadian banks increase other types of lending that are not targeted by the LTV limits. Akinci and Olmsted-Rumsey (2015) and Cerutti, Classens, and Laeven (2016) provide some cross-country evidence of LTV limits having an impact on overall credit growth. Therefore, if a limit tightening is associated with a broader slowdown, then foreign banks can take advantage of this and increase lending more broadly.[11]

3.2 Outward Transmission and Bank Characteristics

Our next specification explores more directly the role of bank characteristics by interacting them with $DestP_{j,t}$ such that

$$\begin{aligned}\Delta Y_{b,j,t} = \alpha_0 &+ (\alpha_1 DestP_{j,t} + \alpha_2 DestP_{j,t-1} + \alpha_3 DestP_{j,t-2}) \\ &+ \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + (\beta_1 DestP_{j,t} \cdot X_{b,t-1} \\ &+ \beta_2 DestP_{j,t-1} \cdot X_{b,t-1} + \beta_3 DestP_{j,t-2} \cdot X_{b,t-1}) \\ &+ f_j + f_t + f_b + \varepsilon_{b,j,t}, \end{aligned} \tag{2}$$

[11] We also ran a baseline specification that includes all prudential measures (and their lags) simultaneously, while excluding the aggregated *PruC* measure. We also excluded the interbank exposure limits and concentration ratios from this specification, since these measures lack sufficient variation in our sample. The results of this specification (not presented for brevity) are almost identical to our findings in table 3, with positive and significant cumulative effects for capital requirements and local reserve requirements.

where all variable definitions are the same as in equation (1), but the balance sheet characteristics are now interacted with the destination-country prudential policy changes and its lags. Among the findings reported in table 4 for this specification, we focus on the cumulative effect (i.e., over the three periods) of the prudential measure and its interactions ($(\alpha_1 + \alpha_2 + \alpha_3)$ and $(\beta_1 + \beta_2 + \beta_3)$). Exploring the prudential index first, we show that better-capitalized Canadian banks increase their lending growth rates under tighter conditions, given the positive interaction term with the tier 1 ratio. The prudential index results also point to the fact that banks that are more internationally active increase lending under such conditions (results are similar when regressions include country-time fixed effects instead of separate country and time fixed effects).

According to table 4, the effect of some of the prudential measures depends on their interaction with the banks' characteristics. For instance, sector-specific capital requirements (SSCBs) are effective at slowing down the growth rate of credit for banks that rely on core deposits. Since SSCBs tend to target retail lending activity (such as mortgage credit, auto loans, or credit cards), it is not surprising to observe that the retail-oriented banks (which rely on deposits) are most affected.[12] The effect is opposite for banks that rely on intragroup funding, suggesting that head-office funding attenuates the negative effect of SSCB on foreign credit extension. Table 4 also indicates a positive relation between LTV tightening and foreign lending growth rates, given the statistical significance of the cumulative policy effect. While the effect depends on bank characteristics (size, liquidity, and foreign activity), it broadly confirms the baseline results.

3.3 Extension: The Effect of Prudential Requirement on Foreign Lending via Affiliates

If a global Canadian bank follows a diverse business model, one that supports both cross-border and affiliate lending, then such a bank may be better positioned to manage regulatory changes in a given jurisdiction, compared with a bank that lends to that jurisdiction

[12] One should interpret the SSCB findings cautiously, since SSCB changes are infrequent over the sample period.

Table 4. Outward Transmission of Policy (bank character interactions)

	DestP = Prudential IndexC	**DestP = Capital Requirements**	**DestP = Sector-Specific Capital Buffer**	**DestP = LTV Ratio**	**DestP = Reserve Requirements: Foreign**	**DestP = Reserve Requirements: Local**
Destination-Country Regulation DestP_{t}	−135.632	−417.905	122.622	310.584***	−461.511**	−139.083*
	(108.377)	(278.540)	(171.578)	(96.801)	(216.681)	(81.663)
Destination-Country Regulation DestP_{t-1}	77.496	529.251	−37.275	−24.686	169.189	−48.745
	(103.963)	(329.417)	(164.511)	(90.363)	(259.695)	(88.057)
Destination-Country Regulation DestP_{t-2}	24.499	143.010	−359.363*	101.997	376.308**	176.612
	(89.743)	(266.809)	(204.726)	(130.919)	(142.100)	(116.807)
Log Total Assets_{t-1}	−9.145	−11.604*	−9.277	−6.570	−8.506	−9.735
	(6.107)	(6.213)	(5.910)	(6.163)	(5.999)	(5.874)
Tier 1 Ratio_{t-1}	−0.735	−0.483	−0.515	−0.557	−0.640	−0.635
	(1.025)	(0.983)	(1.046)	(1.073)	(1.009)	(1.024)
Illiquid Assets Ratio_{t-1}	−0.129	−0.031	−0.139	−0.100	−0.138	−0.119
	(0.263)	(0.305)	(0.259)	(0.274)	(0.265)	(0.267)
International Activity_{t-1}	0.027	0.039	0.072	−0.027	0.059	0.075
	(0.175)	(0.181)	(0.162)	(0.173)	(0.169)	(0.168)
Net Intragroup Funding_{t-1}	0.242*	0.267*	0.218	0.216	0.229	0.219
	(0.138)	(0.149)	(0.136)	(0.143)	(0.140)	(0.130)
Core Deposits Ratio_{t-1}	0.064	−0.047	0.041	0.030	0.054	0.042
	(0.344)	(0.366)	(0.346)	(0.374)	(0.362)	(0.368)
BIS Financial Cycle (Destination Country)	0.010	0.018	0.013	0.011	0.020	0.018
	(0.036)	(0.037)	(0.036)	(0.034)	(0.033)	(0.033)
BIS Business Cycle (Destination Country)	0.541	0.709**	0.720**	0.678*	0.612*	0.542
	(0.338)	(0.310)	(0.314)	(0.335)	(0.360)	(0.322)

(*continued*)

Table 4. (Continued)

	DestP = Prudential IndexC	DestP = Capital Require-ments	DestP = Sector-Specific Capital Buffer	DestP = LTV Ratio	DestP = Reserve Requirements: Foreign	DestP = Reserve Require-ments: Local
Log Total Assets*DestP	−0.842	0.232	20.243	−24.760***	−4.588	−3.385
	(5.699)	(30.395)	(15.314)	(7.278)	(6.578)	(7.054)
Tier 1 Ratio*DestP	1.791**	−10.809	−0.762	1.164	2.852***	1.878**
	(0.838)	(6.452)	(2.205)	(1.203)	(0.833)	(0.817)
Illiquid Assets Ratio*DestP	0.403	−1.818	−1.214	1.247***	−0.355	0.851**
	(0.372)	(2.317)	(0.845)	(0.204)	(0.457)	(0.365)
International Activity*DestP	0.751**	0.0746	−1.371*	2.019***	−0.495	0.444
	(0.351)	(1.392)	(0.682)	(0.574)	(0.583)	(0.575)
Net Intragroup Funding*DestP	0.488	−0.778	30.842***	−5.836	−5.933	−10.537
	(2.179)	(3.608)	(8.008)	(19.266)	(4.690)	(8.388)
Core Deposits Ratio*DestP	−0.169	−0.096	−0.785***	−0.709	0.693	0.267
	(0.314)	(1.210)	(0.283)	(0.491)	(0.711)	(0.228)
Cumulative Effect DestP	−33.637	254.355	−274.016	387.895***	83.985	−11.217
	(93.386)	(524.41)	(272.45)	(134.101)	(149.908)	(111.375)
Observations	2,885	2,885	2,885	2,885	2,885	2,885
Adjusted R^2	0.23	0.26	0.19	0.22	0.19	0.23
No. of Destination Countries	35	35	35	35	35	35
No. of Banks	6	6	6	6	6	6

Notes: This table reports the effects of changes in destination-country regulation and firm characteristics, business and financial cycles, and their interactions on log changes in total loans by destination country. The data are quarterly from 2000:Q1 to 2013:Q4 for a panel of bank holding companies and are globally consolidated at the parent level. DestP refers to the cumulative changes in regulation in the destination country of the loan. For more details on the variables, see table 8 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include bank, country, and time fixed effects. Standard errors (in parentheses) are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

only via an affiliate. The reason is that the affiliate is more likely to be directly exposed to regulatory changes. Since our lending variable captures both cross-border lending (booked by the headquarters in Canada) and credit extension by foreign affiliates (of the Canadian banks via branches or subsidiaries), we can investigate more precisely the benefits of this flexibility by considering the portion of lending conducted via affiliates.

We differentiate between the two types of lending by considering the relative importance of affiliate lending for a given bank in a particular country.[13] Specifically, we define a new indicator variable $Affiliate_{b,j,t}$, which equals one if more than 95 percent of bank b's lending in country j at time t is done via an affiliate.[14] We then interact $Affiliate_{b,j,t}$ with policy changes in the destination country ($DestP_{j,t}$) where all variable definitions are the same as in equation (2). In addition, we experiment with using the change in "total lending" and "total non-bank private lending" as different dependent variables. The empirical specification is

$$\begin{aligned}\Delta Y_{b,j,t} = \alpha_0 &+ (\alpha_1 DestP_{j,t} + \alpha_2 DestP_{j,t-1} + \alpha_3 DestP_{j,t-2}) \\ &+ (\alpha_4 DestP_{j,t} \cdot Affiliate_{b,j,t} + \alpha_5 DestP_{j,t-1} \cdot Affiliate_{b,j,t-1} \\ &+ \alpha_6 DestP_{j,t-2} \cdot Affiliate_{b,j,t-2} + \alpha_7 X_{b,t-1} + f_j + f_t \\ &+ f_b + \varepsilon_{b,j,t}. \qquad (3)\end{aligned}$$

Table 5 reports the results from this specification.[15] For brevity, we only discuss the cumulative effects related to $DestP_{j,t}$ and its interaction with $Affiliate_{b,j,t}$. From panel A we observe that a tightening of the overall prudential index, and especially the LTV requirement, increases the growth of foreign lending, but not if it is through the affiliate ($DestP$ is positive but the interaction of $DestP$ *$Affiliate$ is negative). The stand-alone positive effect of the policy could be

[13]This is especially an issue for cross-border lending, since some Canadian banks only engage in affiliate lending in certain countries.

[14]We have also considered 90 percent and 100 percent as a cut-off for *Affiliate*. Our results are robust to these changes.

[15]We do not interact the bank characteristics with $DestP_{j,t}$ or $Affiliate_{b,j,t}$ in order to keep the specification as simple as possible. However, our main conclusions regarding $DestP_{j,t}$ and its interactions with $Affiliate_{b,j,t}$ are robust to including such interactions in the analysis.

Table 5. Outward Transmission of Policy with Alternate Dependent Variable Definitions

	DestP = Prudential IndexC	DestP = Capital Requirements	DestP = Sector-Specific Capital Buffer	DestP = LTV Ratio	DestP = Reserve Requirements: Foreign	DestP = Reserve Requirements: Local
A. Total Lending						
Destination-Country Regulation $DestP_t$	5.545***	11.981**	−2.309	5.300	−2.549	3.350*
	(1.871)	(5.285)	(3.151)	(5.026)	(1.555)	(1.853)
Destination-Country Regulation $DestP_{t-1}$	1.768	5.786	−3.407	−0.930	1.887	1.598
	(1.827)	(5.148)	(2.673)	(2.819)	(3.417)	(3.106)
Destination-Country Regulation $DestP_{t-2}$	1.164	1.519	3.315	6.105**	−1.140	0.480
	(1.911)	(6.062)	(3.052)	(2.687)	(1.939)	(1.253)
Cumulative Effect DestP	8.477***	19.286	−2.401	10.475***	−1.802	5.428
	(2.784)	(11.806)	(3.151)	(2.993)	(4.161)	(3.331)
$DestP_t$*$Affi_t$	−3.791*	−4.267	3.014	−5.333	4.382***	−1.873
	(2.141)	(5.660)	(3.536)	(3.618)	(1.097)	(2.077)
$DestP_{t-1}$*$Affi_{t-1}$	−1.355	−1.376	5.489*	−0.832	0.621	0.790
	(2.117)	(7.185)	(3.068)	(3.748)	(3.035)	(2.718)
$DestP_{t-2}$*$Affi_{t-2}$	−0.308	1.836	−1.319	−4.384	4.171**	1.136
	(2.187)	(5.895)	(4.212)	(3.674)	(1.938)	(1.686)
Cumulative Effect DestP*Affi	−5.454*	−3.806	7.184	−10.551***	9.174***	0.054
	(2.953)	(9.668)	(4.615)	(3.375)	(3.144)	(3.187)
Observations	2,885	2,885	2,885	2,885	2,885	2,885
Observations with Affi = 1	1,721	1,721	1,721	1,721	1,721	1,721
Adjusted R^2	0.025	0.024	0.021	0.022	0.021	0.022

(*continued*)

Table 5. (Continued)

	DestP = Prudential IndexC	DestP = Capital Requirements	DestP = Sector-Specific Capital Buffer	DestP = LTV Ratio	DestP = Reserve Requirements: Foreign	DestP = Reserve Requirements: Local
B. Non-bank Private Lending						
Destination-Country Regulation $DestP_t$	2.833	11.982**	−0.436	2.956	0.363	−13.368**
	(3.437)	(5.310)	(6.989)	(15.129)	(2.313)	(5.137)
Destination-Country Regulation $DestP_{t-1}$	2.608	8.138	−11.959	−5.739	6.671*	15.030*
	(5.235)	(6.244)	(9.329)	(11.679)	(3.625)	(8.725)
Destination-Country Regulation $DestP_{t-2}$	−6.518	8.855**	11.163	−1.829	−11.761**	−15.778***
	(4.000)	(3.989)	(7.070)	(6.242)	(5.111)	(5.181)
Cumulative Effect DestP	−1.078	28.975***	−1.231	−4.612	−4.727	−14.116***
	(5.714)	(9.371)	(10.934)	(27.861)	(4.034)	(4.568)
$DestP_t$*$Affi_t$	−1.627	−11.047	1.697	−6.105	−1.605	14.504**
	(3.893)	(7.077)	(6.664)	(15.796)	(2.283)	(5.471)
$DestP_{t-1}$*$Affi_{t-1}$	−3.978	−2.426	12.445	7.066	−8.610	−17.626*
	(5.586)	(9.103)	(10.799)	(12.180)	(5.278)	(8.772)
$DestP_{t-2}$*$Affi_{t-2}$	6.367*	−10.771	−13.653*	4.158	13.137***	17.473***
	(3.652)	(7.479)	(6.803)	(6.350)	(3.844)	(5.036)
Cumulative Effect DestP*Affi	0.762	−24.244*	−0.743	5.118	2.921	14.352***
	(5.198)	(13.390)	(2.372)	(28.362)	(5.152)	(4.395)
Observations	2,589	2,589	2,589	2,589	2,589	2,589
Observations with Affi = 1	2,354	2,354	2,354	2,354	2,354	2,354
Adjusted R^2	0.042	0.043	0.041	0.041	0.041	0.047
No. of Destination Countries	35	35	35	35	35	35
No. of Banks	6	6	6	6	6	6

Notes: This table reports the effects of changes in destination-country regulation on log changes in total loans and log changes in "non-bank private loans" by destination country, while accounting for affiliate vs. cross-border lending. The variable *Affiliate* is set at one if more than 95 percent of the lending of a bank in a given country is done through an affiliate. The definition of *Affiliate* is based on the type of loan being considered in the dependent variable. The number of bank-country-time observations where *Affiliate = 1* is provided. The data are quarterly from 2000:Q1 to 2013:Q4 for a panel of bank holding companies. DestP refers to the cumulative changes in regulation in the destination country of the loan. For more details on the variables, see table 8 in the appendix. Each column gives the result for the regulatory measure. All specifications include bank characteristics, but those coefficients are not presented for brevity. All specifications also include bank, country, and time fixed effects. Standard errors (in parentheses) are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

driven by cross-border lending.[16] However, the LTV effect disappears once the dependent variable is defined as the change in non-bank private lending (panel B). This remains a surprise: if Canadian banks circumvent LTV rules in foreign jurisdictions, perhaps via cross-border lending, then one should expect this to show up more strongly for non-bank private loans (which includes the types of loans most likely to be covered under LTV limits, such as mortgages).[17] Finally, we note that tighter capital requirements slow down the growth of non-bank private lending if it is mainly extended by Canadian banks' foreign affiliates (panel B). However, tighter local reserve requirements are less effective (positive and significant interaction term), suggesting that foreign retail and corporate credit do not necessarily depend on locally sourced deposits.

3.4 Extension: Impact of Home-Country Policy Changes

It is possible that regulatory policy changes in Canada also influence Canadian banks' lending abroad. Therefore, we investigate how changes in the home-country prudential instruments (*HomeP*) affect destination-country lending. Since only capital requirements and LTV limits changed in Canada over our sample period, we conduct the analysis on these two instruments. The regression specification is

$$\begin{aligned}\Delta Y_{b,j,t} = \alpha_0 &+ (\alpha_1 DestP_{j,t} + \alpha_2 DestP_{j,t-1} + \alpha_3 DestP_{j,t-2}) \\ &+ \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + (\beta_1 HomeP_{j,t} \cdot X_{b,t-1} \\ &+ \beta_2 HomeP_{j,t-1} \cdot X_{b,t-1} + \beta_3 HomeP_{j,t-2} \cdot X_{b,t-1}) \\ &+ f_j + f_t + f_b + \varepsilon_{b,j,t}. \qquad (4)\end{aligned}$$

In equation (4), the main coefficients of interest are β_1, β_2, and β_3 (since *HomeP* is bank invariant at a given time period, it is captured by the time fixed effect). We focus on the cumulative coefficients ($\beta_1 + \beta_2 + \beta_3$) for ease of comparison. The results from table 6

[16] Of course, the fact that cross-border lending is a relatively small component of Canadian banks' foreign lending (and the fact that some Canadian banks do not engage in cross-border lending to certain jurisdictions at all) makes it difficult to fully establish this conclusion.

[17] Measurement and/or sample-size issues could also be a potential explanation for this observation.

Table 6. Outward Transmission of Policy Changes in the Home Country

	Home/DestP = Prudential Index	**Home/DestP = Capital Requirements**	**Home/DestP = Loan-to-Value Ratio**
Destination-Country Regulation DestP_t	3.629**	9.884**	1.933
	(1.467)	(4.224)	(3.581)
Destination-Country Regulation DestP_{t-1}	1.214	4.997	−1.378
	(1.489)	(3.792)	(1.659)
Destination-Country Regulation DestP_{t-2}	0.957	2.413	3.634**
	(1.335)	(4.522)	(1.608)
Log Total Assets_{t-1}	−11.990	−13.492*	−11.808*
	(7.570)	(7.464)	(6.319)
Tier 1 Ratio_{t-1}	−0.917	−0.775	−0.970
	(1.024)	(1.033)	(1.120)
Illiquid Assets Ratio_{t-1}	−0.301	−0.362	−0.159
	(0.302)	(0.340)	(0.232)
International Activity_{t-1}	0.266	0.199	0.129
	(0.214)	(0.191)	(0.181)
Net Intragroup Funding_{t-1}	0.144	0.226	0.154
	(0.108)	(0.157)	(0.115)
Core Deposits Ratio_{t-1}	0.350	0.252	0.179
	(0.356)	(0.389)	(0.332)
BIS Financial Cycle (Destination Country)	0.016	0.021	0.014
	(0.034)	(0.034)	(0.031)
BIS Business Cycle (Destination Country)	0.572*	0.698**	0.669**
	(0.329)	(0.315)	(0.327)
Log Total Assets*HomeP	23.666**	28.817	31.276**
	(10.740)	(20.182)	(14.161)
Tier 1 Ratio*HomeP	−0.279	−16.616	2.289
	(4.272)	(14.137)	(3.597)
Illiquid Assets Ratio* HomeP	−0.682	−2.786*	−0.803
	(0.771)	(1.591)	(0.842)
International Activity* HomeP	−1.044	−3.312**	−0.883
	(0.679)	(1.477)	(0.659)
Net Intragroup Funding* HomeP	0.265	−0.493	0.171
	(0.527)	(1.722)	(0.724)
Core Deposits Ratio* HomeP	−0.042	1.743*	−0.149
	(0.462)	(0.933)	(0.424)
Cumulative Effect DestP	5.801**	17.294*	4.188
	(2.701)	(9.458)	(4.219)

(*continued*)

Table 6. (Continued)

	Home/DestP = Prudential Index	**Home/DestP = Capital Requirements**	**Home/DestP = Loan-to-Value Ratio**
Observations	2,885	2,885	2,885
Adjusted R^2	0.027	0.028	0.021
No. of Destination Countries	35	35	35
No. of Banks	6	6	6

Notes: This table reports the effects of changes in both destination- and home-country regulation, along with firm characteristics on log changes in total loans by destination country. The data are quarterly from 2000:Q1 to 2013:Q4 for a panel of bank holding companies and are globally consolidated at the parent level. DestP refers to the changes in regulation in the destination country of the loan, while HomeP captures changes in Canadian regulations. For more details on the variables, see table 8 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include bank, country, and time fixed effects. Standard errors (in parentheses) are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

indicate that tighter prudential home requirements push certain types of banks to lend abroad, as observed via the interaction terms between the bank characteristics and *HomeP*. The effect comes from both higher Canadian capital requirements and LTV limits. However, the mechanism through which the requirements affect lending might differ.

Considering capital changes first, more internationally oriented and less liquid banks decrease foreign lending growth rates when capital requirements in Canada are tightened. It could be that these banks engage in foreign lending activities with higher risk weights, and under higher capital requirements these banks shift away from such activities. However, Canadian banks that are more retail deposit funded increase foreign lending growth rates under tighter domestic capital requirements. This might be driven by that fact that the Canadian capital requirement changes in our sample (2012:Q1 and 2013:Q1) coincided with periods in which Canadian banks were engaged in foreign acquisitions. As discussed in Chapman and Damar (2015), since the 2008 crisis, Canadian banks took advantage of their relatively healthy balance sheets (and the official Canadian liquidity facilities) to engage in foreign acquisitions

that boosted their foreign loan book. Hence, the link between capital requirement tightenings in Canada and foreign lending by Canadian banks might be a product of both the timing and contents of the policy change.

Regarding LTV requirements, table 6 indicates that larger Canadian banks increase their foreign lending growth rates when LTV requirements are tightened at home. Specifically, the coefficient of *LogTotalAssets*HomeP* implies that a tightening of Canadian LTV requirements *and* a bank moving from the median asset size to the 75th percentile will be associated with Can$780 million of total new foreign lending.[18] This increase is likely driven by a desire to compensate for slower mortgage credit growth at home. We note that the LTV limits in Canada apply at the borrower level and are only for domestic mortgage lending, and as such are unrelated to the banks' activities abroad. Therefore, the impact of home-country macroprudential policy actions on foreign lending is likely to be dependent on the nature and scope of the policy tool being used, and the timing of the policy change with regard to global (or at least regional) conditions.

3.5 Extension: Inward Transmission of Foreign Policies

Finally, we briefly investigate the transmission of foreign policy changes into Canada via globally active Canadian banks ("inward transmission"). As discussed above, there could potentially exist another inward channel, via foreign subsidiaries and bank branches that operate in Canada. However, the economic magnitudes of this channel are likely small. For instance, over the sample period, the average annual share of domestic lending by foreign subsidiaries and branches is about 4.5 percent and 1.5 percent, respectively. Given the limited role played by these institutions in the Canadian financial system, we limit our inward transmission exercise to large, globally active Canadian banks. We estimate the following model:

[18]The difference between the median and 75th percentile of *LogTotalAssets* is 0.41 (20.16 – 19.75). Multiplying this by the coefficient of *LogTotalAssets*HomeP* yields 12.823, implying $(\textit{foreign lending at time } t/\textit{foreign lending at time } t-1) = e^{(12.823/100)} = 1.136$. Using the average value of foreign lending then results in 780 million.

$$\begin{aligned}\Delta Y_{b,t} = \alpha_0 &+ (\alpha_1 ExpP_{b,t} + \alpha_2 ExpP_{b,t-1} + \alpha_3 ExpP_{b,t-2}) \\ &+ \alpha_4 X_{b,t-1} + (\beta_1 ExpP_{b,t} \cdot X_{b,t-1} + \beta_2 ExpP_{b,t-1} \cdot X_{b,t-1} \\ &+ \beta_3 ExpP_{b,t-2} \cdot X_{b,t-1}) + f_t + f_b + \varepsilon_{b,j,t}, \end{aligned} \tag{5}$$

where $Y_{b,t}$ is domestic (i.e., Canadian) lending of bank b at time t and $ExpP_{b,t}$ is "foreign-exposure-weighted regulation" faced by bank b at time t. $ExpP_{b,t}$ is an average of all foreign regulation indexes at time t, weighted by the total assets and liabilities of bank b in each country. We use the same bank characteristics as in previous specifications. All regressions include time and bank fixed effects. We present the results in table 7. According to the inward channel, tighter foreign capital and LTV requirements are associated with a slowdown in the growth rate of domestic lending by the six largest Canadian global banks (cumulative effect of each policy is negative). These results are in line with the outward analysis from the previous tables, indicating that as foreign regulatory requirements become stricter, Canadian banks increase the foreign lending growth rate to those destination countries and also reduce the growth of domestic credit.

4. Concluding Remarks

We study how regulatory changes in prudential requirements affect the cross-border activities of Canadian banks. Our results show that the effect depends on the regulatory instrument being adjusted, and that bank characteristics determine the extent to which the institutions can maintain or increase lending under stricter conditions.

We find that when a destination country tightens requirements, Canadian banks react by increasing the lending growth rate to that jurisdiction, and the effect is particularly strong for changes in capital requirements. Our results suggest that banks with higher tier 1 ratios increase lending at the destination country, even under tighter prudential requirements. We also show that the effect of prudential policies depends on a global bank's business model. While stricter LTV limits are associated with an increase in foreign lending, the growth of credit slows in destination countries where Canadian banks mainly operate via affiliates. We extend the analysis

Table 7. Inward Transmission of Foreign Policy (bank character interactions)

	DestP = Prudential IndexC	**DestP = Capital Requirements**	**DestP = Sector-Specific Capital Buffer**	**DestP = LTV Ratio**	**DestP = Reserve Requirements: Foreign**	**DestP = Reserve Requirements: Local**
Foreign-Exposure-Weighted Regulation $ExpP_t$	−464.492**	−1268.882	640.904	−6703.659**	−988.182	−377.556
	(152.098)	(783.469)	(4916.893)	(1833.235)	(5085.386)	(777.615)
Foreign-Exposure-Weighted Regulation $ExpP_{t-1}$	−163.995	−184.589	−1282.058	−4037.766	322.496	−371.962
	(84.317)	(1077.507)	(3128.073)	(2320.005)	(843.897)	(224.971)
Foreign-Exposure-Weighted Regulation $ExpP_{t-2}$	60.322	−2981.396***	1216.430	1561.088	1876.443	−1392.669
	(197.240)	(243.664)	(1646.000)	(1739.008)	(3378.243)	(859.248)
Log Total $Assets_{t-1}$	−3.627	−4.635	−2.721	−6.283	−4.674	−1.473
	(4.431)	(5.572)	(4.958)	(4.684)	(4.548)	(3.370)
Tier 1 $Ratio_{t-1}$	−0.533	−0.627	−0.519	−0.314	−0.484	−0.566
	(0.336)	(0.435)	(0.406)	(0.409)	(0.447)	(0.423)
Illiquid Assets $Ratio_{t-1}$	−0.575**	−0.551**	−0.512**	−0.503**	−0.549**	−0.512**
	(0.181)	(0.147)	(0.146)	(0.128)	(0.191)	(0.143)
International $Activity_{t-1}$	0.034	0.049	0.003	0.040	0.036	0.005
	(0.107)	(0.092)	(0.090)	(0.094)	(0.091)	(0.085)
Net Intragroup $Funding_{t-1}$	−0.093	−0.092	−0.172	−0.302	−0.155	−0.109
	(0.334)	(0.302)	(0.316)	(0.356)	(0.303)	(0.275)
Core Deposits $Ratio_{t-1}$	0.584**	0.575**	0.522**	0.495**	0.542**	0.561**
	(0.185)	(0.154)	(0.135)	(0.176)	(0.201)	(0.156)
Log Total Assets*ExpP	33.131	203.307***	−100.054	483.811**	−44.859	114.363
	(13.499)	(13.751)	(76.951)	(87.442)	(181.494)	(46.803)

(*continued*)

Table 7. (Continued)

	DestP = Prudential IndexC	DestP = Capital Requirements	DestP = Sector-Specific Capital Buffer	DestP = LTV Ratio	DestP = Reserve Requirements: Foreign	DestP = Reserve Requirements: Local
Tier 1 Ratio*ExpP	−2.439	−2.138	44.149	−18.581	−14.197	−14.079
	(5.521)	(34.525)	(172.377)	(78.943)	(337.161)	(16.341)
Illiquid Assets Ratio*ExpP	−0.838	5.604**	10.425	−7.037	11.821	−3.634*
	(0.965)	(1.071)	(14.455)	(5.004)	(28.121)	(5.952)
International Activity*ExpP	−1.012	1.869*	6.852	−4.308	−22.734**	0.979
	(1.623)	(2.111)	(4.339)	(3.729)	(7.331)	(2.379)
Net Intragroup Funding*ExpP	−10.106	−156.952***	−3.654	−150.727	126.798	−54.585
	(13.221)	(32.607)	(296.656)	(131.868)	(529.361)	(42.742)
Core Deposits Ratio*ExpP	−0.272	−1.617*	7.228	7.047	−10.813	8.294
	(4.416)	(7.472)	(38.137)	(21.472)	(14.461)	(11.155)
Cumulative Effect ExpP	−568.164	−4434.867***	575.276	−9180.335**	1210.756	−2142.186
	(288.026)	(582.313)	(4940.084)	(3297.954)	(3863.114)	(1512.602)
Observations	324	324	324	324	324	324
Adjusted R^2	0.244	0.232	0.234	0.268	0.233	0.271
No. of Banks	6	6	6	6	6	6

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in total loans. The data are quarterly from 2000:Q1 to 2013:Q4 for a panel of domestic bank holding companies. Foreign-exposure-weighted regulation ExpP is calculated as the weighted average of changes in foreign regulation where the weights are total assets and liabilities of the bank in the respective foreign country. For ExpP and its interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags. For more details on the variables, see table 8 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the table. Standard errors (in parentheses) are clustered by bank. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

to show that home policies push Canadian banks to lend more abroad, and confirm the existence of a limited inward transmission channel.

The spillovers identified in our study do not necessarily represent a negative outcome. If the regulatory policies' original intention was to shift lending away from risky entities, then one could interpret our results as a beneficial outcome, since better-capitalized Canadian banks may have ended up increasing foreign lending. However, if the original intention was to slow down the growth of credit (i.e., lean against the cycle), then our results potentially point to the need for closer international policy coordination. Raising awareness of individual jurisdictions, on how their policy actions may affect the credit cycles of other countries, may be warranted.

Appendix

Table 8. Construction of Balance Sheet Independent Variables

Variable Name	Report Form Description	Source
Illiquid Assets $\text{Ratio}_{b,t-1}$	[All Loans Net of Allowance for Impairment/Total Assets] * 100	Balance Sheet (M4).
Log Real $\text{Assets}_{b,t-1}$	Ln[Total Assets in 2012 Canadian Dollars]	Balance Sheet (M4). CPI is from the Bank of Canada.
Core Deposits $\text{Ratio}_{b,t-1}$	[Demand, Notice, and Time Deposits by Individuals/Total Assets] * 100	Balance Sheet (M4).
Tier 1 $\text{Ratio}_{b,t-1}$	[Tier 1 Risk-Based Capital/Risk-Weighted Assets] * 100	Basel Capital Adequacy Return (BCAR-BA).

(*continued*)

Table 8. (Continued)

Variable Name	Report Form Description	Source
Net Dut $To_{b,t-1}$	[(Total Head-Office Claims on Foreign Branches, Agencies, and Consolidated Subsidiaries – Total Head-Office Liabilities to Foreign Branches, Agencies, and Consolidated Subsidiaries)/Total Liabilities] * 100	Geographic Assets and Liabilities Booked in Canada (GQ). Total Liabilities from Balance Sheet (M4).
International $Ratio_{b,t-1}$	[(Total Foreign Assets + Total Foreign Liabilities)/(Total Assets + Total Liabilities)] * 100	Geographic Assets and Liabilities Booked in Canada (GQ). Total Assets and Total Liabilities from Balance Sheet (M4).

Table 9. LTV Changes in Canada over the Sample Period

Period	Direction	Details
2006:Q4	Loosening	From 95% to 100% on all home buyers
2007:Q1	Loosening	From 90% to 95% on refinancing activities
2008:Q4	Tightening	From 100% to 95% on all home buyers
2010:Q2	Tightening	From 95% to 80% on investment properties From 95% to 90% on refinancing activities
2011:Q1	Tightening	From 95% to 85% on refinancing activities
2012:Q3	Tightening	From 85% to 80% on refinancing activities

References

Akinci, O., and J. Olmsted-Rumsey. 2015. "How Effective are Macroprudential Policies? An Empirical Investigation." International Finance Discussion Paper No. 1136, Board of Governors of the Federal Reserve System.

Bank for International Settlements. 2014. "Debt and the Financial Cycle: Domestic and Global." In *84th Annual Report*, 65–84 (chapter IV) Basel, Switzerland: Bank for International Settlements.

Berrospide, J., R. Correa, L. Goldberg, and F. Niepmann. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from the United States." *International Journal of Central Banking* 13 (S1).

Buch, C., and L. Goldberg. 2017. "Cross-Border Prudential Policy Spillovers: How Much? How Important? Evidence from the International Banking Research Network." *International Journal of Central Banking* 13 (S1).

Cerutti, E., S. Classens, and L. Laeven. 2016. "The Use and Effectiveness of Macroprudential Policies: New Evidence." Forthcoming in *Journal of Financial Stability*.

Cerutti, E., R. Correa, E. Fiorentino, and E. Segalla. 2017. "Changes in Prudential Policy Instruments—A New Cross-Country Database." *International Journal of Central Banking* 13 (S1).

Chapman, J., and H. E. Damar. 2015. "International Banking and Liquidity Risk Transmission: Evidence from Canada." *IMF Economic Review* 63 (3): 455–78.

Chen, D. X., E. H. Damar, H. Soubra, and Y. Terajima. 2012. "Canadian Bank Balance-Sheet Management: Breakdown by Types of Canadian Financial Institutions." Bank of Canada Discussion Paper No. 2012-7.

Drehmann, M., C. Borio, and K. Tsatsaronis. 2011. "Anchoring Countercyclical Capital Buffers: The Role of Credit Aggregates." *International Journal of Central Banking* 7 (4): 189–240.

Ohls, J., M. Pramor, and L. Tonzer. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Germany." *International Journal of Central Banking* 13 (S1).

Ratnovski, L., and R. Huang. 2009. "Why Are Canadian Banks More Resilient?" IMF Working Paper No. 09/152.

International Banking and Cross-Border Effects of Regulation: Lessons from Switzerland*

Simone Auer, Maja Ganarin, and Pascal Towbin
Swiss National Bank

As part of the IBRN initiative on prudential spillovers, we study the effects of changes in foreign prudential measures on banks in Switzerland. For the average bank we find no evidence that the foreign prudential measures considered affect domestic lending growth or foreign funding growth. Meanwhile, the effects of foreign prudential measures differ across banks with different balance sheet characteristics. In particular, changes in foreign capital regulations do have significant effects on the domestic lending growth of banks with unfavorable liquidity positions (low core deposit ratios or high illiquid asset ratios). However, these effects remain quantitatively small, relative to the overall variability of lending growth.

JEL Codes: F42, G21, G28.

1. Introduction

The Swiss country study focuses on the "inward transmission" of foreign regulation, i.e., it analyzes the spillovers of foreign regulatory policies into the Swiss banking sector. More specifically, we study the effects of changes in foreign prudential measures on both domestic lending and foreign funding of banks in Switzerland.

The structure of the Swiss banking system makes Switzerland an interesting and special country for studying the cross-border effects of banking regulation on domestic lending and foreign funding of banks. The Swiss banking sector is large compared with the size of

*These are the personal views of the authors and not necessarily those of the Swiss National Bank. We thank an anonymous referee, the editors (Claudia Buch, Matthieu Bussière, and Linda Goldberg), the country teams of Poland and the United Kingdom, Jürg Blum, Reto Nyffeler, Guzel Valitova, and Dan Wunderli for useful comments. We are also very grateful to Simone Saupe for help with data-related questions.

the economy, and the international activity of banks in Switzerland is significant. At the same time, the business models across banks are heterogeneous. Indeed, with the exception of two big, global systemically important banks, international activities and domestic lending are conducted by largely separate types of banks. This implies that there may be little overlap between those banks that are a priori expected to be exposed to foreign regulation (through their international activity) and banks for which the main variable of interest—domestic lending—is important. Hence, for a large number of banks the potential for spillovers from foreign prudential measures to domestic lending is limited.

The analysis in this paper is based on consolidated banking statistics, covering the period 2002–13. The consolidation is given at the group level and, given the scope of Swiss consolidated banking statistics, is restricted to banks headquartered in Switzerland (henceforth referred to as domestic banks).

Our main results are as follows: Our first main result is there is little evidence that the foreign prudential measures considered affect domestic lending growth of the average Swiss bank, i.e., a Swiss bank with average balance sheet characteristics. In most specifications, the effects of foreign prudential measures on domestic lending growth are not significant. Given the small international exposures of domestic retail banks, which hold a market share of nearly two-thirds in the domestic lending market, our finding of no significant spillovers for the average bank is not surprising. However, the finding of no significant spillovers for the average bank in our sample does not necessarily imply that there is no potential for cross-border spillovers from foreign prudential regulation into the Swiss banking sector. For one, our data only cover domestic banks. We therefore cannot study potential effects on bank lending through affiliates of foreign banks. However, we expect such potential spillover effects to be small, as the market share in domestic lending by these banks is very small. For another, there is a potential for significant spillovers to the two big banks, given their large international exposures. While a separate investigation with these two banks would be interesting, it is unfortunately not possible, given the limited number of observations. Furthermore, prudential measures that are specifically targeted at global systemically important banks (e.g., organizational requirements, specific capital or liquidity

requirements) are not covered in the International Banking Research Network (IBRN) Prudential Instruments Database.

Our second main result is that, while there is little evidence for inward spillovers for the average bank, the effects of foreign prudential policies differ across banks with different balance sheet characteristics and that the variation can be linked to a bank's liquidity position. This heterogeneity is mainly observable in the response to changes in foreign capital requirements. We find robust evidence that banks with a better liquidity position, i.e., with a lower ratio of illiquid assets, decrease their domestic lending growth by less in response to a tightening of foreign capital requirements. Similarly, banks with a higher ratio of core deposits restrain their lending growth by less. These results hold for our baseline specification as well as two alternative specifications that either (i) exclude the two big banks or (ii) exclude wealth-management banks and focus on the growth of loans to non-banks. While these results are robust, such effects remain small when compared with the overall variability of lending growth.

Our third main result is that we also find little empirical evidence for spillovers on the funding side. Theoretically, our finding that the impact of foreign capital requirements on domestic lending growth depends on a bank's liquidity position could point to bank funding being a potential transmission channel. If foreign banks reduce their cross-border bank-to-bank lending as a result of higher capital requirements, domestic banks with a weak liquidity position may be particularly concerned. To investigate this hypothesis further, we analyze whether changes in foreign prudential measures affect foreign funding of domestic banks. A priori cross-border spillovers on foreign funding would seem more likely than on domestic lending, as the link between foreign funding and foreign prudential measures is more direct than the link between domestic lending and foreign prudential measures. Somewhat surprisingly, we find no evidence for such a hypothesis. Foreign prudential measures do not have a statistically significant effect on the foreign funding the average bank in Switzerland receives. The liquidity position of a bank does not seem to play a role either. A potential explanation is that we use data on the overall foreign funding a bank receives, as the split between bank and non-bank funding is not available. Overall foreign funding

is likely to be less sensitive to foreign bank regulation than foreign funding from banks.

Our paper is one of the first that considers the effect of foreign prudential measures on domestic lending in Switzerland. A number of papers have considered other determinants of domestic lending. Beutler et al. (2015) show that a bank's lending response to changes in domestic interest rates depends on their exposure to interest rate risk. Basten and Koch (2015) examine the effect of the countercyclical capital buffer activated in Switzerland on the pricing of mortgages. Among other things, they find that capital-constrained banks and mortgage-specialized banks raise their rates relatively more after an increase in the countercyclical capital buffer. Bichsel and Perrez (2005) show that there is evidence for a bank capital channel for smaller Swiss banks (those belonging to the lower 75 percent of the size distribution), but not for other banks. This suggests that the reaction of these banks' credit supply to a monetary policy shock depends on their capital. Junge and Kugler (2013) investigate the effect of higher capital requirements on the Swiss economy, including their effect on economic growth and lending. Rime (2001) and Bichsel and Blum (2004) investigate how bank capital requirements affect bank risk taking. In a cross-border context, Krogstrup and Tille (2015) investigate the determinants of Swiss franc lending by European banks.

The following section gives a more detailed overview of the Swiss banking sector and the data used in our analysis. Section 3 outlines our specifications and discusses the results. The last section concludes.

2. Stylized Facts and Data for Switzerland

2.1 Stylized Facts

The Swiss banking sector is large, especially when compared with the size of the economy. Based on data for end-2013, the aggregated total assets of all banks constitute around 540 percent of Swiss GDP. The assets of the two big, global systemically important banks (Credit Suisse and UBS) alone already account for around 290 percent of GDP, making the "too-big-to-fail" problem particularly relevant for Switzerland.

Table 1. Banking Groups in the Swiss Banking Sector

	No. of Institutions	Aggregate Balance Sheet Total	% of GDP
Domestic Big Banks	2	CHF 1,860 bn.	293
Domestic Retail Banks	103	CHF 970 bn	153
Domestic Wealth-Management Banks	58	CHF 220 bn.	34
Affiliates of Foreign Banks	120	CHF 380 bn	60
Total	283	CHF 3,440 bn.	541

Source: SNB. Consolidated data as of December 31, 2013.

Swiss banks can be divided into four main banking groups (see table 1): the domestic big banks, domestic retail banks, domestic wealth-management banks, and affiliates of foreign banks (subsidiaries and branches of banks with foreign headquarters).

- The *domestic big banks* have a diversified business model, both in terms of asset structure and in terms of geographical diversification. Loans make up around 50 percent of their assets, with 10 percent of their assets being loans to banks (see table 2). These banks have three main business areas: domestic retail banking, investment banking, and wealth management. Nearly 80 percent of their assets are foreign assets. When considering domestic loans, about 97 percent are loans to non-banks (mortgages and other loans) and 3 percent are loans to banks.
- *Domestic retail banks* have a less diversified business model and focus on domestic retail banking. Most of their assets are domestic (90 percent of total assets) and most of these domestic assets are loans (70 percent of total assets). Again, as for the big banks, about 97 percent of domestic loans are loans to non-banks.
- *Domestic wealth-management banks* focus on wealth management. Around 40 percent of their assets are loans. An important share of assets is invested in trading and financial assets. They have a significant international exposure, and foreign assets account for about 50 percent of their balance sheet.

Table 2. Composition of Banks' Balance Sheets

	Domestic Big Banks	**Domestic Retail Banks**	**Domestic Wealth-Management Banks (Including Private Banks)**	**Affiliates of Foreign Banks (Including Branches)**
Balance Sheet Composition (in % of Total Assets)				
Loans	51	74	42	55
Loans to Non-banks	42	69	22	35
Loans to Banks	10	5	21	20
Other	49	26	58	45
Geographical Breakdown (in % of Total Assets)				
Foreign Assets	78	10	54	53
Domestic Assets	22	90	46	47
Domestic Loans	17	70	12	16
Composition of Domestic Loans (in % of Domestic Loans)				
Domestic Loans to Non-banks	97	97	58	72
Domestic Loans to Banks	3	3	42	28

Source: SNB Banking Statistics. Consolidated data as of December 31, 2013.

Regarding the composition of domestic loans, the category of loans to banks is much more important for domestic wealth-management banks than for the big banks and the retail banks, with around 40 percent of all domestic loans going to banks.

- Finally, *affiliates of foreign banks* are also mainly involved in wealth management. Around 55 percent of their assets are loans (20 percent of their assets are loans to banks); the remaining assets mainly consist of liquid assets and financial assets. Their assets are also more or less evenly split between domestic and foreign markets. For domestic loans, loans to banks account for an important share (around 30 percent).

Regarding the market shares of the different groups of banks in the domestic loan market, domestic retail banks hold the biggest market share (63 percent), followed by the big banks (29 percent). Domestic wealth-management and foreign banks only play a minor role (8 percent). Foreign activity, in turn, is dominated by the big banks, which hold almost 80 percent of total foreign assets in the banking system.

Tables 2 and 3 show that among those banks for which domestic lending is an important business activity, only the two big banks also exhibit large international exposures. Domestic retail banks have a large market share in domestic lending, but little international exposures. Domestic wealth-management banks and affiliates of foreign banks have important international exposures but are basically not active in domestic lending.

2.2 Bank-Level Data

We use the following bank-level data for our regression analysis (the specifications are discussed in section 3). All bank-level data are taken from the Swiss National Bank (SNB) Monthly Banking Statistics, the Bank for International Settlements (BIS) consolidated banking statistics, and the supervisory reportings. All data are collected by the SNB. The bank-level data are confidential and can only be accessed at the SNB. A detailed description on the construction of the balance sheet variables is given in table 11 in the appendix.

Table 3. Market Shares by Bank and Asset Categories (in %)

	Domestic Big Banks	Domestic Retail Banks	Domestic Wealth-Management Banks (Including Private Banks)	Affiliates of Foreign Banks (Including Branches)
Foreign Assets	78	5	6	11
Mortgages	66	2	2	29
Other Loans	79	1	5	14
Loans to Banks	58	10	12	20
Domestic Assets	26	56	6	12
Total Domestic Loans	29	63	2	6
Mortages	29	67	1	3
Other Loans	29	51	6	14
Loans to Banks	14	37	19	30

Source: SNB Banking Statistics. Consolidated data as of December 31, 2013.

2.2.1 Dependent Variables

- $\Delta Y_{b,t}$ = change in log total domestic loans (i.e., the sum of mortgage loans, other loans, and loans to banks)

2.2.2 Balance Sheet Characteristics[1]

- Percentage of a bank's portfolio of assets that is illiquid ($IlliquidAssetsRatio_{b,t-1}$)
- Percentage of a bank's balance sheet financed with core deposits ($CoreDeposits_{b,t-1}$)
- Percentage of a bank's balance sheet equity to asset ratio ($BookEquityRatio_{b,t-1}$)[2]

[1]Because of data constraints, we are not able to include the net intragroup funding position used in other country studies as additional control.

[2]We use balance sheet equity net immaterial assets instead of regulatory capital. Because of the transition from Basel II to Basel III, the regulatory definitions of capital are not consistent across time. A bank with an unchanged balance sheet may have changes in its regulatory capital, just because definitions of regulatory capital change. Similarly, definitions of risk-weighted asset have changed, which is why we use total assets in the denominator.

- Log of a bank's total assets $(LogTotalAssets_{b,t-1})$
- Percentage of a bank's foreign assets plus foreign liabilities relative to total assets plus total liabilities $(InternationalRatio_{b,t-1})$

Summary statistics are shown in table 4.

2.2.3 Coverage

The data cover the time period from 2002:Q1 to 2013:Q4 on a quarterly basis. As we mainly use consolidated data, only domestic banks (i.e., banks headquartered in Switzerland) are part of the sample (columns 1–3 in tables 2 and 3).[3] Domestic banks account for about 90 percent of total domestic banking assets and around 95 percent of total domestic loans. Among these banks, the main data constraint is the availability of quarterly foreign exposures, which are collected from the BIS consolidated banking statistics. These data are available for only 18 domestic banks out of 263 reporting banks in 2013. These banks cover, however, a large share of total assets: specifically, they cover about 70 percent of total assets held by domestic banks, 50 percent of total domestic assets, and 90 percent of total foreign assets held by domestic banks.

2.2.4 Preparation and Cleaning of Data

Consolidated balance sheet statistics are only available at an annual frequency (from 2002 to 2005) or semi-annual frequency (from 2006 onward). To obtain a quarterly frequency, these data are linearly interpolated. The dependent variables are available at a quarterly frequency. They are, however, not fully consolidated, as they only cover the parent company, including foreign branches plus domestic subsidiaries but not foreign subsidiaries. Fully consolidated data on loans are only available at an annual frequency. We have compared the quarterly data employed with the fully consolidated annual data. For most banks these fully consolidated lending data give a similar picture as the lending data employed. For the two big banks

[3] Excluding foreign-owned banks means that we potentially miss an indirect spillover channel, as foreign banks have a 30 percent market share in the domestic interbank market.

Table 4. Summary Statistics on Bank Lending and Characteristics

	All Banks (N = 17)			**All Banks without Two Big Banks (N = 15)**			**All Banks without Wealth-Management Banks and the Variable "(Domestic or Foreign) Loans" Does *Not* Include Loans to Banks (N = 8)**		
	Mean	**Median**	**SD**	**Mean**	**Median**	**SD**	**Mean**	**Median**	**SD**
Variable	*Balance Sheet Data (for Each Bank b and Quarter t)*								
Observations									
Dependent Variables:									
Δ Domestic Loans	1.231	0.646	18.223	1.458	0.847	20.350	0.840	0.931	1.871
Δ Foreign Loans	0.552	0.481	20.002	0.706	0.667	21.975	1.926	1.452	17.032
Independent Variables:									
Log Total Assets	17.622	16.891	1.883	16.771	16.701	0.918	18.452	17.482	1.988
Book Equity Ratio (%)	7.643	7.784	3.742	9.008	8.396	2.849	6.331	6.766	3.803
Illiquid Assets Ratio (%)	95.100	98.064	6.990	94.403	97.855	7.575	96.225	98.588	4.827
International Activity (%)	50.749	53.886	29.697	42.702	45.151	27.972	39.564	23.710	32.454
Deposits Ratio (%)	12.650	4.563	14.693	14.435	3.578	15.940	20.835	26.016	13.876

Notes: This table provides summary statistics for bank balance sheet and lending data. Data are observed quarterly from 2002:Q1 to 2013:Q4. Banking data come from the SNB Banking Statistics and are reported at the consolidated level.

(UBS and Credit Suisse) deviations tend to be larger, particularly for interbank loans. There were no significant mergers in the sample considered.

To reduce sensitivity to outliers, we exclude observations where the absolute value of the dependent variable (log change of loans) exceeds 100 percent. This procedure reduces the number of observations by around 1 percent. All of the removed observations concern banks that belong to the group of wealth-management banks.

2.3 Data on Prudential Instruments

The following prudential instruments are considered in the IBRN Prudential Instruments Database described in Cerutti et al. (2017): (i) a prudential index (*PruC*) over the full group of prudential instruments, (ii) general capital requirements, (iii) sector-specific capital buffers,[4] (iv) loan-to-value ratio limits, (v) reserve requirements on foreign-currency deposits, (vi) reserve requirements on local-currency deposits, (vii) interbank exposure limits, and (viii) concentration limits.

We construct an exposure-weighted measure of these prudential instruments, $ExpP_{b,t}$, as described in Buch and Goldberg (2017). In particular, the exposure of a given bank to a given country is the ratio of the sum of assets and liabilities of that bank in that specific country over the sum of *total foreign* assets plus liabilities of that bank. For both the numerator and the denominator we use a rolling average of this ratio over the four preceding quarters. When constructing the weights, we only take into account the exposures to countries that are classified as core countries by the IBRN. If a given country has not yet (or never) introduced a specific prudential instrument, the observation is set equal to zero.

Table 5 shows that the geographical breakdown of foreign claims changed between 2002 and 2013. In fact, Swiss banks' claims to the United States in percentage of total foreign claims have decreased by around 15 percentage points. At the same time, Swiss banks have increased their exposure to Europe and offshore centers. Offshore centers are not covered by the prudential database. For the exposure-weighted measure, the changes in exposures imply that, on

[4]The countercyclical capital buffer is not included in the database.

Table 5. Geographical Breakdown of Foreign Claims (in %)

	2002:Q1	2013:Q4
Europe	33	39
United Kingdom	17	15
Germany	5	6
France	2	5
United States	51	35
Offshore	5	13
Developing Countries	4	8
Other	7	6

Source: BIS consolidated banking statistics.

average, in recent periods prudential measures used by the United States receive relatively less weight than in earlier periods.

The summary statistics of the prudential measures are shown in table 6. We exclude the local reserve requirements from further analysis, as changes in this instrument were to a large extent driven by monetary policy consideration and are also correlated with other monetary policy steps taken. In particular, the large change of the exposure-weighted measure of local reserve requirements in 2012:Q1 is driven by the European Central Bank's decision to cut local reserve requirements. Meanwhile, most reserve requirement changes on foreign-currency deposits occur in emerging markets, where they are used as active prudential policy instrument (Glocker and Towbin 2012).

3. Empirical Method and Regression Results

3.1 Baseline Analysis of Inward Transmission of Prudential Policies

We explore the effect of changes in regulation on banks' domestic loan growth, following the approach described in Buch and Goldberg (2017). We begin with the following regression specification:

IBRN Baseline Specification: *Inward transmission of exposure-weighted foreign regulation with balance sheet interaction terms (cf. table 7).*

Table 6. Summary Statistics on Changes in Prudential Instruments

Instrument	Base Data (Before Aggregating to Exposure-Weighted Measures)					Exposure-Weighted Observations
	No. of Country-Time Changes	No. of Country-Time Changes (Tightening)	No. of Country-Time Changes (Loosening)	No. of Bank-Time Changes	Proportion Base-MPP Non-zero	Proportion $ExpP_t$ Non-zero
Prudential Index	439	303	136	7,688	16.7	100.0
General Capital Requirements	65	65	15	907	2.5	26.6
Sector-Specific Capital Buffer	60	45	21	1,070	2.3	65.5
Loan-to-Value Ratio Limits	83	62	42	1,464	3.2	82.1
Reserve Requirements: Foreign	121	79	112	2,155	4.6	95.3
Reserve Requirements: Local	216	104	1	3,819	8.2	100.0
Interbank Exposure Limit	17	16	2	314	0.6	21.5
Concentration Ratio	28	26	0	512	1.1	44.5

Source: IBRN.
Notes: This table shows summary statistics on changes in prudential instruments for banks located in Switzerland over the period 2002:Q1–2013:Q4. Data on the instruments come from the IBRN Prudential Instruments Database described by Cerutti et al. (2017) and are at quarterly frequency. The number of changes in prudential instruments is reported on several dimensions, i.e., on the country-time level and on the bank-time level. The last column shows the share of prudential changes to total observations (i.e., the share of non-zero observations). The column "Exposure-Weighted Observations" is based on the underlying data on prudential changes in foreign countries (columns under the "Base Data" heading). The reported data are based on the regression sample.

$$\Delta Y_{b,t} = \alpha_0 + (\alpha_1 ExpP_{b,t} + \alpha_2 ExpP_{b,t-1} + \alpha_3 ExpP_{b,t-2}) + \alpha_4 X_{b,t-}1 + (\beta_1 ExpP_{b,t} \cdot X_{b,t-1} + \beta_2 ExpP_{b,t-1} \cdot X_{b,t-1} + \beta_3 ExpP_{b,t-2} \cdot X_{b,t-1}) + f_b + f_t + \epsilon_{b,t}, \quad (1)$$

where $\Delta Y_{b,t}$ is the log change in domestic lending of bank b at time t; $X_{b,t-1}$ is a vector of bank balance sheet characteristics, lagged by one period to avoid endogeneity problems; f_b is a bank fixed effect; and f_t is a time fixed effect. The prudential policy changes are captured by exposure-weighted prudential policy outside the home country ($ExpP_{b,t}$). The foreign-exposure-weighted prudential measure $ExpP_{b,t-1}$ is included contemporaneously and with two lags. We thereby allow for lags in the effect on lending growth for up to two quarters.

The interaction terms of balance sheet characteristics and prudential measures allow banks with different balance sheet characteristics to differ in their response to changes in foreign regulation.

We are mainly interested in two estimates. The first statistic is the response of domestic lending growth to changes in prudential regulation for the average bank. To characterize the average bank, we use the sample averages of bank balance sheet characteristics $\bar{X}$. We consider a horizon of three quarters. The marginal effect of the average bank is then given by

$$\widehat{\gamma} = \widehat{\alpha}_1 + \widehat{\alpha}_2 + \widehat{\alpha}_3 + \bar{X}(\widehat{\beta}_1 + \widehat{\beta}_2 + \widehat{\beta}_3), \quad (2)$$

where the coefficients correspond to the estimated values from equation (1) above. We use an F-test to test for joint significance. The corresponding results are reported in table 7, panel A. Analogously, we also compute marginal effects for banks at specific percentiles of the distribution of balance sheet characteristics by replacing $\bar{X}$ with the specific percentile value.

We also run a restricted regression specification which excludes balance sheet interaction terms (cf. table 7, panel B):

$$\Delta Y_{b,t} = c_0 + (c_1 ExpP_{b,t} + c_2 ExpP_{b,t-1} + c_3 ExpP_{b,t-2}) + c_4 X_{b,t-1} + f_b + f_t + \varepsilon_{b,t}. \quad (3)$$

The estimate of the response $(\widehat{c}_1 + \widehat{c}_2 + \widehat{c}_3)$ from this more parsimonious specification neglects slope heterogeneity across banks.

Table 7. Exposure-Weighted Inward Transmission of Regulation (IBRN baseline specification)

	Prudential IndexC (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Requirements: Foreign (5)	Interbank Exposure Limits (6)	Concentration Ratios (7)
A. IBRN Baseline Specification with Balance Sheet Interaction Terms: Marginal Effect at Mean of Balance Sheet Variables							
Foreign-Exposure-Weighted Regulation: Sum of Coefficients	−21.769 (20.727)	−85.406 (62.401)	174.959 (164.020)	81.432 (119.939)	213.452 (202.917)	−70.949 (79.550)	57.688 (92.876)
Foreign-Exposure-Weighted Regulation: Cont. Coefficients	−13.654 (10.405)	−24.432 (16.004)	44.964 (46.742)	45.166 (59.671)	−34.766 (164.566)	−2.294 (35.839)	5.176 (35.287)
Foreign-Exposure-Weighted Regulation: Coefficients at t–1	9.238 (12.179)	−4.490 (23.524)	−19.962 (83.511)	13.156 (64.103)	127.768 (90.201)	−2.797 (43.543)	70.615 (47.200)
Foreign-Exposure-Weighted Regulation: Coefficients at t–2	−17.353 (18.373)	−56.484 (56.640)	149.957 (138.005)	23.110 (64.375)	120.450* (70.775)	−65.858 (40.926)	−18.103 (65.175)
B. IBRN Baseline Specification without Balance Sheet Interaction Terms: Sum of Contemporaneous Term and Two Lags							
Foreign-Exposure-Weighted Regulation	−27.229 (24.285)	−60.975* (33.834)	135.473 (133.630)	103.650 (90.310)	−69.560 (114.474)	8.165 (37.552)	38.370 (32.823)
Observations	442	442	442	442	442	442	442
R^2	0.211	0.196	0.205	0.248	0.196	0.189	0.221
Adjusted R^2	0.026	0.007	0.018	0.071	0.007	−0.001	0.038
No. of Banks	16	16	16	16	16	16	16

(*continued*)

Table 7. (Continued)

	Prudential IndexC (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Requirements: Foreign (5)	Interbank Exposure Limits (6)	Concentration Ratios (7)
C. IBRN Baseline Specification with Balance Sheet Interaction Terms: Sum of Contemporaneous Term and Two Lags							
Foreign-Exposure-Weighted Regulation (ExpP)	−123.603	103.758	1914.038	944.883	−4312.035	926.969	−973.139
	(444.372)	(460.803)	(3072.680)	(1604.850)	(2689.219)	(1834.397)	(1677.365)
Log Total Assets$_{t-1}$	−12.576	−9.113	−6.732	−7.334	−10.895	−6.071	−7.103
	(8.177)	(7.914)	(7.540)	(8.044)	(7.103)	(7.170)	(6.999)
Book Equity Ratio$_{t-1}$	−1.276	−0.777	−1.094	−0.842	−1.259	−0.942	−1.225
	(1.269)	(1.256)	(1.281)	(1.220)	(1.272)	(1.387)	(1.297)
Illiquid Assets Ratio$_{t-1}$	0.107	0.357	0.103	0.148	0.002	0.142	0.170
	(0.428)	(0.364)	(0.359)	(0.312)	(0.456)	(0.347)	(0.437)
International Ratio$_{t-1}$	−0.393	−0.206	−0.017	−0.128	−0.300	−0.199	−0.244
	(0.369)	(0.406)	(0.330)	(0.403)	(0.311)	(0.359)	(0.395)
Core Deposits Ratio$_{t-1}$	−0.563	−0.521	−0.418	−0.049	−0.571	−0.387	−0.274
	(0.426)	(0.356)	(0.417)	(0.362)	(0.375)	(0.364)	(0.392)
Log Total Assets*ExpP	−0.501	10.225	−27.932	−142.964**	57.358	24.662	91.180
	(13.314)	(23.581)	(136.033)	(68.908)	(98.975)	(27.914)	(57.747)
Book Equity Ratio*ExpP	2.700	11.460	−15.407	−1.453	136.237**	−13.759	7.622
	(7.206)	(8.749)	(89.693)	(27.488)	(61.676)	(23.885)	(22.373)
Illiquid Assets Ratio*ExpP	1.003	−7.362**	−6.202	7.589	11.162	−11.923	−5.827
	(3.446)	(3.287)	(14.569)	(9.139)	(17.846)	(14.309)	(11.281)
International Ratio*ExpP	−0.566	2.578	−6.322	13.293*	16.288	−3.066	−0.361
	(1.499)	(2.572)	(13.089)	(6.829)	(10.949)	(3.787)	(6.023)
Core Deposits Ratio*ExpP	0.734	7.531*	−16.328	13.734	29.886	−0.167	1.293
	(2.390)	(4.220)	(25.603)	(10.493)	(18.911)	(5.164)	(8.998)
Observations	442	442	442	442	442	442	442
R^2	0.211	0.196	0.205	0.248	0.196	0.189	0.221
Adjusted R^2	0.026	0.007	0.018	0.071	0.007	−0.001	0.038
No. of Banks	16	16	16	16	16	16	16

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in total domestic loans. The data are quarterly from 2002:Q1 to 2013:Q4 for a panel of domestic bank holding companies (domestic owned). Foreign-exposure-weighted ExpP is calculated as the weighted average of changes in foreign regulation where the weights are total assets and liabilities of the bank in the respective foreign country. For more details on the variables, see table 11 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects.. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

The second estimate characterizes how the response to prudential measures varies across banks with different balance sheet characteristics. The impact of banks' balance sheet characteristics on the response of lending growth is given by the coefficient vector $(\widehat{\beta}_1 + \widehat{\beta}_2 + \widehat{\beta}_3)$. Joint significance is again assessed with an F-test. The statistics are reported in table 7, panel C.

In our baseline specification we include all banks for which data are available and focus on growth in total domestic lending, i.e., the sum of domestic mortgage loans, other domestic loans, and domestic loans to banks. To assess robustness, we run two alternative specifications. In the first alternative specification, we exclude the two big banks. In the second alternative specification, we focus on lending to non-banks and exclude the wealth-management banks. The two alternative specifications are discussed in section 3.2.

Our baseline specification provides no evidence for spillovers from foreign prudential measures for an average bank (cf. table 7, panel A). For a bank with average balance sheet characteristics, none of the different prudential measures have a statistically significant effect on domestic lending growth.

This finding is broadly confirmed if we run a restricted version of the baseline regression that excludes the interaction terms (cf. table 7, panel B). In this specification, a tightening in one (capital requirements) of the seven prudential indexes has a negative effect on domestic lending growth. In a specification that includes all considered prudential measures jointly, with the exception of the summary measure *PruC*, the effect of capital requirements remains significant. The evidence, however, is weak, as the coefficients in both specifications are only significant at the 10 percent significance level.

To test whether balance sheet characteristics influence the impact of foreign prudential measures on lending growth, we use a second statistic to test whether the cumulative effect of the interaction terms $(\beta_1 + \beta_2 + \beta_3)$ is significantly different from zero.

We find that banks with different balance sheet characteristics react differently to regulatory changes. In particular, the liquidity position of a bank seems to play a role. Table 7, panel C shows that banks with a higher ratio of illiquid assets restrain their lending growth by more than banks with a lower ratio following an

increase in foreign capital requirements. A possible explanation is that as a result of higher capital requirements, foreign banks reduce their interbank lending (also to Swiss banks). It seems reasonable to assume that banks with a large share of illiquid assets are particularly affected by this reduction in interbank lending, as they are considered less resilient. These banks might hence be induced or forced to restrain their lending growth.

Similarly, banks with a higher ratio of core deposits (and therefore more stable funding) restrain their lending growth less than those with a lower ratio when foreign capital requirements are increased. The intuition for this result could be that banks with more stable funding are less susceptible to cross-border funding conditions, i.e., are less affected if foreign banks cut their interbank lending growth following changes in foreign prudential policies.

However, the magnitude of these effects is relatively small. The total effect $\hat{\gamma}$ according to equation (2) is –112 for a bank that has an illiquid assets ratio equal to the 75th percentile (99 percent illiquid assets) and otherwise average balance sheet characteristics. The median absolute change (excluding zero observations) of the exposure-weighted capital requirements measure is 0.013. An increase of that size implies a decrease in domestic lending growth by about 0.5 percent per quarter over three quarters (–112 * 0.013/3). This is relatively small compared with the standard deviation of quarterly growth rates in domestic lending, which amounts to about 20 percent (see table 4).[5] The effect for a bank with a core deposits ratio at the 25th percentile (0.3 percent core deposits) and otherwise average balance sheet characteristics is of similar size and amounts to about 0.6 percent per quarter over three quarters. Both effects are statistically significant.

We also find some role for other bank balance sheet characteristics. These results are, however, not robust across different specifications. Hence, our findings suggest that balance sheet characteristics other than the illiquid assets and core deposits ratio only play a limited role.

[5]In some cases, however, the effect can be sizable: the 90th percentile absolute change is 0.3 (excluding zeros). An increase of that size implies a decrease in domestic lending by 11 percent per quarter over three quarters.

3.2 Exploration of Alternative Specifications of Inward Transmission of Regulation

To check for robustness, we run two alternative regressions of the baseline specification in this subsection. We find that the main results for the illiquidity ratio and the core deposits ratio are robust across different specifications. That is, there is some evidence that banks with a higher illiquid assets ratio and a lower core deposits ratio restrain their lending growth more than banks with a lower illiquid assets ratio or higher core deposits ratio following a tightening of foreign capital regulation.

Finally, we run a second specification that analyzes prudential spillovers on the funding side of banks' balance sheets. We find no significant effect of foreign prudential regulation on foreign funding of domestic banks. There is therefore no evidence for the hypothesis that the variation in banks' lending response to foreign prudential measures may be related to foreign banks reducing their interbank lending to domestic banks.

Country-Specific Alternative Specification 1.1: *Without big banks.*

In a first alternative specification, we exclude the domestic big banks. This is to check whether the results are driven by the big banks, which have a more diversified business model (in terms of both business activity and geographical exposure) than domestic retail and wealth-management banks. We use the same dependent variable as in the baseline specification.

Our results for the average bank indicate that out of the seven prudential measures, increases in foreign capital requirements have a significant negative effect on domestic lending growth (cf. table 8, panel A). This result holds both when we evaluate the interaction terms of the baseline specification at their mean values of the balance sheet characteristics and when we use the restricted specification without interaction terms. However, the effect of changes in foreign capital requirements is, although statistically significant, typically not very large. It implies a decrease in domestic lending growth by 1 percent per quarter over three quarters for the median absolute change (excluding zero observations) of the exposure-weighted capital requirements measure of the sample (266 * 0.012/3).

Table 8. Exposure-Weighted Inward Transmission of Regulation (country-specific alternative specification 1.1: without big banks)

	Prudential IndexC (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Requirements: Foreign (5)	Interbank Exposure Limits (6)	Concentration Ratios (7)
A. Country-Specific Alternative Specification 1.1 with Balance Sheet Interaction Terms: Marginal Effect at Mean of Balance Sheet Variables							
Foreign-Exposure-Weighted Regulation	−17.272	−266.683***	205.906	−16.063	209.791	−66.277	78.080
	(29.503)	(96.712)	(175.899)	(150.732)	(263.381)	(91.285)	(105.824)
B. Country-Specific Alternative Specification 1.1 with Balance Sheet Interaction Terms: Sum of Contemporaneous Term and Two Lags (Coefficients on Foreign-Exposure-Weighted Regulation and Balance Sheet Variables as in Table 7, Panel C)							
Log Total Assets*ExpP	1.842	−46.970*	−118.843	−28.085	120.020	28.596	109.235
	(17.244)	(28.041)	(179.152)	(98.536)	(123.392)	(35.343)	(72.198)
Book Equity Ratio*ExpP	3.962	10.085	−22.811	34.278	165.918**	−16.378	12.236
	(7.796)	(11.975)	(101.305)	(38.132)	(65.519)	(24.749)	(24.821)
Illiquid Assets Ratio*ExpP	1.278	−13.115**	−3.080	13.119	18.560	−13.763	−5.759
	(3.900)	(5.940)	(16.052)	(10.381)	(19.059)	(15.520)	(12.431)
International Activity*ExpP	−0.726	2.763	−4.870	18.147**	22.763	−3.778	0.319
	(1.773)	(3.129)	(14.855)	(9.019)	(13.830)	(4.127)	(6.789)
Core Deposits Ratio*ExpP	0.578	12.884*	−16.159	14.838	40.569*	−1.148	2.430
	(2.680)	(6.735)	(27.910)	(13.039)	(21.331)	(5.606)	(9.801)
Observations	350	350	350	350	350	350	350
R^2	0.245	0.262	0.243	0.294	0.237	0.222	0.256
Adjusted R^2	0.013	0.035	0.010	0.078	0.003	−0.017	0.027
No. of Banks	14	14	14	14	14	14	14

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in total loans. The data are quarterly from 2002:Q1 to 2013:Q4 for a panel of domestic bank holding companies (excluding the big banks). Foreign-exposure-weighted ExpP is calculated as the weighted average of changes in foreign regulation where the weights are total assets and liabilities of the bank in the respective foreign country. For more details on the variables, see table 11 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects.. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Our two main results about the impact of balance sheet characteristics on the transmission of foreign regulatory measures continue to hold (cf. table 8, panel B). First, banks with a high ratio of illiquid assets restrain their lending growth more following an increase in capital regulation. Second, banks with a high ratio of core deposits restrain their lending growth less than banks with a lower ratio after an increase in capital regulation.

Country-Specific Alternative Specification 1.2: *Without loans to banks and without wealth-management banks.*

In the second alternative specification, we exclude loans to banks and focus on growth in loans to non-banks. As domestic wealth-management banks have only a small market share in the segment for loans to non-banks (see table 3), we exclude these banks as well. We thereby constrain our analysis to growth in loans to the non-bank sector and banks which are strongly involved in the credit market.

For the average bank we find no evidence for an effect of foreign regulation on growth of domestic lending to non-banks (cf. table 9, panel A). In particular, we no longer find a significantly negative effect of an increase in foreign capital requirements on domestic lending growth. This result holds both when we evaluate the interaction terms of the baseline specification at their mean values of the balance sheet characteristics and when we use the restricted specification without interaction terms.[6] Overall, this suggests that the results for the average bank from specification 1.1 are not robust across specifications.

As in the two previous specifications, we find evidence that banks with a high ratio of illiquid assets restrain their lending growth by more when foreign capital regulations are increased (cf. table 9, panel B). In this specification, banks with a high ratio of core deposits do not react statistically differently than banks with a lower ratio to changes in foreign capital requirement; they do, however, restrain their lending growth less to increases in concentration limits.

[6]We have found significant effects in specification 1.1. As specification 1.2 excludes loans to banks, a possible explanation is that the result was driven by volatile interbank lending. However, in a separate specification that focuses on bank loans (not reported), we also do not find a significant effect of foreign capital requirements on domestic lending. This suggests that the effect of foreign capital requirements on domestic lending is not robust.

Table 9. Exposure-Weighted Inward Transmission of Regulation (country-specific alternative specification 1.2: without loans to banks, without wealth-management banks)

	Prudential IndexC (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Requirements: Foreign (5)	Interbank Exposure Limits (6)	Concentration Ratios (7)
A. Country-Specific Alternative Specification 1.2 with Balance Sheet Interaction Terms: Marginal Effect at Mean of Balance Sheet Variables							
Foreign-Exposure-Weighted Regulation	2.514	1.258	−36.523	−31.568	123.018*	−9.264	−30.622*
	(5.715)	(6.023)	(91.098)	(25.910)	(71.148)	(15.989)	(17.364)
B. Country-Specific Alternative Specification 1.2 with Balance Sheet Interaction Terms: Sum of Contemporaneous Term and Two Lags (Coefficients on Foreign-Exposure-Weighted Regulation and Balance Sheet Variables as in Table 7, Panel C)							
Log Total Assets*ExpP	−2.449	−6.396**	−7.514	10.434	−51.078*	2.845	14.702
	(2.512)	(3.033)	(32.817)	(19.785)	(29.889)	(7.013)	(11.898)
Book Equity Ratio*ExpP	−0.547	−2.483*	−20.311	18.776	−2.756	1.700	5.110
	(1.001)	(1.445)	(21.075)	(13.922)	(13.776)	(3.088)	(5.203)
Illiquid Assets Ratio*ExpP	−0.768	−1.594**	2.887	−2.119	2.955	1.127	−3.590
	(0.670)	(0.759)	(4.899)	(2.804)	(6.276)	(1.769)	(2.384)
International Activity*ExpP	0.277	0.280	−0.901	2.725	2.881	0.314	0.869
	(0.221)	(0.275)	(2.391)	(1.676)	(1.881)	(0.434)	(0.744)
Core Deposits Ratio*ExpP	0.606	0.194	−3.587	7.303	−0.044	0.747	4.413***
	(0.399)	(0.499)	(2.759)	(4.603)	(3.882)	(0.675)	(1.685)
Observations	259	259	259	259	259	259	259
R^2	0.253	0.260	0.242	0.248	0.233	0.238	0.308
Adjusted R^2	−0.053	−0.044	−0.068	−0.060	−0.081	−0.074	0.025
No. of Banks	7	7	7	7	7	7	7

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in non-bank loans. The data are quarterly from 2002:Q1 to 2013:Q4 for a panel of domestic bank holding companies (excluding wealth-management banks). Foreign-exposure-weighted ExpP is calculated as the weighted average of changes in foreign regulation where the weights are total assets and liabilities of the bank in the respective foreign country. For more details on the variables, see table 11 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects.. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Country-Specific Specification 2: *Inward transmission of regulation on domestic banks' foreign funding with balance sheet interaction terms (cf. table 10).*

In a second specification, we shift the focus from growth in domestic lending to growth in foreign funding. The funding of banks may be directly affected by foreign prudential measures, e.g., by interbank exposure limits or concentration limits. But it could also be affected indirectly. Foreign capital requirements, for example, may induce foreign banks to reduce their balance sheets, which may include interbank positions.

Our dependent variable is the log change in total liabilities of bank b in country j at time t. Thus, in contrast to the baseline specification above, the regression equation is now defined on a bilateral instead of a foreign-exposure-weighted basis. This significantly increases the number of observations. In this specification we explore the effect of changes in regulation in a foreign country on domestic banks' funding growth. Again, we look at three different sub-specifications. The first specification involves all banks, the second specification excludes the big banks, and the third specification excludes the wealth-management banks.[7]

The regression specification is as follows:

$$\begin{aligned}\Delta Z_{b,j,t} = \alpha_0 &+ (\alpha_1 \mathit{FundP}_{b,j,t} + \alpha_2 \mathit{FundP}_{b,j,t-1} + \alpha_3 \mathit{FundP}_{b,j,t-2}) \\ &+ \alpha_4 X_{b,t-1} + (\beta_1 \mathit{FundP}_{b,j,t} \cdot X_{b,t-1} + \beta_2 \mathit{FundP}_{b,j,t-1} \cdot X_{b,t-1} \\ &+ \beta_3 \mathit{FundP}_{b,j,t-2} \cdot X_{b,t-1}) + f_b + f_t + \epsilon_{b,t}, \end{aligned} \tag{4}$$

where $\Delta Z_{b,j,t}$ is the log change in funding received by bank b from country j at time t; $X_{b,t-1}$ is a vector of bank balance sheet characteristics, lagged by one period to avoid endogeneity problems; f_b is a bank fixed effect; and f_t is a time fixed effect. The prudential policy changes in a given country j are captured by $\mathit{FundP}_{b,j,t}$. This bilateral foreign prudential measure $\mathit{FundP}_{b,j,t-1}$ is included contemporaneously and with two lags. We thereby allow for lags in the effect on funding for up to two quarters.

[7] Note that because foreign interbank liabilities are only available for the most recent period, we are unable to run this regression without interbank liabilities, i.e., we are unable to run this alternative specification analogous to the ones including domestic lending growth as the dependent variable.

Table 10. Inward Transmission of Regulation on Domestic Banks' Foreign Funding—Bank Variables Interactions (country-specific alternative specification 2: all banks)

	Prudential IndexC (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Requirements: Foreign (5)	Interbank Exposure Limits (6)	Concentration Ratios (7)
A. Country-Specific Alternative Specification 2 with Balance Sheet Interaction Terms: Marginal Effect at Mean of Balance Sheet Variables							
Funding-Country Regulation (FundP)	−0.004	0.163	0.016	0.002	−0.037	−0.017	0.002
	(0.024)	(0.101)	(0.047)	(0.064)	(0.034)	(0.086)	(0.072)
B. Country-Specific Alternative Specification 2 with Balance Sheet Interaction Terms: Sum of Contemporaneous Term and Two Lags							
Funding-Country Regulation (FundP)	0.500	0.257	−1.078	0.796	0.442	2.468	1.707
	(0.412)	(1.169)	(0.732)	(1.074)	(0.779)	(1.802)	(1.526)
Log Total Assets$_{t-1}$	−0.072*	−0.091**	−0.079**	−0.077*	−0.076*	−0.078**	−0.078**
	(0.039)	(0.040)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)
Book Equity Ratio$_{t-1}$	0.009	0.007	0.007	0.008	0.008	0.008	0.008
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Illiquid Assets Ratio$_{t-1}$	−0.004***	−0.003***	−0.003***	−0.003***	−0.003***	−0.003***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
International Activity$_{t-1}$	0.004**	0.004**	0.004**	0.004**	0.004**	0.004**	0.004**
	(0.002)	(0.002)	(0.002)	().002)	(0.002)	(0.002)	(0.002)
Core Deposits Ratio$_{t-1}$	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

(*continued*)

Table 10. (Continued)

	Prudential IndexC (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Requirements: Foreign (5)	Interbank Exposure Limits (6)	Concentration Ratios (7)
Log Total Assets*FundP	−0.018	−0.069	0.029	−0.032	−0.005	−0.098	−0.078
	(0.019)	(0.063)	(0.034)	(0.046)	(0.034)	(0.080)	(0.073)
Book Equity Ratio*FundP	−0.014	0.037	0.022	−0.018	−0.023	−0.060	−0.040
	(0.010)	(0.026)	(0.018)	(0.027)	(0.021)	(0.046)	(0.037)
Illiquid Assets Ratio*FundP	0.003	0.001	0.002	0.003	0.001	0.007	0.010*
	(0.002)	(0.007)	(0.004)	(0.005)	(0.003)	(0.012)	(0.006)
International Activity*FundP	0.000	0.010	0.005*	0.000	−0.002	−0.002	0.000
	(0.002)	(0.007)	(0.003)	(0.005)	(0.003)	(0.008)	(0.004)
Core Deposits Ratio*FundP	−0.003	0.016	0.011*	−0.005	−0.006	−0.009	0.000
	(0.003)	(0.013)	(0.006)	(0.009)	(0.005)	(0.015)	(0.008)
Observations	30,417	30,417	30,417	30,417	30,417	30,417	30,417
Adjusted R^2	0.007	0.006	0.006	0.006	0.006	0.005	0.005
No. of Banks	16	16	16	16	16	16	16

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in total liabilities in funding countries. The data are quarterly from 2002:Q1 to 2013:Q4 for a panel of domestic bank holding companies. FundP refers to the changes in regulation in the funding country of the domestic bank (i.e., the country where the bank holds liabilities). For FundP and its interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding F-statistics for joint significance in parentheses. For more details on the variables, see table 11 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects.. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

We are again interested in two main estimates. The first estimate is the response of foreign funding growth to changes in prudential regulation for an average bank. The second estimate describes how this response varies across banks with different balance sheet characteristics.

Looking at the response of the average bank, the baseline specification shows no evidence for spillovers from prudential measures (cf. table 10, panel A). None of the prudential measures have a statistically significant effect. Moreover, we find no evidence that balance sheet characteristics have an impact on the results. In particular, the liquidity position of a bank does not seem to play a role. The finding of no spillovers is somewhat surprising, given that the link between foreign funding growth and foreign prudential measures is more direct than the link between domestic lending growth and foreign prudential measures. A potential explanation is that we use data on the overall foreign funding a bank receives, as the split between bank and non-bank funding is not available. Total foreign funding is likely to be less sensitive to foreign bank regulation than foreign funding from banks.

4. Concluding Remarks

Overall, we find that there are no strong spillovers from foreign prudential regulation on domestic banks, both on the lending side and on the funding side. For the average bank we find no evidence that the foreign prudential measures considered affect domestic lending growth or foreign funding growth. Meanwhile, the effects of foreign prudential measures differ across banks with different balance sheet characteristics. In particular, changes in foreign capital regulations do have significant effects on the domestic lending growth of banks with unfavorable liquidity positions (low core deposit ratios or high illiquid asset ratios). However, these effects remain quantitatively small relative to the overall variability of lending growth.

The results suggest that the foreign prudential measures considered do not compromise Switzerland's own prudential policies regarding domestic lending growth. A potential explanation is that although Switzerland has a large and internationally active banking sector, international and domestic activity are conducted by largely separate types of banks, with the important exception of the two

big banks. While there is a potential for spillovers for the two big banks, the limited number of observations does not allow for a study focusing on such a restricted sample. Furthermore, prudential measures targeted at global systemically important banks (e.g., organizational requirements, specific capital or liquidity requirements) are not covered in the IBRN Prudential Instruments Database.

Appendix

Table 11. Construction of Balance Sheet Variables

Variable Name	Report Form Description	Source	Notes
Dependent Variables:			
Δ Log Domestic Loans$_t$	Δ Log of Sum of Domestic Amounts Due from Banks, Domestic Amounts Due from Customers, and Domestic Mortgage Loans	SNB Montly Banking Statistics, Form MONA-M011	Loans from Foreign Subsidiaries Excluded
Δ Log Domestic Loans Non-Banks$_t$	Δ Log of Sum of Domestic Amounts Due from Customers and Domestic Mortgage Loans	SNB Monthly Banking Statistics, Form MONA-M011	Loans from Foreign Subsidiaries Excluded
Independent Variables:			
Illiquid Assets Ratio$_t$	One minus (Liquid Assets/Total Assets)	Supervisory Reporting, Forms AU1xx, AUH1xx	
Log Total Assets$_t$	Log Total Assets	Supervisory Reporting, Forms AU1xx, AUH1xx	
Core Deposits Ratio$_t$	Amounts Due to Customers in Savings or Deposit Accounts/Total Assets	Supervisory Reporting, Forms AU1xx, AUH1xx	
Book Equity Ratio$_t$	Book Equity Net of Immaterial Assets/Total Assets	Supervisory Reporting, Forms AU1xx, AUH1xx	
International Ratio$_t$	(Total Foreign Assets + Total Foreign Liabilities)/(Total Assets + Foreign Liabilities)	SNB Consolidated Banking Statistics, Forms KONZ-A31x	
Exposure-Weighted Prudential Policy Measure	See Main Text	IBRN Prudential Instruments Database SNB Consolidated Banking Statistics (ASTA), Immediat Risk, Forms ASTA-B1xx.	

References

Basten, C., and C. Koch. 2015. "Higher Bank Capital Requirements and Mortgage Pricing: Evidence from the Countercyclical Capital Buffer (CCB)." BIS Working Paper No. 511 (September).

Beutler, T., R. Bichsel, A. Bruhin, and J. Danton. 2015. "The Impact of Interest Rate Risk on Bank Lending." Working Paper No. 15.05, Swiss National Bank, Study Center Gerzensee (November).

Bichsel, R., and J. Blum. 2004. "The Relationship between Risk and Capital in Swiss Commercial Banks: A Panel Study." *Applied Financial Economics* 14 (8): 591–97.

Bichsel, R., and J. Perrez. 2005. "In Quest of the Bank Lending Channel: Evidence for Switzerland using Individual Bank Data." *Swiss Journal of Economics and Statistics* 141 (2): 165–90.

Buch, C., and L. Goldberg. 2017. "Cross-Border Prudential Policy Spillovers: How Much? How Important? Evidence from the International Banking Research Network." *International Journal of Central Banking* 13 (S1).

Cerutti, E., Correa, R., Fiorentino, and E. Segalla. 2017. "Changes in Prudential Policy Instruments—A New Cross-Country Database." *International Journal of Central Banking* 13 (S1).

Glocker, C., and P. Towbin. 2012. "Reserve Requirements for Price and Financial Stability: When Are They Effective?" *International Journal of Central Banking* 8 (1): 65–114.

Junge, G., and P. Kugler. 2013. "Quantifying the Impact of Higher Capital Requirements on the Swiss Economy." *Swiss Journal of Economics and Statistics* 149 (3): 313–56.

Krogstrup, S., and C. Tille. 2015. "On the Roles of Different Foreign Currencies in European Bank Lending." CEPR Discussion Paper No. 10845.

Rime, B. 2001. "Capital Requirements and Bank Behaviour: Empirical Evidence for Switzerland." *Journal of Banking and Finance* 25 (4): 789–805.

International Banking and Cross-Border Effects of Regulation: Lessons from Chile*

Alejandro Jara and Luis Cabezas
Central Bank of Chile

In this paper we apply the inward transmission approach described in Buch and Goldberg (2017) to a selected group of internationally active banks in Chile for the 2002:Q2–2013:Q4 sample period. We find that the spillover effects generated by changes in the prudential policy abroad have a positive but relatively weak impact on domestic lending. When comparing the two inward approaches suggested by Buch and Goldberg (2017), the spillovers transmitted through the exposure-weighted prudential policy are stronger and economically more significant than those through the foreign subsidiary relationship. This result is robust to different specifications, and might suggest that foreign subsidiaries in Chile behave just like domestic banks, as they have to comply with the local regulation in the same way as local banks. Above all, capital requirements appear to be the most significant prudential policy affecting domestic lending.

JEL Codes: E32, F32, F34, G21, G15.

1. Introduction

As a result of the global financial crisis, the main international jurisdictions around the world have implemented important changes to their banking regulations. Among others, these changes are part of

*We are grateful to Claudia Buch, Linda Goldberg, Matthieu Bussière, Claudio Raddatz, and an anonymous referee for their excellent comments and suggestions. We also would like to thank Faruk Miguel and colleagues in the Monetary and Financial Statistical Department at the Central Bank of Chile for answering many questions related to the external exposure of Chilean banks; and we thank colleagues at the Bank's Financial Research Unit for their helpful comments at different stages of this research. The usual disclaimer applies. Corresponding author (Jara): ajara@bcentral.cl. Cabezas: lcabezas@bcentral.cl.

the Basel III proposal (capital, liquidity, etc.) and the Dodd-Frank and European Market Infrastructure Regulation (EMIR) initiatives in the United States and Europe, respectively. Several of these changes have been promoted by the Basel Committee on Banking Supervision and the Financial Stability Board, and have a mandatory implementation calendar for jurisdictions that are members of these groups.

The Chilean banking system fared very well during the global financial crisis, so there was no perception of an immediate need to reform its regulation and supervision. But Chile is an open economy with an important presence of subsidiaries of internationally active banks and with an incipient, but increasing, presence of local banks in the region. Moreover, some parent banks of these subsidiaries are systemically important at the global level, making the Chilean banking system especially sensitive to changes in the international banking regulation.

At the local level, the framework that regulates Chilean banks has seen no major reform since 1997. Although this framework is similar to Basel I in many respects, it is more demanding in terms of its definition of capital (tier 1 and tier 2) and the limits imposed. In addition, market risk regulation is in compliance with the 1996 Basel I amendment, and a leverage cap—similar to the one recently introduced in Basel III—has been an integral part of the Chilean banking regulation for over two decades. Moreover, liquidity risk exposures have been subject to prudential limits since the early 2000s, and are now in line to be regulated with the Basel III approach.

Therefore, it is fair to say that the Chilean supervisory and regulatory authorities have followed a conservative approach regarding the banking system. In fact, the active role played by independent rating agencies and the use of internal models to evaluate risks suggested in Basel II were never implemented in Chile, as they most probably would have lowered the levels of capital requirements. Despite this conservative approach, the Chilean regulatory authorities seek to meet higher international standards. Indeed, the General Banking Act that regulates banks in Chile is currently under revision and will probably be updated in line with the Basel III proposal. Similarly, the resolution setting could also be reformed, as suggested by International Monetary Fund (2011) and Larraín (2015).

In this article we address the following questions: Could the new banking regulation being implemented around the world affect the domestic lending behavior of banks in Chile? If so, how is this effect being transmitted? Are subsidiaries of foreign banks more likely to respond to these changes? Can even domestically owned banks be dependent on their actual exposure to different jurisdictions? What type of prudential instruments are more likely to generate spillover effects over the domestic banking system? Are these regulatory spillovers symmetric across different types of credit? How important are banks' balance sheets' characteristics in enhancing or reducing these effects?

To address these questions, we apply the inward transmission approach described in Buch and Goldberg (2017) to a selected group of internationally active Chilean banks for the 2002:Q2–2013:Q4 sample period. In particular, we study whether different prudential policies undertaken abroad have any impact on Chile's domestic lending. The inward transmission approach allows us to study two potential channels of regulatory spillovers: the transmission of policy through the international exposure of banks as well as the transmission via affiliates of foreign-owned banks. In the first case, regulatory spillovers are potentially transmitted through the assets and liabilities that each bank holds in the different foreign jurisdictions around the world; in the second, foreign-owned banks can potentially spill over the regulatory policies undertaken in the country where the parent bank is based.

Our main findings are that the spillover effects of changes in the prudential policy abroad have a relatively weak impact on domestic lending. However, a tightening in the prudential policy abroad tends to be associated with an increase in domestic lending. When comparing the two methodologies outlined above, we find stronger and economically more significant spillovers when looking at the exposure-weighted prudential policy rather than at the parent/subsidiary relationship. This result is robust to different specifications and might suggest that foreign subsidiaries in Chile behave just like domestic banks, as they have to comply with the local regulation in the same way as local banks. Above all, capital requirements appear to be the most significant prudential policy affecting domestic lending.

Table 1. The Structure of Chilean Banks (as of the end of 2013)

	Big and Medium	Retail	Treasury	Total
Number of Banks	12	3	8	23
Domestically Owned Banks	7	3	2	12
Foreign-Owned Banks	5	0	6	11
Total Assets (Billions of US$)	274	4	9	287
Domestically Owned Banks	172	4	4	180
Foreign-Owned Banks	102	0	5	107

Source: Authors' calculations based on the Superintendency of Banks and Financial Institutions and Jara and Oda (2015).
Note: This table reports the number of active banks and their total assets by cluster as of the end of 2013.

2. Data and Stylized Facts for Chile

The Chilean banking system is characterized by a high degree of heterogeneity, in terms of size, business orientation, and funding structure. Traditionally, banks in Chile are classified in four different categories: big, medium, retail, and treasury banks (Jara and Oda 2015). Big and medium-sized banks are the standard commercial banks that participate in all market segments (corporate, consumer, and mortgage credits). By the end of 2013, these banks consisted of twelve institutions, seven of which were domestically owned and five subsidiaries of foreign banks. As a whole, they account for more than 95 percent of total assets (table 1). On the other hand, all retail banks are domestically owned, relatively small in size, and focused on households' finance (consumer and mortgage loans). Finally, treasury institutions are mainly subsidiaries of foreign banks whose core activity is to provide investment banking services (corporate finance business and derivatives).

In addition to the differences in size, market focus, and ownership structure, Chilean banks differ in terms of their degree of international exposure. In fact, while treasury banks hold the highest relative level of assets and liabilities overseas, the international activity of retail banks is almost negligible. Since the purpose of this article is

to study potential prudential spillovers of foreign regulation into the domestic lending market, we constrain our analysis to the sub-group of big and medium banks. We leave aside the retail and treasury banks because of their small impact on domestic lending and, in the case of retail banks, also because of their lack of foreign exposure.

Additionally, we deal with the issue of mergers and acquisitions of banks which, over the past two decades, resulted in a substantial drop in the number of banks and a significant increase in the participation of foreign banks in the Chilean banking system. Notwithstanding, the most important mergers and acquisitions occurred during the 1990s and early 2000s (Ahumada and Marshall 2001), and therefore they have a minor impact in this study. For the mergers and acquisitions that did occur during the period of our analysis (2002:Q2–2013:Q4), we followed an eclectic approach. If two banks with their headquarters in the same country merged, we created a fictitious bank, as if both institutions had been merged for the entire sample period (similarly to that suggested in Aiyar et al. 2014). By contrast, if the merger occurred between institutions owned by banks of different origin, we kept these institutions separate. In the latter case, we added a dummy variable that identifies the first four quarters when the merger began in order to control for the effect generated by the merger on lending growth rates. Finally, for the acquisitions, we were especially careful in identifying when the relevant jurisdiction where the banks' headquarters were located changed, an issue that is particularly important when studying spillovers via foreign affiliates.

As a result, we ended up with an unbalanced panel of fourteen banks for the implementation of the inward transmission of policy through international exposures, and six banks for the implementation of the inward transmission via foreign affiliates of foreign-owned banks.

2.1 Bank-Level Data

2.1.1 Dependent Variables

Following Buch and Goldberg (2017), our baseline estimations are performed using the log quarterly changes of total loans as the main dependent variable. In addition, as robustness checks, we use two alternative dependent variables. First, we look at the relevance of

loans composition, by computing the log quarterly change of different types of loans (i.e., commercial, mortgage, and consumer loans). Second, we use an accounting measure of banks' risk taking, and study whether changes in foreign regulation might affect banks' preferences toward risk. Our risk-taking measure is based on Laeven and Levine (2009) and is equivalent to the sum of the capital adequacy ratio (CAR) and the return on assets (ROA), as a ratio of the standard deviation of ROA, i.e., $z\text{-}score_{i,t} = (ROA_{i,t} + CAR_{i,t})/\sigma_i(ROA_{i,t})$.

Table 2 shows the summary statistics of the dependent variables (upper panel) for three different groups of banks: (i) big and medium-sized banks, (ii) retail and treasury banks, and (iii) big and medium-sized banks that are foreign owned. Group (i) corresponds to the those banks used in the implementation of the inward transmission of policy through the international exposure of banks, which includes 568 observations. Group (iii) includes the six subsidiaries used in the transmission of policy through foreign affiliates of foreign-owned banks, equivalent to 250 observations. Finally, group (ii) includes the observations excluded in the empirical analysis presented below. Table 2 also compares the mean of groups (ii) and (iii) with the mean of group (i), and reports when the difference between these means is statistically significant at 5 percent.

As can be seen, when looking at the set of dependent variables (upper panel), the main differences between group (ii) and (iii), and the baseline group (i), are in the measure of risk taking. Nonetheless, the standard deviations are much higher for the group of retail and treasury banks, which is consistent with the fact that these banks do not participate actively in domestic lending, which makes their lending growth rates particularly volatile. When comparing the two groups of banks included in the empirical exercises below ((i) and (iii)), their lending growth rates are similar in both means and standard deviations. On the other hand, our measure of risk taking shows that foreign-owned banks are less risk averse than the banks included in group (i).

2.1.2 Control Variables

As control variables we consider a set of banks' balance sheet characteristics related to the assets and liabilities of each bank. In

Table 2. Summary Statistics on Lending Growth Rates and Banks' Characteristics

	Big and Medium Banks (N = 568)			Retail and Treasury Banks (N = 404)			Big and Medium (Foreign-Owned) Banks (N = 250)		
	Mean	**Median**	**SD**	**Mean**	**Median**	**SD**	**Mean**	**Median**	**SD**
Dependent Variables:									
Δ Domestic Loans: Total	2.692	2.490	4.080	1.838	2.376	22.402	3.169	2.663	6.163
Δ Domestic Loans: Commercial	2.816	2.276	5.564	3.959	1.433	24.057	3.715	2.014	8.872
Δ Domestic Loans: Consumer	2.834	2.639	6.563	−0.646	0.275	38.552	1.240	2.864	30.300
Δ Domestic Loans: Mortgage	2.944	2.860	5.078	8.899	4.818	29.544	2.634	2.757	6.704
z-score	29.551	25.510	14.458	15.404**	14.653	7.490	26.370**	22.710	13.540
Independent Variables:									
Log Total Assets	21.996	22.073	1.315	19.037**	19.232	1.270	21.760**	21.850	1.389
Tier 1 Ratio (%)	8.142	7.530	2.992	29.072**	18.279	22.562	9.472**	8.594	3.737
Illiquid Assets Ratio (%)	83.406	84.634	7.714	67.349**	67.313	22.706	82.720	84.930	8.653
International Activity (%)	9.560	7.898	10.064	22.283**	10.060	29.390	12.520**	9.399	13.870
Net Due To (%)	−0.159	0.000	2.024	−9.152**	0.000	20.846	−0.426	0.000	3.211
Core Deposits Ratio (%)	74.338	75.469	12.063	85.592**	96.414	23.031	72.830	75.570	16.420

Source: Authors' calculations based on the Superintendency of Banks and Financial Institutions, and the Central Bank of Chile.
Notes: This table provides summary statistics for bank balance sheet and lending data for the 2002:Q2–2013:Q4 period, when three different groups of banks are considered: (i) big and medium banks, (ii) retail and treasury banks, and (iii) big and medium banks that are foreign owned. It also compares the mean of group (ii) and (iii) with the mean of group (i). ** shows the results of t-test when these differences are statistically significant at 5 percent.

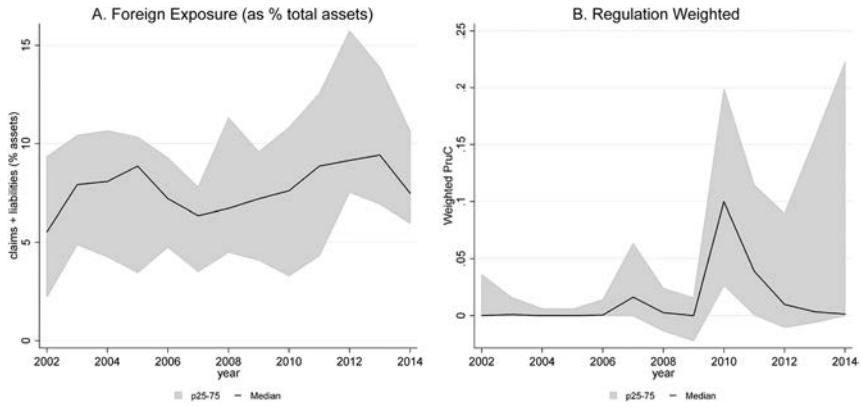
particular, we include (i) a measure of bank size, defined as the log of total assets, (ii) the ratio of tier 1 capital to total assets, (iii) the share of illiquid assets to total assets, and (iv) the ratio of core deposits to total liabilities. We consider the size of banks as a measure of scale economies. The ratio of illiquid assets is included, as it shows the capacity of banks to increase loans. Finally, higher core deposit ratios, as well as higher levels of capitalization, are directly related to lending growth rates, as they allow for a lower financing cost. See table 9 in the appendix for the detailed definitions and sources of these variables.

We also use individual banks' information reported to the Central Bank of Chile regarding their claims and liabilities outstanding positions held with non-residents. This information, which includes loans and deposits vis-à-vis the residency of the counterpart, is in compliance with the requirements needed to prepare the balance-of-payments statistics, and is reported on a quarterly basis. With this information at hand, we construct two additional control variables: (i) the international exposure ratio and (ii) the net due to head office ratio.[1] The international exposure ratio is equivalent to the sum of foreign assets and liabilities, as a percentage of total assets, while the net due to head office ratio is proxied by the difference between liabilities and assets that each bank holds in the country where the headquarters are based. Since we are unable to identify how much foreign assets and liabilities each bank holds of its related parties, we proxy this variable by computing the assets and liabilities that each bank holds in the country where the parent bank resides. Therefore, our measure of net due to head office represents an upper bound of the desired variable.

The summary statistics for all these control variables are shown in the lower panel of table 2. As expected, when comparing the mean value of the control variables, banks included in group (ii) are statistically different from banks included in group (i). On the other hand, group (i) is not statistically different than the subset of foreign affiliates in terms of liquidity, deposits, and net foreign exposure. As a complement to table 2, in figure 1A we present the dynamics of the distribution of the international exposure for the set

[1]Notice that we also use this information to construct the prudential weight variable described below.

Figure 1. International Exposure and Prudential Weighted Index



Source: Authors' calculations based on Cerutti et al. (2017) and the Central Bank of Chile.
Notes: Panel A shows the distribution of foreign exposure (claims and liabilities) as a percentage of total assets and panel B shows the distribution of the prudential weighted index (ExpPruC). The shaded area represents the 25th and 75th percentile of each distribution, and the solid line represents the median.

of big and medium-sized banks included in group (i). As can be seen, on average, banks have increased their international exposure after the global financial crisis, and decreased it slightly by the end of the period. In any case, the dispersion across banks remains relatively high.

Finally, as suggested by Buch and Goldberg (2017), we analyze the relevance of the economic and financial cycle in the transmission of international regulatory spillovers, in particular when accounting for the cyclical behavior of home countries when studying the spillovers via foreign affiliates. The economic and financial cycle is provided by the Bank for International Settlements (BIS), following the methodology suggested by Drehman, Borio, and Tsatsaronis (2012).

2.2 Data on Prudential Instruments

In our empirical analysis, we evaluate the impact of changes in the following seven prudential instruments: (i) an aggregate measure of

prudential policy (*PruC*), (ii) a general capital requirements policy (cap_req), (iii) a sector-specific capital buffer (sscb), (iv) a loan-to-value ratio limit (ltv), (v) a reserve requirement for foreign-currency operations (rr_foreign), (vi) a reserve requirement for local-currency operations (rr_local), and (vii) a regulation concerning the concentration ratio (concrat). We do not evaluate the relevance of the interbank exposure limit policy, as only 11 percent of commercial banks in Chile were exposed to countries where this instrument experienced a change during the sample period. Moreover, when looking at the subsample of foreign-owned banks, no jurisdiction where the headquarters were located experienced a variation in this particular instrument.

Table 3 summarizes the changes in prudential variables faced by banks located in Chile over the 2002:Q2–2013:Q4 sample period. The upper panel focuses on the prudential changes that are relevant when the exposure of banks is considered. As can be seen, Chilean banks were exposed to countries that only tightened their capital requirements during this sample period, while all other instruments were either tightened or loosened at some point in time. This issue might help to better identify the effect of capital requirements when using this specification, even though capital requirements were not the most extensively used instrument in the sample.

Table 3's lower panel shows the prudential changes that occurred in the jurisdictions where the headquarters of foreign banks are located. Here, in addition to capital requirements, the concentration ratio experienced only a tightening during our period of analysis, while the interbank exposure limit experienced no change.

2.2.1 Regulation Weighted by Foreign Exposure

When evaluating the inward transmission of prudential policies of the home country j at time t ($P_{j,t}$), through the international exposure of bank b at time t, we first need to compute the weighted exposure to these changes ($ExpP_{b,t}$), as follows:

$$ExpP_{b,t} = \sum_{j} \frac{(A_{b,j,t-1} + L_{b,j,t-1})P_{j,t}}{(A_{b,t-1} + L_{b,t-1})}.$$

Table 3. Summary Statistics: Changes in Prudential Instruments

Inward: Big and Medium Banks (Foreign and Domestically Owned)						
	Base Data (Before Aggregating to Exposure-Weighted Measures)					Exposure-Weighted Observations
Instrument	**No. of Country-Time Changes**	**No. of Country-Time Changes (Tightening)**	**No. of Country-Time Changes (Loosening)**	**No. of Bank-Time Changes**	**Proportion Base-MPP Non-zero**	**Proportion $ExpP_t$ Non-zero**
Prudential Index	338	256	82	2,046	0.16	0.76
General Capital Requirements	58	58	0	394	0.03	0.19
Sector-Specific Capital Buffer	61	34	5	369	0.03	0.31
Loan-to-Value Limits	71	56	15	488	0.11	0.48
Reserve Requirements: Foreign	100	61	17	475	0.04	0.40
Reserve Requirements: Local	160	87	66	965	0.07	0.58
Interbank Exposure Limit	16	15	1	124	0.02	0.11
Concentration Ratios	22	21	1	121	0.01	0.16

(*continued*)

Table 3. (Continued)

Inward: Big and Medium Banks (Foreign Owned)						
Instrument	**No. of Country-Time Changes**	**No. of Country-Time Changes (Tightening)**	**No. of Country-Time Changes (Loosening)**	**No. of Bank-Time Changes**	**Proportion HomeP$_t$ Non-zero**	
Prudential Index	34	23	11	41	0.156	
General Capital Requirements	7	7	0	9	0.032	
Sector-Specific Capital Buffer	6	3	1	6	0.028	
Loan-to-Value Ratio Limits	12	8	4	14	0.092	
Reserve Requirements: Foreign	4	2	2	4	0.018	
Reserve Requirements: Local	11	4	7	13	0.050	
Interbank Exposure Limit	0	0	0	0	0.000	
Concentration Ratio	1	1	0	1	0.005	

Source: Authors' calculations based on Cerutti et al. (2017).
Notes: This table shows summary statistics on changes in prudential instruments for banks located in Chile over the period 2002:Q2–2013:Q4. The number of changes in prudential instruments is reported on the country-time level and on the bank-time level. The last column of each panel shows the share of prudential changes to total observations (i.e., the share of non-zero observations). The column "Exposure-Weighted Observations" is based on the underlying data on prudential changes in foreign countries (columns under the "Base Data" heading). The reported data are based on the regression sample.

This variable captures the effect of changes in the prudential policy of the home country j, weighted by the assets and liabilities held by bank b in the home country j($A_{b,j}$ and $L_{b,j}$, respectively).[2] Therefore, the regulation weighted by foreign exposure depends on the direction of the change in the regulation (tightening or loosening) and on how exposed banks are to that particular jurisdiction.

The upper panel of table 3 shows some key characteristics of this variable for the set of instruments included in our empirical analysis. As can be seen, the commercial banks established in Chile have been mostly exposed to jurisdictions where prudential policies have been tightened. In addition, the instrument that experienced the strongest variation was the reserve requirement imposed on local operations. Figure 1B complements this information by showing the distribution of this exposure-weighted policy for the aggregated prudential instrument (*ExpPruC*). As can be seen, while banks established in Chile have been exposed, on average, to a tightening in the prudential policy, in recent years the dispersion of this regulation-weighted index has increased. Indeed, while some banks have almost no exposure to changes in the foreign regulation, others have more than one-third of their total assets exposed to jurisdictions where there has been a tightening. In addition, some banks have been exposed to jurisdictions where the prudential policy was loosened (see the negative numbers in figure 1B). This high heterogeneity observed in the regulation weighted by foreign exposure implies that policy changes respond not only to global factors but also to some idiosyncratic bank characteristics.

2.2.2 Home-Country Regulations

Finally, we study the impact of home-country regulations on the domestic lending rates of foreign subsidiaries. In particular, we look at the changes in the prudential policies in those countries where the headquarters of the parent banks of foreign subsidiaries are located.

[2]Notice that big and medium-sized banks in Chile were exposed to a total of 134 different jurisdictions during the 2002:Q2–2013:Q4 sample period, from which 59 of them are included in the IBRN Prudential Instruments Database described in Cerutti et al. (2017). However, with these fifty-nine countries, we are able to capture an average of 96 percent of the total cross-border exposure that banks had during the entire sample period.

Considering the ownership structure of foreign banks in Chile, there are five jurisdictions that are relevant during the 2002:Q2–2013:Q4 sample period: United States, Spain, Canada, Brazil, and the Netherlands.

As can be seen in the lower panel of table 3, there is high heterogeneity across prudential instruments that are relevant for foreign owned banks in Chile. While LTV caps are the instruments most used across countries, the instrument that measures the concentration limits is the least used. The latter is valid excluding the interbank exposure limit, which experienced no variation in the jurisdictions that are relevant in our study. Table 3's lower panel also shows that the majority of prudential instruments relevant for the Chilean foreign subsidiaries have tightened their prudential policies.

Note that in Chile subsidiaries of foreign banks are subject to the same banking regulation as local banks. This is particularly relevant regarding capital requirements, which have to be established in Chile. This characteristic of the Chilean regulation should weaken any potential impact of changes in the prudential instruments that occurred in the home country.

3. Empirical Method and Regression Results

To evaluate potential regulatory spillovers to domestic lending, we implement two complementary methodologies. First, we study the inward transmission of exposure-weighted regulation on a panel of fourteen commercial banks, including domestic and foreign-owned banks. Second, we look at the inward transmission of home macroprudential policy via foreign affiliates, focusing on a panel of six foreign-owned banks. In this last case, we ask whether changes in the prudential policies implemented in the country where the parent bank resides have any impact on the domestic lending activities of these affiliates.

In all cases, we run simple regressions controlling for banks' balance sheet characteristics (lagged one quarter), banks' fixed effects, and time fixed effects. At the end of this section we go beyond the baseline representation by checking for the robustness of our results and exploring further alternatives. As a robustness test, we first look

at the stability of our results after applying alternative ways to measure the regulation weights. Second, we discuss the results associated with the cumulative impact of changes in the prudential policies. Finally, we show the implications of dropping the only state-owned bank present in the sample (BancoEstado). As a further exploration, we study the inward transmission of prudential policies to different types of lending (commercial, consumption, and mortgage) and to a measure of banks' risk aversion.

3.1 Exposure-Weighted Inward Transmission of Regulation

We estimate an equation of the following characteristics:

$$\begin{aligned}\Delta Y_{b,t} = \alpha_0 &+ (\alpha_1 ExpP_{b,t} + \alpha_2 ExpP_{b,t-1} + \alpha_3 ExpP_{b,t-2}) \\ &+ \alpha_4 X_{b,t-1} + (\beta_1 ExpP_{b,t} X_{b,t-1} + \beta_2 ExpP_{b,t-1} X_{b,t-1} \\ &+ \beta_3 ExpP_{b,t-2} X_{b,t-1}) + f_b + f_t + \epsilon_{b,t}. \end{aligned} \quad (1)$$

$\Delta Y_{b,t}$ is the log change in domestic lending of bank b at time t. $X_{b,t-1}$ is the one-quarter lagged vector of control variables, which captures the degree in which banks are exposed to changes in regulation through ex ante balance sheet composition and market access. The prudential weighted policy changes outside the home country are captured by $ExpP$. Its impact is evaluated contemporaneously, and after two lags. As explained before, under this specification, the effective exposure to foreign regulation is captured by the assets and liabilities that each bank holds in each jurisdiction.

From a conceptual point of view, a tightened prudential policy abroad affects domestic lending rates through two distinctive channels. First, it could affect domestic funding conditions through the dynamics of cross-border bank flows. If the regulation abroad tightens, international banks might want to reduce their risk-weighted assets and consequently their cross-border lending. If that is the case, we expect to find that domestic lending would fall after a tightening in the prudential policy overseas. However, as explained by Buch and Goldberg (2017), this expected negative sign also depends on how broad the policy change is in the home country—in particular, whether these changes will affect local and foreign banks equally. Second, a tightened prudential policy abroad could also be associated with an increase in domestic lending rates if, as a

result of that, international investors (including local banks) decide to reduce their positions in the jurisdictions that are tightening and reallocate their assets to those countries where the prudential policies remain unchanged. This potentially increases the availability of funds, busting domestic liquidity and potentially increasing domestic lending.

Before running equation (1), we look at the effects of foreign prudential policies assuming no interactions, i.e., assuming that β_i coefficients of equation (1) are equal to zero. Under this specification, we find almost no effect of prudential policies over domestic lending.[3] In particular, when testing the three-quarter joint effect of prudential policy, the joint p-values are statistically non-significant in almost all policy instruments except capital requirements, which is statistically significant at 1 percent. A snapshot of this last result can be seen in figure 2A, which applies the Frish-Waugh theorem over equation (1) with non-interactions. Here, it can be seen that a tightening in the exposure-weighted regulation on capital requirements has a positive effect on domestic lending rates.[4]

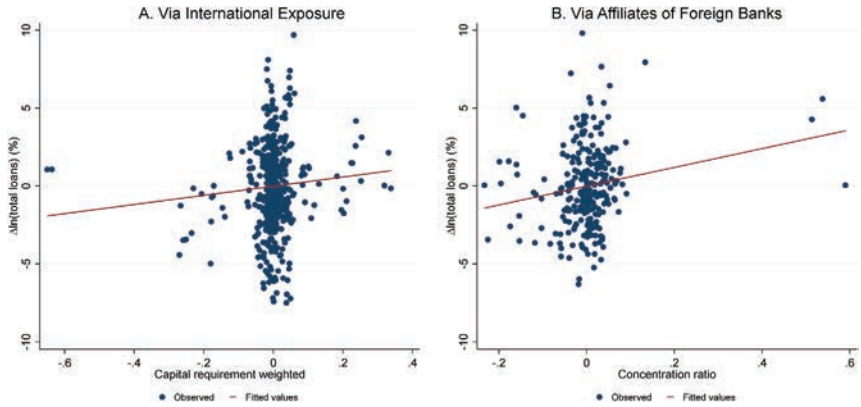
Table 4 then looks at the results from estimating equation (1) with interactions. Here, each column represents a different prudential instrument. The results for the prudential policy in levels are summarized as the sum of the $ExpP$ coefficient in time t and in the two previous quarters, and the corresponding p-value for the joint statistically significance of these coefficients. In addition, this table shows the estimated coefficients for the control variables in levels and interacted with the policy instrument.

The results of table 4 can be summarized as follows. The model fits the data quite well, as the adjusted R^2 is high and above 40 percent. Almost all coefficients associated with the control variables are statistically significant, present the expected signs, and are stable across different specifications. Indeed, banks that have less liquid

[3]These results are not presented here, but can be found in Cabezas and Jara (2016).

[4]The Frisch-Waugh theorem states that the multiple regression coefficient of any single variable can also be obtained by first netting out the effect of other variable(s) in the regression model from both the dependent variable and the independent variable. Therefore, it is always possible to respecify a linear regression model in terms of orthogonal complements, allowing to partial out right-hand-side variables.

Figure 2. Impact of Capital Requirements Weighted and Concentration Ratio on Log Changes in Total Loans



Source: Authors' calculations.
Notes: This figure shows the implementation of the Frish-Waugh theorem as a way to show the conditional impact of prudential measures on lending growth rates. Panel A focuses on the impact of capital requirements weighted on equation (1), and panel B shows the impact of concentration ratio on equation (2). In both cases the effects of interactions where excluded. The Frisch-Waugh theorem says the coefficient from this regression is exactly the same as the one in the multiple regression.

assets have lower lending growth rates, while banks that have higher tier 1 capital ratios and higher core deposits are associated with faster lending growth rates. Finally, banks that are more internationally active also have higher lending growth rates. Now, regarding the significance of prudential spillovers, we find that only two prudential instruments are significant in levels: the capital requirements and the loan-to-value ratios (see columns 2 and 4 in table 4). Capital requirements have a positive effect in lending growth rates, meaning that a tightening in the exposure-weighted prudential policy increases domestic lending, while loan-to-value ratios have a negative effect on lending growth rates. This latter effect is consistent with the idea that housing market cycles tend to be synchronized across countries (Milcheva and Zhu 2015).

When looking at the effects of interactions, we find mixed results. In short, being more exposed to jurisdictions that implemented, for example, a tight capital requirement has a smaller effect on those

Table 4. Inward Transmission of Policy through International Exposures of Domestic Banks

	ExpP = Prudential Index (1)	**ExpP = Capital Requirements (2)**	**ExpP = Sector-Specific Capital Buffer (3)**	**ExpP = LTV Ratio (4)**	**ExpP = Reserve Requirements: Foreign (5)**	**ExpP = Reserve Requirements: Local (6)**	**ExpP = Concentration Ratios (7)**
Sum ExpP	−7.319	81.87*	132.9	−351.4**	215.7	−0.702	−206.3
Joint p-value	0.815	0.057	0.458	0.044	0.180	0.990	0.689
Log Total Assets$_{t-1}$	−2.031	−1.940	−1.315	−1.730	−1.749	−1.522	−1.444
	(1.372)	(1.434)	(1.252)	(1.327)	(1.307)	(1.287)	(1.255)
Tier 1 Ratio$_{t-1}$	0.236*	0.242*	0.236	0.232**	0.237*	0.231*	0.186*
	(0.135)	(0.137)	(0.144)	(0.114)	(0.142)	(0.133)	(0.095)
Illiquid Assets Ratio$_{t-1}$	−0.136***	−0.127***	−0.136***	−0.136***	−0.127***	−0.134***	−0.116***
	(0.049)	(0.047)	(0.051)	(0.045)	(0.049)	(0.049)	(0.045)
International Activity$_{t-1}$	0.125***	0.121***	0.092***	0.087***	0.105***	0.096***	0.096***
	(0.033)	(0.031)	(0.029)	(0.033)	(0.031)	(0.030)	(0.029)
Net Due To (Head Office)$_{t-1}$	−0.000	−0.012	−0.027	−0.022	−0.001	0.007	−0.005
	(0.082)	(0.080)	(0.077)	(0.083)	(0.079)	(0.077)	(0.085)
Core Deposits Ratio$_{t-1}$	0.088***	0.078***	0.071**	0.067**	0.073**	0.074***	0.068**
	(0.030)	(0.030)	(0.029)	(0.029)	(0.029)	(0.028)	(0.028)
Sum Log Total Assets*ExpP	0.429	−3.571**	−4.536	22.47***	−6.313	0.100	34.27**
Joint p-value	0.768	0.030	0.607	0.001	0.287	0.964	0.035
Sum Tier 1 Ratio*ExpP	2.444**	3.780**	0.897	15.96*	−3.778	0.737	30.21
Joint p-value	0.039	0.041	0.830	0.093	0.599	0.698	0.181

(*continued*)

Table 4. (Continued)

	ExpP = Prudential Index (1)	**ExpP = Capital Requirements (2)**	**ExpP = Sector-Specific Capital Buffer (3)**	**ExpP = LTV Ratio (4)**	**ExpP = Reserve Requirements: Foreign (5)**	**ExpP = Reserve Requirements: Local (6)**	**ExpP = Concentration Ratios (7)**
Sum Illiquid Assets Ratio*ExpP	0.043	−0.284	0.993	−2.249	0.376	0.001	−2.726
Joint p-value	0.864	0.417	0.220	0.358	0.704	0.998	0.704
Sum International Activity*ExpP	−0.320**	−0.428***	−0.274	4.719**	0.451	0.257	7.829
Joint p-value	0.034	0.007	0.783	0.021	0.803	0.640	0.383
Sum Net Due To (Head Office)*ExpP	0.308	0.097	−10.07	0.166	−19.41*	−18.22**	−28.07
Joint p-value	0.669	0.893	0.780	0.989	0.096	0.013	0.388
Sum Core Deposits Ratio*ExpP	−0.275	0.141	−1.540	−1.751*	−1.019	−0.129	−7.888***
Joint p-value	0.175	0.545	0.455	0.085	0.520	0.839	0.009
Observations	568	568	568	568	568	568	568
Adjusted R^2	0.406	0.406	0.409	0.440	0.404	0.412	0.436
No. of Banks	14	14	14	14	14	14	14
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in total loans. The data are quarterly from 2002:Q2 to 2013:Q4 for a panel of domestic bank holding companies. Foreign-exposure-weighted regulation ExpP is calculated as the weighted average of changes in foreign regulation where the weights are total assets and liabilities of the bank in the respective foreign country. For ExpP and its interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-value for joint significance. For more details on the variables, see table 9 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects. Standard errors in parentheses are robust. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

banks that are bigger in size and more internationally active. Meanwhile, banks that have higher tier 1 capital ratios are more sensitive to changes in the foreign prudential policies.

Finally, we test the net significance of prudential regulation. The net effects measure the significance of prudential policies, taking into account the interactions between these policies and banks' characteristics. These results are shown in table 7. Net effects are computed considering the contemporaneous weighted prudential policy only, and the contemporaneous plus two lags. Again, capital requirements appear to be the most significant policy instrument affecting domestic lending. Moreover, these effects are economically significant, as a one-standard-deviation tightening in capital requirements in all relevant jurisdictions increases lending growth rate by almost 80 percent of the median growth rate observed in the entire sample.

3.2 Inward Transmission of Home Macroprudential Policy via Affiliates

We now turn to the estimation of the following equation, which is run over a panel of six foreign affiliates:

$$\begin{aligned}\Delta Y_{b,t} = \alpha_0 &+ (\alpha_1 HomeP_{j,t} + \alpha_2 HomeP_{j,t-1} + \alpha_3 HomeP_{j,t-2}) \\ &+ \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + (\beta_1 HomeP_{j,t} X_{b,t-1} \\ &+ \beta_2 HomeP_{j,t-1} X_{b,t-1} + \beta_3 HomeP_{j,t-2} X_{b,t-1}) \\ &+ f_b + f_t + \epsilon_{b,t}. \qquad (2)\end{aligned}$$

Similarly to equation (1), $X_{b,t-1}$ is the vector of control variables for bank b at time t lagged one quarter. Regarding the prudential policy changes, we are now interested only in the prudential policy of the country where the parent of the foreign affiliates is located. We call this variable $HomeP$ and, as in the previous approach, we measure its effect at time t and in the previous two quarters. Finally, $Z_{j,t}$ represents the business and the financial cycle in home country j as measured by the BIS.

Table 5 shows the results of this estimation. We find that most changes in the prudential policies in the home countries do not have a significant effect on the domestic lending provided by foreign affiliates. This result is not surprising given that subsidiaries are required to comply with the local regulation.

Table 5. Inward Transmission of Policy via Affiliates of Foreign-Owned Banks

	HomeP = Prudential Index (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Requirements: Foreign (5)	HomeP = Reserve Requirements: Local (6)	HomeP = Concentration Ratios (7)
Sum HomeP	61.32**	−131.8	44.26	−191.9	651.4	50.53	18.63**
Joint p-value	0.044	0.368	0.906	0.237	0.153	0.805	0.010
Log Total Assets$_{t-1}$	−7.106*	−7.099*	−7.503**	−25.321**	−7.104**	−7.124**	−5.958**
	(2.774)	(2.557)	(2.066)	(3.061)	(2.198)	(2.113)	(1.925)
Tier 1 Ratio$_{t-1}$	0.135	0.174*	0.123	0.018	0.158	0.171	0.183*
	(0.076)	(0.078)	(0.082)	(0.126)	(0.079)	(0.089)	(0.074)
Illiquid Assets Ratio$_{t-1}$	−0.301***	−0.313***	−0.314***	−0.142	−0.332***	−0.293***	−0.253***
	(0.054)	(0.060)	(0.052)	(0.071)	(0.044)	(0.048)	(0.041)
International Activity$_{t-1}$	0.072*	0.086	0.080*	−0.238	0.067	0.089	0.057
	(0.027)	(0.048)	(0.031)	(0.186)	(0.041)	(0.043)	(0.031)
Net Due To (Head Office)$_{t-1}$	0.168	0.157**	0.116**	0.218	0.137**	0.139**	0.106**
	(0.085)	(0.051)	(0.029)	(0.283)	(0.043)	(0.043)	(0.037)
Core Deposits Ratio$_{t-1}$	0.083***	0.082***	0.089***	−0.282	0.083**	0.074**	0.068***
	(0.012)	(0.016)	(0.017)	(0.120)	(0.024)	(0.018)	(0.015)
BIS Financial Cycle (Home Country)	13.447*	12.580*	15.063**	23.777***	14.277**	13.463**	12.010**
	(5.266)	(5.161)	(4.300)	(1.872)	(4.524)	(4.403)	(3.328)
BIS Business Cycle (Home Country)	−58.760	−62.987	−40.151	−58.966*	−58.522	−51.053	−37.291
	(44.689)	(43.804)	(37.488)	(16.833)	(38.089)	(50.278)	(34.816)
Sum Log Total Assets*HomeP	−1.436*	−1.507	−3.743	3.874	−30.07	0.109	
Joint p-value	0.059	0.610	0.608	0.419	0.162	0.989	

(*continued*)

Table 5. (Continued)

	HomeP = Prudential Index (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Requirements: Foreign (5)	HomeP = Reserve Requirements: Local (6)	HomeP = Concentration Ratios (7)
Sum Tier 1 Ratio*HomeP	0.356	2.968*	−1.375	−0.066	−6.089	−0.114	
Joint p-value	0.363	0.073	0.105	0.817	0.392	0.956	
Sum Illiquid Assets Ratio*HomeP	−0.248	1.923*	0.495	1.200*	0.857	−0.390	
Joint p-value	0.412	0.063	0.547	0.094	0.422	0.547	
Sum International Activity*HomeP	−0.219	−0.029		0.275		−0.084	
Joint p-value	0.130	0.911		0.394		0.871	
Sum Net Due To (Head Office)*HomeP	−0.124	−1.676	−9.169	−2.475		7.608	
Joint p-value	0.839	0.134	0.568	0.438		0.506	
Sum Core Deposits Ratio*HomeP	−0.119	−0.285**	0.023	0.044		−0.214	
Joint p-value	0.345	0.033	0.991	0.669		0.670	
Observations	250	250	250	152	250	250	250
Adjusted R^2	0.727	0.720	0.725	0.878	0.727	0.719	0.743
No. of Banks	6	6	6	6	6	6	6
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in total loans. The data are quarterly from 2002:Q2 to 2013:Q4. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. For HomeP and its interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-value for joint significance. For more details on the variables, see table 9 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects. Standard errors in parentheses are clustered by home country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

However, the coefficient of the prudential instrument that regulates the concentration ratios is positive and statistically significant at 5 percent. See column 7 in table 5 and figure 2B, which shows the positive relationship between concentration ratios and the aggregate domestic lending growth. The positive effect is consistent with the existence of potential regulatory spillovers generated by the parent/subsidiary relationship. Under these circumstances, a tightening in the concentration ratio (provided that it does not affect cross-border lending) will facilitate the foreign funding of local subsidiaries. Despite this positive effect, the economic significance of this policy is lower than the one found for capital requirements through international exposures, as a tightening in the concentration index by one standard deviation in all foreign affiliates increases domestic lending growth rates by roughly 40 percent of the median growth rate observed in the entire sample.

The interactions between the home prudential policy and banks' characteristics are not statistically important, while most of the control variables have the expected sign, similarly to the previous specification. One additional variable that turns out to be consistently significant across different instruments is the financial cycle of the home country. The stronger the financial cycle in the home country, the higher the domestic lending growth of foreign subsidiaries.

Finally, table 6 shows the impact of foreign prudential regulation when all instruments are included at the same time with no interactions. The results shown in table 6 confirm the positive and statistically significant effect of capital requirements over domestic lending growth rates when the exposure-weighted specification is considered (column 1). Similarly, the positive effect of the concentration ratio remains statistically significant when prudential policy spillovers are measured via foreign affiliates (column 2).

3.3 Robustness Checks and Further Explorations

We run two robustness checks for our inward transmission estimates through international exposures. First, we use three alternative definitions of weights in the construction of the exposure-weighted prudential index. In addition to the definition of weights based on the sum of foreign claims and liabilities (w1), we use foreign claims only (w2), foreign liabilities only (w3), and the sample average of w1. The

Table 6. Inward Transmission of Policy: All Instruments Together

	ExpP = Via International Exposure (1)	**HomeP = Via Affiliates of Foreign Banks (2)**
Log Total Assets$_{t-1}$	−1.747	−6.428**
	(1.268)	(2.492)
Tier 1 Ratio$_{t-1}$	0.235*	0.181*
	(0.137)	(0.098)
Illiquid Assets Ratio$_{t-1}$	−0.124***	−0.257***
	(0.047)	(0.087)
International Activity$_{t-1}$	0.109***	0.056*
	(0.029)	(0.032)
Net Due To (Head Office)$_{t-1}$	−0.019	0.112
	(0.080)	(0.104)
Core Deposits Ratio$_{t-1}$	0.074***	0.065*
	(0.028)	(0.035)
BIS Financial Cycle (Home Country)	—	12.458***
		(3.508)
BIS Business Cycle (Home Country)	—	−37.209
		(30.149)
Sum Capital Requirements	12.69***	−4.261
Joint p-value	0.006	0.210
Sum Sector-Specific Capital Buffer	0.595	0.713
Joint p-value	0.803	0.765
Sum Loan-to-Value Ratio	−7.057	
Joint p-value	0.254	
Sum Reserve Requirements: Foreign	4.833	−1.056
Joint p-value	0.165	0.651
Sum Reserve Requirements: Local	−1.273	−0.161
Joint p-value	0.463	0.892
Sum Concentration Ratios	−2.484	19.42***
Joint p-value	0.891	0.000
Observations	568	250
Adjusted R^2	0.409	0.736
No. of Banks	14	6
Time Fixed Effects	Yes	Yes
Bank Fixed Effects	Yes	Yes

Notes: This table reports the effects of changes in regulation and bank characteristics on log changes in total loans. The data are quarterly from 2002:Q2 to 2013:Q4. Each column gives the result for the inward transmission of policy through international exposure of domestic banks and via affiliates of foreign-owned banks, respectively. For ExpP and HomeP, the reported coefficient is the sum of the contemporaneous term and two lags with the corresponding p-value for joint significance. Robust standard errors are clustered by home country and appear in parentheses. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

net effects of the exposure-weighted prudential policy using these alternative definitions of weights are shown in table 7, which confirms the positive and statistically significant impact of a tightened capital requirement over domestic lending, independently on how the weights were constructed.

Secondly, we run a similar specification of equation (1), but now considering the cumulative prudential policy for each instrument, as follows:

$$\Delta Y_{b,t} = \alpha_0 + \alpha_1 ExpP_{cum,b,t-1} + \alpha_2 X_{b,t-1} + \alpha_3 ExpP_{cum,b,t-1} Z_t + f_b + f_t + \epsilon_{b,t}. \quad (3)$$

Here, $ExpP_{cum,b,t-1}$ represents the cumulative sum of each instrument since the first quarter of 2000 (see Cerutti et al. 2017 for more details). Under these specifications, we also control for the interactions between the cumulative policy and the business and the financial cycle of the host country provided by the BIS (Z_t). We find that, when adding the same set of controls, the net impact of capital requirements remains significant, although now only at the 10 percent confidence level (see table 7, panel B). Additionally, a tightened reserve requirement in foreign operations also generates a positive impact in domestic lending. Furthermore, when using the alternative definitions of weights described above, the net effect becomes not significant for capital requirements and significant at 1 percent for reserve requirements in foreign operations when using w3. This may suggest that capital requirements' spillovers from home to host are less important when the regulatory changes are permanent rather than transitory. The opposite is true for reserve requirements.

In addition, we run the exposure-weighted specification without including the state-owned bank (BancoEstado). The reason we do this is that although BancoEstado tends to behave similarly to private banks in normal times, it usually acts countercyclically during crises. Our results show that, if anything, the models presented in table 4 get a slightly better fit when the state-owned bank is not included.

As a further exploratory analysis, we implement equations (1) and (2) for a set of alternative dependent variables. First, we split total lending growth into different types of credits (commercial, consumer, and mortgage loans). Second, we look at the effect of

Table 7. Inward Transmission of Policy through International Exposures of Domestic Banks: Net Effects

Exercise	Coefficient Sum	ExpP = Prudential Index (1)	ExpP = Capital Requirements (2)	ExpP = Sector-Specific Capital Buffer (3)	ExpP = LTV Ratio (4)	ExpP = Reserve Requirements: Foreign (5)	ExpP = Reserve Requirements: Local (6)	ExpP = Concentration Ratios (7)
A. Inward Transmission through International Exposures								
w1 = Claims + Liabilities	$\Sigma_{i=1}^{3}(\alpha_i + \beta_i \bar{X}_{b,t-1})$	2.055	17.08***	8.061	−1.267	9.754	3.912	57.50
	Joint p-value	0.416	0.002	0.535	0.925	0.465	0.443	0.179
	$(\alpha_1 + \beta_1 \bar{X}_{b,t-1})$	0.716	7.760**	9.338	6.528	9.712	1.959	1.416
	Joint p-value	0.699	0.013	0.278	0.491	0.300	0.667	0.945
w2 = Claims	$\Sigma_{i=1}^{3}(\alpha_i + \beta_i \bar{X}_{b,t-1})$	0.294	13.61***	5.031	−0.174	3.898	−1.486	2.230
	Joint p-value	0.862	0.009	0.263	0.989	0.492	0.666	0.938
	$(\alpha_1 + \beta_1 \bar{X}_{b,t-1})$	−1.208	5.354**	4.588**	−2.626	3.011	0.577	−7.173
	Joint p-value	0.341	0.033	0.042	0.565	0.518	0.832	0.761
w3 = Liabilities	$\Sigma_{i=1}^{3}(\alpha_i + \beta_i \bar{X}_{b,t-1})$	1.398	21.44***	−5.414	3.477	30.55	−3.434	33.62
	Joint p-value	0.582	0.000	0.591	0.761	0.188	0.629	0.194
	$(\alpha_1 + \beta_1 \bar{X}_{b,t-1})$	1.448	9.752***	2.052	6.256	−2.730	−0.146	17.96
	Joint p-value	0.358	0.000	0.715	0.447	0.842	0.972	0.279
Mean w1	$\Sigma_{i=1}^{3}(\alpha_i + \beta_i \bar{X}_{b,t-1})$	−2.018	21.40***	−30.63*	−26.07***	35.45*	1.978	−68.18
	Joint p-value	0.626	0.010	0.099	0.006	0.080	0.80	0.157
	$(\alpha_1 + \beta_1 \bar{X}_{b,t-1})$	−0.917	15.60**	−6.199	−8.515	3.927	2.672	−18.36
	Joint p-value	0.709	0.016	0.408	0.188	0.779	0.605	0.554
Without BancoEstado	$\Sigma_{i=1}^{3}(\alpha_i + \beta_i \bar{X}_{b,t-1})$	−1.537	19.32***	4.091	−6.572	−1.206	1.423	−30.83
	Joint p-value	0.617	0.002	0.793	0.627	0.965	0.847	0.607
	$(\alpha_1 + \beta_1 \bar{X}_{b,t-1})$	−0.598	9.108**	10.03	6.687	13.42	2.359	−99.95***
	Joint p-value	0.773	0.019	0.267	0.476	0.455	0.669	0.006

(*continued*)

Table 7. (Continued)

Exercise	Coefficient Sum	ExpP = Prudential Index (1)	ExpP = Capital Requirements (2)	ExpP = Sector-Specific Capital Buffer (3)	ExpP = LTV Ratio (4)	ExpP = Reserve Requirements: Foreign (5)	ExpP = Reserve Requirements: Local (6)	ExpP = Concentration Ratios (7)
B. Inward Transmission of Cumulative Policy through International Exposures								
w1 = Claims + Liabilities	$(\alpha_1 + \alpha_3 \bar{Z}_t)$	0.232	11.54*	−0.335	0.479	2.467**	0.281	0.147
	Joint p-value	0.153	0.081	0.474	0.507	0.003	0.424	0.926
w2 = Claims	$(\alpha_1 + \alpha_3 \bar{Z}_t)$	0.132*	3.228	−0.375	0.396	0.377	0.210	1.398
	Joint p-value	0.096	0.325	0.303	0.175	0.364	0.208	0.202
w3 = Liabilities	$(\alpha_1 + \alpha_3 \bar{Z}_t)$	0.266	9.400	−0.372	0.671	8.705***	0.156	0.814
	Joint p-value	0.268	0.354	0.546	0.489	0.001	0.734	0.478
Mean w1	$(\alpha_1 + \alpha_3 \bar{Z}_t)$	0.185	3.031	−3.474**	0.304	2.885	1.322	−2.530
	Joint p-value	0.637	0.676	0.020	0.824	0.228	0.204	0.542
Without BancoEstado	$(\alpha_1 + \alpha_3 \bar{Z}_t)$	0.320*	11.17	−0.009	0.840	2.389***	0.371	2.132
	Joint p-value	0.051	0.119	0.986	0.326	0.005	0.302	0.256

Notes: This table reports the net effects of changes in regulation on log changes in loans. The data are quarterly from 2002:Q2 to 2013:Q4 for a panel of domestic banks. Each row shows an estimation according to equation (1) expressed in section 3 with different weight measures, and the last one excludes BancoEstado. Additionally, panel B expresses the net effect of cumulative weighted measure on log changes in total loans, according to equation (3). Each column gives the result for the regulatory measure specified in the column headline.

prudential policy spillovers on the banks' risk taking. These results are presented in table 8, which shows in panel A the results for the inward transmission through international exposures, and in panel B the inward transmission via foreign affiliates. For simplification, we only report the p-values for the joint net effects associated with each prudential instrument. We do not report the coefficients associated with the control variables and their interactions.

As one of the main results, we find that changes in the prudential policy generate small spillover effects on the disaggregated lending portfolio. Moreover, the effects found above tend to remain significant only for the commercial loan growth rates, and not for consumer or mortgage lending.

Table 8 also shows that, when applying the exposure-weighted prudential policy, a tightening in LTV abroad decreases risk aversion (i.e., reduces the z-score). A similar effect is found when applying the inward transmission via foreign affiliates after a tightening of capital requirements.

4. Concluding Remarks

We find that the spillover effects of changes in the prudential policy abroad have a relatively weak impact on domestic lending. If this relationship exists, it tends to be positive, meaning that a tightening of the prudential policy abroad is associated with an increase in domestic lending. Above all, capital requirements appear to be the most significant prudential policy affecting domestic lending.

When comparing the two methodologies analyzed in the paper, we find stronger and economically more significant spillovers when looking at the exposure-weighted prudential policy rather than at the parent/subsidiary relationship. This result is not surprising given that foreign subsidiaries in Chile have to comply with the local regulation just as if they were a domestic-owned bank.

Our results, although moderated, represent a challenge for domestic policymakers, as domestic credit may be affected by changes in prudential policies implemented in foreign jurisdictions. Moreover, the jurisdictions that may affect domestic credit go beyond those where parent banks of foreign subsidiaries are located.

Table 8. Inward Transmission of Policy: Types of Lending and Risk Taking

		ExpP = Prudential Index (1)	ExpP = Capital Requirements (2)	ExpP = Sector-Specific Capital Buffer (3)	ExpP = LTV Ratio (4)	ExpP = Reserve Requirements: Foreign (5)	ExpP = Reserve Requirements: Local (6)	ExpP = Concentration Ratios (7)
A. Through International Exposures of Domestic Banks								
Commercial	Sum Coef.	0.740	11.62*	1.367	−4.647	3.392	−1.368	2.777
	Joint p-value	0.630	0.073	0.540	0.562	0.464	0.430	0.906
	Observations	568	568	568	568	568	568	568
	Adjusted R^2	0.406	0.408	0.406	0.408	0.407	0.407	0.408
Consumer	Sum Coef.	1.599	2.879	−1.275	0.860	0.504	3.380	−28.65
	Joint p-value	0.547	0.757	0.712	0.920	0.931	0.304	0.147
	Observations	525	525	525	525	525	525	525
	Adjusted R^2	0.115	0.114	0.114	0.114	0.114	0.116	0.115
Mortgage	Sum Coef.	1.676	10.80*	2.961	−9.760	3.426	1.323	−15.92
	Joint p-value	0.351	0.093	0.200	0.119	0.463	0.484	0.207
	Observations	525	525	525	525	525	525	525
	Adjusted R^2	0.454	0.456	0.452	0.452	0.451	0.452	0.451
z-score	Sum Coef.	−1.142	2.770	5.158*	−12.33**	−5.877*	−1.995	3.492
	Joint p-value	0.459	0.523	0.092	0.049	0.096	0.274	0.825
	Observations	567	567	567	567	567	567	567
	Adjusted R^2	0.968	0.968	0.968	0.968	0.968	0.968	0.968

(*continued*)

Table 8. (Continued)

		HomeP = Prudential Index (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Requirements: Foreign (5)	HomeP = Reserve Requirements: Local (6)	HomeP = Concentration Ratios (7)
B. Via Affiliates of Foreign-Owned Banks								
Commercial	Sum Coef.	−0.827	1.412	−0.604	−2.958	−5.852*	−2.076*	20.54*
	Joint p-value	0.473	0.569	0.794	0.401	0.055	0.085	0.076
	Observations	250	250	250	152	250	250	250
	Adjusted R^2	0.716	0.714	0.715	0.878	0.717	0.722	0.726
Consumer	Sum Coef.	−0.037	−27.88	−0.010	4.655	0.753	2.362	
	Joint p-value	0.969	0.175	0.996	0.443	0.866	0.344	
	Observations	206	206	206	138	206	206	
	Adjusted R^2	0.318	0.364	0.316	0.328	0.315	0.324	
Mortgage	Sum Coef.	1.078	1.187	−0.837	4.497	−0.752	0.859	
	Joint p-value	0.254	0.362	0.619	0.157	0.444	0.537	
	Observations	206	206	206	138	206	206	
	Adjusted R^2	0.830	0.828	0.829	0.842	0.828	0.830	
z-score	Sum Coef.	−1.036**	−6.121**	−2.186	3.533	1.889	−0.697	−10.10
	Joint p-value	0.041	0.031	0.410	0.119	0.318	0.388	0.250
	Observations	248	248	248	152	248	248	248
	Adjusted R^2	0.957	0.957	0.957	0.970	0.957	0.957	0.957

Notes: This table reports the effects of changes in foreign regulation on log changes in domestic loans (considering separately commercial, consumer, and mortgage loans), and on a measure of risk taking. All specifications assume no interactions between the idiosyncratic bank characteristics and the prudential policy variables. The data are quarterly from 2002:Q2 to 2013:Q4 for a panel of domestic banks. In panel A, ExpP is calculated as the weighted average of changes in foreign regulation where the weights are total assets and liabilities of the bank in the respective foreign country. Robust standard errors are in parentheses. In panel B, HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. Each column gives the result for the regulatory measure specified in the column headline. Standard errors are clustered by the country of the parent bank. In both specifications, the control variables and fixed effects are not reported, but they are available upon request.

Therefore, local regulatory authorities seeking international cooperation should take into account the exposure that banks have to different jurisdictions, both from their liabilities and from their assets.

Finally, an area for future research could consider the magnitude and potential asymmetries of regulatory changes, as the approach presented here relies only on the direction of changes, without considering their magnitude or the differences between tightening and loosening.

Appendix

Table 9. Definition and Source of Variables

Variable Name	Report Form Description	Source
	Dependent Variables	
ΔLn(Total Loans)	Quarterly change of the total loans' logarithm.	Bank's Balance Sheet Data
	Independent Variables	
Log Total Assets	Logarithm of total assets.	Bank's Balance Sheet Data
Tier 1 Ratio	Core capital to total asset ratio.	Bank's Balance Sheet Data
Illiquid Assets Ratio	Ratio of total assets minus liquid assets to total assets.	Bank's Balance Sheet Data
Net Due To (Head Office)	Ratio of liabilities minus claims to total assets. We assume that the liabilities and cliams of each bank with the entire parent country are totally sent to the subsidiary.	Central Bank of Chile (CBCh)

(*continued*)

Table 9. (Continued)

Variable Name	Report Form Description	Source
Core Deposits Ratio	Ratio of term deposit plus sight deposits to liabilities.	Bank's Balance Sheet Data
International Activity	Ratio of foreign liabilities plus foreign claims to total assets.	CBCh
BIS Financial Cycle (Home Country)	It corresponds to the financial cycle of the parent bank.	BIS
BIS Business Cycle (Home Country)	It corresponds to the economic cycle of the parent bank.	BIS
Weights		
w1	It corresponds to the ratio of total exposure (claims plus liabilities) to the sum of total exposure to every country.	CBCh
w2	It corresponds to the ratio of claims to the sum of total claims to every country.	CBCh
w3	It corresponds to the ratio of liabilities to the sum of total liabilities to every country.	CBCh
w1 Mean	It corresponds to the average by each bank of w1's weight.	CBCh

References

Ahumada, A., and J. Marshall. 2001. "The Banking Industry in Chile: Competition, Consolidation and Systemic Stability." *BIS Papers* 4 (August): 45–53.

Aiyar, S., C. Calomiris, J. Hooley, Y. Korniyenko, and T. Wieladek. 2014. "The International Transmission of Bank Capital Requirements: Evidence from the United Kingdom." *Journal of Financial Economics* 113 (3): 368–82.

Buch, C., and L. Goldberg. 2017. "Cross-Border Prudential Policy Spillovers: How Much? How Important? Evidence from the International Banking Research Network." *International Journal of Central Banking* 13 (S1).

Cabezas, L., and A. Jara. 2016. "International Banking and Cross-Border Effects of Regulation: Lessons from Chile." Working Paper No. 790, Central Bank of Chile.

Cerutti, E., R. Correa, E. Fiorentino, and E. Segalla. 2017. "Changes in Prudential Policy Instruments—A New Cross-Country Database." *International Journal of Central Banking* 13 (S1).

Drehmann, M., C. Borio, and K. Tsatsaronis. 2012. "Characterizing the Financial Cycle: Don't Lose Sight of the Medium Term!" BIS Working Paper No. 380.

International Monetary Fund. 2011. "Chile: Financial System Stability Assessment." IMF Country Report No. 11/261 (August).

Jara, A., and D. Oda. 2015. "Agrupación de Instituciones Bancarias a Partir del Análisis de Clúster: Una Aplicación al Caso de Chile." Notas de Investigación, *Journal Economía Chilena* (*The Chilean Economy*) 17 (2): 80–102.

Laeven, L., and R. Levine. 2009. "Bank Governance, Regulation and Risk Taking." *Journal of Financial Economics* 93 (2): 259–75.

Larraín, C. 2015. "Basel, the Financial Crisis and Regulatory Institutions in Chile: Proposals for Reforms."

Milcheva, S., and B. Zhu. 2015. "Bank Integration and Comovements across Housing Markets." *Journal of Banking and Finance* 72 (Supplement): S148–S171.

International Banking and Cross-Border Effects of Regulation: Lessons from Germany*

Jana Ohls,[a] Marcus Pramor,[a] and Lena Tonzer[b]
[a]Deutsche Bundesbank
[b]Halle Institute for Economic Research

We analyze the inward and outward transmission of regulatory changes through German banks' (international) loan portfolio. Overall, our results provide evidence for international spillovers of prudential instruments. These spillovers are, however, quite heterogeneous between types of banks and can only be observed for some instruments. For instance, domestic affiliates of foreign-owned global banks reduce their loan growth to the German economy in response to a tightening of sector-specific capital buffers, local reserve requirements, and loan-to-value ratios in their home country. Furthermore, from the point of view of foreign countries, tightening reserve requirements is effective in reducing lending inflows from German banks. Finally, we find that business and financial cycles matter for lending decisions.

JEL Codes: F30, G01, G21, G28.

*This paper was written as part of the International Banking Research Network (IBRN) project on cross-border regulatory spillovers. We thank Deutsche Bundesbank, the IBRN, and the Bank for International Settlements for providing data. Also, we would like to thank Claudia Buch, Luisa Carpinelli, Evren Damar, Elisabetta Fiorentino, Linda Goldberg, Friederike Güttner, Chris Jürschik, Cornelia Kerl, Axel Loeffler, and Adi Mordel as well as seminar participants at the Deutsche Bundesbank for their helpful comments. All remaining errors and inconsistencies are entirely our own responsibility. The paper represents the authors' personal opinions and does not necessarily reflect the views of the Deutsche Bundesbank or its staff. Author contact: Jana Ohls, Deutsche Bundesbank, Wilhelm-Epstein-Strasse 14, 60431 Frankfurt am Main, Germany, jana.ohls@bundesbank.de; Marcus Pramor, Deutsche Bundesbank, Wilhelm-Epstein-Strasse 14, 60431 Frankfurt am Main, Germany, marcus.pramor@bundesbank.de; Lena Tonzer, Halle Institute for Economic Research (IWH), Kleine Maerkerstrasse 8, 06108 Halle (Saale), Germany, lena.tonzer@iwh-halle.de.

1. Introduction

In response to the recent financial crisis, numerous and substantial changes have been made to the architecture of the financial system. One key objective is to maintain financial stability by widening the focus of regulation from individual banks to the stability of the financial system as a whole. Prudential instruments can help in achieving this objective. The effectiveness of these instruments for financial stability hinges, however, on the absence of unintended leakages and spillovers. In integrated financial markets, such as in the German case, this might be a challenge given that banks can circumvent prudential regulation by adapting their global activities.

In this paper, we analyze how prudential policies implemented in domestic and foreign markets affect German banks' local and global lending behavior following the methodology described in Buch and Goldberg (2017). Our study relates to the current policy debate on cross-border effects of regulatory policies and reciprocation. For instance, the European Systemic Risk Board (ESRB), which is the European macroprudential authority, has recently issued recommendations calling for an annual assessment of cross-border effects of national macroprudential measures (ESRB 2015). We use detailed micro-level data on German banks to study regulatory spillovers across borders in three different dimensions: inward transmission of foreign regulation into Germany due to international activities of German global banks, inward transmission through domestic affiliates of foreign-owned global banks, and outward transmission to foreign countries through foreign lending of German global banks and their foreign affiliates.[1]

The German case in the International Banking Research Network (IBRN) is interesting because of the high degree of international activity of German banks. We analyze international lending growth of German-owned banks to fifty-two foreign countries. These foreign claims amount to 33 percent of total claims of German banks. Also, Germany hosts seventy-two affiliates of foreign global banks which hold 9 percent of all German claims. From a German policy

[1]Please see Buch and Goldberg (2017, figure 1) for a detailed presentation of the terminology used to describe inward and outward transmission.

perspective, it is important to understand whether and how these foreign-owned banks transmit regulatory changes from their home country into the German market. Finally, German banks enter foreign markets not only through cross-border lending but also through foreign branches and foreign subsidiaries. Besides following the common IBRN methodology, our data allow us to test whether foreign branches and subsidiaries behave differently in response to changes in regulation.

While our results provide evidence for international spillovers of changes in prudential instruments, we document that these spillovers are heterogeneous between types of instruments and types of banks. First, analyzing the inward transmission of regulatory changes abroad due to foreign exposures of German banks, we find that, for the average bank, domestic lending growth increases when foreign regulation tightens. This holds true specifically for a tightening in capital requirements and loan-to-value ratios.

Second, domestic affiliates owned by foreign global banks contract their lending growth in Germany in response to a policy tightening in their home country. This finding is surprising, as one might expect foreign global banks to respond to stricter regulation in their home country by increasing lending activities by their domestic affiliates located in Germany that are not subject to that regulation. However, regulatory pressure can have indirect effects on domestic affiliates owned by foreign global banks if a parent bank draws resources from these affiliates in order to fulfill tighter requirements in the home country. While there is substantial heterogeneity between different types of banks, the role of bank characteristics differs across regulatory instruments. Overall, the retrenchment from lending in Germany is less pronounced for larger banks that are better capitalized and that display a higher ratio of illiquid assets to total assets.

Third, for the outward transmission exercise, we find evidence that international lending growth by German global banks is negatively affected by stricter regulation in the destination country. However, for most prudential instruments, we only find short-run effects that vanish after one quarter. Only in the case of local reserve requirements do we find that a tightening in this instrument significantly reduces loan growth over a longer time horizon. This suggests that reserve requirements, which have been used mainly by

emerging markets in our sample, have been successful in controlling capital inflows from German global banks.

Furthermore, we study whether foreign branches and subsidiaries of German global banks differ in their responses to changes in prudential regulation in their foreign host country. Institution-based regulation in the foreign host country usually applies to foreign subsidiaries, while foreign branches are subject to home, in this case German, regulation. The differential treatment of branches and subsidiaries may facilitate regulatory leakages in the foreign country. Our results suggest that foreign subsidiaries are constrained by foreign regulation, as they reduce lending growth in response to a tightening in the foreign country prudential index (as well as in sector-specific capital buffers, loan-to-value ratios, and foreign reserve requirements). Foreign branches, however, do not change their lending growth significantly following a change in foreign regulation (except for a negative effect of concentration ratios and a positive contemporaneous effect of the prudential index). In contrast to foreign subsidiaries, marginal effects of a tightening in prudential instruments are positive in the foreign branch subsample but not significant.

Finally, we find that business and financial cycles affect lending decisions. For instance, domestic affiliates of foreign global banks increase lending growth when the financial cycle in their home country expands. Similarly, German global banks raise lending growth to destination countries that experience an upturn in their financial and business cycles. This procyclical connection with destination-country cycles, however, cannot be found for loan growth by German banks' foreign affiliates hosted in these countries.

Our study adds to research on the pattern of German banks' international activities and cross-border spillovers. Buch, Koch, and Koetter (2014), for example, find that more productive German banks are more likely to maintain cross-border activities. In contrast, the propensity to maintain cross-border loans decreases with risk aversion (Düwel, Frey, and Lipponer 2011). Besides productivity and risk aversion, bank size also matters. While a large percentage of German banks are active abroad, only large banks maintain foreign affiliates (Buch, Koch, and Koetter 2011b). We include a set of bank control variables based on this literature.

The recent financial crisis has shifted banks' international activities. Banks have withdrawn from international markets, with one reason being changes in funding conditions or government interventions (Buch, Neugebauer, and Schröder 2013; Kerl and Koch 2015). Internal capital markets have been used to stabilize foreign affiliates' lending activities after the crisis depending on parent banks' characteristics (Frey and Kerl 2015). Investigating international spillovers, Buch, Koch, and Koetter (2011a) look at the effect of rescue measures implemented in response to the recent financial crisis in the United States and Germany and find evidence of spillover effects through foreign affiliates.

Our paper adds to the aforementioned literature by focusing on the effects of changes in prudential regulation on German banks' (international) lending activity. We address this issue by exploiting a novel data set on regulatory changes obtained from Cerutti et al. (2017), thereby contributing to a relatively new strand of the literature (e.g., Aiyar, Calomiris, and Wieladek 2014; Claessens, Ghosh, and Mihet 2013; and Jiménez et al. 2012). Overall, we find a withdrawal from foreign markets when regulation in the home or foreign market tightens.

The paper is structured as follows. The following section describes the data and stylized facts on international activities of German banks. The third section presents regression results for the analysis of inward and outward transmission of changes in prudential instruments. In addition to the common methodology, we analyze whether adjustments differ for foreign branches and subsidiaries of German banks. The final section concludes the paper.

2. Data and Stylized Facts for Germany

2.1 Bank-Level Data

We use confidential data collected by Deutsche Bundesbank for the monthly balance sheet statistics of banks (BISTA).[2] The sample covers the period from 2002:Q1 to 2013:Q4. Data are available

[2]For more information on Deutsche Bundesbank's monthly balance sheet statistics of banks, see https://www.bundesbank.de/Redaktion/EN/Standardartikel/Service/Reporting_systems/monthly_balance_sheet_statistics.html?https=1.

for (i) all banks located in Germany, including domestic affiliates owned by foreign global banks, and (ii) German banks' branches and subsidiaries operating abroad. Data on German banks' international activities by destination country are obtained from Deutsche Bundesbank's external position report.[3] The analysis is conducted at a quarterly frequency. To aggregate monthly data to quarterly frequency, we use quarter-end values.

2.1.1 Dependent Variables

For the dependent variable, we use log changes in loans. In the baseline specification, we employ total loans; for robustness tests, we exploit the sectoral breakdown and analyze the effect on loans to banks, non-financial firms, and the public sector separately.[4]

For the inward transmission exercise, we resort to total domestic loans as provided by the monthly balance sheet statistics. These data are available for domestic (German) banks and domestic affiliates of foreign global banks.[5] For the latter, we can identify the home country of the foreign parent bank. For the outward transmission exercise, we make use of data from the external position report. All German banks, including their foreign affiliates (branches and subsidiaries), are required to report foreign asset positions, broken down by destination country. While foreign subsidiaries of German banks have to report their foreign claims individually, foreign branches are aggregated for each German parent bank by country.[6] Our analysis includes the fifty-two largest destination countries (in terms of overall claims in the German banking system) and the ninety-two

[3]Deutsche Bundesbank's data on the external positions of individual German banks are confidential but can be used under certain conditions for research projects. For more information, please see http://www.bundesbank.de/Navigation/EN/Bundesbank/Research/RDSC/rdsc.html.

[4]For a more detailed discussion of the sectoral breakdown and the resulting effects, we refer the reader to Ohls, Pramor, and Tonzer (2016).

[5]Please note that domestic affiliates owned by foreign global banks are not included in the outward transmission exercise due to data restrictions. In the inward transmission exercise, these banks are only included when specifically analyzing inward transmission through domestic affiliates of foreign global banks. We cannot differentiate between branches and subsidiaries due to data limitations.

[6]For a comprehensive description of the external position report, see Fiorentino, Koch, and Rudek (2010).

largest banks (plus their foreign affiliates) in terms of foreign assets. We thereby cover more than 90 percent of the German banking system's total foreign loans as of December 2013. Our analysis focuses on the intensive margin, i.e., on lending growth, not on adjustments along the extensive margin. In order to reduce the cases of entries into and exits out of foreign markets in our data set, we exclude small banks and less relevant destination countries. As a result, 84 percent of all bank/destination country combinations show up in at least 75 percent of all sample periods.

Regarding the level of consolidation, we proceed as follows. When studying the lending responses of German-owned banks, we use consolidated (parent plus foreign branch) data if a German global bank owns foreign affiliates, but also include banks that lend directly cross-border without owning a foreign affiliate. This is the case for inward transmission through international activities of German global banks and the outward transmission exercise. This consolidation choice accounts for the fact that parents and their foreign branches are often subject to home-country regulation, whereas subsidiaries are subject to foreign-country regulation. We approximate consolidated exposures at the parent-foreign branch level by using the unconsolidated positions of the parent and its foreign branches and a proxy for intrabank flows. This proxy has been used in previous studies based on these data (Frey and Kerl 2015). For the inward transmission specification through domestic affiliates of foreign global banks, we use unconsolidated data due to data constraints, but control for internal capital market positions.

To account for outliers, we drop observations for which the log change of lending exceeds 100 percent in absolute terms. We only keep series for which at least two consecutive observations and at least eight observations in total are available. Qualitatively, our main regression results are not affected by the sample adjustment. Summary statistics are provided in table 1.

2.1.2 Balance Sheet Characteristics

The balance sheet characteristics are taken from the monthly balance sheet statistics (BISTA). To remove outliers, we drop observations for which the ratios described below are less than zero

Table 1. Summary Statistics on Bank Characteristics and Loan Growth

Variable	All Banks (Inward A) (Bank-Quarter Obs. = 3,852)			All Banks (Inward B) (Bank-Quarter Obs. = 2,591)			All Banks (Outward) (Bank-Quarter/Destination Country Obs. = 182,379)		
	Mean	**Median**	**SD**	**Mean**	**Median**	**SD**	**Mean**	**Median**	**SD**
Balance Sheet Data									
Dependent Variables:									
Δ Domestic Loans	0.18	0.14	10.51	1.25	0.64	26.11			
Δ Destination-Country Loans							−0.58	0.00	21.13
Δ Loans to Banks	−0.23	−0.13	26.66	−0.51	0.00	38.76	−0.19	0.00	19.12
Δ Loans to Non-bank Private Sector	0.20	0.21	9.74	0.69	0.35	20.93	−0.49	0.00	16.29
Δ Loans to Public Sector	−0.80	−0.35	20.07	−0.01	−0.01	0.59	0.00	0.00	0.18
Independent Variables:									
Log Total Assets	23.49	23.60	1.87	21.99	21.96	1.55	23.44	23.54	1.89
Capital Ratio (%)	4.38	3.90	3.00	6.51	4.97	6.98	4.53	3.86	4.41
Illiquid Assets Ratio (%)	68.85	70.19	15.89	81.52	89.69	20.04	68.39	70.10	16.43
International Activity (%)	6.48	3.30	7.46	NA	NA	NA	6.16	2.98	7.38
Net Intragroup Funding/Liabilities (%)	−0.22	0.00	3.30	0.00	0.00	1.00	−0.24	0.00	3.32
Core Deposits Ratio (%)	23.55	15.11	24.18	19.77	8.48	24.20	24.75	15.15	25.55

Notes: This table provides summary statistics for bank balance sheet and lending data for the inward and outward transmission data set. For inward A and B we report log changes of domestic loans, i.e., to Germany, on an aggregate basis as well as split by counterparty sector. For outward transmission, we report log changes of loans in each destination country, again on an aggregate basis as well as split by counterparty sector. Data are observed quarterly from 2002:Q1 to 2013:Q4. Banking data are taken from the monthly balance sheet statistics and the external position report of Deutsche Bundesbank and are reported at the group level (inward A and outward sample) as well as at the level of the individual bank (inward B sample). The net intragroup funding variable measures, from the perspective of a bank's head office, total net internal borrowing vis-à-vis all its related domestic and international offices.

or greater than 100 percent.[7] Balance sheet variables include the illiquid assets ratio, the core deposits ratio, the capital ratio, the net intragroup funding ratio, the log of total assets, and the international activities ratio. These variables are defined in table 8 in the appendix, with corresponding summary statistics provided in table 1.

2.2 Data on Prudential Instruments

To analyze spillovers of regulatory policies, this study draws on the IBRN Prudential Instruments Database described in Cerutti et al. (2017), which provides quarterly information on changes in seven prudential instruments plus a composite index for more than sixty countries over the 2000–14 period. The prudential variables provide information on tightening (coded by 1) and loosening (coded by −1) of a specific instrument in the specific quarter when the change came into effect, and zero otherwise. In this study, we focus on six out of seven instruments to study spillovers of prudential policies: general capital requirements, sector-specific capital requirements, loan-to-value ratio limits, reserve requirements (in local and foreign currency), and concentration limits. We exclude interbank exposure limits from our analysis due to the small number of changes for this instrument in our sample (see table 2).

We use this information in our analysis to control for individual changes in prudential instruments in the home country of domestic affiliates of global foreign banks and in the destination country of lending by German banks. We do not analyze the effects of regulatory changes in Germany on bank lending because we do not observe enough changes in regulatory instruments in Germany over the sample period. Instead, we control for German regulation through time fixed effects. See Buch and Goldberg (2017) for more details on the construction of regulatory measures. The variables are defined as follows:

[7] The variable capturing internal capital market positions can also be less than zero; we therefore drop values that exceed 100 percent in absolute terms.

Table 2. Summary Statistics on Changes in Prudential Instruments

Inward: Specification A						
	Base Data (Before Aggregating to Exposure-Weighted Measures)					Exposure-Weighted Observations
Instrument	No. of Country-Time Changes	No. of Country-Time Changes (Tightening)	No. of Country-Time Changes (Loosening)	No. of Bank-Time Changes	Proportion Base-MPP Non-zero	Proportion $ExpP_t$ Non-zero
Prudential Index	441	305	136	3,623	0.166	0.952
General Capital Requirements	66	66	0	880	0.024	0.209
Sector-Specific Capital Buffer	62	47	15	2,299	0.023	0.526
Loan-to-Value Limits	83	62	21	2,833	0.031	0.657
Reserve Requirements: Foreign	121	79	42	3,623	0.046	0.778
Reserve Requirements: Local	215	104	111	3,623	0.081	0.871
Interbank Exposure Limit	18	17	1	838	0.007	0.193
Concentration Ratio	28	26	2	1,623	0.011	0.368
Inward: Specification B						
	Policy Changes in Home Country					
Instrument	No. of Country-Time Changes	No. of Country-Time Changes (Tightening)	No. of Country-Time Changes (Loosening)	No. of Bank-Time Changes		Proportion $HomeP_t$ Non-zero
Prudential Index	131	102	29	304		0.120
General Capital Requirements	24	24	0	69		0.027
Sector-Specific Capital Buffer	17	16	1	24		0.009
Loan-to-Value Ratio Limits	28	22	6	68		0.027
Reserve Requirements: Foreign	32	25	7	48		0.019
Reserve Requirements: Local	73	39	34	144		0.057
Interbank Exposure Limit	9	9	0	18		0.007
Concentration Ratio	10	10	0	42		0.017

(*continued*)

Table 2. (Continued)

Outward Transmission of Policy to Destination Country					
	Policy Changes in Destination Country				
Instrument	**No. of Country-Time Changes**	**No. of Country-Time Changes (Tightening)**	**No. of Country-Time Changes (Loosening)**	**No. of Bank-Time Changes**	**Proportion Base-MPP Non-zero**
Prudential Index	390	267	123	29,347	0.161
General Capital Requirements	61	61	0	4,393	0.024
Sector-Specific Capital Buffer	58	43	15	4,331	0.024
Loan-to-Value Ratio Limits	80	60	20	5,898	0.032
Reserve Requirements: Foreign	99	62	37	7,615	0.042
Reserve Requirements: Local	185	82	103	14,136	0.078
Interbank Exposure Limit	17	16	1	1,264	0.007
Concentration Ratio	26	23	3	1,959	0.011

Source: IBRN.
Notes: This table shows summary statistics on changes in prudential instruments for banks located in Germany over the 2002–13 period. Data on the instruments come from the IBRN Prudential Instruments Database described in Cerutti et al. (2017) and are at quarterly frequency. The number of changes in prudential instruments is reported along several dimensions, i.e., at country-time level and at bank-time level. The last column of each panel shows the ratio of prudential changes to total observations (i.e., the share of non-zero observations). The column "Exposure-Weighted Observations" is based on the underlying data on prudential changes in foreign countries (columns under the heading "Base Data"). The reported data are based on the regression sample.

- Regulation weighted by foreign exposures (all exposures of banks *outside* the home country): $ExpP_{b,t-l}$ (where $l = 0, 1, 2$) = foreign-exposure-weighted regulation
- Home-country regulation (home country = country of the foreign parent bank): $HomeP_{j,t-l}$ (where $l = 0, 1, 2$) = home-country regulation with zero, one, and two lags
- Destination-country regulation (destination country = country to which the loan goes): $DestP_{j,t-l}$ (where $l = 0, 1, 2$) = destination-country regulation with zero, one, and two lags

Table 2 provides summary statistics for changes in these instruments. We see that most changes occur for reserve requirements on local- and foreign-currency deposits followed by capital requirements. A tightening of standards occurred more often than a loosening.

Our sample is rather dominated by advanced economies (60 percent of the underlying observations in the inward A and outward specifications, 90 percent of the underlying observations in the inward B specification). However, we observe relatively more regulatory changes in emerging market economies for the significant regulatory instruments. This holds particularly true for foreign and local reserve requirements.

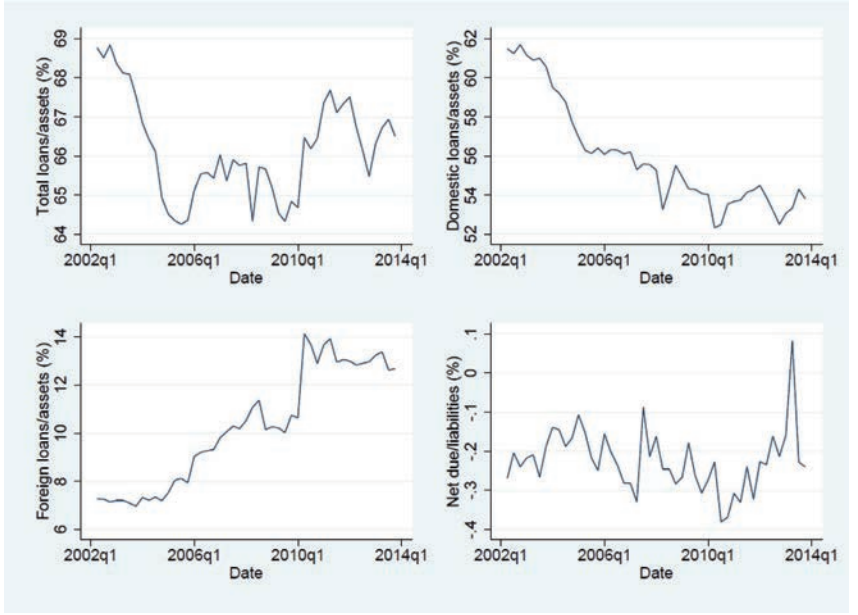
2.3 Data on the Business and Financial Cycles

The second database focuses on macroeconomic conditions and was provided by the Bank for International Settlements (BIS). It allows us to control for the current state of the business (output gap) and financial (credit-to-GDP gap) cycles when assessing regulatory spillovers (BIS 2014; Drehmann, Borio, and Tsatsaronis 2011). This is important given that changes in regulation often take place in response to economic and financial conditions while their implementation might, in turn, affect economic outcomes.

2.4 Stylized Facts

Fact 1: *The degree of internationalization is heterogeneous across German banks.*

Figure 1. Domestic and Foreign Lending Activities of German Banks



Notes: This figure shows the evolution of German banks' loan supply. Data are observed quarterly from 2002:Q1 to 2013:Q4. The figure shows unweighted averages across the sample of German bank holding companies. Banking data are taken from the monthly balance sheet statistics of Deutsche Bundesbank and are reported at the group level for individual banks. Descriptive statistics are shown for banks' loan-to-asset ratios (in %), the breakdown into domestic versus foreign loans to assets (in %), and the net intragroup funding (net due) variable which measures, from the perspective of a bank's headquarters, total net internal borrowing, i.e., liabilities minus claims of the parent bank vis-à-vis all foreign affiliates of the parent bank relative to total liabilities (in %).

A large percentage of German banks maintain international activities (Buch, Koch, and Koetter 2011b). Figure 1 shows that German banks have recently increased their foreign loan supply relative to assets (lower left graph), whereas this cannot be observed for domestic lending (upper right graph). On average, German banks are net lenders regarding their intragroup positions (lower right graph). Hence, on average, they distribute liquidity to their foreign subsidiaries rather than absorbing liquidity from them.

Table 3. Correlations between Loan Shares and Balance Sheet Characteristics

Variable	All Banks (Inward A) (N = 3,852)		
	Loans/ Assets (%)	Domestic Loans/ Assets (%)	Foreign Loans/ Assets (%)
Correlation with Balance Sheet Variable (for Each Bank b and Quarter t)			
Independent Variables:			
Total Assets (EUR thousands)	−0.24	−0.38	0.31
Capital Ratio (%)	0.20	0.16	−0.01
Illiquid Assets Ratio (%)	0.93	0.68	0.06
International Activity (%)	−0.02	−0.59	0.94
Net Intragroup Funding/Liabilities (%)	−0.09	0.12	−0.31
Core Deposits Ratio (%)	−0.10	0.14	−0.35

Notes: This table shows correlations between banks' loan-to-asset ratios and balance sheet data. Data are observed quarterly from 2002:Q1 to 2013:Q4. Banking data come from Deutsche Bundesbank's monthly balance sheet statistics and are reported at the (consolidated) group level. Descriptive statistics are shown for banks' loan-to-asset ratios (in %) and the breakdown into domestic versus foreign loans to assets (in %). Balance sheet characteristics are as defined in table 8 in the appendix.

The size of international activities of German banks and thus presumably their potential to generate cross-border spillovers of regulation varies with the banks' business models: notably, large German banks conduct a relatively large amount of their business abroad (Fiorentino, Koch, and Rudek 2010). Table 3 shows correlations of banks' total, domestic, and foreign loan shares with balance sheet characteristics. Besides the relevance of bank size, it can be seen that German banks' capital and core deposits ratios correlate positively with the share of domestic loans to assets, whereas this finding is less pronounced or even reversed for the share of foreign loans to assets. We will therefore test whether banks' balance sheet characteristics affect their responses to regulatory changes abroad and at home (section 3.1).

Heterogeneity in international activities also comes into play if we look at foreign loans by bank group relative to total foreign

lending by German banks. For example, in 2013:Q4, around 60 percent of foreign loans granted by German banks can be attributed to the "large commercial banks" and around 20 percent to the "head institutes of savings banks and credit unions," but only 6 percent to "other commercial banks" and less than 1 percent to "savings banks and credit unions." The average bank size in the latter two banking groups is significantly smaller compared with the former two banking groups, such that the result is consistent with the relevance of bank size for the conducting of international activities. Furthermore, comparing large commercial banks and head institutes of savings banks and credit unions with banks in the other banking groups reveals that they have, on average, a lower capital ratio and illiquid assets ratio, they are net lenders regarding their intragroup positions, and they are financed to a lower degree by core deposits. These differences in exposure to foreign activities as well as business models might thus impact the transmission of prudential changes.

Fact 2: *Foreign affiliates of German banks include both branches and subsidiaries.*

German banks maintain both foreign subsidiaries and foreign branches in a large number of different countries. In an extended analysis on the impact of the organizational structure, we cover around forty destination countries with approximately 170 subsidiaries and 190 aggregates of branches.[8] Foreign subsidiaries are assumed to respond differently to foreign regulation than foreign branches. For example, German banks' foreign branches, which are under home-country regulation, can expand/reduce their activities compared with other banks in the foreign country if the latter face a tighter/looser regulatory environment. In section 3.2, we thus analyze whether foreign branches respond differently to a tightening or loosening of foreign policies compared with foreign subsidiaries of German banks.

[8]Note that, as described in the data section, we do not have data on individual branches but on the aggregate of branches per German parent bank and foreign country. For example, if the German parent bank A has two branches in the United States, we have information on the sum of these two branches.

3. Empirical Method and Regression Results

This section presents the baseline estimations for inward and outward transmission of prudential instruments (section 3.1). We extend our analysis and ask whether banks adjust their lending growth differently depending on their organizational form (section 3.2).

3.1 Baseline Analysis of Inward and Outward Transmission of Prudential Policies

In the following, we provide a description of the baseline empirical model to study inward and outward transmission and comment on the results. The analysis closely follows the approach described in Buch and Goldberg (2017).

In each specification 1 to 3, we include our variable of interest, a prudential policy change, both contemporaneously and with its two lags. Furthermore, the prudential policy is interacted with banks' balance sheet characteristics, showing how banks with different (structural) balance sheet characteristics adjust their loan growth in response to changes in regulation. In regression tables 4 to 7, for the sake of brevity, the reported coefficients are the sum of the contemporaneous term and its two lags, with the corresponding p-values of the F-statistics for joint significance in square brackets. As the prudential instrument enters individually as well as in the interaction effects with bank variables, we calculate a marginal effect (at the average) for both the contemporaneous changes and the sum of contemporaneous and lagged changes. These marginal effects give the effects of regulation for the average bank and are reported at the bottom of each table. Baseline regression models include time and bank fixed effects.

Specification 1: *Exposure-weighted inward transmission of regulation (table 4).*

$$\begin{aligned}\Delta Y_{b,t} = \alpha_0 &+ (\alpha_1 ExpP_{b,t} + \alpha_2 ExpP_{b,t-1} + \alpha_3 ExpP_{b,t-2}) + \alpha_4 X_{b,t-1} \\ &+ (\beta_1 ExpP_{b,t} \cdot X_{b,t-1} + \beta_2 ExpP_{b,t-1} \cdot X_{b,t-1} \\ &+ \beta_3 ExpP_{b,t-2} \cdot X_{b,t-1}) + f_b + f_t + \varepsilon_{b,t}, \qquad (1)\end{aligned}$$

where $\Delta Y_{b,t}$ is the log change in the domestic lending of bank b at time t. $X_{b,t-1}$ is a vector of control variables that captures the degree to which a bank is exposed to changes in regulation through ex ante balance sheet composition as described in section 2.1. The prudential policy changes are captured by *ExpP*, which is an index of exposure-weighted prudential policies outside the home country.

Results for specification 1 are shown in table 4; we see that the exposure-weighted index of changes in the overall prudential index increases domestic lending growth for the average bank (see marginal effects at the bottom of table 4). While this effect is significant contemporaneously, it becomes insignificant in the medium run if we add the effects for the first and second lag to a joint effect. One reason for the lack of medium-run effects can be that most of the changes in instruments are clustered in 2012 and 2013. The result on the prudential index is driven by two instruments: capital requirements and loan-to-value ratios. For the latter, we also see a significant effect for the average bank over current and two lags. In quantitative terms as well, the current effect of the loan-to-value ratio is strongest: Given a tightening of the policy, loan growth rates increase on average by 15.2 percent, which corresponds to an increase of the median loan growth rate (0.27 percent per quarter) by 0.04 percentage points in that quarter. Loan-to-value ratios have been used actively by emerging market economies over our sample period and have been both tightened and loosened. This provides a solid ground for the empirical analysis.

Differences in bank characteristics do not seem to consistently affect the response to regulatory changes abroad. The positive effect in the case of the prudential index is weakened for banks with higher net intragroup positions; banks' response to a tightening in the instrument is more than four times weaker if the net intragroup funding ratio increases by one standard deviation. This might be because foreign affiliates have less scope to provide intragroup funding to the German parent bank given tighter regulation.

Specification 2: *Inward transmission of home prudential policy via domestic affiliates of foreign global banks (table 5).*

Table 4. Inward Transmission of Policy through Domestic Banks' International Exposures

	ExpP = Prudential IndexC (1)	ExpP = Capital Require-ments (2)	ExpP = Sector-Specific Capital Buffer (3)	ExpP = LTV Ratio (4)	ExpP = Reserve Require-ments: Foreign (5)	ExpP = Reserve Require-ments: Local (6)	ExpP = Concen-tration Ratios (7)
Foreign-Exposure-Weighted Regulation (ExpP)	−4.417	73.107	−145.850	132.524	−260.478	−64.081	62.442
	[0.909]	[0.258]	[0.170]	[0.139]	[0.431]	[0.272]	[0.423]
Log Total Assets$_{t-1}$	−5.922***	−5.634***	−5.632***	−5.637***	−5.466***	−5.634***	−5.803***
	[0.001]	[0.003]	[0.001]	[0.002]	[0.003]	[0.002]	[0.002]
Capital Ratio$_{t-1}$	−0.591**	−0.475*	−0.488*	−0.473*	−0.409*	−0.472*	−0.595**
	[0.035]	[0.086]	[0.073]	[0.097]	[0.097]	[0.085]	[0.034]
Illiquid Assets Ratio$_{t-1}$	−0.189***	−0.182***	−0.192***	−0.193***	−0.187***	−0.172***	−0.190***
	[0.001]	[0.001]	[0.000]	[0.001]	[0.001]	[0.001]	[0.001]
International Activity$_{t-1}$	0.142*	0.121	0.179**	0.114	0.131*	0.124*	0.143*
	[0.056]	[0.139]	[0.017]	[0.170]	[0.053]	[0.088]	[0.050]
Net Intragroup Funding$_{t-1}$	−0.311	−0.398**	−0.386	−0.365	−0.419*	−0.380*	−0.327
	[0.158]	[0.047]	[0.115]	[0.108]	[0.064]	[0.080]	[0.125]
Core Deposits Ratio$_{t-1}$	−0.032	−0.026	−0.029	−0.005	−0.017	−0.023	−0.024
	[0.510]	[0.588]	[0.529]	[0.901]	[0.716]	[0.616]	[0.614]
Log Total Assets*ExpP	0.133	−2.111	4.534	−2.528	12.148	0.616	−1.900
	[0.919]	[0.390]	[0.267]	[0.376]	[0.396]	[0.778]	[0.534]
Capital Ratio*ExpP	3.105	−0.719	2.091	−3.811	17.859*	4.391	4.602**
	[0.155]	[0.772]	[0.484]	[0.203]	[0.051]	[0.175]	[0.011]
Illiquid Assets Ratio*ExpP	−0.170	−0.313	0.478	−0.641	−2.032	0.383*	−0.531
	[0.357]	[0.248]	[0.355]	[0.223]	[0.115]	[0.077]	[0.108]
International Activity*ExpP	−0.260	0.268	−2.095***	0.662	0.675	−0.396	−0.350
	[0.468]	[0.685]	[0.005]	[0.428]	[0.767]	[0.207]	[0.455]
Net Intragroup Funding*ExpP	−1.383***	−0.402	3.542	−1.034	22.045*	0.919	−5.552***
	[0.005]	[0.721]	[0.220]	[0.355]	[0.054]	[0.573]	[0.000]
Core Deposits Ratio*ExpP	0.053	0.090	0.166	−0.089	−0.264	−0.034	−0.263
	[0.594]	[0.467]	[0.345]	[0.708]	[0.756]	[0.814]	[0.211]

(*continued*)

Table 4. (Continued)

	ExpP = Prudential IndexC (1)	ExpP = Capital Require-ments (2)	ExpP = Sector-Specific Capital Buffer (3)	ExpP = LTV Ratio (4)	ExpP = Reserve Require-ments: Foreign (5)	ExpP = Reserve Require-ments: Local (6)	ExpP = Concen-tration Ratios (7)
Observations	3,757	3,757	3,757	3,757	3,757	3,757	3,757
R^2	0.062	0.070	0.057	0.064	0.086	0.063	0.054
Adjusted R^2	0.043	0.052	0.038	0.045	0.068	0.045	0.035
No. of Banks	96	96	96	96	96	96	96
Time Period	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marginal Effect of ExpP (Contemporaneous and Lagged Indicator)	0.405 [0.874]	2.722 [0.446]	−7.636 [0.217]	14.785** [0.012]	-44.407 [0.141]	−7.674 [0.206]	−5.984 [0.364]
Contemporaneous Marginal Effect of ExpP	3.754** [0.014]	5.523*** [0.002]	−5.078 [0.232]	15.173*** [0.001]	−21.458 [0.244]	1.745 [0.604]	−0.163 [0.966]

Notes: This table reports the effects of changes in regulation and bank characteristics and their interactions on log changes in total loans. Data are quarterly from 2002:Q1 to 2013:Q4 for a panel of domestic bank holding companies, whereas we use consolidated data. Foreign-exposure-weighted regulation ExpP is calculated as the weighted average of changes in foreign regulation where the weights are the total assets and liabilities of the bank in the respective foreign country. For ExpP and its interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-value of the F-statistic for joint significance reported below. For more details on the variables, see table 8 in the appendix. Each column shows the result for the regulatory measure specified in the column title. All specifications include fixed effects as specified in the lower part of the table. Standard errors are clustered by bank. P-values are reported in square brackets. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

$$\begin{aligned}\Delta Y_{b,j,t} = \alpha_0 &+ (\alpha_1 HomeP_{j,t} + \alpha_2 HomeP_{j,t-1} + \alpha_3 HomeP_{j,t-2}) \\ &+ \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + (\beta_1 HomeP_{j,t} \cdot X_{b,t-1} \\ &+ \beta_2 HomeP_{j,t-1} \cdot X_{b,t-1} + \beta_3 HomeP_{j,t-2} \cdot X_{b,t-1}) \\ &+ f_b + f_t + \varepsilon_{b,j,t}, \end{aligned} \tag{2}$$

where $\Delta Y_{b,j,t}$ is the log change in the lending to Germany of an affiliate bank b located in Germany with a foreign parent from country j at time t.[9] The vector of bank control variables $X_{b,t-1}$ is the same as above. The prudential policy changes are captured by *HomeP*, reflecting prudential policy in the home country, i.e., the country of the foreign parent bank of the affiliate located in Germany. $Z_{j,t}$ represents the cycle variables for home country j.

Results of specification 2 are shown in table 5. For the average affiliates owned by a foreign global bank (see marginal effects at the bottom of the table), home-country policy is important for sector-specific capital buffers, loan-to-value ratios, and reserve requirements on local-currency deposits. The latter two instruments have been used mainly by emerging market countries in our sample. An increase in these instruments reduces the host (i.e., German) lending growth by affiliates located in Germany but owned by a foreign parent bank. The economic magnitude of the current effect is strongest for sector-specific capital buffers: Given a tightening of the policy, on average loan growth rates decrease by 17.4 percent, which corresponds to an increase of the median loan growth rate (1.43 percent per quarter) by 0.25 percentage point.

This decrease in loan growth can be caused by foreign parents drawing on resources of their affiliates located in Germany to fulfill higher reserve or capital requirements and to maintain lending at home. The effect is, for example, less pronounced for illiquid banks which might have less scope to transfer liquidity to their parent bank. Larger and better-capitalized banks are also affected less severely,

[9]Ideally, we would like to distinguish between foreign-owned affiliates that are subject to German (i.e., host-country) regulation and those that are subject to home-country regulation. Unfortunately, our data do not allow us to do so. However, regulatory changes in the home country might be important for both types of foreign affiliates due to the internal capital market and the influence of the parent bank.

Table 5. Inward Transmission of Policy via Domestic Affiliates Owned by Foreign Global Banks

	HomeP = Prudential IndexC (1)	HomeP = Capital Require-ments (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Require-ments: Foreign (5)	HomeP = Reserve Require-ments: Local (6)	HomeP = Concen-tration Ratios (7)
Home-Country Regulation HomeP_{t}	−41.624	22.788	−286.785**	−64.058	193.626	−10.774	−11.312
	[0.563]	[0.579]	[0.012]	[0.293]	[0.294]	[0.810]	[0.938]
Home-Country Regulation HomeP_{t-1}	−48.934**	−14.234	129.751	93.210*	−253.897***	−121.710***	−11.289
	[0.028]	[0.771]	[0.481]	[0.072]	[0.004]	[0.006]	[0.869]
Home-Country Regulation HomeP_{t-2}	−11.523	−3.113	−116.128	−83.172***	−56.095	37.359	3.800
	[0.675]	[0.932]	[0.366]	[0.006]	[0.267]	[0.346]	[0.871]
Log Total Assets_{t-1}	−5.309***	−4.731***	−5.057***	−5.064***	−4.768***	−4.939***	−4.665***
	[0.002]	[0.002]	[0.001]	[0.001]	[0.002]	[0.002]	[0.001]
Capital Ratio_{t-1}	0.143	0.224**	0.207**	0.184*	0.206*	0.186*	0.207**
	[0.233]	[0.041]	[0.047]	[0.098]	[0.067]	[0.094]	[0.046]
Illiquid Assets Ratio_{t-1}	−0.126*	−0.083	−0.103*	−0.095	−0.105*	−0.111*	−0.094*
	[0.055]	[0.163]	[0.079]	[0.119]	[0.061]	[0.042]	[0.088]
Net Intragroup Funding_{t-1}	−0.143	−0.131	−0.189	−0.266	−0.294	−0.266	−0.271
	[0.663]	[0.684]	[0.532]	[0.359]	[0.253]	[0.332]	[0.312]
Core Deposits Ratio_{t-1}	0.020	0.034	0.035	0.022	0.039	0.028	0.035
	[0.808]	[0.663]	[0.655]	[0.773]	[0.609]	[0.714]	[0.656]
BIS Financial Cycle (Home Country)	0.094**	0.098**	0.093*	0.094**	0.081*	0.086*	0.090**
	[0.046]	[0.032]	[0.056]	[0.020]	[0.088]	[0.053]	[0.044]
BIS Business Cycle (Home Country)	0.650	0.582***	0.713	0.780	0.451	0.523	0.561
	[0.302]	[0.343]	[0.230]	[0.227]	[0.462]	[0.410]	[0.358]
Log Total Assets*HomeP	3.593***	0.853***	5.225***	0.730***	2.212***	2.452***	2.797***
	[0.234]	[0.732]	[0.258]	[0.777]	[0.611]	[0.033]	[0.396]
Capital Ratio*HomeP	0.783***	−0.599***	1.709***	1.156***	−0.128***	0.904***	−1.049***
	[0.115]	[0.542]	[0.375]	[0.454]	[0.922]	[0.034]	[0.158]
Illiquid Assets Ratio*HomeP	0.117***	−0.264***	1.648***	0.058***	0.843***	0.373***	−0.481***
	[0.542]	[0.187]	[0.052]	[0.867]	[0.110]	[0.016]	[0.145]
Net Intragroup Funding*HomeP	−4.497***	−7.707***	11.750***	−5.000***	−19.778***	7.533***	4.072***
	[0.015]	[0.099]	[0.524]	[0.098]	[0.686]	[0.267]	[0.243]
Core Deposits Ratio*HomeP	0.160***	0.188***	−1.439***	0.638***	0.340***	−0.129***	0.129***
	[0.170]	[0.238]	[0.001]	[0.061]	[0.586]	[0.472]	[0.022]

(*continued*)

Table 5. (Continued)

	HomeP = Prudential IndexC (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Requirements: Foreign (5)	HomeP = Reserve Requirements: Local (6)	HomeP = Concentration Ratios (7)
Observations	2,466	2,466	2,466	2,466	2,466	2,466	2,466
R^2	0.091	0.081	0.084	0.094	0.084	0.094	0.080
Adjusted R^2	0.035	0.025	0.029	0.039	0.029	0.039	0.024
No. of Banks	72	72	72	72	72	72	72
Time Period	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marginal Effect of HomeP	-5.334^{*}	2.510	-41.154^{***}	-13.187^{*}	6.892	-7.485	-0.814
(Contemporaneous and Lagged Indicator)	[0.069]	[0.746]	[0.000]	[0.075]	[0.442]	[0.145]	[0.837]
Contemporaneous Marginal Effect of HomeP	-3.886	0.469	-17.384^{**}	-9.863	-9.303	-8.850^{*}	5.191^{***}
	[0.233]	[0.901]	[0.011]	[0.101]	[0.523]	[0.083]	[0.004]

Notes: This table reports the effects of changes in regulation and bank characteristics and their interactions on log changes in total loans. Data are quarterly from 2002:Q1 to 2013:Q4 for a panel for foreign-owned affiliates located in Germany. HomeP refers to changes in regulation in the home (i.e., parent-bank) country of affiliates located in Germany owned by a foreign global bank. For the marginal effect of HomeP as well as for HomeP interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-value of the F-statistic for joint significance reported below. For more details on the variables, see table 8 in the appendix. Each column shows the result for the regulatory measure specified in the column title. All specifications include fixed effects as specified in the lower part of the table. Standard errors are clustered by home country. P-values are reported in square brackets. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

possibly due to higher buffers which allow them to maintain lending growth. Two conclusions can be drawn from these results. First, reductions in lending growth in response to activity-based measures such as loan-to-value ratios might be especially problematic from the perspective of the German regulator if domestic and foreign financial cycles do not coincide. Second, affiliates located in Germany and owned by a foreign parent bank are not independent of home-country regulation; in particular, tighter regulation in their parent bank's country does not make it more attractive to increase lending growth in Germany.[10]

Regarding the financial and business cycles, we find that an upswing in the financial cycle of the home country has positive effects on lending growth of affiliates of foreign global banks located in Germany. In sum, this suggests that these affiliates are not independent of developments in the country in which their parent bank is located. Regulatory changes and macroeconomic developments alike are mirrored in their lending activities within the host country.

SPECIFICATION 3: *Outward transmission of destination-country prudential policy (table 6).*

$$\begin{aligned}\Delta Y_{b,j,t} = \alpha_0 &+ (\alpha_1 DestP_{j,t} + \alpha_2 DestP_{j,t-1} + \alpha_3 DestP_{j,t-2}) \\ &+ \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + (\beta_1 DestP_{j,t} \cdot X_{b,t-1} \\ &+ \beta_2 DestP_{j,t-1} \cdot X_{b,t-1} + \beta_3 DestP_{j,t-2} \cdot X_{b,t-1}) \\ &+ f_j + f_t + f_b + \varepsilon_{b,j,t}, \end{aligned} \tag{3}$$

where $\Delta Y_{b,j,t}$ is the log change in the lending of a German global bank b to a foreign destination country j at time t. The prudential policy changes are captured by *DestP,* reflecting prudential changes in the destination country j of the loan by bank b. All other variables are defined in parallel to specifications 2 and 3. Again we interpret the effect of the regulatory index by computing its marginal effect for the average bank.

[10]Interestingly, a tightening in concentration ratios in the home market has the opposite effect, namely an increase in lending growth to the host (i.e., German) market. With tighter concentration ratios, banks might seek to increase diversification across regions. However, changes in this instrument go back to only two countries (the Netherlands and France), such that these results should be viewed with caution.

Results in table 6 reveal that a tightening in the prudential index of the destination country reduces lending growth of the average German bank to this country. Hence, stricter policies in the destination country spill over to German banks even though these are not always directly subject to the change in regulation. The significant result for the prudential index is driven in particular by changes in reserve requirements. For local reserve requirements, banks not only react in the short run, as can be observed for the prudential index, the concentration ratio, or foreign reserve requirements. The cumulative effect over the current and following two quarters is also negative and significant. Our results thus suggest that reserve requirements which have been used mostly by emerging market countries have indeed been successful in dampening lending inflows.[11] A tightening of local reserve requirements relates on average to a short-run decline in loan growth rates by 0.41 percentage point. The negative effect is smaller for banks with more liquid assets, possibly because holding the required reserves may be less costly for these banks but reinforced for banks that obtain higher net intragroup funding.

Finally, macroeconomic developments in the destination country matter for German banks' international loan portfolio. An upturn in the business and financial cycles causes a positive response in loan growth. This suggests that German banks expand across borders during economic and financial upswings in the respective destination country.

3.1.1 Robustness Tests

We test the robustness of our results by exploiting the granularity of our data and conducting regressions in which the dependent variable is broken down by loans to banks, the non-bank private sector (i.e., non-financial firms and households), and the public sector. For brevity, we do not report those results that are more explicitly discussed in Ohls, Pramor, and Tonzer (2016). The sector breakdown

[11] An increase in reserve requirements imposes additional costs on funding, which might in turn be passed on to borrowers by increasing loan rates and hence dampening credit growth. To simultaneously reduce the country's attractiveness for foreign capital inflows, an increase in reserve requirements can be accompanied by expansive monetary policy, which translates into lower returns for foreign investors.

Table 6. Outward Transmission of Policy to Destination Country

	DestP = Prudential IndexC (1)	DestP = Capital Require-ments (2)	DestP = Sector-Specific Capital Buffer (3)	DestP = LTV Ratio (4)	DestP = Reserve Require-ments: Foreign (5)	DestP = Reserve Require-ments: Local (6)	DestP = Concen-tration Ratios (7)
Destination-Country Regulation $DestP_t$	6.609***	28.453***	2.199	8.388	2.940	2.842	−2.739
	[0.007]	[0.000]	[0.692]	[0.227]	[0.345]	[0.293]	[0.446]
Destination-Country Regulation $DestP_{t-1}$	−5.333**	4.961	−3.519	−4.265	−3.742	−5.977*	3.078
	[0.038]	[0.504]	[0.273]	[0.557]	[0.157]	[0.053]	[0.562]
Destination-Country Regulation $DestP_{t-2}$	−2.903	17.253***	−12.359***	−4.044	−4.829	−1.215	−7.128
	[0.204]	[0.004]	[0.005]	[0.555]	[0.114]	[0.588]	[0.459]
Log Total $Assets_{t-1}$	−0.187	−0.171	−0.191	−0.188	−0.187	−0.180	−0.184
	[0.263]	[0.318]	[0.257]	[0.261]	[0.270]	[0.287]	[0.274]
Capital $Ratio_{t-1}$	−0.012	−0.013	−0.011	−0.012	−0.010	−0.010	−0.010
	[0.543]	[0.517]	[0.546]	[0.514]	[0.563]	[0.594]	[0.568]
Illiquid Assets $Ratio_{t-1}$	−0.004	−0.006	−0.005	−0.004	−0.004	−0.005	−0.004
	[0.557]	[0.408]	[0.496]	[0.561]	[0.552]	[0.477]	[0.542]
International $Activity_{t-1}$	−0.043**	−0.034*	−0.040**	−0.038*	−0.039**	−0.037*	−0.038*
	[0.034[	[0.080]	[0.043]	[0.054]	[0.044]	[0.056]	[0.054]
Net Intragroup $Funding_{t-1}$	0.072	0.051	0.074	0.066	0.073	0.070	0.074
	[0.120]	[0.255]	[0.111]	[0.156]	[0.116]	[0.131]	[0.114]
Core Deposits $Ratio_{t-1}$	0.008	0.007	0.008	0.008	0.008	0.008	0.007
	[0.358]	[0.447]	[0.363]	[0.361]	[0.365]	[0.339]	[0.382]
BIS Financial Cycle (Destination Country)	0.012***	0.012***	0.012***	0.012***	0.012***	0.012***	0.012***
	[0.004]	[0.003]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
BIS Business Cycle (Destination Country)	0.081**	0.082**	0.082**	0.079**	0.083**	0.082**	0.082**
	[0.024]	[0.022]	[0.024]	[0.026]	[0.023]	[0.020]	[0.022]
Log Total Assets*DestP	0.069	−1.996***	0.460**	0.038	0.277	0.223	0.305
	[0.721]	[0.000]	[0.014]	[0.948]	[0.162]	[0.310]	[0.488]
Capital Ratio*DestP	0.023	−0.151**	0.046	0.027	0.018	0.060	0.091
	[0.575]	[0.028]	[0.472]	[0.805]	[0.593]	[0.260]	[0.748]
Illiquid Assets Ratio*DestP	−0.006	−0.024	0.033	−0.011	−0.026*	−0.027***	−0.026
	[0.468]	[0.549]	[0.290]	[0.611]	[0.077]	[0.001]	[0.659]
International Activity*DestP	0.042	−0.019	0.087*	0.047	0.054	0.048	0.011
	[0.144]	[0.804]	[0.096]	[0.505]	[0.183]	[0.148]	[0.932]
Net Intragroup Funding*DestP	0.014	0.096	0.001	0.334**	−0.004	−0.094**	0.037
	[0.751]	[0.531]	[0.994]	[0.042]	[0.891]	[0.026]	[0.831]
Core Deposits Ratio*DestP	0.004	−0.043	0.012	0.004	0.020**	0.004	0.041
	[0.697]	[0.172]	[0.452]	[0.906]	[0.012]	[0.756]	[0.155]

(*continued*)

Table 6. (Continued)

	DestP = Prudential IndexC (1)	DestP = Capital Require-ments (2)	DestP = Sector-Specific Capital Buffer (3)	DestP = LTV Ratio (4)	DestP = Reserve Require-ments: Foreign (5)	DestP = Reserve Require-ments: Local (6)	DestP = Concen-tration Ratios (7)
Observations	177,777	177,777	177,777	177,777	177,777	177,777	177,777
R^2	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Adjusted R^2	0.004	0.004	0.004	0.004	0.004	0.004	0.004
No. of Destination Countries	52	52	52	52	52	52	52
No. of Banks	96	96	96	96	96	96	96
Time Period	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4
Destination-Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marginal Effect of HomeP (Contemporaneous and Lagged Indicator)	0.060 [0.749]	0.350 [0.560]	0.371 [0.290]	0.628 [0.230]	0.011 [0.975]	−0.293** [0.042]	0.043 [0.962]
Contemporaneous Marginal Effect of HomeP	−0.269** [0.039]	0.176 [0.581]	−0.110 [0.742]	0.129 [0.675]	−0.326* [0.060]	−0.407** [0.013]	−0.667* [0.063]

Notes: This table reports the effects of changes in destination-country regulation and bank characteristics on log changes in total loans by destination country. Data are quarterly from 2002:Q1 to 2013:Q4 for a panel of bank holding companies, whereas we use consolidated data. DestP refers to changes in regulation in the destination country of the loan. For the marginal effect of DestP as well as for DestP interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-value of the F-statistic for joint significance reported below. For more details on the variables, see table 8 in the appendix. Each column shows the result for the regulatory measure specified in the column title. All specifications include fixed effects as specified in the lower part of the table. Standard errors are clustered by destination country. P-values are reported in square brackets. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

shows that responses to prudential measures vary across loan sectors and specifications, which might explain why we observe only a few significant results for total loan growth. For inward transmission through foreign exposures of domestic global banks, our results are strongest for lending growth to banks and less pronounced to the non-bank private sector. For outward transmission, the negative effect of a tightening in local-currency reserve requirements on German banks' total international lending is confirmed contemporaneously and in the medium run for loan growth toward the non-bank private sector, as well as in the short run toward the bank sector.

We further test the robustness of our results by excluding small exposures of a bank to a foreign country, as this might reflect idiosyncratic business outside the scope of our model. Results remain robust if we exclude the 1 percent or 5 percent smallest destination-country bank positions. Finally, we alternate the set of fixed effects, for instance by including country-time fixed effects controlling for demand factors, and clustering the standard errors, which does not cause major changes to our results.

3.2 Exploration of Organizational Structure

This section explores whether foreign affiliates of German global banks differ in their lending behavior in response to prudential instruments due to their organizational form. We focus on outward transmission and distinguish between lending by foreign subsidiaries and by foreign branches of German banks. This reduces our sample size relative to table 6, as we exclude all German banks that do not own foreign affiliates but only lend cross-border. Foreign branches and subsidiaries might be affected differently by changes in prudential instruments in the home and the foreign country (Danisewicz, Reinhardt, and Sowerbutts 2015). For institution-based instruments, such as capital requirements or concentration limits, branches tend to be subject to home-country regulation, whereas subsidiaries have to comply with foreign regulation. We use this variation across bank and instrument types to analyze banks' differential responses.

Our approach is similar to specification 3, but the sample pools across foreign branches and foreign subsidiaries of German banks. We allow for heterogeneous effects of cycle variables, of regulation, and of the interaction between regulation and bank variables by

interacting them with an indicator variable that equals one in case of a foreign subsidiary. At the bottom of table 7, we report the marginal effects of the prudential instruments for branches and subsidiaries, where the latter consists of the joint effect of the baseline category (=branch) plus the interaction effect. We find that the average foreign subsidiary reduces lending growth contemporaneously following a tightening in the prudential index, sector-specific capital buffers, and loan-to-value ratios. A tightening in foreign reserve requirements leads to a reduction in lending growth of foreign subsidiaries in the medium run. While foreign subsidiaries are thus constrained by foreign regulation, we only find weaker evidence for foreign branches. A tightening in concentration ratios leads to a reduction in lending growth in the short run, while a tightening in the prudential index leads to an increase in lending growth in the medium run (findings significant at the 10 percent level only). Bank characteristics, other than the organizational structure, seem to play a less important role in the response of foreign affiliates to regulatory changes. Overall, we find that foreign subsidiaries react more strongly to foreign regulation. Foreign branches do not generate regulatory leakages by increasing lending growth after a tightening in foreign regulation.

4. Concluding Remarks

Global banks may generate cross-border spillovers of the regulatory stance if they adjust their international loan portfolio in response to foreign and domestic regulation. While prudential instruments such as reserve requirements or loan-to-value ratios have mostly been implemented by emerging market countries, in recent times advanced countries have also increased their macroprudential toolkit to target financial stability. For countries like Germany with a highly internationalized banking system, concerns about regulatory spillovers are a topic of utmost importance. Therefore policy discussions and coordination are conducted at the European level at the ESRB. This macroprudential body has recently recommended monitoring cross-border effects of macroprudential instruments on an annual basis (ESRB 2015). Our study may inform this current policy debate by analyzing the inward and outward transmission of regulation for German banks.

Table 7. Outward Transmission of Policy to Destination Country—Foreign Branches vs. Subsidiaries

	DestP = Prudential IndexC (1)	DestP = Capital Require-ments (2)	DestP = Sector-Specific Capital Buffer (3)	DestP = LTV Ratio (4)	DestP = Reserve Require-ments: Foreign (5)	DestP = Reserve Require-ments: Local (6)	DestP = Concen-tration Ratios (7)
Log Total Assets*DestP (Branches)	−5.848**	−9.772	−2.097	−1.138	5.093	2.902	−15.680*
	[0.042]	[0.230]	[0.827]	[0.836]	[0.583]	[0.404]	[0.062]
Capital Ratio*DestP (Branches)	−1.448**	−1.133	−0.796	−0.117	2.546	−0.446	−2.920***
	[0.043]	[0.555]	[0.737]	[0.910]	[0.110]	[0.596]	[0.003]
Illiquid Assets Ratio*DestP (Branches)	0.229	−0.195	0.410	0.470	−1.995***	0.735**	0.778
	[0.249]	[0.484]	[0.602]	[0.107]	[0.001]	[0.038]	[0.184]
International Activity*DestP (Branches)	−0.097	−0.014	−0.733	−0.163	0.239	−0.096	−1.951
	[0.615]	[0.982]	[0.573]	[0.559]	[0.616]	[0.708]	[0.301]
Net Intragroup Funding*DestP (Branches)	−0.119	−0.287	0.228	−0.073	0.368*	−0.203	0.065
	[0.351]	[0.193]	[0.298]	[0.615]	[0.072]	[0.510]	[0.888]
Core Deposits Ratio*DestP (Branches)	−0.341	−0.348	−0.223	−0.930	−0.974***	−0.054	−2.501***
	[0.281]	[0.562]	[0.844]	[0.171]	[0.008]	[0.898]	[0.000]
Log Total Assets*DestP (Subsidiaries)	0.236	−1.592	−0.181	−1.962	2.053	−1.669	12.099
	[0.895]	[0.774]	[0.927]	[0.761]	[0.504]	[0.558]	[0.243]
Capital Ratio*DestP (Subsidiaries)	0.294	0.117	−0.308	0.809	0.882	0.485	1.969
	[0.367]	[0.838]	[0.756]	[0.515]	[0.290]	[0.474]	[0.112]
Illiquid Assets Ratio*DestP (Subsidiaries)	0.329	−0.786	−0.043	0.794	−0.343	0.850	0.876
	[0.253]	[0.366]	[0.807]	[0.456]	[0.129]	[0.149]	[0.537]
International Activity*DestP (Subsidiaries)	−0.023	1.213	−0.352*	0.029	0.960**	−0.572	1.583
	[0.928]	[0.321]	[0.084]	[0.972]	[0.012]	[0.344]	[0.215]
Net Intragroup Funding*DestP (Subsidiaries)	0.253	0.392	0.298	0.252	0.601**	0.023	0.848
	[0.182]	[0.218]	[0.320]	[0.390]	[0.018]	[0.925]	[0.376]
Core Deposits Ratio*DestP (Subsidiaries)	0.314	0.353	0.250*	−0.011	0.047	0.245	1.200*
	[0.147]	[0.692]	[0.083]	[0.813]	[0.824]	[0.491]	[0.090]

(*continued*)

Table 7. (Continued)

	DestP = Prudential IndexC (1)	DestP = Capital Requirements (2)	DestP = Sector-Specific Capital Buffer (3)	DestP = LTV Ratio (4)	DestP = Reserve Requirements: Foreign (5)	DestP = Reserve Requirements: Local (6)	DestP = Concentration Ratios (7)
Observations	9,273	9,273	9,273	9,273	9,273	9,273	9,273
R^2	0.024	0.023	0.021	0.021	0.020	0.021	0.023
Adjusted R^2	0.014	0.012	0.011	0.011	0.010	0.011	0.013
No. of Host Countries	49	49	49	49	49	49	49
No. of Banks	349	349	349	349	349	349	349
Time Period	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4	2002:Q1–2013:Q4
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marginal Effect of DestP (Contemporaneous and Lagged Indicator) (Branches)	11.209*	12.910	10.439	0.856	14.393	11.649	−2.724
	[0.092]	[0.176]	[0.604]	[0.927]	[0.533]	[0.230]	[0.782]
Contemporaneous Marginal Effect of DestP (Branches)	2.523	6.508	3.360	4.876	21.345	3.151	−19.115***
	[0.468]	[0.112]	[0.660]	[0.335]	[0.150]	[0.490]	[0.000]
Marginal Effect of DestP (Contemporaneous and Lagged Indicator) (Subsidiaries)	−6.495	−27.280	6.958	−13.781	−31.083**	5.997	−74.528
	[0.358]	[0.206]	[0.305]	[0.557]	[0.015]	[0.714]	[0.116]
Contemporaneous Marginal Effect of DestP (Subsidiaries)	−12.384***	−16.168	−11.815***	−27.211**	−19.162	2.026	−7.676
	[0.000]	[0.149]	[0.005]	[0.020]	[0.140]	[0.810]	[0.316]

Notes: This table reports the effects of changes in foreign-country regulation and bank characteristics on log changes in local lending of German banks' foreign branches and subsidiaries. Data are quarterly from 2002:Q1 to 2013:Q4 for a panel of foreign affiliates of German banks. Branch-level data are aggregated across all branches of one parent bank per destination country. Coefficients referring to subsidiaries show the total effect by aggregating the coefficients of the baseline category (Branches) and the subsidiary-specific interaction effect and reporting their joint significance. DestP refers to changes in regulation in the destination country of the loan, which is the host country in this specification. For the marginal effect of DestP as well as for DestP interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-value of the F-statistic for joint significance reported below. For more details on the variables, see table 8 in the appendix. Each column shows the result for the regulatory measure specified in the column title. All specifications include fixed effects as specified in the lower part of the table. Bank explanatory variables, cycle variables, and prudential instruments are included in the regressions but not reported. Standard errors are clustered at the destination-country level. P-values are reported in square brackets. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Overall, while we find evidence for cross-border spillovers of regulation, there is no general conclusion that holds true for all types of policy instruments and banks. Instead, heterogeneity between banks, loan types, and specification matters.

Foreign regulatory changes spill over to lending growth in Germany through both domestic affiliates of global foreign banks and German-owned banks which maintain international activities. Affiliates of global foreign banks reduce their local loan growth following a tightening of sector-specific capital buffers, local reserve requirements, and loan-to-value ratios in their parent bank's country. This finding suggests that regulatory pressure can have indirect effects on affiliates owned by global foreign banks if their parent bank draws resources from them in order to fulfill tighter requirements in the home country. German-owned banks also transmit changes in foreign countries' regulatory stance toward German borrowers. A tightening of foreign regulation leads to an increase in domestic lending growth.

Furthermore, we find that German banks reduce foreign lending growth given a tightening in prudential instruments in the destination country. However, these negative responses abate rather quickly, except for reserve requirements. Thus, our results suggest that reserve requirements have been effective in dampening lending inflows by German banks into foreign economies.

Finally, transmission occurs not only because of regulatory changes but also because of economic developments. This is reflected by the fact that business and financial cycles matter for lending decisions: affiliates of foreign global banks increase lending growth in the host country in response to an upturn in the financial cycle of their home country. Also, German banks' international lending behavior is procyclical in the sense that loan growth increases in response to an upturn in the financial and business cycles of the destination country.

Appendix

Table 8. Construction of Balance Sheet Independent Variables

Variable Name	Description	Data Source
Illiquid Assets Ratio	(Loans and Advances to Banks + Loans and Advances to Non-banks, including Received Bills)/Assets (in %)	Monthly Balance Sheet Statistics (Deutsche Bundesbank)
Core Deposits Ratio	Savings Deposits/Assets (in %)	Monthly Balance Sheet Statistics (Deutsche Bundesbank)
Capital Ratio	Equity Capital/Assets (in %)	Monthly Balance Sheet Statistics (Deutsche Bundesbank)
Net Intragroup Funding	(Liabilities minus Claims of the Parent Bank vis-à-vis Foreign Affiliates, Summed across All Affiliates per Parent Bank)/ Liabilities (in %)	Monthly Balance Sheet Statistics (Deutsche Bundesbank)
Log Total Assets	Log (Balance Sheet Total)	Monthly Balance Sheet Statistics (Deutsche Bundesbank)
International Activity Ratio	Ratio of (Foreign Assets + Foreign Liabilities) to (Total Assets + Total Liabilities) (in %)	Monthly Balance Sheet Statistics (Deutsche Bundesbank)

References

Aiyar, S., C. W. Calomiris, and T. Wieladek. 2014. "Does Macro-Prudential Regulation Leak? Evidence from a UK Policy Experiment." *Journal of Money, Credit and Banking* 46 (s1): 181–214.

Bank for International Settlements. 2014. "Debt and the Financial Cycle: Domestic and Global." In *84th Annual Report*, 65–84 (chapter IV). Basel, Switzerland: Bank for International Settlements.

Buch, C. M., and L. Goldberg. 2017. "Cross-Border Regulatory Spillovers: How Much? How Important? Evidence from the International Banking Research Network." *International Journal of Central Banking* 13 (S1).

Buch, C. M., C. T. Koch, and M. Koetter. 2011a. "Crises, Rescues, and Policy Transmission through International Banks." Discussion Paper No. 15/2011, Deutsche Bundesbank.

———. 2011b. "Size, Productivity, and International Banking." *Journal of International Economics* 85 (2): 329–34.

———. 2014. "Should I Stay or Should I Go? Bank Productivity and Internationalization Decisions." *Journal of Banking and Finance* 42: 266–82.

Buch, C. M., K. Neugebauer, and C. Schröder. 2013. "Changing Forces of Gravity: How the Crisis Affected International Banking." Discussion Paper No. 48/2013, Deutsche Bundesbank.

Cerutti, E., R. Correa, E. Fiorentino, and E. Segalla. 2017. "Changes in Prudential Policy Instruments—A New Cross-Country Database." *International Journal of Central Banking* 13 (S1).

Claessens, S., S. R. Ghosh, and R. Mihet. 2013. "Macro-Prudential Policies to Mitigate System Vulnerabilities." *Journal of International Money and Finance* 39: 153–85.

Danisewicz, P., D. Reinhardt, and R. Sowerbutts. 2015. "On a Tight Leash: Does Bank Organisational Structure Matter for Macroprudential Spillovers?" Working Paper No. 524, Bank of England.

Drehmann, M., C. Borio, and K. Tsatsaronis. 2011. "Anchoring Countercyclical Capital Buffers: The Role of Credit Aggregates." *International Journal of Central Banking* 7 (4): 189–240.

Düwel, C., R. Frey, and A. Lipponer. 2011. "Cross-Border Bank Lending, Risk Aversion and the Financial Crisis." Series 1 Discussion Paper No. 2011/29, Deutsche Bundesbank.

European Systemic Risk Board. 2015. "Recommendation of the European Systemic Risk Board of 15 December 2015 on the Assessment of Cross-Border Effects of and Voluntary Reciprocity for Macroprudential Policy Measures (ESRB/2015/2)." Available at https://www.esrb.europa.eu/pub/pdf/recommendations/2016/Recommendation_ESRB_2015_2.pdf?b0d610270cb9edc85524d64e7e8a81e7.

Fiorentino E., C. T. Koch, and W. Rudek. 2010. "Microdatabase: External Position Reports of German Banks." Technical Documentation, Deutsche Bundesbank.

Frey, R., and C. Kerl. 2015. "Multinational Banks in the Crisis: Foreign Affiliate Lending as a Mirror of Funding Pressure and Competition on the Internal Capital Market." *Journal of Banking and Finance* 50: 52–68.

Jiménez, G., S. Ongena, J.-L. Peydro, and J. Saurina Salas. 2012. "Macroprudential Policy, Countercyclical Bank Capital Buffers and Credit Supply: Evidence from the Spanish Dynamic Provisioning Experiments." Discussion Paper No. 2012-011, European Banking Center.

Kerl, C., and C. T. Koch. 2015. "International Banking and Liquidity Risk Transmission: Lessons from Germany." *IMF Economic Review* 63 (3): 496–514.

Ohls, J., M. Pramor, and L. Tonzer. 2016. "International Banking and Cross-Border Effects of Regulation: Lessons from Germany." Discussion Paper No. 27/2016, Deutsche Bundesbank.

International Banking and Cross-Border Effects of Regulation: Lessons from France*

Matthieu Bussière, Julia Schmidt, and Frédéric Vinas
Banque de France

As part of the International Banking Research Network, the Banque de France contribution to the research project on prudential policy spillovers concentrates on the "outward" adjustment of French banks' cross-border lending. We consider both adjustment of cross-border lending to foreign ("destination-country") and French ("home-country") regulation and investigate differences between financial and non-financial counterparties. For some regulatory measures, we find that French banks increase their cross-border lending growth in response to regulatory tightening abroad—presumably because they are not subject to these regulatory changes. All in all, we do not find particularly large quantitative adjustments to changes in foreign regulatory policies. Lastly, we find that balance sheet variables are important for the adjustment of cross-border lending growth in response to French regulatory policy changes.

JEL Codes: F36, G21, G28.

1. Introduction

The recent financial turmoil in industrialized countries and the particular vulnerabilities of the banking sector have led to an increased

*The authors would especially like to thank Laurence Lelogeais from the Banque de France's Statistics Department for helping out with the data on cross-border loans as well as for valuable comments and discussions. We would also like to thank François Mouriaux as well as an anonymous referee for valuable comments on an earlier draft. This paper was written in the context of the International Banking Research Network (IBRN) project on cross-border regulatory spillovers (see Buch and Goldberg 2017). All views expressed are solely those of the authors and do not represent the views or opinions of the Banque de France, the Autorité de Contrôle Prudentiel et de Résolution (ACPR), or the Eurosystem. Author e-mails: matthieu.bussiere@banque-france.fr, julia.schmidt@banque-france.fr (corresponding author), and frederic.vinas@banque-france.fr.

discussion about how to strengthen the resilience of the financial system via banking regulation and macroprudential policy. France, which is characterized by a concentrated banking system in which the four largest banking groups are classified as global systemically important banks, is particularly concerned: regulatory changes are potentially transmitted cross-border through the international activities of large banks. In this paper,[1] we try to tackle these issues using French micro-level bank data in order to explore whether French banks adjust their external positions in response to regulatory changes in the destination country as well as to French regulation.

International banking regulation was characterized by a stable environment over 2000–06. While Basel II negotiations started in 2004, implementation in many European countries only began in 2007.[2] Thus, the time period we cover (2000–13) is marked by a first period with few regulatory changes (over 2000:Q1–2007:Q2) and a second time period marked by many regulatory changes from Basel II, Basel II.5, and Basel III in parallel to the subprime crisis and the European debt crisis.[3]

In 2000, the main regulatory tools used in France[4] were capital requirements for credit and market risks,[5] concentration limits on large exposures as well as liquidity ratios. Neither a countercyclical capital buffer nor a leverage ratio were used prior to the introduction of Basel III regulation. Capital requirements significantly changed with the implementation of Basel II in 2007–08, Basel II.5 at the end of 2011, and Basel III starting from 2014 (with a phase-in).

[1]This paper presents the Banque de France contribution to a research project undertaken within the International Banking Research Network (IBRN), which aims to analyze issues related to global banks and their international activities.

[2]See Cornford (2006) for a detailed illustration.

[3]For example, as illustrated by the IBRN Prudential Instruments Database described in Cerutti et al. (2017), one regulatory change concerning capital requirements occurred in the period 2000:Q1–2006:Q4, one in 2007:Q1–2010:Q4, and ninety-eight in 2011:Q1–2014:Q4.

[4]We abstract here from a discussion on reserve requirements in France, as these are mainly used as a monetary policy tool in the Eurosystem. Reserve requirements are, however, used as a regulatory tool in emerging market economies.

[5]These were implemented respectively in 1993 and 1996; see Thoraval (1996).

While liquidity regulation evolved in 2010, the main changes came from the introduction of Basel III, namely the liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR). An observation period for both ratios started in 2014:Q1 prior to the implementation of the LCR with a phase-in over 2015–19. The NSFR is planned to be implemented in 2018.

In the context of this IBRN project, we concentrate on the external adjustment to regulatory changes abroad ("outward transmission"). We do so because the French banking system is strongly dominated by French banks. The first nine French banking groups cover 85 percent of credit to the real economy in France in 2006:Q4. With regards to the remaining market share, foreign banking groups are not very highly represented. Thus, we do not expect large effects of regulatory changes "imported" to France by affiliates of foreign banks ("inward transmission").

More importantly, during the financial turmoil of 2008–09 as well as 2010–12 (periods that coincide also with the introduction of various regulatory changes abroad), French domestic bank lending was relatively stable, reflecting the fact that banks paid particular attention to their core business in France. As such, we do not expect large adjustments at home, on the one hand since there were governmental actions aimed at facilitating the resolution of credit disputes and curbing risks of a credit crunch, and on the other hand since domestic retail business proved to be quite resilient to financial market distress.[6]

We thus expect more adjustments to take place abroad, which is why we concentrate on how *foreign* lending growth was adjusted. The fact that French banks are large and very active abroad, both through cross-border lending and through the establishment of affiliates abroad, is useful in this sense, as we can include a relatively high number of countries and banks in our analysis.[7] Using locational

[6]Figure 2 traces the growth rates of domestic as well as foreign lending (cross-border as well as lending by French banks' branches abroad). As shown, the low variability of domestic lending, especially to the non-financial sector, exemplifies the importance of the domestic retail market for the overall stability of the French banking sector.

[7]Though we include a large number of banks, one should keep in mind that those belong to a smaller number of banking groups.

data (in contrast to consolidated data), however, we can only concentrate on cross-border loans from French banks and thus cannot include lending by affiliates abroad in our measure of foreign loans. This notwithstanding, the use of locational data allows better econometric identification of regulatory changes abroad, as these are not targeted at French banks. For the regulatory data, we use the IBRN Prudential Instruments Database described in Cerutti et al. (2017).

Our findings can be summarized as follows: *First*, we find that cross-border lending growth is driven by the business cycle in the respective destination countries, but less so by regulatory changes. We only find consistent and significant outward adjustment in response to changes in capital requirements, reserve requirements, and interbank exposure limits. In quantitative terms, these effects are rather small. This finding is not surprising given that the bulk of regulatory changes was implemented during the Great Recession.

Second, we find that French banks' reaction to a regulatory tightening abroad depends on the type of regulatory policy. Whereas French banks decrease their cross-border lending growth in response to a tightening in interbank exposure limits, they increase their cross-border lending growth when reserve requirements are tightened abroad. Our results show that the capacity of French banks to adjust their cross-border loans depends on their balance sheet variables—in particular, the illiquid assets ratio and the dependence on net intragroup funding. If the latter two are very high, banks might be constrained in their ability to extend cross-border loans and actually decrease lending growth in response to a regulatory tightening. All in all, we interpret our findings as indicative of regulatory leakages (for selected policy measures): while lending growth by banks resident in the destination country that is tightening regulation ("locally regulated banks") presumably decreases, French banks not subject to this foreign regulation substitute for the activities of locally regulated banks by increasing their cross-border lending growth. Since the results are driven by lending to the non-financial sector, we conclude that French banks do not use their affiliate network to substitute for a reduction in lending by "locally regulated banks," but rather lend directly to (non-financial) counterparties.

Third, the results show that banks' balance sheet characteristics are important for the cross-border transmission of domestic capital regulation. We find that a high tier 1 capital ratio and a high reliance

on net intragroup funding significantly reduce cross-border lending growth in the case of a French tightening of capital requirements. On the contrary, the availability of cheap and stable funding due to a high reliance on core deposits can facilitate the maintenance of strong cross-border lending growth in the case of such tightening. However, the economic magnitudes of these effects remain small.

2. Data and Stylized Facts for France

2.1 Bank-Level Data

Our bank-level data come from the Statistics Department of the Banque de France and the Autorité de Contrôle Prudentiel et de Résolution (ACPR), the French supervisory body for the banking sector.[8] We use locational data for our analysis, thus concentrating on the unconsolidated balance sheet of individual entities within a banking group.[9] However, as a robustness check, we include balance sheet variables from the consolidated level in the regressions to check whether these affect the results.[10] We specifically rely on data of French banks' outstanding amounts of cross-border loans for which we know the country (as well as the sector) of the counterparty. Though we also have information on French banks' branches abroad (as they are regulated by the French supervisor), a disaggregation of their assets with regards to the country of residence of the counterparty is not available. This is why we use these information only for aggregate statistics and to restrict the sample of banks in robustness checks.[11]

[8]The data are confidential. They can be accessed if the application for data access has been approved by the Banque de France. External researchers as well as Banque de France staff have to apply for data access.

[9]We do so for several reasons: The French banking system is very concentrated, thus not allowing for a large number of banking groups to be analyzed. Further, mergers and acquisitions lead to a considerable change in the size of banks and their respective cross-border loans—a problem that is more pronounced on the consolidated level than on the locational level. In addition, consolidated balance sheet data are only available at biannual frequency.

[10]The sample size is thus reduced for these robustness checks.

[11]The underlying data in figures 1, 2 (cross-border loans), 3, 4, and 5 are based on locational data of French banks' cross-border loans which are collected by the Statistics Department of the Banque de France for the purpose of the locational

We cover the time period of 2000:Q1–2013:Q2 (with 2013:Q2 being the last available data point at the time we started implementing this project). We restrict the sample in several dimensions. First, we only consider countries reported in the IBRN Prudential Instruments Database described in Cerutti et al. (2017). This leads us to consider sixty-four countries, of which fifty-three are included in the final data set. Second, we only include French banks and exclude banks that are very small or have non-significant cross-border activities. Thus, we exclude bank observations with loans to non-banks smaller than EUR 100 million, or total assets smaller than EUR 1 billion. We also restrict the sample to banks for which foreign assets represent at least 0.5 percent of total assets all of the time. Third, we only include bank observations if a bank has a positive stock of loans in at least five countries.[12] We impose continuity by including only observations with eight consecutive quarters of non-missing observations of the left-hand-side (LHS) variable. We truncate observations if cross-border lending growth exceeds +100/–100 percent.

From an initial sample of more than 500 banks, we finally retain only 42 banks that have a stable presence over the entire sample and have significant cross-border lending activity. Though the use of locational data reduces the incidence of mergers and acquisitions (in comparison with consolidated data), our individual bank series contain a few breaks. These are most likely due to mergers and acquisitions, but are taken care of by the truncation of the LHS variable.

2.1.1 Dependent Variables

The dependent variable, $\Delta Y_{b,j,t}$, is the change in the log of loans granted by bank b to counterparties in destination country j at time t. We notably consider all cross-border loans as well as loans to the non-financial and financial sectors only to specifically investigate the importance of intragroup flows.

banking statistics of the Bank for International Settlements (BIS). The underlying data of figure 2 (domestic loans and loans by branches) and table 3 are derived from balance sheet data collected by the ACPR. The underlying data of table 2 are based on consolidated data of French banking groups' foreign loans which are collected by the Statistics Department of the Banque de France for the purpose of the consolidated banking statistics of the BIS.

[12]We do so in order to only include banks with significant international activity.

2.1.2 Balance Sheet Characteristics

We include the following balance sheet variables:

- Log of total real assets, i.e., assets deflated by the GDP deflator ($LogTotalAssets_{b,t-1}$)
- Share of tier 1 capital to total assets in % ($Tier1Ratio_{b,t-1}$)
- Share of illiquid assets over total assets in % ($IlliquidAssets\text{-}Ratio_{b,t-1}$)
- Share of a bank's foreign assets relative to total assets in % ($InternationalActivity_{b,t-1}$)
- Share of a bank's net intragroup funding, i.e., liabilities of the bank vis-à-vis its branches abroad minus the corresponding assets; this difference is scaled by total assets and reported in % ($NetIntragroupFunding_{b,t-1}$)
- Share of core deposits over total assets in % ($Deposit\text{-}Ratio_{b,t-1}$)

2.2 Data on Prudential Instruments

For the measures of regulatory changes, we rely on the IBRN Prudential Instruments Database described in Cerutti et al. (2017). Regulatory changes associated with a tightening of regulation are coded as 1 in the database, whereas a loosening of regulation is associated with –1. However, for the case of reserve requirements and the sector-specific capital buffers, the numbers can take on absolute values larger than 1 to capture the intensity of the change. We consider seven instruments for the analysis: capital requirements, sector-specific capital buffers, loan-to-value ratios, reserve requirements (both for foreign- and local-currency deposits), interbank exposure limits, and concentration ratios. An aggregate index ($PruC$) that sums the changes across all seven instruments is also included. We use the following definitions to measure the impact of regulatory changes:

- $DestP_{j,t-l}$ (where $l = 0, 1, 2$): Destination-country regulation (destination = foreign country receiving a loan) with 0, 1, and 2 lags
- $HomeP_{t-l}$ (where $l = 0, 1, 2$): Home-country regulation (home = France) with 0, 1, and 2 lags

Table 1 shows that the number of changes of prudential instruments is rather small given the large number of observations.

2.3 Stylized Facts

The French banking sector is made up of a small number of banking groups, of which most are characterized as universal banks. This concentration is illustrated in the French credit registry: 85 percent of the credit exposure to the real economy in France is carried out by nine banking groups in 2006:Q4. Four among those groups have important international activities, leading the Financial Stability Board to classify them as global systematically important banks after the 2008 crisis.[13] On the contrary, activities by foreign banking groups in the domestic French market are rather limited.

2.3.1 Foreign Lending by French Banks

Figure 1 describes the sum of outstanding cross-border loans for the banks that we retain in our sample. Compared with the overall cross-border loans by banks resident in France (depicted by the official data series in the BIS international banking statistics), our restricted sample closely follows the dynamics of the total amount, though it only represents about half of the outstanding amounts. The series show a strong upward trend, especially from 2004 to 2007, before stagnating due to the Lehman shock in 2008 and the European sovereign debt crisis.

Figure 2 depicts the growth rates of French banks' domestic and cross-border lending over the time period in question. Whereas cross-border lending growth fluctuates to a substantial amount, domestic lending growth is more stable, displaying growth rates that are smaller in absolute terms. In figure 2, we also compare these growth rates with the one of lending by foreign branches—data for which we do not have the disaggregation by destination country and which can therefore only be used for comparison purposes. Figure 2 shows that lending growth by branches abroad is also very volatile, thus confirming that foreign lending is inherently more volatile than domestic

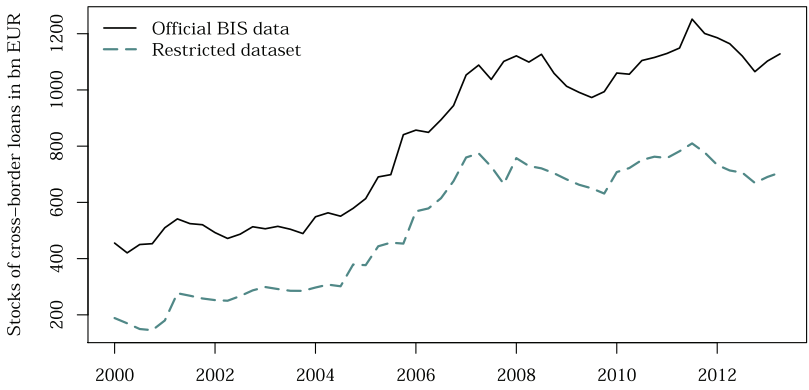
[13]Financial Stability Board (2014): "2014 Update of List of Global Systemically Important Banks (G-SIBs)." Available at http://www.fsb.org/wp-content/uploads/r_141106b.pdf.

Table 1. Summary Statistics on Changes in Prudential Instruments

Policy Changes in Destination Country					
Instrument	**No. of Country-Time Changes**	**No. of Country-Time Changes (Tightening)**	**No. of Country-Time Changes (Loosening)**	**No. of Bank-Country-Time Changes**	**Proportion Base-MPP Non-zero**
Prudential Index	4,110	2,618	1,492	27,414	0.150
General Capital Requirements	491	491	0	27,414	0.018
Sector-Specific Capital Buffer	608	422	186	27,414	0.022
Loan-to-Value Ratio	864	582	282	27,414	0.032
Reserve Requirements: Foreign	1,138	637	501	27,414	0.042
Reserve Requirements: Local	2,076	952	1,124	27,414	0.076
Interbank Exposure Limit	212	212	0	27,414	0.008
Concentration Ratios	276	246	30	27,414	0.010

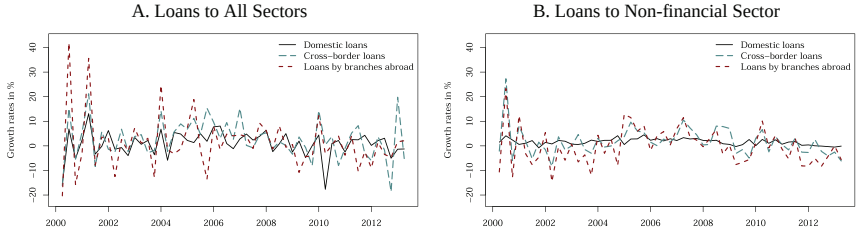
Notes: This table shows summary statistics on changes in prudential instruments for banks located in France over the period 2000:Q1–2013:Q2. Data on the instruments come from the IBRN Prudential Instruments Database described in Cerutti et al. (2017) and are on the quarterly level. The number of changes in prudential instruments is reported on several dimensions, i.e., on the country-time level and on the bank-time level. The last column of the table shows the share of prudential changes to total observations (i.e., the share of non-zero observations).

Figure 1. Sum of Cross-Border Loans



Notes: The figure depicts the sum of outstanding amounts of cross-border loans by banks resident in France over 2000:Q1–2013:Q2. The straight line represents the overall sum, whereas the dashed line represents the sum computed from the banks that are retained in the sample.

Figure 2. Growth Rates of Domestic and Foreign Loans



Notes: The figure depicts the growth rate of the sum of outstanding amounts of loans for a subsample of banks (those present over the entire sample 2000:Q1–2013:Q2). Domestic loans denote loans to French residents, whereas cross-border loans are extended to non-residents. Loans by branches abroad are extended by the branches of the same subsample of banks.

lending. Panel B of figure 2 shows that this is especially the case for lending to the non-financial sector, thus pointing to the resilience of the French domestic retail market.

Much of French banks' foreign lending is done through local lending by their affiliates abroad. Using consolidated data for six major French banking groups over the period 2006:Q4–2013:Q2, one can

Table 2. Sum of Foreign Lending of Six Major French Banking Groups (consolidated data), Mean over 2006:Q4–2013:Q2, in EUR bn

Variable	Mean	Min.	Max.
Foreign Lending	1,356.74	937.41	1,535.05
Cross-Border Lending	607.98	515.26	673.17
Lending to Financial Sector	276.54	150.94	419.16
Lending to Non-financial Sector	286.24	149.72	370.41
Lending by Affiliates Abroad	748.76	422.15	956.60
Lending to Financial Sector	121.36	34.98	201.36
Lending to Non-financial Sector	543.76	271.19	733.78

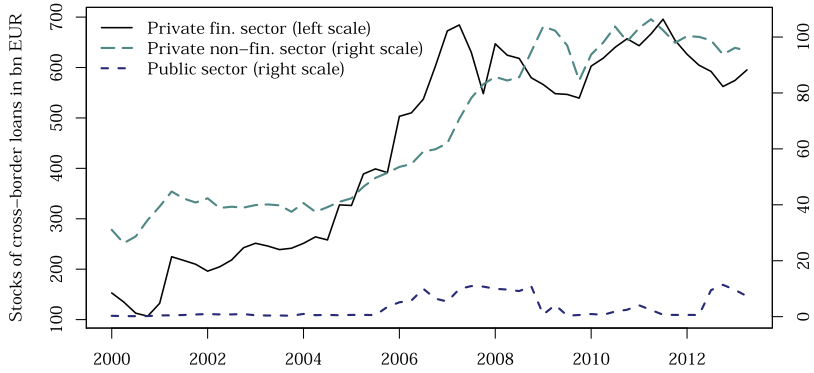
Notes: This table lists the sum of outstanding amounts of different types of loans averaged over the period 2006:Q4–2013:Q2. Data are reported at the consolidated level of six major banking groups and thus exclude intragroup flows. Foreign lending is the sum of cross-border lending as well as local lending by affiliates abroad. The financial and non-financial sector both exclude public entities.

see in table 2 that affiliates abroad mainly engage in lending to the non-financial sector.[14] At the locational level, we only have access to cross-border loans. Figure 3 splits the sum of cross-border loans into different counterparties, notably loans to the private financial (bank and non-bank) and non-financial sectors as well as the public sector. In terms of magnitudes, loans to the private financial sector (left scale of figure 3) make up the bulk of the stock of cross-border loans. Within the category of lending to the financial sector, we are specifically interested in the part stemming from lending to banks, as these represent largely intragroup flows ("internal capital markets"). Table 3 shows that cross-border interbank loans are largely composed of intragroup flows: for the year 2010,[15] the sum of outstanding amounts of intragroup loans for the banks in the sample is on average EUR 328.11 billion and makes up about 55 percent of overall cross-border loans to the bank sector. Out of these intragroup positions, only 28 percent are vis-à-vis subsidiaries, whereas

[14]Discrepancies between the numbers in tables 2 and 3 mainly stem from the fact that consolidated data do not include intragroup positions.

[15]Unfortunately, we only have access to these data for 2010, which is why table 3 is restricted to this time period.

Figure 3. Sum of Cross-Border Loans, by Counterparty



Notes: The figure depicts the sum of outstanding amounts of cross-border loans by the banks in the sample over the period 2000:Q1–2013:Q2. The counterparties denote the sectors that receive the loans.

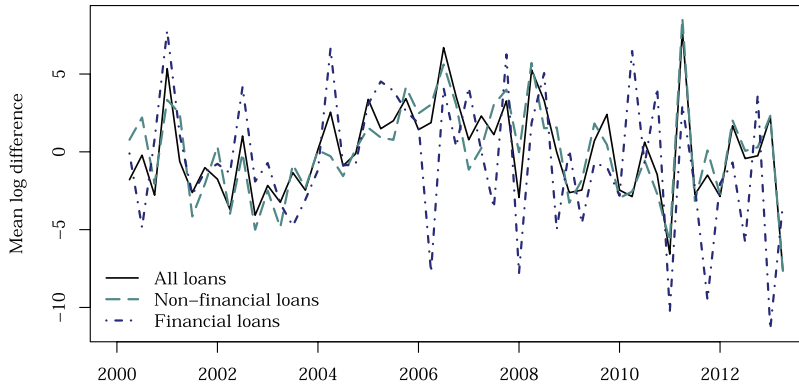
Table 3. Sum of Cross-Border Interbank Positions, Mean over 2010:Q1–2010:Q4

Variable	EUR Billions
Interbank Loans to Subsidiaries	91.17
Interbank Loans to Branches	236.94
Interbank Loans to Financial Sector Outside of Group	268.03
Interbank Borrowing from Subsidiaries	78.18
Interbank Borrowing from Branches	319.06
Interbank Borrowing from Financial Sector Outside of Group	339.83

Notes: The table lists the sum of outstanding amounts of cross-border interbank lending and borrowing averaged over the period 2010:Q1–2010:Q4. Data are reported at the locational level.

the remaining 72 percent are vis-à-vis branches. The importance of intragroup flows within the category of cross-border flows to the financial sector is important for the interpretation of the regression results. As will be explained later in more detail, intragroup flows represent one potential transmission channel, and we will test its

Figure 4. Log Difference of Cross-Border Loans (means across banks)



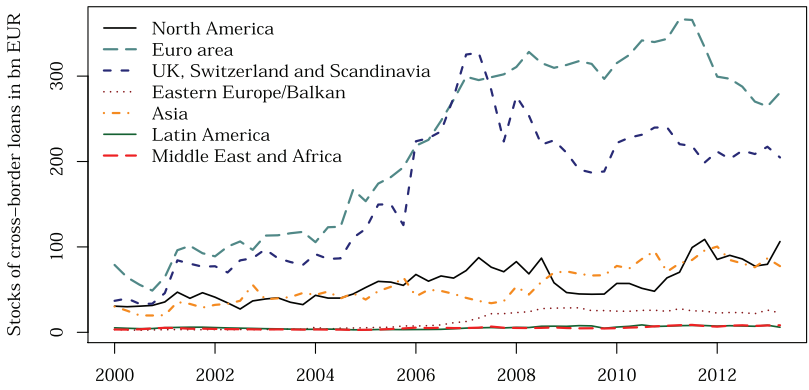
Notes: The figure depicts the mean of the dependent variables (in percentages) across the banks in the sample over the period 2000:Q1–2013:Q2.

importance by running regressions for the subsample of lending to the financial sector only.

Figure 4 traces the mean of the dependent variable, the difference of the log of loans. Cross-border lending growth to the nonfinancial sector closely follows the pattern of overall cross-border lending growth, whereas cross-border lending growth to the financial sector fluctuates to a larger extent. Though highly volatile, the growth rates are clearly positive in 2005–07 before slumping into negative territory from 2008 onward. While regulatory changes could be one of the factors behind these negative growth rates, the financial crisis, the turmoil in interbank and wholesale funding markets, and large changes in monetary policy have certainly also contributed to the adjustments in foreign lending.

French banks' cross-border loans are mainly directed at euro-area countries and the United Kingdom, followed by the United States and Asian countries (figure 5). With regards to the United Kingdom, this predominant position is mainly driven by flows to the financial sector, reflecting the importance of the London interbank market. The large exposure of French banks toward industrialized countries implies that there is very little time variation of the regulatory changes in the countries that French banks are mainly exposed

Figure 5. Sum of Cross-Border Loans, Different Regions



Notes: The figure depicts the sum of outstanding amounts of cross-border loans by the banks in the sample for different regions of residence of the counterparty.

to: These countries did not implement a large number of regulatory changes (in comparison with emerging market economies) and often implement regulatory changes simultaneously (due to Basel II–III or in the case of reserve requirements due to the common monetary policy in the Eurosystem). In addition, these countries have been affected the most by financial market distress during the recent financial crisis.

2.3.2 Balance Sheet Characteristics

Summary statistics in table 4 describe the balance sheet features. Real total assets continuously grew since 2002 before abating in 2008. The tier 1 capital ratio equals 6 percent on average. The illiquid assets ratio rises from a mean of around 87 percent to 93 percent in 2009 when this trend stalled, possibly due to increased liquidity holdings during the European sovereign debt crisis. The variable capturing banks' international activities fluctuates around 24 percent before decreasing steadily from 2010 onward. Once again, this might be driven by the retrenchment from foreign markets and, in particular, from periphery euro-area countries. Net intragroup funding, which was positive at the beginning of the sample, steadily declined over 2000–13 to values as low as –5 percent, suggesting that

Table 4. Summary Statistics

Variable	Mean	Median	SD
Dependent Variables:			
Δ Cross-Border Loans	0.16	−0.19	30.69
Δ Cross-Border Non-financial Loans	0.19	−0.44	27.32
Δ Cross-Border Financial Loans	−0.66	0.00	36.92
Independent Variables:			
Log Total Assets	16.97	16.79	1.76
Tier 1 Ratio	6.02	5.10	6.52
Illiquid Assets Ratio	90.14	98.81	16.70
International Activity	23.25	11.48	23.32
Net Intragroup Funding	−0.75	0.00	7.87
Deposit Ratio	32.96	30.09	26.97

Notes: This table provides summary statistics for bank balance sheet and lending data. Data are observed quarterly from 2000:Q1 to 2013:Q2. Banking data are reported at the locational level, i.e., the level of the individual bank. Only banks resident in France and of French nationality are included in the sample. The Net Intragroup Funding variable measures the difference of borrowing minus lending from branches abroad and is scaled by total assets. All are expressed in percentages.

French banks supported their affiliates abroad during the financial troubles of 2007–09 as well as during the European sovereign debt crisis. The mean core deposits ratio fluctuates around 31 percent before increasing steadily from 2010:Q3 to over 40 percent in 2013, reflecting banks' desire as well as regulatory pressure to rely on more stable sources of funding.

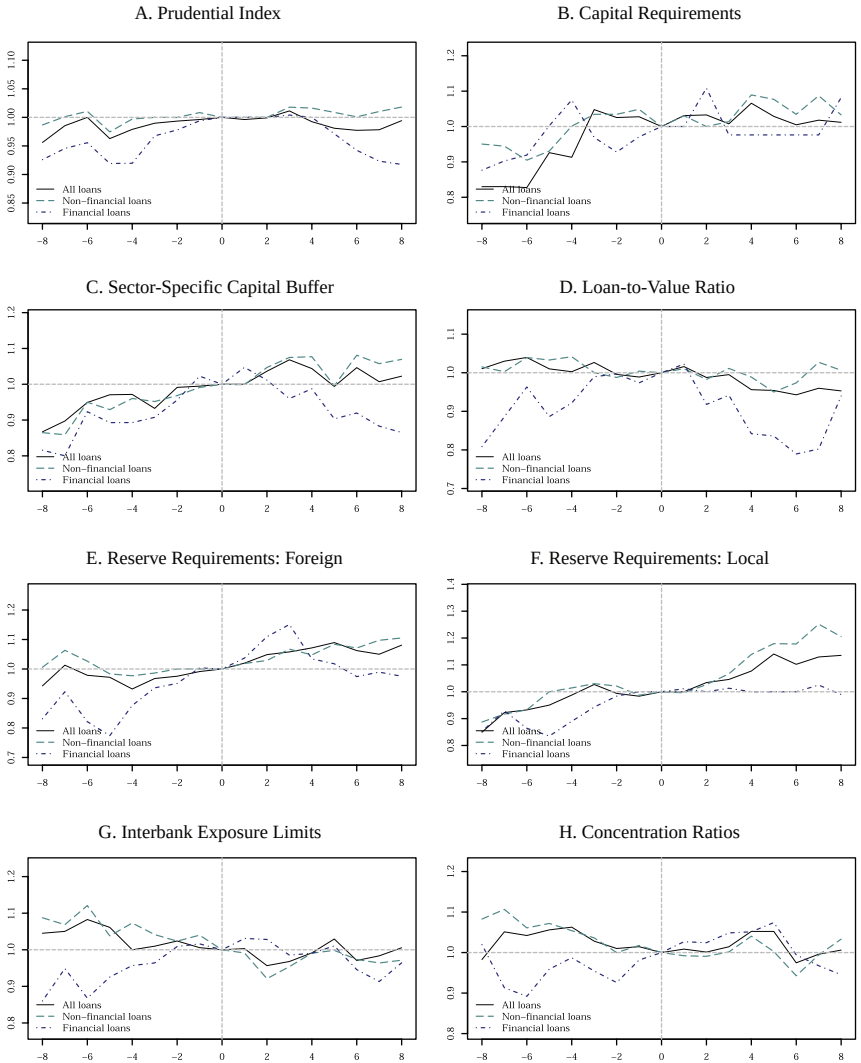
2.3.3 Prudential Instruments

We use locational data and thus only include cross-border loans (loans granted by French banks resident in France to non-residents) in our measure of foreign loans. In comparison with the other type of foreign lending, namely local lending by French banks' affiliates abroad, this has one advantage, as we can be sure that the regulatory change in a respective destination country is not directly targeted at French banks resident in France (while their affiliates abroad might be subject to regulation in the host country).

The effect of a regulatory change in a given destination country on cross-border lending growth by French banks might be driven by several channels. Let us assume a regulatory tightening that is associated with a reduction in lending. On the one hand, French banks' affiliates in the respective destination country could be subject to the regulation, thus reducing their lending and potentially requiring less funding from the head office in France. This is the case for French subsidiaries abroad, but potentially also their branches in the case where the prudential regulation is targeted at the borrowers, as could be the case for loan-to-value limits. On the other hand, the reduction in lending by domestic and foreign banks resident in the destination country implementing the regulatory change could lead to increased cross-border lending by French banks, as these are substituting for the reduction in lending by locally regulated banks. They can do so either by increasing their direct cross-border lending or by using their branches abroad that are presumably not subject to the regulatory tightening in question. We therefore test all regressions in terms of overall lending growth as well as growth of lending to the non-financial sector (direct adjustment) and financial sector (adjustment via branch network) to test these different channels of adjustment.

As a first—preliminary and unconditional—look at the data, we track the evolution of foreign loans around a regulatory tightening in figure 6. Loans are normalized to 1 on the date of the regulatory tightening, and the graphs show the median evolution of loans around the tightening. The graphs show that prior to a regulatory tightening, stocks fluctuate around their normalized value of 1 and pick up afterward for the case of capital requirements, sector-specific capital buffers, and reserve requirements (both for local and foreign currency). An opposite trend can be seen with regards to the loan-to-value ratio, interbank exposure limits, and concentration ratios: a decrease in lending can be observed following the implementation of a regulatory tightening. In the following analysis, we will show that this preliminary assessment holds—in terms of statistical significance—for reserve requirements in local and foreign currency as well as interbank exposure limits.

Figure 6. Median Time-Series Behavior around Regulatory Changes (tightening)



Notes: The figure depicts the median of the time-series behavior around a regulatory tightening event which happens at 0. Before taking the median, the series have been normalized to 1 at the time of the regulatory tightening.

3. Empirical Method and Regression Results

3.1 Baseline Analysis of Outward Transmission of Prudential Policies

The analysis explores the effect of regulatory changes on banks' lending growth, following the approach described in Buch and Goldberg (2017).

Specification 1. *Outward transmission of destination-country policy (see table 5).*

$$\Delta Y_{b,j,t} = \alpha_0 + (\alpha_1 DestP_{j,t} + \alpha_2 DestP_{j,t-1} + \alpha_3 DestP_{j,t-2}) + \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + f_b + f_j + f_t + \varepsilon_{b,j,t},$$

where *DestP* denotes the prudential policy of the destination country where the loan goes to. The regressions include bank, country, and time fixed effects. In this first specification, we test the effect of contemporaneous and lagged regulatory changes on cross-border lending growth, controlling both for bank balance sheet characteristics $X_{b,t-1}$ and destination-country demand factors $Z_{j,t}$ (financial and business cycle). Table 5 describes these results. One first notes the highly significant and positive coefficient of the financial and business cycle indicators, thus suggesting that demand factors played a significant role in the adjustment process. With regards to the balance sheet variables, the regression results in table 5 show that a low tier 1 capital ratio and a high dependence on net intragroup funding are associated with higher cross-border lending growth. The latter suggests that banks relying to a large extent on affiliate funding are the ones increasing lending growth the most via cross-border activities. This could on the one hand be related to large banks' affiliates obtaining cheap wholesale funding abroad which is then invested cross-border by the head office in France (i.e., the "global banking glut" story; see Shin 2012). On the other hand, those banks that supported their foreign affiliates to a large extent were thus constrained in their ability to increase cross-border lending growth.

Our variable of interest is the regulatory change in the destination country. At the bottom of table 5, we summarize the effect of destination-country regulation by summing the coefficients α_1, α_2, and α_3 and evaluating their joint significance with an F-test. In

Table 5. Outward Transmission of Destination-Country Policy

	Prudential IndexC (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Requirements: Foreign (5)	Reserve Requirements: Local (6)	Interbank Exposure Limits (7)	Concentration Ratios (8)
Destination-Country Regulation $DestP_t$	0.006	0.007	0.010	0.011	0.006	0.009*	−0.015	0.021
	(0.005)	(0.016)	(0.015)	(0.012)	(0.005)	(0.005)	(0.024)	(0.017)
Destination-Country Regulation $DestP_{t-1}$	0.002	−0.034**	−0.006	0.009	0.010	−0.003	−0.031*	0.022
	(0.005)	(0.013)	(0.008)	(0.016)	(0.007)	(0.004)	(0.016)	(0.014)
Destination-Country Regulation $DestP_{t-2}$	−0.001	−0.020	0.008	−0.027*	0.008*	0.011**	−0.025	−0.002
	(0.005)	(0.019)	(0.010)	(0.014)	(0.004)	(0.005)	(0.019)	(0.020)
Log Total $Assets_{t-1}$	−0.009	−0.009	−0.009	−0.009	−0.009	−0.010	−0.010	−0.009
	(0.012)	(0.012)	(0.013)	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)
Tier 1 $Ratio_{t-1}$	−0.002**	−0.002**	−0.002**	−0.002**	−0.002**	−0.002**	−0.002**	−0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Illiquid Assets $Ratio_{t-1}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
International $Activity_{t-1}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Net Intragroup $Funding_{t-1}$	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Core Deposits $Ratio_{t-1}$	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
BIS Financial Cycle (Destination Country)	0.046***	0.047***	0.046***	0.047***	0.046***	0.046***	0.046***	0.048***
	(0.016)	(0.016)	(0.017)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
BIS Business Cycle (Destination Country)	0.552***	0.561***	0.557***	0.558***	0.553***	0.566***	0.557***	0.557***
	(0.112)	(0.113)	(0.113)	(0.111)	(0.114)	(0.114)	(0.112)	(0.113)
Observations	27,414	27,414	27,414	27,414	27,414	27,414	27,414	27,414
R^2	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Adjusted R^2	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
No. of Destination Countries	53	53	53	53	53	53	53	53
No. of Banks	42	42	42	42	42	42	42	42
Sum of $\alpha_1 + \alpha_2 + \alpha_3$	0.007	−0.047	0.012	−0.007	0.023***	0.017**	−0.071***	0.041
p(F-test)	[0.348]	[0.144]	[0.560]	[0.682]	[0.003]	[0.030]	[0.010]	[0.232]

Notes: This table reports the effects of changes in destination-country regulation and bank characteristics on log changes in cross-border loans by destination country. Data are collected at the locational level. The data are quarterly from 2000:Q1 to 2013:Q2. DestP refers to the changes in regulation in the destination country of the loan. For more details on the variables, see table 9 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include bank, country, and time fixed effects. Standard errors (in parentheses) are clustered at the country level. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

response to a tightening of interbank exposure limits (column 7), French banks' cross-border lending growth slows down or contracts. On the contrary, a tightening of reserve requirements (columns 5 and 6) in the destination country leads to an increase of cross-border lending growth by French banks. As already alluded to above, these differences in reaction can be attributed to the ability of French banks to substitute for the presumed contraction in lending by the banks resident in the destination country that are subject to the regulatory tightening: Whereas tightened reserve requirements affect the banks regulated in the destination country, French banks are able to maintain cross-border lending growth, as they are not concerned by this destination-country policy. In the case of interbank exposure limits, however, French banks' counterparties are directly affected and, as a consequence, French banks are affected as well, thus explaining the negative effect on cross-border lending growth.

In terms of economic magnitudes, these effects are relatively small. A regulatory tightening of reserve requirements has a positive cumulative effect (sum of α_1, α_2, and α_3) on cross-border lending growth, increasing it by 2.3 percent. Given the extremely large standard deviation of the dependent variable (30.69 percent), this effect can be categorized as quantitatively small. The cumulative reduction due to interbank exposure limits is also rather small, amounting to –7.1 percent.

In the following specification, we want to investigate the role of balance sheet variables in characterizing banks' ability to maintain or expand cross-border lending growth in response to a regulatory tightening in the destination country. We therefore include interaction effects between regulatory changes and the aforementioned balance sheet characteristics.

Specification 2. *Outward transmission of destination-country policy: the role of balance sheet characteristics (see table 6).*

$$\begin{aligned}\Delta Y_{b,j,t} = \alpha_0 &+ (\alpha_1 DestP_{j,t} + \alpha_2 DestP_{j,t-1} + \alpha_3 DestP_{j,t-2}) \\ &+ \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + (\beta_1 DestP_{j,t} X_{b,t-1} \\ &+ \beta_2 DestP_{j,t-1} X_{b,t-1} + \beta_3 DestP_{j,t-2} X_{b,t-1}) \\ &+ f_b + f_j + f_t + \varepsilon_{b,j,t}\end{aligned}$$

The interaction terms show how banks with different balance sheet characteristics adjust their lending growth in response to regulatory changes. Thus, as in specification 1, we measure the impact of regulatory changes abroad on cross-border lending growth by French banks, but differentiate between the impact when balance sheet characteristics are zero and the one provoked via balance sheet characteristics.

Table 6 reports the results for this regression. Throughout all regressions, the cycle variables are positively and significantly associated with higher foreign lending growth as in table 5. With regards to the regulatory variables, we concentrate on the sum of α_1, α_2, and α_3 (F-statistic at the bottom of table 6), which measures the effect of regulatory changes if all balance sheet variables were equal to zero, as well as the sum of β_1, β_2, and β_3 presented in the bottom half of table 6. With respect to reserve requirements (columns 5 and 6), table 6 shows that there is no statistically significant differential impact of a tightening in reserve requirements when differentiating between its direct impact (sum of α_1, α_2, and α_3) and its impact via balance sheet variables (sum of β_1, β_2, and β_3).

However, the overall negative impact of regulatory tightening of capital requirements (column 2) and interbank exposure limits (column 7) can be decomposed into a positive direct effect (sum of α_1, α_2, and α_3) and a negative effect (sum of β_1, β_2, and β_3). The latter is brought about by large bank size and a high illiquid assets ratio in the case of capital requirements and a high illiquid assets ratio and a high dependence on net intragroup funding in the case of interbank exposure limits. Banks with a high illiquid assets ratio might therefore not be able to mobilize the funds necessary to increase cross-border lending growth. Overall, the findings suggest that, on average, balance sheet constraints can limit French banks' ability to substitute for the presumed contraction of lending by the banks subject to regulatory tightening. In terms of economic magnitudes, we note that the cumulative direct effect of regulatory tightening (assuming balance sheet variables are zero) is not only positive for capital requirements and interbank exposure limits but also one order of magnitude larger (in absolute terms).

Our results are robust to the following modifications of the baseline specifications. We include parent-bank controls (in this case, the sample runs only from 2000:Q4 to 2013:Q2). We also restrict the

Table 6. Outward Transmission of Destination-Country Policy: The Role of Balance Sheet Characteristics

	Prudential IndexC (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Requirements: Foreign (5)	Reserve Requirements: Local (6)	Interbank Exposure Limits (7)	Concentration Ratios (8)
Destination-Country Regulation DestP_t	0.049	0.648^{***}	0.124	0.178	0.073	−0.076	0.115	0.140
	(0.083)	(0.231)	(0.149)	(0.255)	(0.057)	(0.103)	(0.234)	(0.173)
Destination-Country Regulation DestP_{t-1}	0.002	0.234	−0.036	−0.197	−0.011	−0.033	0.174	−0.094
	(0.062)	(0.206)	(0.140)	(0.214)	(0.086)	(0.065)	(0.249)	(0.332)
Destination-Country Regulation DestP_{t-2}	−0.011	0.060	−0.005	−0.112	−0.019	0.067	0.330	−0.269
	(0.076)	(0.282)	(0.202)	(0.261)	(0.063)	(0.089)	(0.213)	(0.272)
Log Total Assets_{t-1}	−0.010	−0.011	−0.009	−0.009	−0.009	−0.010	−0.010	−0.010
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.012)	(0.013)	(0.013)
Tier 1 Ratio_{t-1}	-0.002^{**}	-0.002^{**}	-0.002^{**}	-0.002^{**}	-0.002^{**}	-0.002^{**}	-0.002^{**}	-0.002^{**}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Illiquid Assets Ratio_{t-1}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
International Activity_{t-1}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Net Intragroup Funding_{t-1}	0.002^{***}	0.002^{***}	0.002^{***}	0.002^{***}	0.002^{***}	0.002^{***}	0.002^{***}	0.002^{***}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Core Deposits Ratio_{t-1}	−0.001	-0.001^{*}	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
BIS Financial Cycle (Destination Country)	0.047^{***}	0.048^{***}	0.046^{***}	0.046^{***}	0.046^{***}	0.046^{***}	0.046^{***}	0.048^{***}
	(0.016)	(0.016)	(0.017)	(0.016)	(0.016)	(0.017)	(0.016)	(0.016)
BIS Business Cycle (Destination Country)	0.553^{***}	0.561^{***}	0.558^{***}	0.555^{***}	0.550^{***}	0.566^{***}	0.557^{***}	0.563^{***}
	(0.113)	(0.113)	(0.113)	(0.111)	(0.114)	(0.114)	(0.112)	(0.112)

(*continued*)

Table 6. (Continued)

	Prudential IndexC (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Requirements: Foreign (5)	Reserve Requirements: Local (6)	Interbank Exposure Limits (7)	Concentration Ratios (8)
Log Total Assets*DestP	−0.002	−0.035*	−0.006	0.001	−0.002	0.002	0.005	0.017
	[0.638]	[0.063]	[0.487]	[0.892]	[0.588]	[0.670]	[0.761]	[0.389]
Tier 1 Ratio*DestP	0.000	−0.014	0.004	0.002	0.002	0.000	0.010	0.000
	[0.817]	[0.442]	[0.205]	[0.703]	[0.304]	[0.855]	[0.192]	[0.947]
Illiquid Assets Ratio*DestP	0.000	−0.004*	0.000	0.002	0.000	0.000	−0.009***	0.000
	[0.957]	[0.087]	[0.993]	[0.422]	[0.922]	[0.788]	[0.000]	[0.905]
International Activity*DestP	0.000	0.002	0.000	0.000	0.000	0.000	−0.003**	−0.001
	[0.658]	[0.381]	[0.963]	[0.716]	[0.854]	[0.617]	[0.033]	[0.576]
Net Intragroup Funding*DestP	0.001	0.004	0.000	0.001	−0.001	0.002	−0.011***	0.004
	[0.362]	[0.402]	[0.975]	[0.681]	[0.765]	[0.190]	[0.000]	[0.463]
Core Deposits Ratio*DestP	0.000	0.002	0.000	−0.001	0.000	0.000	0.001	−0.001
	[0.932]	[0.381]	[0.843]	[0.254]	[0.731]	[0.977]	[0.198]	[0.619]
Observations	27,414	27,414	27,414	27,414	27,414	27,414	27,414	27,414
R^2	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Adjusted R^2	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
No. of Destination Countries	53	53	53	53	53	53	53	53
No. of Banks	42	42	42	42	42	42	42	42
Sum of $\alpha_1 + \alpha_2 + \alpha_3$	0.040	0.942**	0.083	−0.131	0.044	−0.041	0.618*	−0.223
p(F-test)	[0.697]	[0.035]	[0.706]	[0.544]	[0.584]	[0.730]	[0.063]	[0.625]

Notes: This table reports the effects of changes in destination-country regulation and bank characteristics on log changes in cross-border loans by destination country. Data are collected at the locational level. The data are quarterly from 2000:Q1 to 2013:Q2. DestP refers to the changes in regulation in the destination country of the loan. For DestP and its interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-values for significance in squared brackets. For more details on the variables, see table 9 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include bank, country, and time fixed effects. Standard errors (in parentheses) are clustered at the country level. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

bank sample to only comprise banks which have a very large presence abroad and are present in the sample with at least 1,000 observations. Another robustness check that we perform is the restriction of the country sample to include only those destination countries that actually changed one of the instruments over the time period in question. The use of exchange-rate-adjusted stocks for the calculation of cross-border loan growth rates[16] does not alter the results.

We also include all prudential instruments simultaneously (excluding the aggregate *PruC* measure) for the case of specification 1. Only the sums of $\alpha_1 + \alpha_2 + \alpha_3$ for foreign-currency reserve requirements and interbank exposure limits are statistically significant and show the same sign as in table 5. Since specification 2 concentrates on the importance of balance sheet variables for the adjustment to policy changes in destination countries (lower panel of table 6), we also run this specification including country-time fixed effects as well as a saturated model including country-time, bank-time, and bank-country fixed effects. Whereas most of the significant results carry over to the setup with country-time fixed effects, only the respective interactions of interbank exposure limits with the illiquid assets ratio and net intragroup funding remain significant in the case of the highly saturated model.

3.2 Exploration of Loan Growth to the Non-financial and Financial Sectors

In this section, we explore the channels of the adjustments demonstrated in table 5. In particular, we want to test whether results differ when considering different counterparties: lending to the non-financial sector will automatically exclude intragroup flows, whereas lending to the financial sector is presumably driven to a large extent by intragroup flows, notably to branches: as described in section 2.3, much of interbank lending is done with regards to branches and less so to subsidiaries abroad (see table 3).

[16]We follow the BIS methodology and calculate stocks in original currency by using average-of-period exchange rates and then calculate exchange-rate-adjusted flows using end-of-period exchange rates. These flows are then used to construct exchange-rate-adjusted stocks.

The results for specification 1 are displayed in table 7, panel A (non-financial sector) and panel B (financial sector).[17] The aggregate results in table 5 seem to be driven mainly by lending to the non-financial sector: the sum of α_1, α_2, and α_3 is statistically significant and positive for both types of reserve requirements as well as negative for interbank exposure limits. However, we also note the significant and positive cumulative effect of foreign-currency reserve requirements for lending to the financial sector. In this case, the economic magnitudes are even double the size of the one for lending to the non-financial sector (0.36 versus 0.18).

We thus do not find convincing evidence that French banks increase their lending growth to branches abroad because these are not regulated by the supervisory authority in the host country (the destination country). Instead of these branches substituting for the decrease in lending growth by the locally regulated banks, French banks rather lend directly cross-border (to the non-financial sector), thus potentially substituting for a presumed reduction in lending by locally regulated banks. Interestingly, we also note the high significance of the financial cycle in the destination country for lending growth to the financial sector, whereas it is the business cycle that shows a high significance for lending growth to the non-financial sector.

3.3 Exploration of External Adjustment in Response to French Regulation

As pointed out in the introduction, the main regulatory instruments used during the time period in question were capital requirements and concentration limits on large exposures. These regulatory changes motivate the choice of instruments for the analysis of outward transmission of French regulation. We also include reserve requirements for local-currency deposits, but keep in mind that this is primarily a monetary policy tool in the euro area.

In particular, we estimate the following specification to measure the adjustment of external lending growth to regulatory changes in France:

[17] We note that the number of observations drops considerably when restricting cross-border loans to financial counterparties.

Table 7. Outward Transmission of Destination-Country Policy: By Counterparty Sector

	Prudential IndexC (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Requirements: Foreign (5)	Reserve Requirements: Local (6)	Interbank Exposure Limits (7)	Concentration Ratios (8)
A. Non-financial Counterparties								
Destination-Country Regulation $DestP_t$	0.007	−0.010	0.003	0.014	0.002	0.009	−0.021	0.015
	(0.005)	(0.016)	(0.010)	(0.010)	(0.005)	(0.006)	(0.030)	(0.022)
Destination-Country Regulation $DestP_{t-1}$	0.003	−0.022	−0.010	0.007	0.008	0.001	−0.020	−0.019
	(0.005)	(0.015)	(0.009)	(0.014)	(0.007)	(0.005)	(0.013)	(0.017)
Destination-Country Regulation $DestP_{t-2}$	0.001	−0.011	−0.001	−0.023*	0.008	0.013***	−0.036	0.000
	(0.006)	(0.020)	(0.006)	(0.013)	(0.005)	(0.005)	(0.025)	(0.021)
Observations	27,174	27,174	27,174	27,174	27,174	27,174	27,174	27,174
R^2	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Adjusted R^2	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
No. of Destination Countries	53	53	53	53	53	53	53	53
No. of Banks	40	40	40	40	40	40	40	40
Sum of $\alpha_1 + \alpha_2 + \alpha_3$	0.011	−0.043	−0.007	−0.002	0.018**	0.024***	−0.077**	−0.004
p(F-test)	[0.136]	[0.226]	[0.633]	[0.908]	[0.035]	[0.007]	[0.014]	[0.925]

(*continued*)

Table 7. (Continued)

	Prudential IndexC (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Requirements: Foreign (5)	Reserve Requirements: Local (6)	Interbank Exposure Limits (7)	Concentration Ratios (8)
B. Financial Counterparties								
Destination-Country Regulation $DestP_t$	0.006	0.018	0.013	0.002	0.024**	0.027***	0.002	−0.003
	(0.008)	(0.027)	(0.023)	(0.018)	(0.011)	(0.008)	(0.032)	(0.027)
Destination-Country Regulation $DestP_{t-1}$	0.000	0.013	0.002	0.019	0.006	−0.014	−0.022	−0.004
	(0.009)	(0.028)	(0.016)	(0.016)	(0.008)	(0.013)	(0.034)	(0.030)
Destination-Country Regulation $DestP_{t-2}$	−0.007	−0.010	−0.011	−0.003	0.006	−0.009	−0.013	0.023
	(0.010)	(0.026)	(0.021)	(0.026)	(0.009)	(0.012)	(0.034)	(0.037)
Observations	11,988	11,988	11,988	11,988	11,988	11,988	11,988	11,988
R^2	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Adjusted R^2	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
No. of Destination Countries	53	53	53	53	53	53	53	53
No. of Banks	40	40	40	40	40	40	40	40
Sum of $\alpha_1 + \alpha_2 + \alpha_3$	−0.001	0.020	0.004	0.018	0.036*	0.005	−0.034	0.016
P(F-test)	[0.971]	[0.700]	[0.919]	[0.597]	[0.084]	[0.830]	[0.519]	[0.754]

Notes: This table reports the effects of changes in destination-country regulation and firm characteristics on log changes in cross-border loans by destination country. The regression model corresponds to specification 1, but the coefficients on bank characteristics and the business and financial cycle are not reported. Data are collected at the locational level. The data are quarterly from 2000:Q1 to 2013:Q4. DestP refers to the changes in regulation in the destination country of the loan. For more details on the variables, see table 9 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include bank, country, and time fixed effects. Standard errors (in parentheses) are clustered at the country level. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Specification 3. *Outward transmission of French policy (see table 8).*

$$\begin{aligned}\Delta Y_{b,j,t} = \alpha_0 &+ (\alpha_1 DestP_{j,t} + \alpha_2 DestP_{j,t-1} + \alpha_3 DestP_{j,t-2}) \\ &+ \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + (\beta_1 HomeP_t X_{b,t-1} \\ &+ \beta_2 HomeP_{t-1} X_{b,t-1} + \beta_3 HomeP_{t-2} X_{b,t-1}) \\ &+ f_j + f_b + f_t + \varepsilon_{b,j,t},\end{aligned}$$

where all variables are defined as above and $HomeP_t$ denotes changes in French regulation.

Table 8 shows the impact of French regulatory changes on the growth of cross-border credit by French banks. As time fixed effects are set in the regressions, we measure only the differential impact of regulatory changes through banks' balance sheet characteristics. With regards to the aggregate prudential index (column 1), French banks with a high tier 1 ratio are the ones that are more constrained in their ability to maintain cross-border lending growth. Most likely, this effect is driven by the variation in French regulation on capital requirements (column 2).

Overall, we find that the adjustment of cross-border lending growth to French regulation due to balance sheet characteristics is economically small: In the case of a regulatory tightening, a bank with a one-standard-deviation higher capital ratio decreases its growth of cross-border loans by 0.34 percent (= 0.052 × 6.52 percent). The same goes for the effect on intragroup borrowing: a bank that is characterized by a one-standard-deviation higher reliance on intragroup funding (7.87 percent) will decrease cross-border lending growth by 0.07 percent. A high core deposits ratio is associated with a better ability to extend loans abroad in response to a tightening of capital requirements in France, but once again economic magnitudes are small: a one-standard-deviation higher dependence on core deposit funding (26.97 percent) increases lending growth by 0.22 percent.

We note that the economic magnitudes for the significant variables in column 2 of table 8 are nevertheless higher than in the case of destination-country capital requirements (column 2 of table 6). This can be related to the fact that French capital regulation specifically targets French banks' balance sheets and these constraints thus have

Table 8. Outward Transmission of French Policy

	Prudential IndexC (1)	Capital Require-ments (2)	Reserve Require-ments: Local (3)	Concen-tration Ratios (4)
Destination-Country Regulation DestP_t	0.006	0.007	0.009*	0.021
	(0.005)	(0.016)	(0.005)	(0.017)
Destination-Country Regulation DestP_{t-1}	0.002	−0.034**	−0.003	0.022
	(0.005)	(0.013)	(0.004)	(0.015)
Destination-Country Regulation DestP_{t-2}	−0.001	−0.021	0.011**	−0.001
	(0.005)	(0.018)	(0.005)	(0.020)
Log Total Assets_{t-1}	−0.007	0.009	−0.011	−0.009
	(0.013)	(0.013)	(0.012)	(0.012)
Tier 1 Ratio_{t-1}	−0.002**	−0.002**	−0.002**	−0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
Illiquid Assets Ratio_{t-1}	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
International Activity_{t-1}	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Net Intragroup Funding_{t-1}	0.003***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Core Deposits Ratio_{t-1}	−0.001	−0.001	−0.001*	−0.001
	(0.000)	(0.000)	(0.000)	(0.000)
BIS Financial Cycle (Destination Country)	0.046***	0.047***	0.046***	0.047***
	(0.016)	(0.016)	(0.017)	(0.016)
BIS Business Cycle (Destination Country)	0.552***	0.562***	0.566***	0.555***
	(0.112)	(0.112)	(0.114)	(0.112)
Log Total Assets*HomeP	0.004	−0.013	0.022	0.004
	[0.597]	[0.457]	[0.201]	[0.612]
Tier 1 Ratio*HomeP	−0.006*	−0.052**	0.014	−0.004
	[0.055]	[0.013]	[0.353]	[0.239]
Illiquid Assets Ratio*HomeP	0.000	−0.004	0.003	0.000
	[0.982]	[0.128]	[0.210]	[0.858]
International Activity*HomeP	−0.001	−0.002	0.000	−0.001
	[0.119]	[0.442]	[0.871]	[0.176]
Net Intragroup Funding*HomeP	−0.001	−0.009*	0.001	0.001
	[0.699]	[0.069]	[0.841]	[0.770]
Core Deposits Ratio*HomeP	0.001	0.008***	−0.003*	0.000
	[0.297]	[0.000]	[0.084]	[0.655]
Observations	27,414	27,414	27,414	27,414
R^2	0.02	0.02	0.02	0.02
Adjusted R^2	0.02	0.02	0.02	0.02
No. of Destination Countries	53	53	53	53
No. of Banks	42	42	42	42
Sum of $\alpha_1 + \alpha_2 + \alpha_3$	0.007	−0.048	0.017**	0.042
p(F-test)	[0.337]	[0.127]	[0.028]	[0.0233]

Notes: This table reports the effects of changes in destination-country regulation and bank characteristics on log changes in cross-border loans by destination country. Data are collected at the locational level. The data are quarterly from 2000:Q1 to 2013:Q2. DestP refers to the changes in regulation in the destination country of the loan. For HomeP (French regulation) and its interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-values for significance in squared brackets. For more details on the variables, see table 9 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include bank, country, and time fixed effects. Standard errors (in parentheses) are clustered at the country level. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

a larger impact on the outward adjustment of foreign lending growth than in the case of destination-country policy which is not directed at French banks.

4. Concluding Remarks

In this paper, we investigate the outward adjustment of French cross-border lending growth to changes in regulatory policies in destination countries as well as in reaction to French domestic policy changes.

We first note that we cannot rule out that the scarcity of regulatory changes, both in France and in countries to which French banks are exposed, might drive some of the results. This problem is further exacerbated by the fact that most regulatory changes were implemented during times of financial turmoil.

This caveat notwithstanding, we find that French banks sometimes expand their cross-border loans in response to a regulatory tightening abroad, thus suggesting that international banking might be contributing to regulatory leakages. This is especially the case for the tightening of reserve requirements. For the case of capital requirements and interbank exposure limits, banks are only able to increase cross-border lending growth if their balance sheet characteristics allow them to do so. Differentiating between lending to the financial and non-financial sector shows that the overall results are driven by lending to the latter. Combining these results with the stylized facts on French banks' cross-border lending, we thus do not find evidence that French banks use their branch network abroad to substitute for the presumed contraction in lending by locally regulated banks; they rather do so directly using their cross-border operations.

The findings also imply that balance sheet characteristics such as the tier 1 capital ratio, dependence on intragroup funding, or the core deposits ratio matter for the transmission of French domestic regulation to foreign lending growth. This is coherent given the fact that French domestic regulation specifically targets changes in the balance sheet structure of French banks, whereas French banks that are not subject to foreign regulation can adjust their cross-border lending growth independently of their balance sheet constraints.

Appendix

Table 9. Construction of Balance Sheet Variables

Variable	Description
Log Total Assets	Log(Total Assets, Deflated by GDP Deflator)
Tier 1 Capital Ratio	Capital without Subordinated Debt/Total Assets
Illiquid Assets Ratio	Total Assets – (Cash + Central Bank Accounts + Assets from Repo Transactions + Other Liquid Financial Securities)/Total Assets
International Activity	Assets vis-à-vis Non-residents/Total Assets
Net Intragroup Funding	(Borrowing from Branches Abroad – Lending to Branches Abroad)/Total Assets
Core Deposits Ratio	Deposits (without Term Deposits, nor Special Savings Accounts like "Livret A"/Total Assets

References

Buch, C. M., and L. Goldberg. 2017. "Cross-Border Prudential Policy Spillovers: How Much? How Important? Evidence from the International Banking Research Network." *International Journal of Central Banking* 13 (S1).

Cerutti, E., R. Correa, E. Fiorentino, and E. Segalla. 2017. "Changes in Prudential Policy Instruments—A New Cross-Country Database. *International Journal of Central Banking* 13 (S1).

Cornford, A. 2006. "The Global Implementation of Basel II: Prospects and Outstanding Problems." UNCTAD Blue Series Paper No. 34.

Shin, H. S. 2012. "Global Banking Glut and Loan Risk Premium." *IMF Economic Review* 60 (2): 155–92.

Thoraval, P.-Y. 1996. "La surveillance prudentielle des risques de marché supporté par les établissements de crédit." *Revue d'économie financière* 37 (2): 22–37.

International Banking and Cross-Border Effects of Regulation: Lessons from Hong Kong*

Kelvin Ho, Eric Wong, and Edward Tan
Hong Kong Monetary Authority

Using a confidential data set of foreign bank affiliates (FBAs) in Hong Kong, this study finds evidence of an international transmission of prudential policies through banks' balance sheets from a host-country perspective. Specifically, in response to tighter capital requirements in the home country, parent banks with a higher tier 1 capital ratio tend to sustain higher loan growth by their FBAs in Hong Kong than their peers. When tighter liquidity requirements are considered, differences in parent banks' core deposit shares and reliance on net intragroup funding are found to significantly affect the loan responses of FBAs in Hong Kong. One implication is that from a host supervisor's perspective, understanding the balance sheet structure of an FBA's parent bank is important in assessing the international transmission of prudential policies. Regarding the impact on the loan supply of the Hong Kong banking sector, our findings show that the size of the spillover effects for the overall capital requirements and reserve requirements are larger than those for sector-specific prudential measures. The relatively smaller spillover effects for sector-specific prudential measures can be partly explained by a significant portfolio rebalancing effect both across and within affiliates of international banks, making the net impact on the host country less clear.

JEL Codes: E58, F34, G21, G28.

*Author contact (all authors): Research Department, Hong Kong Monetary Authority, 55/F, Two International Finance Centre, 8 Finance Street, Central, Hong Kong, China. Ho: Tel: +852 2878 1794; Fax: +852 2878 1891; E-mail: kkwho@hkma.gov.hk. Wong: Tel: +852 2878 8735; Fax: +852 2878 1891; E-mail: etcwong@hkma.gov.hk. Tan: Tel: +852 2878 1734; Fax: +852 2878 1891; E-mail: ekytan@hkma.gov.hk.

1. Introduction

While prudential policies have been increasingly tightened by policymakers globally to contain systemic risk after the global financial crisis (figure 1), their implementation may have unintended international spillover effects. The issue of international spillovers of prudential policies has drawn increasing attention from policymakers. Hong Kong is an international financial center with a strong presence of foreign banks, implying that the Hong Kong banking sector is not immune to the spillover effects arising in the home countries of foreign affiliate banks in Hong Kong.

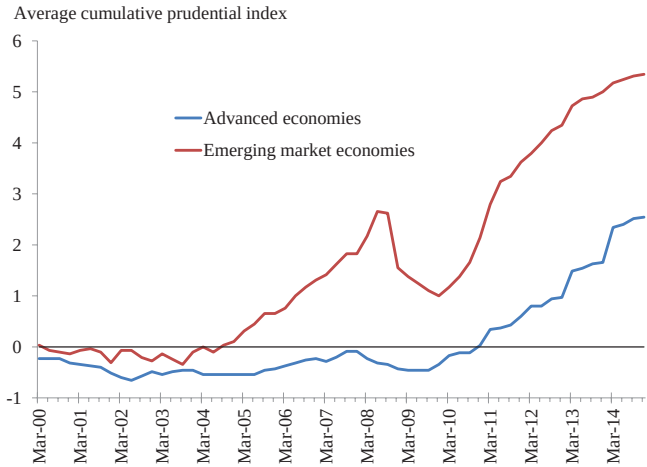
To broaden our understanding of this policy issue, this paper focuses on the cross-border inward spillover effects of prudential policies from a host-country perspective. More specifically, we examine how foreign banks' affiliates (FBAs)[1] in Hong Kong adjust their lending in response to tighter prudential policies imposed in their home countries.

The strong presence of FBAs in Hong Kong provides a natural and suitable experiment setting to study the issue of inward spillover effects of prudential policies from the home countries of foreign banks. At the end of 2014, there were 191 FBAs operating in Hong Kong, accounting for 73 percent of total banking assets.[2] Although these FBAs operate with different business functions, in aggregate they account for 74 percent of total banking-sector loans. Since these FBAs are subject to prudential policies imposed in their home countries (*HomeP*), by studying how their change in lending in Hong Kong is associated with changes in *HomeP*, we can identify the inward spillover effects of *HomeP* empirically. The large number of foreign banks in Hong Kong is conducive to a reliable statistical result. Meanwhile, the inward spillover of foreign prudential measures could also arise through domestic banks' exposure of their affiliates in foreign markets, which, in turn, affects their lending behavior in Hong Kong. However, the identification of spillover effects for this specification is not feasible, as there are only a few domestic banks in Hong Kong that have operations in many foreign countries, and is therefore not examined in this study.

[1]This includes foreign bank branches and subsidiaries in Hong Kong.

[2]Of the total 191 FBAs in Hong Kong, 145 are foreign bank branches and 46 are foreign subsidiaries.

Figure 1. Average Cumulative Prudential Index of Advanced and Emerging Market Economies



Source: Authors' estimates based on IBRN Prudential Instruments Database described by Cerutti et al. (2017).
Notes: The index reflects the average cumulative number of prudential policy actions by assigning a positive value for tightening and a negative value for loosening. Policy instruments include general capital requirements, sector-specific capital requirements, limits on interbank exposure, concentration ratio limits, caps on loan-to-value ratios, and reserve requirements on local and foreign currencies.

We conduct our empirical study using a confidential panel data set reported by foreign banks to the Hong Kong Monetary Authority (HKMA) from 2000:Q1 to 2014:Q4, with parent-bank data obtained from Bankscope. Data on prudential policies are from the International Banking Research Network (IBRN) Prudential Instruments Database (Cerutti et al. 2017). All empirical estimations are based on the baseline analytical framework described in Buch and Goldberg (2017).

This study aims to answer two questions: First, do balance sheet characteristics matter for the inward transmission of prudential measures through FBAs' operations in Hong Kong? This question is particularly relevant to host-country policymakers, as international banks generally have very different balance sheet structures due to

their heterogeneous business models.[3] Second, do banks respond differently to alternative types of prudential measures and what is the economic magnitude of their response? We answer the second question by studying the directional changes of lending among FBAs in Hong Kong in response to various types of prudential measures and their aggregate impact on the banking sector's lending.

For the first question, we identify a set of bank balance sheet characteristics that could significantly affect the inward spillover effects of four types of prudential policies considered in this paper. We find that these bank balance sheet characteristics vary across prudential measures but are strongly associated with the nature of the prudential measure (i.e., capital or liquidity related) being studied. Specifically, we find that in response to tighter capital requirements in the home country, a bank with a higher tier 1 capital ratio tends to sustain higher loan growth of its affiliates in Hong Kong than that of other FBAs in Hong Kong. For tighter liquidity prudential measures (e.g., higher reserve requirements), a bank's core deposit share and its reliance on net intragroup funding are found to significantly affect the loan response of its affiliates in Hong Kong. Overall, these findings may reflect the notion that the loan response of FBAs in Hong Kong to tighter prudential measures in the home country is crucially dependent on how the tighter requirements produce a binding constraint on the capital or liquidity ratios of its banking organization.

For the second question, among the four types of prudential measure considered, only the overall capital requirements are estimated to have a clear pattern of spillover effects: most FBAs in the sample are estimated to reduce their lending in Hong Kong in response to tighter overall capital requirements in their respective home country. Consistent with this finding, the size of the spillover effects for the overall capital requirements is found to be larger than the size of those associated with sector-specific prudential measures. We attribute the latter finding to a significant portfolio rebalancing effect of FBAs in Hong Kong.

[3]Recent studies on international banking have found empirical evidence to support the idea that the balance sheet characteristics of global banks matter for the international transmission of risk. See Cetorelli and Goldberg (2012a, 2012b) and Buch and Goldberg (2014).

The remainder of this paper is organized as follows. Section 2 provides a brief description of data and stylized facts for foreign affiliates in Hong Kong. Section 3 discusses the empirical models and results. Section 4 concludes.

2. Data and Stylized Facts for Foreign Affiliates in Hong Kong

2.1 Bank-Level Data

We construct affiliate-level variables for foreign banks in Hong Kong using regulatory data from the *return of assets and liabilities* and the *quarterly analysis of loans and advances and provisions* submitted to the HKMA. Parent-level variables are constructed using consolidated data of the ultimate parent from Bankscope.[4] Details of the variables are shown in appendix 1 of Ho, Wong, and Tan (2016).

2.1.1 Dependent Variables[5]

This empirical study includes the quarterly change in log total loans ($\Delta Loans_{b,j,t}$) in the baseline estimation. In addition, changes in log mortgage loans ($\Delta Mortgage_{b,j,t}$), corporate loans ($\Delta Corp_{b,j,t}$), and consumer loans[6] ($\Delta Consumer_{b,j,t}$) are analyzed to complement our investigation on whether foreign banks have an incentive to rebalance their loan portfolios in response to a tightening in prudential measures.

2.1.2 Balance Sheet Characteristics

We follow Cornett et al. (2011) in assuming that the ex ante balance sheet condition of a bank matters for the transmission of regulatory spillover effects. The ex ante balance sheet condition of a banking

[4]Since quarterly data are only available in recent years for most of our sample, missing quarterly data in the early part of the estimation period are obtained by linearly interpolating the annual data.

[5]All dependent variables considered are winsorized at the 1st and 99th percentiles. Apart from winsorizing the dependent variables, a robustness check has been conducted by excluding the log changes of loans exceeding 100 percent and –100 percent; the results remain broadly unchanged.

[6]This is defined as household loans excluding mortgage loans.

organization is proxied by three parent-level variables: the fraction of the parent bank's assets that are illiquid at the beginning of period ($IlliquidAssetsRatio_{b,j,t-1}$), the fraction of the parent bank's balance sheet financed with core deposits ($CoreDeposits_{b,j,t-1}$), and the parent bank's regulatory tier 1 capital ratio ($Tier1Ratio_{b,j,t-1}$). All specifications include the log of real total assets of the parent bank as a control variable ($LogRealAssets_{b,j,t-1}$). In addition, we also include a ratio of *NetDueTo* to liabilities ($NetDueTo_{b,j,t-1}$) in the regression equation, where *NetDueTo* is defined as "due to overseas offices" (i.e., liabilities of foreign affiliates in Hong Kong) minus "due from overseas offices" (i.e., assets of foreign affiliates in Hong Kong), to capture an FBA's net intragroup funding. By definition, a positive (negative) *NetDueTo* for an FBA in Hong Kong means the FBA is a net borrower from (lender to) the rest of its banking group. An FBA with a large positive *NetDueTo* suggests that the FBA is more reliant on its parent bank's funding.

2.2 Data on Prudential Instruments

Regarding data on prudential instruments ($HomeP_{j,t}$), this study considers four types of policy instruments, which differ in scope of application and policy objectives. The first two are related to a bank's capital adequacy: the overall capital requirements ($CapitalReg_{j,t}$) and sector-specific capital buffers ($SSCB_{j,t}$), with the latter generally imposed on loans to the real estate sector. These two measures are usually applied on a consolidated basis at the parent-bank level. The loan-to-value ratio cap for mortgage loans ($LTVCap_{j,t}$), which is conventionally applied in a geographically confined area (e.g. mortgage loans in the home country), is also considered in this study. In addition, reserve requirements on local-currency deposits ($RRLocal_{j,t}$), a measure affecting banks' liquidity is included in the analysis.[7] The variable $HomeP_{j,t}$ considered in the study is defined in the following fashion: 1 if country j tightens

[7]Sector-specific capital buffers for consumer and other loans, the reserve requirements on foreign-currency deposits, interbank exposure limits, and concentration limits are excluded in estimation, as there is too little variation in these instruments in our sample (see table 2).

a particular measure at time t, -1 if a country loosens the measure, and 0 otherwise.[8]

Furthermore, a prudential index ($Pruc_{j,t}$), which measures the aggregate prudential policy stance in the home country, is included in the estimation. The index is defined as being equal to 1 if the sum of all instrument indexes is greater than or equal to 1 at time t, -1 if that same sum is less than or equal to –1, and 0 otherwise.

The estimation sample includes seventy foreign banks in Hong Kong, covering the period 2000:Q1–2014:Q4. These banks are selected using the following criteria: We first include all licensed banks with their parent bank's home country not equal to Hong Kong (i.e., the estimation sample includes both foreign bank branches and subsidiaries). We then exclude banks that are no longer active at the end of 2014 and have less than seven years of operation.[9] Banks that have experienced mergers and acquisitions or changes in their home country or no lending operation during the sample period are also excluded. The estimation sample of banks accounts for about 79 percent of the total assets of all foreign banks in Hong Kong at the end of 2014.

2.3 Stylized Facts

The summary statistics for major variables in our estimations are shown in table 1. There is a significant variation in the balance sheet structure among FBAs' parent banks, as reflected in a relatively large standard deviation for the tier 1 ratio, illiquid assets ratio, and core deposits ratio. This feature is consistent with the fact that international banks generally have very different balance sheet structures due to their diverse range of business functions. Similarly, the business functions of FBAs also exhibit a large degree of heterogeneity, as indicated by a large standard deviation for *NetDueTo* (i.e., 32 percent). The large standard deviation indicates that some FBAs in Hong Kong are highly reliant on net intragroup funding,

[8]For reserve requirements, changes in a given period t could take a value of greater (lower) than 1 (–1) to account for the intensity of the change in the instrument that the index captures.

[9]Thus, the selected FBAs have lending operations that cover at least half of the estimation period.

Table 1. Summary Statistics on Bank Lending and Characteristics

Variable	All Banks (N = 70)				
	Mean	**Median**	**25th Percentile**	**75th Percentile**	**SD**
Balance Sheet Data (for Each Bank b and Quarter t)					
Dependent Variables					
Δ Total Loans (%)	3.44	1.98	−4.35	9.74	19.20
Δ Mortgage Loans (%)	−3.92	−2.42	−6.82	−0.12	19.40
Δ Corporate Loans (%)	2.80	1.82	−6.80	11.72	27.07
Δ Consumer Loans (%)	−1.38	−0.11	−9.11	7.38	48.81
Independent Variables					
Parent-Bank Characteristics:					
Log Real Total Assets	19.85	20.11	18.88	20.99	1.34
Tier 1 Ratio (%)	9.96	9.60	7.81	11.68	2.74
Illiquid Assets Ratio (%)	78.98	81.59	71.92	88.47	12.73
Core Deposits Ratio (%)	56.64	58.02	40.44	74.64	20.40
Foreign Affiliates Characteristics:					
Net Due To/Liabilities (%)	−1.97	−1.31	−20.64	13.44	32.21

Notes: This table provides summary statistics for bank balance sheet and lending data. Data are observed quarterly from 2000:Q1 to 2014:Q4. Banking data of the parent banks come from Bankscope and are reported at the consolidated level of the ultimate parent. Banking data of the foreign affiliates located in Hong Kong come from the HKMA which reflects the positions of the local offices. The "Net Due To" variable measures from the perspective of a bank's affiliates net internal borrowing (or lending) in Hong Kong vis-à-vis overseas offices.

while some FBAs would instead act as net lenders to their banking organization.

Table 2 presents summary statistics on changes in the regulation in the home countries of the FBAs in our sample. The home countries of FBAs in our sample include twenty-one countries,[10] of which six are emerging Asian economies and the rest are advanced economies. In general, the set of prudential instruments being implemented in each country tends to vary, and largely depends on country-specific conditions. Specifically, among the prudential measures being considered, overall capital requirements are the most widely adopted instruments, with all countries having tightened the requirements at least once over the estimation period. On the other hand, interbank exposure limits and concentration limits are the least-adopted instruments, with only a few countries implementing these types of instrument in our sample.

3. Empirical Method and Regression Results

3.1 Baseline Analysis of Inward Transmission of Prudential Policies via Foreign Affiliates

This section draws mainly on the framework developed by Buch and Goldberg (2017) to examine the inward spillover effects of prudential policies implemented abroad on Hong Kong via foreign bank affiliates. The empirical model is specified as follows[11]:

$$\begin{aligned}\Delta Y_{b,j,t} = {} & \alpha_0(\alpha_1 HomeP_{j,t} + \alpha_2 HomeP_{j,t-1} + \alpha_3 HomeP_{j,t-2}) \\ & + \alpha_4 X_{b,j,t-1} + \alpha_5 Z_{j,t} \\ & + (\beta_1 HomeP_{j,t} + \beta_2 HomeP_{j,t-1} + \beta_3 HomeP_{j,t-2}) \\ & \cdot X_{b,j,t-1} + f_b + f_t + \varepsilon_{b,j,t}, \end{aligned} \quad (1)$$

[10]These include Australia, Austria, Belgium, Canada, China, France, Germany, Indonesia, India, Italy, Japan, Malaysia, the Netherlands, Singapore, South Korea, Spain, Sweden, Switzerland, Thailand, the United Kingdom, and the United States.

[11]The empirical model, without the interaction term between changes in the home-country prudential measures and bank-level variables, is also estimated and results are reported in appendix 2 of Ho, Wong, and Tan (2016).

Table 2. Summary Statistics on Changes in Prudential Instruments

Instrument	No. of Country-Changes	No. of Country-Time Changes (Tightening)	No. of Country-Time Changes (Loosening)	No. of Bank-Time Time Changes	Proportion HomeP$_t$ Non-Zero
Prudential Index	173	136	37	594	0.171
General Capital Requirements	37	37	0	123	0.035
Sector-Specific Capital Buffer (Real Estate)	22	19	3	58	0.017
Sector-Specific Capital Buffer (Consumer)	3	2	1	8	0.002
Sector-Specific Capital Buffer (Other)	4	2	2	17	0.005
Loan-to-Value Ratio Limits	49	39	10	174	0.151
Reserve Requirements: Foreign Currency	10	7	3	30	0.009
Reserve Requirements: Local Currency	70	35	35	282	0.081
Interbank Exposure Limits	15	15	0	37	0.020
Concentration Ratios	13	13	0	41	0.017

Source: IBRN.
Notes: This table shows summary statistics on changes in the regulation on prudential instruments in home countries of banks located in Hong Kong over the period 2000–14. Data on the instruments come from the IBRN Prudential Instruments Database described by Cerutti et al. (2017) and are at a quarterly frequency. The table is based on the estimation sample. The table shows the total number of changes, i.e., tightening or loosening, for each instrument as well as the proportion of non-zero entries. All home countries of banks located in Hong Kong are included.

where $\Delta Y_{b,j,t}$ is the log change in total lending of the foreign bank b in Hong Kong whose parent bank is headquartered in country j at time t ($\Delta Loans_{b,j,t}$). $X_{b,j,t-1}$ is a vector of bank-level variables $\{IlliquidAssetsRatio_{b,j,t-1}, CoreDeposits_{b,j,t-1}, Tier1Ratio_{b,j,t-1}, LogRealAssets_{b,j,t-1}, NetDueTo_{b,j,t-1}\}$, which captures the degree to which a foreign bank b is exposed to changes in regulation in the home country j through ex ante balance sheet composition and market access, while $NetDueTo_{b,j,t-1}$ captures the FBA's dependence on net intragroup funding. $Z_{j,t}$ represents the business and financial cycle variables for country j, as compiled by the Bank for International Settlements (BIS).[12] The business cycle is defined as the output gap measured as a percentage of potential output, which is estimated by a Hodrick-Prescott filter on log real GDP, while the financial cycle is measured by the credit-to-GDP ratio gap. The prudential policy changes are captured by the variable *HomeP*.

The baseline model includes bank and time fixed effects, f_b and f_t respectively, with the latter capturing changes in loan demand conditions and host-country prudential measures that are common across banks in Hong Kong.[13] Since the regression model includes f_b and f_t, the estimated $\beta(= \beta_1 + \beta_2 + \beta_3)$ reflects the importance of cross-sectional differences in balance sheet characteristics on the response of $\Delta Y_{b,j,t}$ to changes in *HomeP*.

Table 3 reports the estimation result for equation (1) by types of prudential policy instruments. For brevity, the reported coefficients on the interaction terms (i.e., $X_{b,j,t-1}$ * *HomeP)* are the sum of the contemporaneous term and two lags (i.e., $\beta = \beta_1 + \beta_2 + \beta_3$). The interaction terms show how banks with different balance sheet characteristics adjust their FBA total lending in Hong Kong in response to regulatory changes imposed in the home country.

[12]For details on business cycle variables, see Drehmann, Borio, and Tsatsaronis (2011). For financial cycle variables, see BIS (2014).

[13]While the time-effect dummies capture the economy-wide loan demand that is common across banks in Hong Kong, these dummies may not fully absorb the country-specific component of the loan demand. Specifically, to the extent that the FBA's borrowers in Hong Kong have some ties to the home country of the foreign banks, it is possible that the country-specific component of the loan demand may be related to home-country regulatory changes. Therefore, business and financial cycle variables of the home countries of the foreign banks are included in the model to account for the country-specific component of the loan demand.

Table 3. Inward Transmission of Policy via Foreign Affiliates

	HomeP = Prudential IndexC (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (Real Estate) (3)	HomeP = LTV Ratio Cap (4)	HomeP = Reserve Requirements: Local Currency (5)
Dependent Variable	**Δ Total Loans**	**Δ Total Loans**	**Δ Total Loans**	**Δ Total Loans**	**Δ Total Loans**
HomeP_t	−11.366	−88.100***	70.453	27.768	−20.159
	(16.409)	(30.673)	(41.482)	(64.792)	(23.273)
HomeP_{t-1}	14.140	−83.178**	58.990**	62.640	60.498***
	(11.700)	(39.471)	(22.966)	(48.857)	(17.450)
HomeP_{t-2}	4.127	−74.328*	−142.404***	5.113	−25.471
	(18.792)	(43.065)	(29.890)	(29.145)	(19.002)
Log Total Assets_{t-1}	−0.635	−1.017	−0.313	5.979	−1.456
	(2.578)	(2.624)	(2.622)	(4.028)	(2.341)
Tier 1 Ratio_{t-1}	−0.104	−0.203	−0.013	−0.609	0.005
	(0.375)	(0.357)	(0.368)	(0.590)	(0.347)
Illiquid Assets Ratio_{t-1}	−0.066	−0.073	−0.064	0.041	0.056
	(0.066)	(0.069)	(0.066)	(0.070)	(0.065)
Core Deposits Ratio_{t-1}	0.022	0.009	0.025	0.285***	−0.006
	(0.119)	(0.111)	(0.123)	(0.071)	(0.105)
Foreign Affiliates Characteristics:					
Net Due To (Overseas Offices)$_{t-1}$	0.041*	0.029	0.028	−0.035	0.025
	(0.021)	(0.020)	(0.021)	(0.029)	(0.021)
Home-Country Cycles:					
BIS Financial Cycle (Home Country)$_t$	0.005	0.002	0.003	0.069	−0.008
	(0.063)	(0.052)	(0.064)	(0.040)	(0.056)
BIS Business Cycle (Home Country)$_t$	−0.051	0.050	0.158	0.112	0.047
	(0.243)	(0.272)	(0.260)	(0.246)	(0.250)

(*continued*)

Table 3. (Continued)

	HomeP = Prudential IndexC (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (Real Estate) (3)	HomeP = LTV Ratio Cap (4)	HomeP = Reserve Requirements: Local Currency (5)
Dependent Variable	**Δ Total Loans**	**Δ Total Loans**	**Δ Total Loans**	**Δ Total Loans**	**Δ Total Loans**
HomeP (Sum, F-test)	6.902	−245.606***	−12.960	95.522***	14.868
	(0.072)	(14.030)	(0.034)	(12.360)	(0.640)
	[0.792]	[0.001]	[0.857]	[0.006]	[0.433]
Log Total Assets*HomeP	−0.815	8.205***	−2.142	−5.047***	0.696
(Sum, F-test)	(1.655)	(11.700)	(0.294)	(15.550)	(1.134)
	[0.213]	[0.003]	[0.593]	[0.003]	[0.300]
Tier 1 Ratio*HomeP	0.792*	2.556*	2.100*	1.977**	−0.735
(Sum, F-test)	(3.523)	(3.923)	(3.549)	(5.227)	(2.110)
	[0.075]	[0.062]	[0.074]	[0.045]	[0.162]
Illiquid Assets Ratio*HomeP	0.054	0.448	0.503	−0.503***	0.291**
(Sum, F-test)	(0.099)	(1.581)	(1.780)	(14.330)	(4.635)
	[0.756]	[0.223]	[0.197]	[0.004]	[0.044]
Core Deposits Ratio*HomeP	−0.052	0.164	−0.186	0.347**	−0.601***
(Sum, F-test)	(0.258)	(0.833)	(0.166)	(6.740)	(37.070)
	[0.617]	[0.372]	[0.688]	[0.027]	[0.000]
Net Due To (Overseas Offices)*	−0.137*	−0.050	0.253	0.014	−0.094*
HomeP (Sum, F-test)	(3.942)	(0.161)	(2.029)	(0.068)	(3.339)
	[0.061]	[0.692]	[0.170]	[0.799]	[0.083]
Observations	3,302	3,302	3,302	1,039	3,302
Adjusted R^2	0.035	0.037	0.033	0.071	0.037
No. of Banks	70	70	70	30	70
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes

Notes: This table reports the effects of changes in regulation and bank characteristics and their interactions on log changes in total loans. The data are quarterly from 2000:Q1 to 2014:Q4. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. For HomeP interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding F-statistics and p-values for joint significance in parentheses and squared brackets, respectively. All specifications include time and bank fixed effects. Standard errors are clustered by home country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

We focus on the bottom panel of table 3, where the estimation results for the interaction terms between *HomeP* and the selected balance sheet characteristics are presented. The estimation results show that bank balance sheet characteristics do affect the inward spillover effects of *HomeP*. Specifically, we find that in response to tighter capital requirements (both for *CapitalReq* and *SSCB*), a bank with a higher tier 1 ratio tends to sustain higher loan growth of its affiliates in Hong Kong than that of other FBAs in Hong Kong (see row *Tier1Ratio*HomeP*).[14] This may reflect that tighter capital requirements may be less likely to produce a binding constraint on well-capitalized banks, and therefore their affiliates can register higher loan growth than the FBAs of less capitalized banks.

However, the significance of tier 1 ratio as a determinant of the inward spillover effects does not carry over for liquidity-related measures (see columns 5 and 6). Instead, we find that the liability structure of banks matters more in determining cross-sectional differences in lending by FBAs in Hong Kong. For *RRLocal*, we find that banks with a higher deposits ratio tend to reduce lending growth of their FBAs in Hong Kong by more than their peers (see row *CoreDepositsRatio*HomeP* in column 5). This probably reflects the notion that tighter reserve requirements tend to reduce the lending capacity more for banks with a higher deposits ratio.

The reliance on internal funding, as proxied by *NetDueTo*, is another important factor in determining the extent of the inward spillover effects for *RRLocal* (see row *NetDueTo*HomeP* for column 5). Specifically, FBAs that rely more on net intragroup funding (i.e., a high positive value of *NetDueTo*) are estimated to have lower loan growth than their peers in Hong Kong in response to a tighter *RRLocal*, suggesting that a bank's internal capital market is an important channel in transmitting inward spillover effects of liquidity-related *HomeP* internationally.

Finally, for *LTVCap* (see column 4), our findings suggest that both banks' capital adequacy and liquidity are important factors

[14]To reveal whether differences in loan responses are driven by home-country effects, we reestimate the baseline model and replace the bank fixed effects with home-country fixed effects as a robustness check. The results are broadly in line with those reported in table 3, suggesting that the significant differences in loan response arising from cross-sectional differences in a bank's capital adequacy position are not driven by home-specific effects. The estimation results are presented in appendix 3 of Ho, Wong, and Tan (2016).

affecting inward spillover effects. This result shows that banks with stronger balance sheet conditions (i.e., higher tier 1 ratio, lower illiquid assets ratio, and higher core deposits ratio) tend to have higher loan growth of affiliates in Hong Kong than their counterparts.

The above findings suggest that cross-sectional differences in the balance sheet composition of banks influence the international transmission of prudential policy.[15] To reveal whether the findings in table 3 are robust to alternative specifications, we reestimate the baseline model without bank fixed effects and find that the results are similar (table 4).[16] In table 4, the β coefficients capture absolute and cross-sectional differences in balance sheet composition.

In the final part of the baseline analysis, we conduct a simple exercise to assess the economic significance of differences in loan responses arising from cross-sectional differences in balance sheet characteristics based on the estimation results reported in table 3. First, we consider tier 1 capital ratio. The coefficient on the interaction between *CapitalReq* and tier 1 capital ratio (2.556, from the second column of the bottom panel of table 3) and the standard deviation of tier 1 ratio (2.74, percent from table 1) implies that an FBA moving its tier 1 ratio up by one standard deviation will increase total loan growth by 7.0 percent relative to its initial position. We repeat this exercise for all significant balance sheet characteristics for the four types of prudential policies and report the results in table 5, panel A. The economic magnitude of the differences in loan responses (in absolute terms) ranges from 3 percent to 12.3 percent.[17] In table 5, panel B, we present the economic significance of differences in loan responses by increasing the balance sheet variables from a position at the 25th percentile to the 75th percentile. These results suggest that the lending growth of FBAs in Hong Kong is quite sensitive to home prudential policies through the balance sheet of their banking organization.

[15]Recall that the baseline regression model includes both bank and time fixed effects. The coefficient on the interaction terms β therefore measures how the structure of banks' balance sheets affects the response of an FBA's lending to tighter prudential policies in the home country.

[16]The adjusted R^2 remain broadly similar after excluding bank fixed effects (i.e., table 4), suggesting that bank time-invariant fixed effects only have limited explanatory power for log changes in total loans.

[17]The former is for the difference in loan response to tighter reserve requirements due to *NetDueTo*, while the latter is for the difference in loan response to tighter reserve requirements due to *CoreDepositsRatio*.

Table 4. Inward Transmission of Policy via Foreign Affiliates, Excluding Bank Fixed Effects

	HomeP = Prudential IndexC (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (Real Estate) (3)	HomeP = LTV Ratio Cap (4)	HomeP = Reserve Requirements: Local Currency (5)
Dependent Variable	**Δ Total Loans**	**Δ Total Loans**	**Δ Total Loans**	**Δ Total Loans**	**Δ Total Loans**
HomeP_{t}	−4.871	−91.847***	72.447	33.048	−6.045
	(21.295)	(30.450)	(42.919)	(64.733)	(32.404)
HomeP_{t-1}	16.946	−88.384**	63.532**	67.868	57.764***
	(13.688)	(36.177)	(26.990)	(49.390)	(18.140)
HomeP_{t-2}	8.242	−74.390	−141.739***	4.203	−16.103
	(21.074)	(43.514)	(39.545)	(29.654)	(14.071)
Log Total Assets_{t-1}	0.128	−0.384*	−0.080	0.054	−0.044
	(0.202)	(0.209)	(0.236)	(0.638)	(0.191)
Tier 1 Ratio_{t-1}	0.052	−0.026	0.060	−0.203	0.074
	(0.243)	(0.241)	(0.235)	(0.413)	(0.218)
Illiquid Assets Ratio_{t-1}	−0.008	−0.023	−0.010	0.130	−0.011
	(0.034)	(0.039)	(0.036)	(0.091)	(0.035)
Core Deposits Ratio_{t-1}	0.039	0.024	0.031	0.075*	0.027
	(0.024)	(0.017)	(0.019)	(0.040)	(0.022)
Foreign Affiliates Characteristics:					
Net Due To (Overseas Offices)$_{t-1}$	0.012	0.004	0.002	−0.013	0.004
	(0.011)	(0.012)	(0.012)	(0.027)	(0.013)
Home-Country Cycles:					
BIS Financial Cycle (Home Country)$_{t}$	0.027	0.027	0.022	0.069	0.019
	(0.052)	(0.046)	(0.053)	(0.055)	(0.048)
BIS Business Cycle (Home Country)$_{t}$	−0.090	0.031	0.124	0.155	0.004
	(0.250)	(0.272)	(0.266)	(0.219)	(0.244)

(*continued*)

Table 4. (Continued)

	HomeP = Prudential IndexC (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (Real Estate) (3)	HomeP = LTV Ratio Cap (4)	HomeP = Reserve Requirements: Local Currency (5)
Dependent Variable	**Δ Total Loans**	**Δ Total Loans**	**Δ Total Loans**	**Δ Total Loans**	**Δ Total Loans**
HomeP (Sum, F-test)	20.317	−254.621***	−5.760	105.119***	35.616
	(0.254)	(16.010)	(0.004)	(16.070)	(1.196)
	[0.620]	[0.001]	[0.948]	[0.002]	[0.287]
Log Total Assets*HomeP	−0.994	8.645***	−1.533	−5.123***	0.407
(Sum, F-test)	(0.846)	(13.670)	(0.099)	(16.860)	(0.101)
	[0.369]	[0.001]	[0.757]	[0.002]	[0.754]
Tier 1 Ratio*HomeP	0.329	2.426*	1.796	1.951*	−1.103**
(Sum, F-test)	(0.305	(3.905)	(1.791)	(3.956)	(7.542)
	[0.587]	[0.062]	[0.196]	[0.075]	[0.012]
Illiquid Assets Ratio*HomeP	0.010	0.528	0.297	−0.575***	0.166
(Sum, F-test)	(0.002)	(1.770)	(0.557)	(22.720)	(0.728)
	[0.967]	[0.198]	[0.464]	[0.001]	[0.404]
Core Deposits Ratio*HomeP	−0.064	0.079	−0.139	0.319**	−0.605***
(Sum, F-test)	(0.273)	(0.162)	(0.075)	(5.555)	(22.610)
	[0.607]	[0.691]	[0.787]	[0.040]	[0.000]
Net Due To (Overseas Offices)*	−0.106	−0.048	0.229	0.020	−0.051
HomeP (Sum, F-test)	(1.967)	(0.159)	(1.441)	(0.088)	(0.495)
	[0.176]	[0.694]	[0.244]	[0.773]	[0.490]
Observations	3,302	3,302	3,302	1,039	3,302
Adjusted R^2	0.034	0.038	0.033	0.070	0.037
No. of Banks	70	70	70	30	70
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	No	No	No	No	No

Notes: This table reports the effects of changes in regulation and bank characteristics and their interactions on log changes in total loans. The data are quarterly from 2000:Q1 to 2014:Q4. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. For HomeP interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding F-statistics and p-values for joint significance in parentheses and squared brackets, respectively. All specifications include time and bank fixed effects. Standard errors are clustered by home country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 5. Differences in Loan Responses Arising from Cross-Sectional Difference in Balance Sheet Characteristics

	Capital Requirements	Sector-Specific Capital Buffer	Loan-to-Value Ratio Cap	Reserve Requirements on Local-Currency Deposits
A. One-Standard-Deviation Difference				
Tier 1 Ratio	7.0% (2.556*2.74%)	5.8% (2.100*2.74%)	5.4% (1.977*2.74%)	
Illiquid Assets Ratio			–6.4% (–0.503*12.73%)	3.7% (0.291*12.73%)
Core Deposits Ratio			7.1% (0.347*20.40%)	–12.3% (–0.601*20.40%)
Net Due to (Overseas Offices) Ratio				–3.0% (–0.094*32.21%)
B. Increasing from 25th Percentile to 75th Percentile				
Tier 1 Ratio	9.9% (2.556*3.86%)	8.1% (2.100*3.86%)	7.6% (1.977*3.86%)	
Illiquid Assets Ratio			–8.3% (–0.503*16.56%)	4.8% (0.291*16.56%)
Core Deposits Ratio			11.9% (0.347*34.21%)	–20.6% (–0.601*34.21%)
Net Due to (Overseas Offices) Ratio				–3.2% (–0.094*34.08%)

Notes: In both panels, the first figure in the parentheses denotes the estimated coefficient of the interaction term between the prudential policy and the bank balance sheet characteristics (see table 3). In panel A, the second figure refers to the standard deviation of the balance sheet characteristics being studied (see table 1). In panel B, the second figure refers to the difference of the balance sheet characteristics between the 75th and 25th percentile (defined as 75th percentile minus 25th percentile) being studied (see table 1).

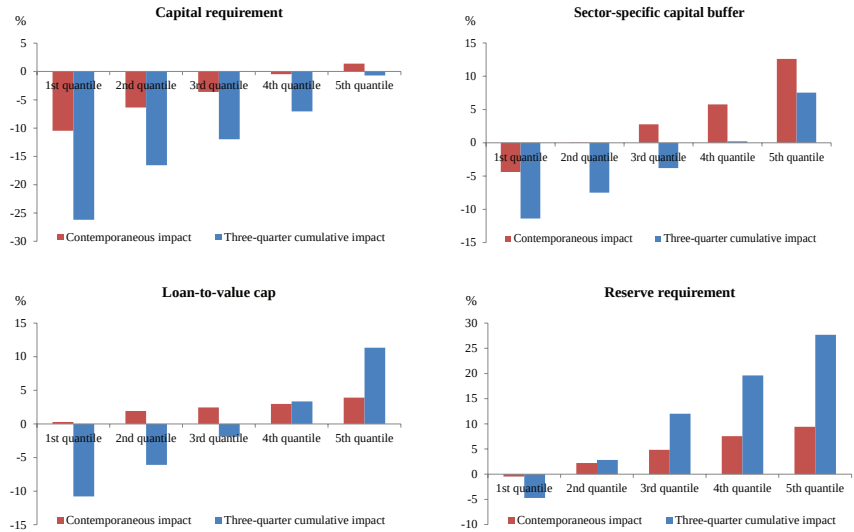
3.2 Economic Magnitude and the Pattern of Inward Spillover Effects

The significant impact of balance sheet characteristics on the loan responses of FBAs to home prudential policies, as identified in the previous section, together with the heterogeneous balance sheet structure among international banks poses an important question. What is the degree of diversity in the inward spillover effects among FBAs both in terms of the direction and size of their loan responses? Answering this question may help policymakers gauge the potential impact of inward spillover effects on loan supply in their banking sectors. To shed light on this issue, we analyze the distribution of loan responses among FBAs to different prudential measures. Our core interest is on whether FBAs would generally adjust their loans in the same direction in response to tighter home prudential policy. We are also interested in assessing the aggregate impact of FBAs' loan responses on total lending in the banking sector. All estimates in this section are based on the estimation results reported in table 4 (i.e., without bank fixed effects), as they capture both absolute and cross-sectional differences in loan responses.

Figure 2 presents the distribution of the estimated marginal effect of tighter home prudential policies on total loans of FBAs based on our estimation results. Recall that from equation (1), the marginal effect on the log change of total loans over quarter t, due to home-country regulatory changes over the three quarters, for each FBA can be obtained by summing the partial derivative of $\Delta Y_{b,j,t}$ with respect to contemporaneous *HomeP* and the two lags of *HomeP*, which is equal to $(\alpha_1+\alpha_2+\alpha_3)+(\beta_1+\beta_2+\beta_3)X_{b,j,t-1}$. Taking the sample mean of balance sheet characteristics of bank b (i.e., $\bar{X}_{b,j}$) together with the estimated coefficients $\hat{\alpha}$ and $\hat{\beta}$ gives an average estimated marginal effect of *HomeP* for bank b. To reveal a fuller picture, figure 2 shows the estimated impact of contemporaneous and three-quarter cumulative changes of home-country prudential measures.[18] The bars show the average loan responses by quantile (which

[18]The estimated contemporaneous impact of *HomeP* is calculated by the partial derivative of $\Delta Y_{b,j,t}$ with respect to the contemporaneous *HomeP* at time t, which is equal to $\hat{\alpha_1}+\hat{\beta}_1\bar{X}_{b,j}$.

Figure 2. Distributions of Inward Spillover Effects on Total Loans (by type of instrument)



are sorted by the estimated loan responses). Among the four prudential measures considered, only the overall capital requirements are estimated to generate a clear pattern of spillover effects: most FBAs in the sample reduce their loans in response to tighter overall capital requirements in the home country. One plausible explanation is that the overall capital requirements are a consolidated and non-sectoral specific measure such that the loan response of FBAs is consistent with the expected loan response of the whole banking organization (i.e., reducing loans). Affected banks may not have much room to mitigate the regulatory impact through rebalancing loan portfolios among entities within the banking organization (i.e., a "waterbed effect").[19] Consistent with the above conjecture, we find a mixed

[19]For *RRLocal*, the differences in loan response among FBAs may be attributable to the fact that the scope of application for reserve requirements varies across countries. For example, European bank branches located outside European Union member states are not subject to home reserve requirements. In this regard, banks may respond differently to the same tightening stance depending on whether the foreign banks in Hong Kong are subject to the reserve requirements imposed in their respective home country.

pattern of loan responses among FBAs to sector-specific prudential measures. Broadly speaking, our results suggest that half of FBAs in Hong Kong increase their loans in Hong Kong in response to a tighter *SSCB* and *LTVCap* in the home country, and the remaining half of FBAs reduce their loans.

One hypothesis that may account for the mixed pattern of loan responses to sector-specific prudential measures is that banks mitigate the regulatory impact by rebalancing their loans portfolio between and/or within bank affiliates. To test this hypothesis, we repeat our estimation exercise on log changes in mortgage loans, corporate loans, and consumer loans, respectively. The estimation results are reported in table 6. Based on the estimation results, we estimate the marginal impact on FBAs' mortgage, corporate, and consumer loan growth to tighter *SSCB* and *LTVCap*. The distribution of loan responses among FBAs is presented in figure 3, which generally supports the view that affected banks may try to partially offset the regulatory impact by redistributing their loan portfolio toward exposures that are not subject to or outside the scope of tighter prudential policies. Specifically, for *SSCB*, most of the affected banks are estimated to contract their mortgage and consumer loans while expanding their corporate loans. Likewise, it is found that most affected banks expand their mortgage loans in Hong Kong in response to lower LTV caps imposed in the home country, probably reflecting the fact that banks have strong incentives to maintain their portfolio mix by increasing mortgage loans in overseas markets.[20]

Finally, we assess the possible impact of inward spillover effects on the banking sector, by estimating the aggregate loan response among FBAs for different prudential policies. Table 7 reports both the aggregate marginal impacts of contemporaneous and three-quarter cumulative changes in home-country prudential measures on total loans of affected FBAs (as a percentage of the banking sector's loans). To calculate the aggregate marginal impact of *HomeP*, we compute the estimated change in a bank's loans by multiplying a

[20]The directional change in corporate and consumer loans is less clear in the case of *LTVCap*, which may partly reflect the possibility that some banks expand their mortgage loans at the expense of corporate and consumer loans.

Table 6. Inward Transmission of Policy via Foreign Affiliates (with mortgage, corporate, and consumer loan growth as dependent variables), Excluding Bank Fixed Effects

	HomeP = Sector-Specific Capital Buffer (Real Estate) (1)	HomeP = Sector-Specific Capital Buffer (Real Estate) (2)	HomeP = Sector-Specific Capital Buffer (Real Estate) (3)	HomeP = LTV Ratio Cap (4)	HomeP = LTV Ratio Cap (5)	HomeP = LTV Ratio Cap (6)
Dependent Variable	**Δ Mortgage Loans**	**Δ Corporate Loans**	**Δ Consumer Loans**	**Δ Mortgage Loans**	**Δ Corporate Loans**	**Δ Consumer Loans**
HomeP_t	566.680***	−133.746**	23.562	−95.157	41.610	−34.573
	(178.840)	(62.442)	(50.349)	(51.542)	(87.207)	(39.272)
HomeP_{t-1}	350.271**	211.343***	137.266***	67.217**	77.504	13.565
	(128.266)	(54.901)	(27.073)	(25.701)	(48.680)	(59.118)
HomeP_{t-2}	−16.806	−3.763	32.330	65.174**	−17.806	62.997
	(135.704)	(66.527)	(32.944)	(22.111)	(66.158)	(58.273)
Log Total Assets_{t-1}	1.011	0.202	0.965*	2.121**	−0.116	1.875**
	(0.830)	(0.435)	(0.505)	(0.659)	(0.784)	(0.660)
Tier 1 Ratio_{t-1}	0.269	−0.320	0.280	0.424	−0.418	0.502
	(0.299)	(0.447)	(0.303)	(0.408)	(0.607)	(0.313)
Illiquid Assets Ratio_{t-1}	−0.028	0.024	−0.081	0.045	0.002	0.185
	(0.076)	(0.063)	(0.060)	(0.114)	(0.137)	(0.139)
Core Deposits Ratio_{t-1}	0.057	0.048	0.168***	0.164**	0.061	0.269***
	(0.047)	(0.030)	(0.030)	(0.051)	(0.069)	(0.081)
Foreign Affiliates Characteristics:						
Net Due To (Overseas Offices)$_{t-1}$	0.017	0.010	−0.043	0.036*	−0.078	−0.034
	(0.017)	(0.020)	(0.034)	(0.017)	(0.045)	(0.076)
Home-Country Cycles:						
BIS Financial Cycle (Home Country)$_t$	0.024	0.007	0.051	0.039	0.015	0.115
	(0.069)	(0.030)	(0.043)	(0.088)	(0.059)	(0.065)
BIS Business Cycle (Home Country)$_t$	−0.201	0.188	−0.864	−0.260	−0.177	0.115
	(0.309)	(0.434)	(0.575)	(0.391)	(0.456)	(0.582)

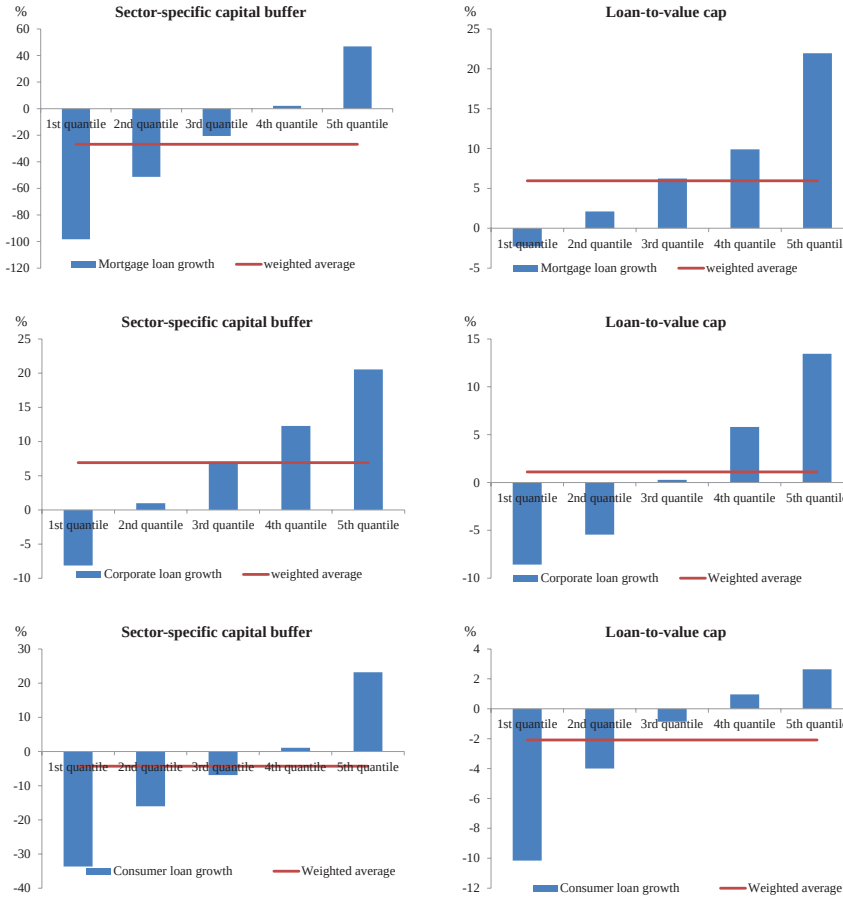
(*continued*)

Table 6. (Continued)

	HomeP = Sector-Specific Capital Buffer (Real Estate) (1)	HomeP = Sector-Specific Capital Buffer (Real Estate) (2)	HomeP = Sector-Specific Capital Buffer (Real Estate) (3)	HomeP = LTV Ratio Cap (4)	HomeP = LTV Ratio Cap (5)	HomeP = LTV Ratio Cap (6)
Dependent Variable	**Δ Mortgage Loans**	**Δ Corporate Loans**	**Δ Consumer Loans**	**Δ Mortgage Loans**	**Δ Corporate Loans**	**Δ Consumer Loans**
HomeP (Sum, F-test)	900.145**	73.835	193.157**	37.234	101.308**	41.989
	(7.144)	(0.199)	(6.056)	(0.311)	(6.015)	(0.420)
	[0.016]	[0.660]	[0.024]	[0.592]	[0.034]	[0.532]
Log Total Assets*	−30.252	1.118	−6.113	−0.981	−5.521***	−0.292
HomeP (Sum, F-test)	(2.685)	(0.019)	(2.608)	(0.111)	(11.140)	(0.014)
	[0.120]	[0.893]	[0.123]	[0.748]	[0.008]	[0.908]
Tier 1 Ratio*HomeP	0.227	−1.595	0.487	0.050	2.059	−1.100
(Sum, F-test)	(0.031)	(2.344)	(0.132)	(0.003)	(2.649)	(0.336)
	[0.863]	[0.141]	[0.721]	[0.961]	[0.135]	[0.575]
Illiquid Assets Ratio*	−3.090**	−1.224***	−1.111***	0.329	−0.468*	−0.539*
HomeP (Sum, F-test)	(5.787)	(18.120)	(11.930)	(0.652)	(3.888)	(3.693)
	[0.028]	[0.000]	[0.003]	[0.443]	[0.077]	[0.084]
Core Deposits Ratio*	−1.439	0.417	0.042	−0.566	0.358**	0.245
HomeP (Sum, F-test)	(1.201)	(0.511)	(0.053)	(1.238)	(7.117)	(0.335)
	[0.288]	[0.483]	[0.820]	[0.298]	[0.024]	[0.576]
Net Due To (Overseas	−0.252	0.165*	−0.659***	−0.011	0.285*	0.050
Offices)*HomeP	(1.070)	(3.281)	(10.620)	(0.062)	(3.290)	(0.049)
(Sum, F-test)	[0.315]	[0.085]	[0.004]	[0.809]	[0.100]	[0.830]
Observations	1,707	3,144	2,096	735	964	775
Adjusted R^2	0.028	0.027	0.016	0.026	0.053	0.029
No. of Banks	48	70	61	20	30	28
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	No	No	No	No	No	No

Notes: This table reports the effects of changes in regulation and bank characteristics and their interactions on log changes in total loans. The data are quarterly from 2000:Q1 to 2014:Q4. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. For HomeP interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding F-statistics and p-values for joint significance in parentheses and squared brackets, respectively. All specifications include time and bank fixed effects. Standard errors are clustered by home country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Figure 3. Distributions of Inward Spillover Effects on Mortgage, Corporate, and Consumer Loans to Tighter Sector-Specific Measures (*SSCB* and *LTVCap*)



bank's estimated marginal effect of *HomeP* by its total loans at the end of 2014. We then sum across the estimated change in loans of the affected FBAs and divide by the total amount of loans in the Hong Kong banking sector at the end of 2014. In computing the aggregate marginal impact of a prudential measure, we further assume that all countries which have adjusted prudential measures during the

Table 7. Estimated Marginal Impacts of Contemporaneous and Cumulative Changes in Home-Country Prudential Measures on the Loan Supply of Hong Kong Banking Sector

	Capital Requirements	**Sector-Specific Capital Buffer**	**LTV Cap**	**Reserve Requirements on Local-Currency Deposits**
Contemporaneous Change in Home-Country Prudential Measure	−0.5%	0.2%	0.6%	2.8%
Three-Quarter Cumulative Change in Home-Country Prudential Measure	−4.1%	−3.9%	−0.8%	6.2%

Note: This table shows changes in lending as a percentage of the banking sector's loans at the end of 2014.

estimation period simultaneously tighten the policy.[21] The size of the spillover effects is larger for the overall capital requirements and the reserve requirements on local-currency deposits. The impact of three-quarter cumulative changes in home-country prudential measures is equivalent to a 4.1 percent decline in total loans in Hong Kong for *CapitalReq* and a 6.2 percent increase in total loans for *RRLocal*. Conversely, the impact of sector-specific prudential measures is relatively small, which may be attributable to a significant portfolio rebalancing effect within FBAs.

4. Concluding Remarks

Using a confidential data set of FBAs in Hong Kong, our study finds evidence of an international transmission of prudential policy through banks' balance sheets. The set of balance sheet factors that influence the spillover transmission is found to vary according to the nature of the prudential measure (i.e., capital or liquidity related) considered. Specifically, a bank's tier 1 capital ratio affects the loan response of its FBAs in Hong Kong to tighter capital requirements in the home country, while a bank's core deposit share and its reliance on internal funding affects its loan response to tighter liquidity requirements. One implication is that, from a host supervisor's perspective, understanding the balance sheet structure of the banking organization of an FBA is important in assessing the international transmission of prudential policy.

From a host country's perspective, the spillover effects from prudential measures abroad on loan supply of the domestic banking sector may be the most important policy question. Our empirical findings show that the size of the spillover effects arising from changes in the overall capital requirements and reserve requirements is larger than the size of those for sector-specific measures. The relatively smaller spillover effects for sector-specific prudential measures can be partly explained by a significant portfolio rebalancing effect across and within affiliates of international banks, thus making the net impact on the host country less clear.

[21]This assumption provides a hypothetical scenario which is similar to an upper-bound estimate of the aggregate spillover effects on the Hong Kong banking sector.

References

Bank for International Settlements. 2014. "Debt and the Financial Cycle: Domestic and Global." In *84th Annual Report*, 65–84 (chapter IV). Basel, Switzerland: Bank for International Settlements.

Buch, C. M., and L. S. Goldberg. 2014. "International Banking and Liquidity Risk Transmission: Lessons from Across Countries." *IMF Economic Review* 63 (3): 377–410.

———. 2017. "Cross-Border Prudential Policy Spillovers: How Much? How Important? Evidence from the International Banking Research Network." *International Journal of Central Banking* 13 (S1).

Cerutti, E., R. Correa, E. Fiorentino, and E. Segalla. 2017. "Changes in Prudential Policy Instruments—A New Cross-Country Database." *International Journal of Central Banking* 13 (S1).

Cetorelli, N., and L. S. Goldberg. 2012a. "Follow the Money: Quantifying Domestic Effects of Foreign Bank Shocks in the Great Recession." *American Economic Review* 102 (3): 213–18.

———. 2012b. "Liquidity Management of U.S. Global Banks: Internal Capital Markets in the Great Recession." *Journal of International Economics* 88 (2): 299–311.

Cornett, M. M., J. J. McNutt, P. E. Strahan, and H. Tehranian. 2011. "Liquidity Risk Management and Credit Supply in the Financial Crisis." *Journal of Financial Economics* 101 (2): 297–312.

Drehmann, M., C. Borio, and K. Tsatsaronis. 2011. "Anchoring Countercyclical Capital Buffers: The Role of Credit Aggregates." *International Journal of Central Banking* 7 (4): 189–240.

Ho, K., E. Wong, and E. Tan. 2016. "International Banking and Cross-border Effects of Regulation: Lessons from Hong Kong." HKIMR Working Paper No. 12/2016.

International Banking and Cross-Border Effects of Regulation: Lessons from Italy*

Marianna Caccavaio, Luisa Carpinelli, and Giuseppe Marinelli
Banca d'Italia

In this paper we study how foreign lending by Italian banks adjust to prudential policy changes of destination markets over the period 2000–14. We find a positive prudential spillover effect: Italian banks tend to lend more to countries that tighten a prudential measure. The impact is not very large nevertheless, and it is driven by cross-border lending and lending by hosted branches that are not directly affected by the changes in regulations. This evidence highlights the need for international cooperation among authorities.

JEL Codes: G20, G21.

1. Introduction

The aim of this paper is to assess how and to what extent the regulatory changes that have interested the prudential environment of the countries to which Italian banks are exposed might have affected the growth rate of lending to foreign residents. We do so by examining the lending of Italian banks over the period 2000–14. The analysis of this topic is particularly insightful for policymaking activity in a supranational environment, in which issues like cross-country prudential spillovers must be taken into account when assessing the effectiveness and outcomes of new measures.

There is the possibility that the non-synchronized introduction of regulatory rules in economies that are financially linked might induce a different behavior in the intermediaries that are headquartered in such countries. Following Buch and Goldberg (2017), we refer to

*Author e-mails: marianna.caccavaio@bancaditalia.it, luisa.carpinelli@bancaditalia.it, giuseppe.marinelli@bancaditalia.it.

spillover-type mechanisms as the consequences that regulations in one market might have on other markets or other institutions. This behavior does not necessarily reflect regulatory arbitrage or policy leakages. Specifically, in our paper we look at how Italian banks adjust credit in response to variations in the prudential settings of foreign markets to which they are exposed. We find a positive prudential spillover effect: lending tends to increase to markets where prudential instruments are tightened.

This impact is not necessarily detrimental to the original purpose behind the tightening of rules. If a stricter regulation is introduced within a prudential framework, with the aim to reduce credit growth in relation to GDP so as to preserve financial stability, then the effect of regulatory spillover can defeat the original objective of regulation. On the other hand, if a tighter regulation is driven by other reasons, regulatory spillover might also have some beneficial effect, in that the presence of foreign banks, sustaining credit to the nonfinancial sector, mitigates the negative impact that more severe rules might have on credit supply by domestic banks, at least in the short run.[1]

The research question is particularly important, from a policy perspective, because the presence of international spillovers of regulation warrants coordination of policies, as pointed out by Visco (2011) and Panetta (2013). A potential case for spillover occurs when prudential policy measures introduced in one country propel imbalances elsewhere in the system, by modifying the flow of credit toward countries other than the one where the regulatory change has occurred. The existence of such spillovers calls for cooperation among authorities, which in turn needs to be grounded in sound empirical analysis of their nature.

We choose to concentrate on outward lending by Italian banks, as we deem outward transmission to be particularly sensible in the Italian case for a number of reasons. First, although a large part of

[1]To fully assess the degree to which the spillover mechanism can weaken the regulatory purpose or, alternatively, mitigate its negative effects, one would need to examine the behavior of foreign banks jointly with the response of local banks to the introduction of the rule. Unfortunately, since we do not have information on loans by domestic banks of destination countries, we are only partially addressing this question and we cannot draw any conclusion on substitutability.

outward credit flows is directed toward EU destinations, cross-country heterogeneity in the destination markets of Italian banks is still quite large, and it is certainly more diversified than the variety of the headquarters' countries of foreign intermediaries operating in Italy. To our knowledge, from a methodological point of view, foreign regulatory tools have not yet been mapped to the presence of Italian banks in each of these markets. Second, it is more meaningful to examine the regulatory frameworks of foreign countries and the outward transmission, given that the Italian regulatory setting varied very little over the period of our analysis. The few relevant measures introduced basically consisted of a tightening of capital requirements and were undertaken mainly after the financial crisis of 2007–08 to address existing risks. The impact of capital requirements on bank lending and real activity is still an open issue (see De Nicolo 2015 for details) and there is no empirical evidence based on Italian data. More significant effects might emerge in the near future with the Basel III full implementation in the European Union through the Capital Requirements Directive IV (CRD IV) and the Capital Requirements Regulation (CRR).

This paper sheds some light on these phenomena. It illustrates how Italian banks have modified their loan growth rates not only based on the destination countries' business cycle but also, though to a lesser degree, depending on the tightness of their regulatory environment. In particular, lending by Italian banks responds positively to tighter rules in the destination markets; the effect is not very large economically, and it is driven by direct cross-border lending and lending by foreign branches. The paper then shows that, on the contrary, Italian banks did not adjust their loan quantities to a specific country depending on the average regulatory stance of the third countries to which they are exposed, thus highlighting the absence of spillover effects across different sets of regulatory stances. Furthermore, we explore the main result more in depth, by examining whether the main finding is common to both banks with foreign subsidiaries and banks that lend to foreign residents through cross-border lending and branches. We find that the two types of international banks adjust their lending to different sets of regulatory instruments. Finally, we also look separately at loans to households and loans to non-financial corporations and find some heterogeneity in their response to regulation.

2. Data

We use data coming from a variety of sources for a period that spans from the first quarter of 2000 to the end of 2014. A first set of data are obtained from statistical and supervisory reports and are relative to banks' balance sheet statistics. A second part of the data set comes from a cross-country database on a set of prudential policy indicators (Cerutti et al. 2017). Country-level measures of economic and financial activity, such as the output gap and the credit-to-GDP ratio, were provided by the Bank for International Settlements (BIS).

2.1 Bank-Level Data

Bank-level statistics are collected from the statistical and supervisory reports that all the banks resident in Italy must transmit to the Bank of Italy. Data for banking groups are taken from the consolidated statistics, while data on stand-alone intermediaries come from the individual reports. We use information at the consolidated level for banking groups (or aggregate information at the banking group level, where only individual information is available) since lending policies are typically decided at the banking group level. The perimeter of consolidated data includes branches and subsidiaries abroad, which could turn out to be problematic in the econometric identification, as branches are in principle subject to the home-country supervision/regulation, whereas subsidiaries are subject to the supervisory and regulatory authority of the host country. The richness of the data set allows us to distinguish lending extended by these two distinct components of the banking groups, which are likely to display different behavior.

2.1.1 Dependent Variables

The baseline dependent variable is the quarterly change in the logarithm of loans to the private non-financial sector broken down by destination country. Moreover, we are able to identify the borrower sector (households and non-financial corporations) and the banking group component which actually extends the loans (the parent bank or one of the domestic banks of the group, the branches, or

the subsidiaries abroad). Our dependent variables therefore are as follows:

- $\Delta Y_{b,j,t}$, the change in the logarithm of loans extended by bank b during quarter t in destination country j
- $\Delta Y^{HH}_{b,j,t}$, the change in the logarithm of loans extended by bank b to households (HHs) during quarter t in destination country j
- $\Delta Y^{NFC}_{b,j,t}$, the change in the logarithm of loans extended by bank b to non-financial corporations (NFCs) during quarter t in destination country j
- $\Delta Y^{PB}_{b,j,t}$, the change in the logarithm of loans extended by the parent bank b and its branches abroad during quarter t in destination country j
- $\Delta Y^{SU}_{b,j,t}$, the change in the logarithm of loans extended by the subsidiaries of bank b during quarter t in destination country j

2.1.2 Balance Sheet Characteristics

The regression specifications include several bank balance sheet characteristics, which are used as control variables and as a measure of possible differential effects of regulation based on bank heterogeneity. All variables are lagged by one period to avoid simultaneity problems. They are as follows:

- The ratio of illiquid assets to total assets ($IlliquidAsset\ Ratio_{b,t-1}$)
- The ratio of deposits placed by households (HHs) and non-financial corporations (NFCs) to total liabilities ($Core\ Deposits_{b,t-1}$)
- The banking organization's ratio of capital to total assets ($CapitalRatio_{b,t-1}$)
- The log of real total assets ($LogRealAssets_{b,t-1}$)
- The ratio of foreign assets plus foreign liabilities relative to total assets plus total liabilities ($InternationalRatio_{b,t-1}$)

Table 7 in the appendix provides further details on how variables are obtained and on other methodological aspects.

Our analysis focuses on international banks. Under such label we include intermediaries characterized by the presence of affiliates

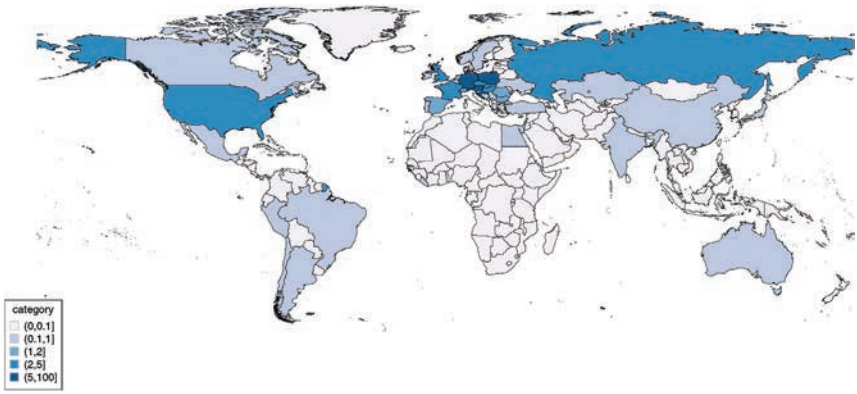
abroad (branches or subsidiaries) and intermediaries that, albeit not having foreign affiliates, hold a share of claims toward foreign countries of at least 2 percent. As illustrated by Caccavaio et al. (2015), international banks (with or without affiliates) are characterized by larger assets, a lower proportion of liquid assets, and a more diversified portfolio of loans and securities with respect to domestic banks. International banks tend to be less capitalized than domestic banks; a significant part of their funding consists of stable deposits placed by households and non-financial corporations (more than 40 percent), but they still rely on the wholesale interbank markets and on intragroup funding more than domestic intermediaries. The proportion of illiquid assets is slightly larger than that of domestic banks.

As already mentioned, in the most recent years about one-fifth of loans of Italian banks has been extended to foreign counterparties. Italian banking groups include several branches and subsidiaries, as several acquisitions of foreign banking groups took place since 2006–07. Prior to that, in the first part of the sample period (2000–06), the average proportion of loans to non-residents was smaller, around 8 percent. Subsidiaries in the first phase (2000–06) predominantly lent to households. They are now the main source of loans for both households and firms: over the period 2007–14, subsidiaries represented 85 percent of total lending to foreign non-financial corporations, and over 97 percent of lending to foreign households.

Italian banking groups mostly lend to European (85 percent) and North American (6 percent) borrowers. Aside from these areas, country shares are negligible (up to 0.1 percent) or smaller than 1 percent, as shown in figure 1, which displays average loan shares by destination country during our period of reference. In Europe, as shown in figure 2, the largest loan shares are directed to Germany, Austria, Poland, and Croatia, which all represent more than 5 percent of loans to foreign residents. Smaller but still significant shares can be found in France, United Kingdom, Russia, the Czech Republic, Slovakia, and Hungary.

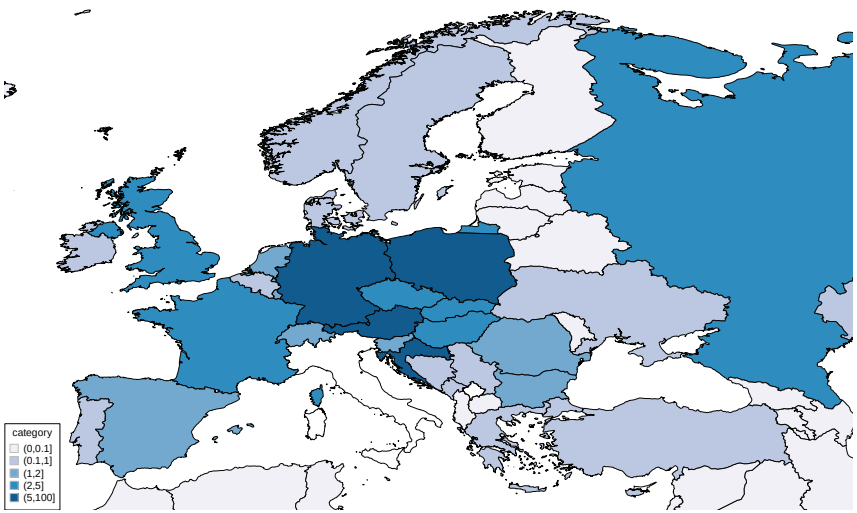
Table 1 reports a few descriptive statistics of the variables used in our regressions. The dependent variable, loans extended by bank b at time t to destination country j, on average slightly decreased in our sample period. The breakdown by counterparty sector shows that the non-financial corporations component is responsible for the

Figure 1. Loan Shares by Destination Country in the World



Notes: The figure represents the average loan shares by destination country of Italian international banks in the sample period (2000–14). The shares are calculated as the percentage ratio of the sum of loans over time in a specific country over the total sum of loans to foreign counterparties over time. A comprehensive description of the variables can be found in table 7 in the appendix.

Figure 2. Loan Shares by Destination Country in Europe



Notes: The figure represents the average loan shares by destination country of Italian international banks in the sample period (2000–14). The shares are calculated as the percentage ratio of the sum of loans over time in a specific country over the total sum of loans to foreign counterparties over time. A comprehensive description of the variables can be found in table 7 in the appendix.

Table 1. Summary Statistics on Bank Lending and Characteristics

Variable	All Banks (N = 61)			Banks without Foreign Affiliates (N = 44)			Banks with Foreign Affiliates (N = 17)		
	Mean	**Median**	**SD**	**Mean**	**Median**	**SD**	**Mean**	**Median**	**SD**
A. Balance Sheet Data									
Dependent Variables:									
Δ logLoans	−0.2	−0.3	25.0	0.7	0.0	20.1	−0.3	−0.4	25.9
of which:									
Δ logLoansHH	1.0	−0.3	24.3	0.6	0.0	20.4	1.0	−0.4	25.0
Δ logLoansNFC	−1.1	−0.0	24.2	1.6	0.7	16.7	−1.5	−0.3	25.2
Δ logLoansPB	−0.3	−0.3	25.2	0.7	0.0	20.1	−0.5	−0.6	26.1
Δ logLoansSU	−0.6	−0.2	25.6	—	—	—	−0.6	−0.2	25.6
Independent Variables:									
Capital Ratio	12.1	8.8	11.1	13.4	8.9	13.2	10.3	8.7	6.6
Core Deposits	45.5	46.7	17.3	49.8	54.4	17.8	39.9	40.0	14.8
International Ratio	6.5	4.0	8.1	4.3	2.8	5.9	9.5	6.5	9.6
Illiquid Assets Ratio	88.3	91.0	10.2	87.2	90.0	11.0	89.8	91.7	8.7
Log Real Assets	8.1	8.1	2.4	6.7	7.1	1.7	9.9	10.1	1.9
B. Other Data									
Financial Cycle	1.7	2.3	16.5						
Business Cycle	0.0	−0.1	2.3						
Consumer Price Index	99.57	98.78	4.57						

Notes: The table provides summary statistics for bank balance sheet and lending data. Data have a quarterly frequency from 2000:Q1 to 2014:Q4. Banking data come from consolidated reports in the case of banking groups and from individual reports in the case of banks not belonging to banking groups. Banks are considered to have a foreign affiliate if they report claims for branches or subsidiaries located in foreign countries. Loans are broken down by counterparty sector (households and non-financial corporations) and by banking group component (parent bank and its branches and subsidiaries abroad). The independent variables, except for *LogRealAssets,* are reported in percentage values. Panel B reports other data on economy-wide variables (financial and business cycle indicators) and the Italian consumer price index which was used to deflate the outstanding amounts of loans. A detailed description of the variables, the derivation methodologies, and the data sources are reported in table 7 in the appendix.

decrease of loans extended by international banks. The different growth patterns of loans to households and to non-financial corporations may suggest heterogeneity in the response of banks depending on the composition of their portfolios and on the nature of the prudential policy instrument.

2.2 Data on Prudential Instruments

Data on prudential instruments, drawn from the International Banking Research Network (IBRN) Prudential Instruments Database described in Cerutti et al. (2017), are available for more than sixty countries over the period 2000–14. Each indicator is expressed in terms of change over the previous quarter; a zero value means an unchanged prudential policy relative to the past, a positive value represents a tightening, and a negative value represents a loosening. The prudential policy instruments include capital requirements, sector-specific capital ratios, loan-to-value ratios, reserve requirements for local and foreign currencies, interbank exposure limits, and concentration ratios. An aggregated prudential policy index is calculated as the sum of all the available indexes in terms of change and of cumulative change over time. Such indicators are employed to capture the response of bank loans to changes in the destination countries' regulations ($DestP_{j,t}$). Tables 2 and 3 provide some key statistics about the above-mentioned indexes for destinations of Italian banking groups. The instruments that have been activated more frequently in the sample period are the reserve requirements on local and foreign currencies, capital ratios, loan-to-value ratios, and sector-specific capital buffers overall, whereas concentration ratios and interbank exposure limits have been used less frequently. Most of the changes in the prudential policy instruments were in the form of a tightening. Unfortunately, the information on certain instruments is missing for some combinations of bank-country-year of our sample, thus reducing the number of observations.

The impact of changes in the regulation of third countries is captured with a second measure, namely the foreign-exposure-weighted regulation index ($ExpP_{b,j,t}$). This is derived for each bank b and destination country j through a weighted mean of the prudential regulation indexes $P_{i,t}$ in all the countries other than the home and destination ones. The weights $\phi_{b,i,t}$ at time t are the shares $e_{b,i,s}$ of

Table 2. Outward Transmission of Policy to Destination Country

Instrument	Policy Changes in Destination Country				
	No. of Country-Time Changes	**No. of Country-Time Changes (Tightening)**	**No. of Country-Time Changes (Loosening)**	**No. of Bank-Country-Time Changes**	**Proportion of Non-zero MPP**
Prudential Index	549	365	184	10,457	19.1
Capital Ratios	100	100	0	2,282	3.0
Sector-Specific Capital Ratios	69	51	18	1,345	2.1
Loan-to-Value Ratios	94	69	25	1,813	8.0
Reserve Requirements: Foreign Currencies	135	85	50	2,045	4.1
Reserve Requirements: Local Currency	274	116	158	4,850	8.7
Interbank Exposure Limits	24	23	1	794	2.2
Concentration Ratios	32	30	2	723	1.7

Notes: This table provides summary statistics on changes in prudential instruments for Italian banking groups over the period 2000–14. Quarterly data on the prudential policy changes broken down by instrument type come from the IBRN Prudential Instruments Database described in Cerutti et al. (2017). The prudential index at time t is calculated as the sum of the changes of all the instruments at time t.

Table 3. Outward Transmission of Policy to Destination Country via Third-Country Exposures

Instrument	Base Data (Before Aggregating to Exposure-Weighted Measures)					Exposure-Weighted Observations
	No. of Country-Time Changes	No. of Country-Time Changes (Tightening)	No. of Country-Time Changes (Loosening)	Proportion of Non-zero MPP	No. of Bank-Country-Time Changes	Proportion of Non-zero MPP
Prudential Index	549	365	184	19.1	10,457	15.0
Capital Ratios	100	100	0	3.0	2,282	2.9
Sector-Specific Capital Ratios	69	51	18	2.1	1,345	1.7
Loan-to-Value Ratios	94	69	25	8.0	1,813	7.6
Reserve Requirements: Foreign Currencies	135	85	50	4.1	2,045	2.6
Reserve Requirements: Local Currency	274	116	158	8.7	4,850	6.4
Interbank Exposure Limits	24	23	1	2.2	794	2.5
Concentration Ratios	32	30	2	1.7	723	1.6

Notes: This table provides summary statistics on changes in prudential instruments for Italian banking groups over the period 2000–14. Quarterly data on the prudential policy changes broken down by instrument type come from the IBRN Prudential Instruments Database described in Cerutti et al. (2017). Tightening (+1) refers to, e.g., an increase in capital or reserve requirements or a reduction in exposure limits; these changes make regulation more binding. Moves in the other direction are loosening (–1). The prudential index at time t is calculated as the sum of the changes of all the instruments at time t.

total exposure of bank b to each country except j, as given by over the four preceding quarters s. Thus the exposure-weighted regulation index is represented by

$$ExpP_{b,j,t} = \sum_{i \neq j} P_{i,t} \cdot \phi_{b,i,t-1}$$

$$\phi_{b,i,t-1} = \frac{\sum_{s=t-4}^{t-1} e_{b,i,s}}{\sum_{i \neq j} \sum_{s=t-4}^{t-1} e_{b,i,s}},$$

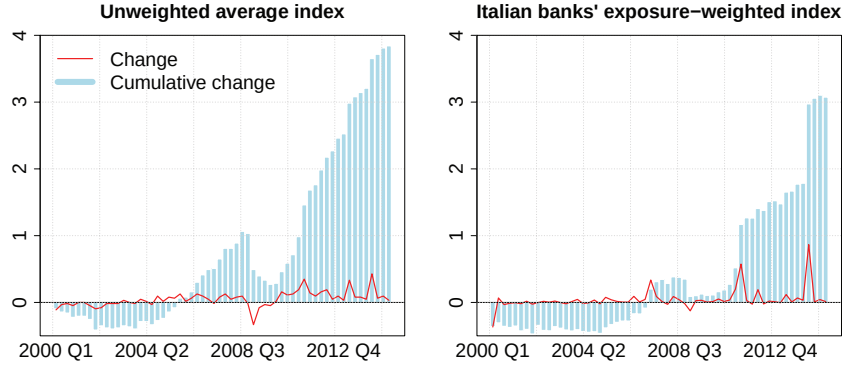
where exposures $e_{b,i,s}$ are calculated as the sum of loans, holdings of securities, deposit liabilities, and other debts, as described in table 7 in the appendix. Figure 3 shows the developments of prudential policy indexes in terms of unweighted average for the full sample of countries in the database (graph on the left) and in terms of Italian banks' exposure-weighted mean (graph on the right). While the former is calculated as a simple mean of the prudential indexes across countries over time, the latter takes into account the relative importance of the exposure to each country for Italian banks. The comparison of the two indexes suggests that the general index moved more steadily, thereby reaching higher values in cumulative terms with respect to the Italian banks' exposure-weighted index. This is mostly explained by the larger exposures of Italian banks toward European countries versus the rest of the world. The largest prudential policy changes occurred in the emerging economies, namely China and India, which have a relatively small weight in Italian banks' portfolios.

3. Empirical Method and Regression Results

3.1 Baseline Analysis of the Outward Transmission of Prudential Policies

We now proceed with the empirical analysis of the effect of changes in regulation on banks' lending growth, following the approach described in Buch and Goldberg (2017). As mentioned above, our interest is in assessing if and to what extent changes in lending to foreign residents respond to changes in prudential policies in destination markets. We begin by estimating the following equation:

Figure 3. Prudential Policy Indexes



Source: Authors' calculations on Cerutti et al. (2017) and Bank of Italy data.
Notes: The graph on the left represents the simple mean of prudential policy changes and cumulative changes for the full sample of countries in the IBRN Prudential Instruments Database described in Cerutti et al. (2017). The graph on the right represents Italian banks' exposure-weighted index of prudential policy changes and cumulative changes, with exposures being calculated as the sum of loans, holdings of securities, deposit liabilities, and other debts. Further details and a comprehensive description of the variables can be found in table 7 in the appendix.

$$\Delta Y_{b,j,t} = \alpha_0 + (\alpha_1 * DestP_{j,t} + \alpha_2 * DestP_{j,t-1} + \alpha_3 * DestP_{j,t-2}) + \alpha_4 * X_{b,t-1} + \alpha_5 * Z_{j,t} + f_j + f_t + f_b + \epsilon_{b,j,t}, \quad (1)$$

where $\Delta Y_{b,j,t}$ is the log change in lending of bank b toward country j at time t, $X_{b,t-1}$ is a vector of bank balance sheet variables that proxy for the degree to which a bank is exposed to changes in regulation, and $Z_{j,t}$ is the vector of financial and business cycle indicators in country j represented by the credit-to-GDP ratio and the output gap. The prudential policy changes are captured by $DestP_j$, the prudential policy measures adopted in country j to which the loan is directed. f_j, f_t, and f_b are, respectively, country, time, and bank fixed effects. The inclusion of a measure of business cycle and time-invariant country fixed effects allows to control for demand effects.

Estimates of this specification, which we consider the baseline model, are shown in table 4, where we report the cumulative effects

Table 4. Outward Transmission of Destination-Country Regulation Policy—Baseline

	Prudential IndexC (1)	Capital Requirement (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Requirements: Foreign (5)	Reserve Requirements: Local (6)	Interbank Exposure Limits (7)	Concentration Ratios (8)
Destination-Country Regulation	1.112***	−2.281	2.612*	−0.574	1.736**	2.754***	1.437	−1.531
	(0.058)	(2.026)	(2.960)	(0.058)	(5.726)	(16.673)	(0.215)	(0.699)
Log Total Assets$_{t-1}$	−0.017**	−0.016**	−0.017**	−0.018	−0.016**	−0.017**	−0.011	−0.008
	(0.008)	(0.008)	(0.008)	(0.021)	(0.008)	(0.008)	(0.011)	(0.009)
Tier 1 Ratio$_{t-1}$	0.061	0.062	0.061	0.012	0.062	0.060	0.126	0.057
	(0.097)	(0.096)	(0.097)	(0.208)	(0.096)	(0.097)	(0.108)	(0.144)
Illiquid Assets Ratio$_{t-1}$	−0.199***	−0.200***	−0.199***	−0.173	−0.199***	−0.199***	−0.249***	−0.159**
	(0.056)	(0.057)	(0.056)	(0.111)	(0.056)	(0.056)	(0.074)	(0.068)
International Activity$_{t-1}$	−0.064	−0.065	−0.063	−0.091	−0.065	−0.064	−0.042	−0.083
	(0.056)	(0.056)	(0.056)	(0.065)	(0.056)	(0.056)	(0.079)	(0.070)
Core Deposits Ratio$_{t-1}$	0.012	0.013	0.012	0.014	0.012	0.012	0.073**	0.022
	(0.028)	(0.028)	(0.028)	(0.063)	(0.028)	(0.028)	(0.035)	(0.033)
Financial Cycle (Destination Country)	0.003	0.004	0.003	−0.000	0.004	0.003	0.003	0.023
	(0.014)	(0.015)	(0.015)	(0.019)	(0.015)	(0.015)	(0.032)	(0.018)
Business Cycle (Destination Country)	0.199*	0.217**	0.205**	0.368	0.206*	0.210**	0.451***	0.278***
	(0.103)	(0.103)	(0.102)	(0.225)	(0.104)	(0.103)	(0.150)	(0.103)
Observations	28,273	28,273	28,273	8,575	28,273	28,273	11,981	16,495
R^2	0.019	0.019	0.019	0.031	0.019	0.019	0.028	0.027
Adjusted R^2	0.0132	0.0131	0.0131	0.0153	0.0131	0.0134	0.0168	0.0177
No. of Destination Countries	52	52	52	30	52	52	18	29
No. of Banks	61	61	61	48	61	61	61	60

Notes: This table reports the effects of changes in destination-country regulation and firm characteristics on log changes in total loans by destination country. The dara are quarterly from 2000:Q1 to 2014:Q4 for a panel of Italian bank holding companies that have cross-border claims greater than 2 percent of assets. Destination-country regulation refers to the changes in regulation in the destination country of the loan. For destination-country regulation, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding F-statistics for significance in parentheses. For more details on the variables, see table 7 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include bank, time, and destination-country fixed effects. Standard errors are clustered by bank. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

of the prudential measures ($\alpha_1+\alpha_2+\alpha_3$) over the three periods.[2] We notice that, overall, larger and more illiquid banks tend to increase lending to foreign counterparties at a lower growth rate. Also, lending growth consistently responds to economic activity of the destination country: loans increase (decrease) more toward those countries that are experiencing an expansionary (contractionary) phase of the business cycle.

Then, moving to the prudential variables that are the core of our analysis, we observe that Italian banks increase lending to countries with an overall tighter regulation, as shown by the sign of the aggregated prudential index of column 1. The impact is statistically significant and sizable: a unit variation in the prudential instrument determines a positive readjustment in loans of 1.1 percent. The economic effect is non-negligible but not very large: it corresponds to 4.5 percent of the standard deviation of loans. Such result shows that foreign banks modify their lending policy based on the differences of the regulatory regimes of destination and home countries. Also, the finding has relevant policy implication, as it shows a potential beneficial effect associated with the presence of foreign intermediaries in an environment where regulation is tightened. In case such regulatory change induces a negative credit supply shock for domestic banks, foreign intermediaries seem to be able to step in and offset the decline in loans to local borrowers.

Looking at the specific regulatory measures, lending growth is higher toward destinations that have stricter sector-specific capital buffers (column 3), higher reserve requirements in foreign currency (column 5), and higher reserve requirements in local currency (column 6). We will give a more specific interpretation of the impact of the single measures by looking at the breakdown between different types of international banks in section 3.3. Our baseline estimation was repeated on the subset of observations for the years following 2006, which is when major acquisitions of foreign banks by Italian groups took place, thereby shaping the current

[2]For robustness purposes we also ran weighted regressions with banks' size (logarithm of total assets) as weights so as to take into account the magnitude of the behavior of each bank within our sample. Additionally, we winsorize bank characteristics variables at the 1st and 99th percentiles. In both cases all the results hold.

organization of Italian intermediaries abroad. All results hold in this subperiod.

In order to explore these findings more in depth, we expand our baseline model of table 4 in different directions.

3.2 Third-Country Exposure

First, we examine outward transmission toward the given country j also taking into account what happens in the regulatory framework of all the other countries to which the bank is lending, weighted by the size of its exposure to each one of these countries. The specification is then

$$\begin{aligned}\Delta Y_{b,j,t} = \alpha_0 &+ (\alpha_1 * DestP_{j,t} + \alpha_2 * DestP_{j,t-1} + \alpha_3 * DestP_{j,t-2}) \\ &+ \alpha_4 * X_{b,t-1} + \alpha_5 * Z_{j,t} \\ &+ (\beta_1 * ExpP_{j,t} + \beta_2 * ExpP_{j,t-1} + \beta_3 * ExpP_{j,t-2}) \\ &+ f_j + f_t + f_b + \epsilon_{b,j,t}, \end{aligned} \tag{2}$$

where $ExpP_{j,t}$ is the measure of exposure-weighted prudential policy of bank b toward all the countries it lends to except country j, at time t. Estimates of this specification are shown in table 5, where we report the cumulative effects for $\alpha_1+\alpha_2+\alpha_3$ and $\beta_1+\beta_2+\beta_3$. It can be argued that third-country changes in prudential regulation basically leave lending growth unaffected, whereas destination-country regulation shifts consistently affect lending growth as in the baseline. This provides evidence of absence of regulatory spillovers between the different destination countries of financial intermediaries.

3.3 Exploration of Heterogeneity by Type of Internationalization and by Borrowing Sector

Second, we rerun the baseline equation *jointly* to include the main regulatory measures of destination countries, so as to address our main question and, at the same time, to take into account cross-correlation between the different prudential indicators. Now $DestP_j$ of equation (1) is a *matrix* of the prudential policy measures adopted in country j to which the loan is directed. Results are shown in table 6.

Table 5. Outward Transmission of Destination-Country Regulation Policy and Third-Country Exposure-Weighted Policy

	Prudential IndexC (1)	Capital Requirement (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Requirements: Foreign (5)	Reserve Requirements: Local (6)	Interbank Exposure Limits (7)	Concentration Ratios (8)
Destination-Country Regulation	1.12***	−2.275	2.658*	−0.488	1.802**	2.783***	1.202	−1.484
	(9.648)	(2.037)	(3.120)	(0.042)	(6.133)	(17.209)	(0.153)	(0.639)
Log Total Assets$_{t-1}$	−0.016**	−0.016**	−0.017**	−0.021	−0.014*	−0.016**	−0.010	−0.008
	(0.008)	(0.008)	(0.008)	(0.020)	(0.008)	(0.008)	(0.011)	(0.009)
Tier 1 Ratio$_{t-1}$	0.061	0.064	0.060	−0.016	0.069	0.056	0.128	0.061
	(0.098)	(0.097)	(0.098)	(0.195)	(0.098)	(0.097)	(0.108)	(0.145)
Illiquid Assets Ratio$_{t-1}$	−0.201***	−0.199***	−0.203***	−0.174	−0.198***	−0.198***	−0.249***	−0.161**
	(0.057)	(0.057)	(0.057)	(0.112)	(0.055)	(0.056)	(0.074)	(0.068)
International Activity$_{t-1}$	−0.063	−0.065	−0.062	−0.085	−0.064	−0.063	−0.040	−0.082
	(0.056)	(0.056)	(0.057)	(0.066)	(0.056)	(0.057)	(0.080)	(0.071)
Core Deposits Ratio$_{t-1}$	0.015	0.012	0.012	0.017	0.027	0.013	0.074**	0.023
	(0.029)	(0.028)	(0.028)	(0.062)	(0.031)	(0.029)	(0.035)	(0.034)
Financial Cycle (Destination Country)	0.004	0.004	0.003	−0.000	0.004	0.003	0.003	0.023
	(0.014)	(0.015)	(0.015)	(0.018)	(0.015)	(0.015)	(0.032)	(0.018)
Business Cycle (Destination Country)	0.200*	0.217**	0.204*	0.357	0.206*	0.209**	0.452***	0.278***
	(0.103)	(0.103)	(0.102)	(0.226)	(0.104)	(0.103)	(0.150)	(0.103)
Foreign-Exposure-Weighted Regulation	1.124	1.596	3.727	−16.234	10.419**	7.047	−4.292	2.854
	(0.569)	(0.175)	(0.922)	(2.072)	(5.740)	(1.162)	(0.719)	(0.181)
Observations	28,273	28,271	28,271	8,575	28,271	28,271	11,981	16,495
R^2	0.019	0.019	0.019	0.032	0.019	0.020	0.028	0.027
Adjusted R^2	0.0132	0.0131	0.0130	0.0159	0.0132	0.0135	0.0167	0.0176
No. of Destination Countries	52	52	52	30	52	52	18	29
No. of Banks	61	61	61	48	61	61	61	60

Notes: This table reports the effects of changes in destination-country regulation and firm characteristics on log changes in total loans by destination country. The data are quarterly from 2000:Q1 to 2014:Q4 for a panel of Italian bank holding companies that have cross-border claims greater than 2 percent of assets. Destination-country regulation refers to the changes in regulation in the destination country of the loan. Foreign-exposure-weighted regulation is calculated as the weighted average of changes in foreign regulation where the weights are total assets and liabilities of the bank in the respective foreign country. For change in regulation, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding F-statistics for significance in parentheses. For more details on the variables, see table 7 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include bank, time, and destination-country fixed effects. Standard errors are clustered by bank. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 6. Outward Transmission of Destination-Country Regulation Policy: Breakdown by Type of Foreign Presence and Sectors

	Total Lending (1)	Total Lending (2)	Direct Cross-Border Lending and Lending through Branches (3)	Lending through Subsidiaries (4)	Loans to Households (5)	Loans to Non-financial Corporations (6)
Log Total Assets$_{t-1}$	-0.017^{**}	-0.017^{**}	-0.020^{*}	-0.031	-0.012	-0.019^{**}
	(0.008)	(0.008)	(0.011)	(0.031)	(0.010)	(0.009)
Tier 1 Ratio$_{t-1}$	0.058	0.058	0.088	-0.049	0.009	-0.099
	(0.097)	(0.098)	(0.116)	(0.198)	(0.129)	(0.124)
Illiquid Assets Ratio$_{t-1}$	-0.199^{***}	-0.202^{***}	-0.176^{***}	0.006	-0.071	-0.203^{***}
	(0.056)	(0.057)	(0.066)	(0.256)	(0.047)	(0.073)
International Activity$_{t-1}$	-0.063	-0.062	0.002	-0.147	0.001	-0.083
	(0.056)	(0.057)	(0.062)	(0.097)	(0.039)	(0.057)
Core Deposits Ratio$_{t-1}$	0.012	0.015	-0.001	0.126	-0.011	0.029
	(0.028)	(0.028)	(0.028)	(0.193)	(0.036)	(0.071)
Financial Cycle (Destination Country)	0.002	0.003	0.009	0.017	0.011	-0.008
	(0.014)	(0.014)	(0.015)	(0.022)	(0.016)	(0.011)
Business Cycle (Destination Country)	0.201^{*}	0.202^{*}	0.103	0.093	0.197^{*}	0.213
	(0.105)	(0.105)	(0.126)	(0.221)	(0.115)	(0.135)
Capital Requirements:	-2.34	-2.299	-2.467	4.501^{**}	-1.414	0.099
	(2.158)	(2.109)	(1.963)	(4.596)	(0.877)	(0.003)
Sector-Specific Capital Buffer	2.275	2.303	2.673^{*}	1.687	1.848	-0.258
	(2.156)	(2.228)	(3.337)	(1.200)	(2.720)	(0.026)
Reserve Requirements: Foreign	0.643	0.676	0.701	-0.515	3.593^{***}	-1.135
	(0.683)	(0.745)	(0.705)	(0.032)	(10.200)	(1.364)
Reserve Requirements: Local	2.383^{***}	2.392^{***}	1.361^{**}	1.061	-0.851	1.691
	(9.541)	(9.568)	(4.044)	(0.807)	(0.927)	(2.500)
Foreign-Exposure-Weighted Regulation		1.237				
		(0.708)				

(*continued*)

Table 6. (Continued)

	Total Lending (1)	**Total Lending (2)**	**Direct Cross-Border Lending and Lending through Branches (3)**	**Lending through Subsidiaries (4)**	**Loans to Households (5)**	**Loans to Non-financial Corporations (6)**
Observations	28,273	28,273	27,476	7,919	24,016	16,535
R^2	0.020	0.020	0.019	0.046	0.018	0.027
Adjusted R^2	0.0133	0.0132	0.0127	0.0290	0.0101	0.0173
No. of Destination Countries	52	52	52	52	52	52
No. of Banks	61	61	61	19	60	47

Notes: This table reports the effects of changes in destination-country regulation and firm characteristics on log changes in total loans by destination country. The data are quarterly from 2000:Q1 to 2014:Q4 for a panel of Italian bank holding companies that have cross-border claims greater than 2 percent of assets. Capital requirements, sector-specific capital buffer, reserve requirements foreign and reserve requirements local refer to the changes in regulation in the destination country of the loan. Foreign exposure-weighted regulation is calculated as the weighted average of changes in foreign regulation where the weights are total assets and liabilities of the bank in the respective foreign country. For change in regulation, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding F-statistics for significance in parentheses. For more details on the variables, see table 7 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include bank, time, and destination-country fixed effects. Standard errors are clustered by bank. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Of all the measures in the original data set, we select those that have enough observations in our sample of destination countries. These are capital requirements, sector-specific capital ratios, and reserve requirements for local and foreign currencies, for which we have more than 28,000 bank-country-time observations. As can be seen in table 4, observations on concentration ratios, interbank exposure limits, and loan-to-value ratios drop to half to a quarter of that number, hence we chose to exclude them.

Within this setting, we begin by rerunning the basic regression (column 1) and then add the third-country exposure-weighted index (column 2), in order to check the consistency with the results found in tables 4 and 5. Then, we explore the heterogeneity across banks in their degree of internationalization, to shed light on whether the type of foreign presence determines a different response to the regulatory framework. Indeed, one possibility is that subsidiaries' lending is characterized by a different response of lending policy to prudential regulation of destination countries relative to cross-border and branches' lending. Whereas subsidiaries located in EU countries are, all in all, legal entities of the destination market and are fully subject to its legal framework, Italian banks and their branches abroad might be differently affected, as they have to respect the domestic legal setting and comply with less foreign regulation. Thus we run equation (1) separately for cross-border and branches' lending $\Delta Y^{PB}_{b,j,t}$ and subsidiaries' lending $\Delta Y^{SU}_{b,j,t}$; results are shown in columns 3 and 4.

Finally, we also examine the possibility that the response to regulation might differ depending on whether loans are directed to households or non-financial corporations. Indeed, ex ante, one could expect that regulatory tools, such as sector-specific capital buffers (mostly associated with lending to residential and commercial real estate) and capital requirements, might affect different components of lending. Sector-specific capital buffers will presumably have a stronger effect on households' financing, since they are largely related to the real estate market, while capital requirements will presumably have an impact on loans to firms, since these are the ones that display higher probability of default and therefore imply a higher absorption of capital. The specification is therefore the same as in equation (1), except that the dependent variables are now $\Delta Y^{HH}_{b,j,t}$ and $\Delta Y^{NF}_{b,j,t}$; estimates are shown in columns 5 and 6.

Results show an interesting picture. First, adding the four measures of prudential rules together does not alter the picture of the baseline: lending growth is higher toward countries that are economically growing more and also responds positively to a stricter regulation in the destination country, namely in the form of higher reserve requirements in the local currency (column 1). The result is unchanged once one takes into consideration the possible interactions with the regulatory frameworks of the other countries toward which the bank is lending, which are confirmed to be irrelevant (column 2).

Second, we observe that the impact of reserve requirements in local-currency and sector-specific capital buffers on lending growth operates through branches and direct cross-border lending by Italian banks (columns 3 and 4). Domestic banks and branches operating abroad are not subject to these requirements and can easily step in with more expansive credit policy, possibly substituting credit that might be reduced by local banks that suffer a negative regulatory shock. Subsidiaries are instead behaving differently. Not only do they remain unaffected by regulatory changes in reserve requirements and sector-specific capital buffers, but they also do not adjust lending based on balance sheet characteristics. Presumably this latter phenomenon is due to the very limited degree of heterogeneity among this class of banks, since subsidiaries all belong to very large banking groups, with a similar business model and funding structure. Interestingly, subsidiaries' lending growth is higher toward countries whose capital requirements become stricter. Although they are subject to the destination-country regulation, these banks more likely benefit from a more than adequate capitalization and liquidity position of their parent, which allows them to easily comply with destination-country regulation and to increase their lending toward the private non-financial sector of those destinations. Furthermore, tightening capital requirements might signal a generally sounder financial environment in the destination country, making foreign banks more inclined to strengthen their position in the credit market. Finally, as to the type of borrower (columns 5 and 6), we observe that reserve requirements play a role in lending growth to households, whereas lending to non-financial corporations is less responsive to the regulatory stance of the destination country.

4. Concluding Remarks

This paper provides evidence on the impact of foreign regulatory measures on international credit flows by Italian banks. We take into account the regulatory regime of the recipient country itself, but also of the whole set of countries toward which the bank is exposed, so as to assess the existence and the size of the impact of regulatory spillovers on these flows. The issue is of central importance for regulators and is a relevant empirical background to evaluate the pros and cons of coordination among prudential authorities.

We find that Italian banks adjusted their lending to the strictness of the regulatory environment of destination countries, whereas they did not modify lending patterns depending on the regulatory regime of their overall foreign exposure, highlighting the absence of spillover effects. Interestingly, Italian banks increased lending toward countries with stricter regulation, although the effect is not very large. This seems to point to a mechanism of regulatory spillover by which foreign banks are more insulated from the stricter requirements and can increase their market shares. This implies that the presence of foreign banks might make a prudential policy aimed at reducing the credit-to-GDP ratio less effective; at the same time it possibly offsets a potential retrenchment by local banks, thus working as a cushion for local negative temporary shocks.

When exploring heterogeneity by type of presence that Italian banks establish abroad, we find that most of the response to foreign regulation of the destination country takes place through cross-border and branches' lending, which are insulated from changes in the regulation of the recipient country. Subsidiaries' lending seems overall less responsive to changes in regulation, although it interestingly responds positively to tighter capital requirements.

Appendix

Table 7. Construction of Variables

Variable Name	Report Form Description	Source	Notes
	Dependent Variables		
ΔLoans	ΔLog(Loans to Households + Loans to Non-financial Corporations)	§A1, EP	Loans include also the non-performing components.
ΔLoansHH	ΔLog(Loans to Households)	§A1, EP	Loans include also the non-performing components.
ΔLoansNFC	ΔLog(Loans to Non-financial Corporations)	§A1, EP	Loans include also the non-performing components.
ΔLoansPB	ΔLog(Loans Extended by the Parent Bank, other Domestic Banks Belonging to the Same Group, and Their Branches Abroad)	§A1, EP	Loans include also the non-performing components.
ΔLoansSU	ΔLog(Loans Extended by the Subsidiaries Abroad)	§A1, EP	Loans include also the non-performing components.
	Independent Variables		
Log Real Assets	log(Total Assets) – log(Consumer Price Index)	§A1, EP, Istat	The consumer price index for the whole nation (NIC) was used in order to obtain real assets.
Illiquid Assets Ratio	(Assets – Cash – Holdings of Government Securities)/Assets	§A1, EP	
International Ratio	100 * (Foreign Claims + Liabilities vis-à-vis Foreign Residents)/ (Total Assets + Total Liabilities)	§A1, EP	

(*continued*)

Table 7. (Continued)

Variable Name	Report Form Description	Source	Notes
Independent Variables			
Capital Ratio	(Capital + Reserves)/Assets	§Y	As the reporting frequency for banking groups is semi-annual from 2008:Q4, the first and third quarters' values are derived as the average of the lagged and leaded values (linear interpolation).
Core Deposits	(Deposits of Households + Deposits of Non-financial Corporations)/Liabilities	§A1, EP	Deposits include the following instruments: overnight deposits, deposits with agreed maturity, deposits redeemable at notice, and repurchase agreements.
Other Variables			
Exposures	Loans + Holdings of Securities + Deposit Liabilities + Other Debts	§A1, EP	Loans include also the non-performing components. Deposits include the following instruments: overnight deposits, deposits with agreed maturity, deposits redeemable at notice, and repurchase agreements.
Financial Cycle	Credit-to-GDP Gap	BIS	
Business Cycle	Output Gap Measured as the Difference between the Actual Output and the HP-filtered Output	BIS	

Notes: Data sources for banks' balance sheet data are section A1 (individual balance sheet data reporting), section EP (consolidated banking group balance sheet data broken down by counterparty sector and country), and section Y (capital requirements) of the Italian bank supervision data. All data are confidential.

References

Buch, C. M., and L. Goldberg. 2017. "Cross-Border Prudential Policy Spillovers: How Much? How Important? Evidence from the International Banking Research Network." *International Journal of Central Banking* 13 (S1).

Caccavaio, M., L. Carpinelli, G. Marinelli, and E. Sette. 2015. "International Banking and Liquidity Risk Transmission: Evidence from Italy." *IMF Economic Review* 63 (3): 568–84.

Cerutti, E., R. Correa, E. Fiorentino, and E. Segalla. 2017. "Changes in Prudential Policy Instruments—A New Cross-Country Database." *International Journal of Central Banking* 13 (S1).

De Nicolo, G. 2015. "Revisiting the Impact of Bank Capital Requirements on Lending and Real Activity." Mimeo.

Panetta, F. 2013. "Macroprudential Tools: Where Do We Stand?" Remarks during the presentation of the 2013 Financial Stability Review, Central Bank of Luxembourg, May 14.

Visco, I. 2011. "Key Issues for the Success of Macroprudential Policies." *BIS Papers* 60 (December): 129–35. (Papers from a joint conference organized by the BIS and the Bank of Korea, held in Seoul, January 17–18).

International Banking and Cross-Border Effects of Regulation: Lessons from Mexico*

Gabriel Levin-Konigsberg,[a,b] Calixto López,[a]
Fabrizio López-Gallo,[a] and Serafín Martínez-Jaramillo[a]
[a]Banco de México
[b]Harvard University

Following the methodological specification provided by the International Banking Research Network (IBRN), a panel data model was estimated using bank-level data to assess the inward cross-border spillover effects in Mexico of prudential policies implemented in other jurisdictions. Two specifications were tested, the cross-border spillover effects of prudential policies implemented in counterparty jurisdictions and those in the home countries. It was shown that when home countries of global banks with foreign affiliates operating in Mexico implement prudential policies, there can be a significant impact in such affiliates. In particular, increasing capital requirements in the United States have a negative and significant impact on bank lending growth in Mexico. However, the specification assessing the average effects of prudential policies of counterparty jurisdictions yields results that are not significant or not robust to changes in the specification, which makes them harder to interpret.

JEL Codes: G01, G21, G28, E58, F65.

1. Introduction

The conditions of the Mexican financial system have been shaped by the recent history and evolution of the Mexican economy and its transition from being a closed economy to a small open economy. In

*The views expressed in this paper are those of the authors and do not necessarily reflect the opinion of Banco de México. The authors are grateful to the referees for their insights and to Guzel Valitova, Matthieu Bussière, and Linda Goldberg for their comments and editorial assistance. Corresponding author (Calixto López): clopezc@banxico.org.mx.

turn, the Mexican financial system hosts many foreign affiliates[1] of international banks, and in the wake of the 1995 crisis it has become more susceptible to shocks generated abroad. Although the literature has emphasized the impact of economic-related shocks such as terms of trade or trade partners' total factor productivity shocks, the effect of changes in another country's regulation should not be underestimated given the large presence of foreign affiliates.

Although prudential regulation and other policy measures have always been present, since the last financial crisis there has been a notable update of the international agreed regulation, encompassing changes in the regulatory framework and new rules that will be enforced in the near future. These prudential policies have a clear target—microprudential, such as fostering the resilience of each bank in the financial system, or macroprudential, focusing on the system as a whole—depending on the scope of the regulation. Each target is well delimited, yet the reach of the policies is not; for some recent studies, we refer the reader to Berrospide and Edge (2010), Akinci and Olmstead-Rumsey (2015), Aiyar, Calomiris, and Wieladek (2014, 2015), and Cerutti, Claessens, and Laeven (2015). This, in turn, could generate cross-border spillover effects that are not limited to the country which enacted the policy, as well as other unintended consequences. Even though these kinds of effects have usually been present, there has been no systematic record or quantification of the unintended cross-border effects of prudential policies implemented in foreign jurisdictions. Taking this into consideration, the International Banking Research Network (IBRN) decided to lead a joint effort among different countries to assess the impact of these kinds of shocks, to determine whether these policies (intended to have a more limited scope) produced effects on aggregated credit growth in other jurisdictions, as well as having other implications, such as affecting other aspects of banking activity at their costs, like holdings of sovereign securities, risk-taking incentives, rebalancing of credit and trading portfolios, and retrenchment of certain activities and/or markets, among others. This paper constitutes the Mexican contribution to this effort, which has already produced some

[1]Foreign banks participate in Mexico only with subsidiaries. This is an important point to emphasize given that subsidiaries are formally independent legal entities, but they follow the guidelines of the parent bank.

Table 1. Prudential Policies by Target Effects

Limiting Resource Availability	Limiting Resource Allocation
Capital Requirements	Sector-Specific Capital Buffers
Loan-to-Value Ratios	Interbank Exposure Limits
Reserve Requirements	Concentration Ratios

relevant results, as is shown in Berrospide et al. (2017), Buch and Goldberg (2017), Bussière, Schmitt, and Vinas (2017), Cabezas and Jara (2017), Damar and Mordel (2017), Frost, de Haan, and van Horen (2017), Ho, Wong, and Tan (2017), and Ohls, Pramor, and Tonzer (2017).

Bank regulation and prudential measures are in general justified because there are market failures. These measures are aimed at mitigating these market failures. The problem of cross-border spillover effects is that the consequences of prudential measures can go beyond the market where these were intended to act, and affect the way other jurisdictions' banking systems work, and this could be reflected in bank lending growth. Credit availability plays a crucial role in the economic development of a country, while at the same time, excessive credit growth has been identified as one of the key elements leading to financial crises. In many countries, banks are the most important credit suppliers and are subject to prudential regulation. Prudential regulation affects both sides of the banks' balance sheet—the availability of resources (the liability side) as well as the allocation of resources through intermediation and credit supply (the asset side). Table 1 divides the different policies that will be studied in this paper according to which element of credit supply is affected.

Even though it is empirically difficult to disentangle the effects of prudential regulation (resource availability and allocation), the classification proposed in table 1 provides a framework to analyze the possible spillover effects to other countries, allowing empirical testing of the unintended consequences of regulation. When binding, policies induce banks to reallocate funds to other purposes. This paper intends to measure which prudential policies have affected credit growth in the Mexican banking system and to what extent.

Exposures of foreign intermediaries to Mexican banks are small. For that reason, the main analysis in this paper is related to the inward transmission of prudential policies implemented abroad. For instance, we found that there is a negative significant effect in lending growth of U.S. foreign affiliates with residence in Mexico when additional capital requirements are imposed in the home country.

The rest of this paper is organized in the following way: section 2 outlines the main features of the Mexican banking system, section 3 describes the data used, section 4 explains the empirical specifications and the main results, and section 5 concludes.

2. The Mexican Banking System

Banking systems with several international links are more susceptible to shocks originating from abroad than those that are mostly home grown. In Mexico fifteen out of the forty-three banks currently in operation are domestic affiliates of foreign globally active banks. This causes the Mexican banking system to be potentially affected by shocks at the parent bank's country.[2]

Domestic affiliates of foreign global banks in Mexico vary significantly in size and scope, ranging from banks with relatively limited activity to some which are among the largest in the Mexican financial system. In Mexico the seven largest banks hold around 80 percent of the system's assets, and five out of these seven banks are domestic affiliates of foreign global banks. This adds to the possibility of wide and significant transmission mechanisms from any regulatory change in the parent country of any of these banks. As figure 1 illustrates, around 10 percent of the banks hold more than 50 percent of the assets. Any regulation that affects the allocation of resources of the most important players in the system will likely have a large impact on the system as a whole.

Another significant feature of the Mexican banking system is that banks tend to keep very high capital buffers. Figure 2 shows that capital ratios are well above regulatory limits. The available data do not allow identification of whether this is due to risk aversion,

[2]It is worth mentioning again that foreign global banks only operate through subsidiaries. Branches of foreign banks are not present in Mexico.

Figure 1. Lorenz Curve of Banks' Assets

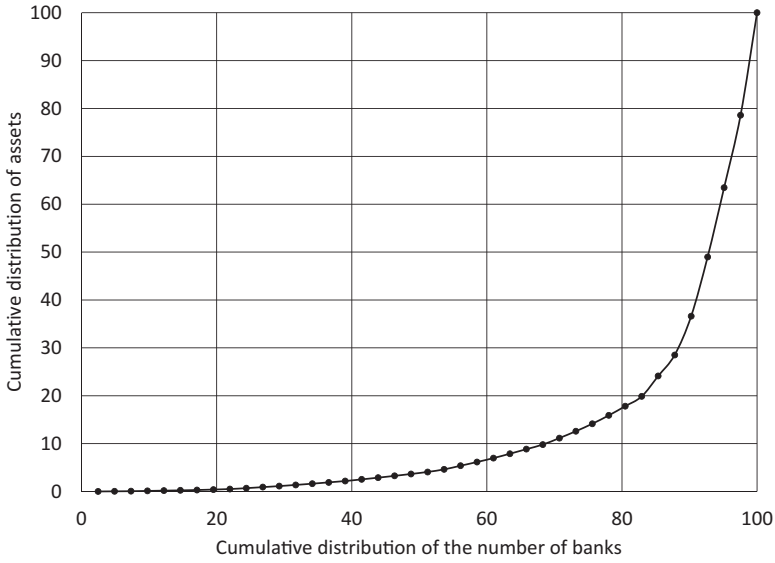


Figure 2. Banking System Capital Ratio

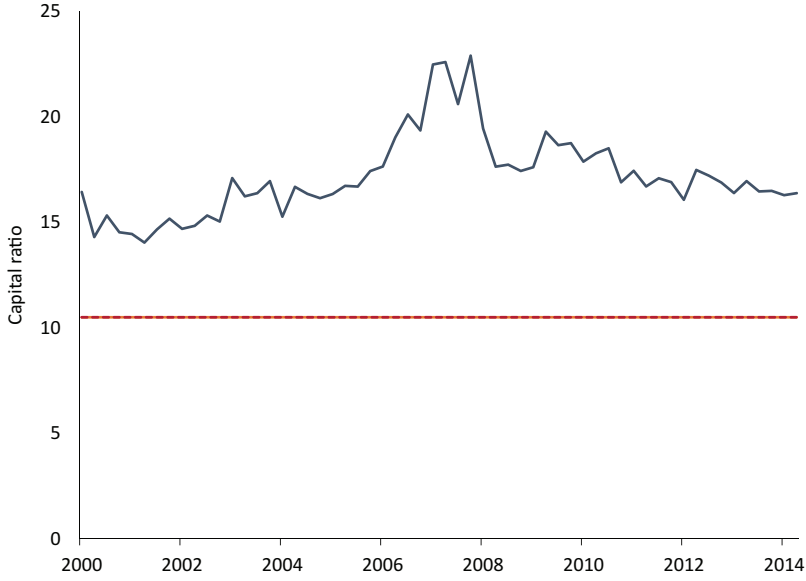


Figure 3. Bank Credit-to-GDP Ratio

business strategies, or simply spare capacity. If the capital levels chosen by some banks are above the regulatory minimum, their response to prudential measures abroad, such as higher capital requirements in the home country, could be more moderate than those of banks with capital levels closer to the limits. This could affect the estimation results, because if the choices of capital levels above the regulatory minimum are not based on hard constraints, it is likely that non-binding capital adequacy limits could dilute the impact of some regulatory measures abroad. On the other hand, higher capital levels could be due to higher risk aversion, which could lead banks to be more responsive to policies implemented abroad, resulting in relatively higher cross-border spillover effects. Even though there is not enough information to assess this, it is important to keep it in mind to interpret results.

Bank credit to GDP is relatively low in Mexico, as figure 3 shows, although this indicator has grown in recent years. There is a possibility that an external shock might further hamper financial intermediation by limiting credit availability even more. This in turn may have

an adverse effect on the real economy; therefore, it is important to measure if exogenous changes in regulation could affect the financial deepening process.

3. Data

In order to study the impact of external regulatory shocks on bank credit growth in Mexico, the guidelines of the IBRN are used, and data from a panel of Mexican banks from the second quarter of 2001 until the fourth quarter of 2013 will be used. The dependent variable is the quarterly log change of total loans of each bank. The focus will be only on observations where the dependent variable is bound between –100 and 100, and on banks for which there are at least two years (eight quarters) of information in a row.[3] This leaves thirty-four banks (thirteen domestic affiliates of foreign global banks) and 1,310 observations. Data come from the following sources: the National Banking and Securities Commission (CNBV), Banco de México, the IBRN, the different participating countries, and cycle variables from the Bank for International Settlements.

The CNBV information is mainly balance sheet data.[4] Banco de México collects daily data on banks' counterparties exposures; we used this data to compute an international activity ratio.[5] Finally, the data set compiled by the IBRN includes information on changes on eight types of regulations in sixty-four different countries. The policies being considered are capital requirements, sector-specific capital requirements, loan-to-value ratios, reserve requirements (both in local and foreign currency), interbank exposure limits, and limits on concentration ratios. Also, the IBRN provides information on a prudential index, which is a summary measure.

[3]During the time frame considered, some banks entered the market and a few left. It has been observed that new banks go through an adjustment period, and though it is difficult to judge how long this period may last, some observations lead us to consider two years as a reasonable time frame to go through the adjustment phase. Some new domestic banks did not have the required operating time.

[4]For the estimation some indicators such as the illiquid assets ratio, real assets, core deposits ratio, and tier 1 capital ratio are constructed using this information.

[5]From this data set, the information at the end of each quarter was used to build weights to calculate the exposure of each bank to counterparties in specific countries.

Table 2. Summary Statistics (balance sheet information main variables)

Balance Sheet Characteristics	Median	SD	Median	P75
Log Assets	10.470	1.769	10.232	11.684
Tier 1 Capital Ratio	20.462	15.379	16.172	20.861
Illiquid Assets Ratio	41.020	24.661	40.470	57.370
International Activity Ratio	46.063	78.437	17.757	36.617
Deposits Ratio	15.640	15.496	10.964	24.098
Loans (Log Change)	4.716	15.483	3.391	9.340

Table 3. Summary Statistics (weighted exposure)

	Max.	Min.	Mean	SD	< 0	> 0
Prudential Index	1.000	−1.000	0.041	0.171	107	275
Capital Requirements	1.000	0.000	0.037	0.140	0	142
Sector-Specific Capital Buffers	0.423	−0.001	0.003	0.029	1	32
Loan-to-Value Ratios	0.934	−1.000	−0.003	0.071	90	73
Reserve Requirements: Foreign	0.135	0.000	0.0003	0.006	0	14
Reserve Requirements: Local	0.135	−1.000	−0.005	0.055	35	26
Interbank Exposure Limit	0.889	0.000	0.008	0.067	0	39
Concentration Ratios	0.889	0.000	0.008	0.068	0	36

Table 2 shows the summary statistics of the balance sheet information main variables used for the estimation. Table 3 shows the weighted exposure statistics. Finally, table 4 shows the summary indicators of prudential policies implementation in different jurisdictions.

4. Empirical Method and Regression Results

The models are those included as part of the joint IBRN research project. These consisted in testing the transmission of regulatory shocks through each bank's counterparties, using an exposure-weighted average of the changes in policy as well as the transmission of regulatory changes through each bank's parent bank. The

Table 4. Summary Statistics (indicators of prudential policies implementation)

	Median	SD	< 0	> 0
Prudential Index	0.046	0.235	8	73
Capital Requirements	0.039	0.194	0	55
Sector-Specific Capital Buffers	0.001	0.038	0	2
Loan-to-Value Ratios	−0.001	0.088	6	5
Reserve Requirements: Foreign	0.000	0.000	0	0
Reserve Requirements: Local	−0.003	0.053	4	0
Interbank Exposure Limit	0.009	0.096	0	13
Concentration Ratios	0.009	0.092	0	12

research project considered a third specification to assess the outward transmission, but because Mexican banks that are not domestic affiliates of foreign global banks are small on a global scale, they do not have many operations abroad. Hence, the foreign exposure to Mexican banks is negligible and an assessment of outward transmissions for Mexico will not be done; therefore, for the Mexican case, only the inward transmission of prudential policies will be evaluated.

4.1 Baseline Analysis of Inward Transmission of Prudential Policies

In accordance with the research protocol established by the IBRN, we will analyze two transmission channels for the prudential policies. The first one is through each bank's counterparties. Three different specifications will be considered:

- Specification 1: $\Delta Y_{b,t} = \alpha_0 + (\alpha_1 ExpP_{b,t} + \alpha_2 ExpP_{b,t-1} + \alpha_3 ExpP_{b,t-2}) + \alpha_4 X_{b,t-1} + f_b + f_t + \varepsilon_{b,t}$
- Specification 2: $\Delta Y_{b,t} = \alpha_0 + (\alpha_1 ExpP_{b,t} + \alpha_2 ExpP_{b,t-1} + \alpha_3 ExpP_{b,t-2}) + \alpha_4 X_{b,t-1} + (\beta_1 ExpP_{b,t} X_{b,t-1} + \beta_2 ExpP_{b,t-1} X_{b,t-1} + \beta_3 ExpP_{b,t-2} X_{b,t-1}) + f_b + f_t + \varepsilon_{b,t}$
- Specification 3: $\Delta Y_{b,t} = \alpha_0 + \alpha_1 ExpP_{cum,b,t} + \alpha_2 X_{b,t-1} + \alpha_3 ExpP_{cum,b,t} Z_t + f_b + f_t + \varepsilon_{b,t}$

In the above specifications $\Delta Y_{b,t}$ is the log change of credit for bank b at time t; $ExpP_{b,t}$ is the exposure-weighted change in policy for bank b at time t, that is, an indicator variable that is activated when a country implements a policy measure, weighted by the total exposure of the bank to that country; $X_{b,t}$ is a vector of controls (mostly balance sheet indicators); f_b and f_t are bank and time fixed effects, respectively; $ExpP_{cum,b,t}$ is the exposure-weighted cumulative change in prudential policies; and Z_t is a set of variables that capture the financial and business cycle conditions at the time.

The first specification intends to measure the raw effect of policies implemented abroad on credit growth. The second one recognizes the fact that banks with differing characteristics may be hit differently by changes in regulations, hence the interaction terms. Finally, the third specification takes into account the fact that policy changes may accumulate over time and that different cycle conditions may modify the strength of the cross-border impact of foreign regulation. The aim of these specifications is to assess the indirect cross-border spillover effects that prudential policy measures in different jurisdictions may have in the analyzed jurisdiction (in this case, Mexico).

The disadvantage of this approach is that given the way the exposure variable was constructed, using relatively aggregated data and by using weights based on country exposure, it may aggregate several possibly offsetting effects and therefore prevent the identification of any possible cross-border effect of the policy at the bank level. In addition to this, as can be seen in table 3, exposures to other jurisdictions are relatively low. Hence, the weighted exposure measure on average has a small magnitude, and it is expected for these indicators to have a moderate effect on bank credit, at least in economic terms.

Table 5 shows the results for specification 1. This table shows the estimated coefficients for the policy measure (denoted by $ExpP_t$) contemporaneously and with one and two lags, as well as the sum of all these effects. Considering the joint effects, only the loan-to-value ratio and the reserve requirement in foreign currency are statistically significant. Contemporaneous interbank exposure limits are negative and significant, as well as concentration ratio limits, both contemporaneously and with one lag, but the sum is not significant.

Table 6 shows the result for specification 2. When considering interactions with bank-specific controls, only the effects of reserve

Table 5. Results for Specification 1

	Prudential Index	Capital Requirements	Sector-Specific Capital Buffer	LTV Ratio	Reserve Requirements: Foreign	Reserve Requirements: Local	Interbank Exposure Limits	Concentration Ratios
$ExpP_t$	−2.397	10.120	30.910	−8.273	−44.670*	−18.100	−24.490**	−24.550**
	(4.81)	(13.39)	(16.59)	(7.67)	(19.31)	(10.52)	(8.50)	(7.13)
$ExpP_{t-1}$	−8.250	0.383	−8.086	−22.660	8.988	6.359	−6.406	−7.117**
	(6.38)	(14.46)	(16.51)	(13.91)	(12.52)	(10.53)	(4.03)	(2.40)
$ExpP_{t-2}$	−5.268	−5.510	10.990	−18.470	−39.070*	29.290	−3.566	−13.100
	(6.33)	(11.34)	(16.40)	(13.93)	(19.26)	(25.08)	(2.61)	(14.00)
$\Sigma ExpP_{t-s}$	−15.915	4.989	33.817	−49.403*	−74.745**	17.542	−34.467	−44.765
	[0.28]	[0.89]	[0.46]	[0.07]	[0.02]	[0.64]	[0.01]	[0.03]
L. Log Total Assets	−4.040**	−4.029**	−3.904*	−3.924**	−3.967**	−4.150**	−4.199**	−4.199**
	(1.67)	(1.57)	(1.65)	(1.59)	(1.67)	(1.56)	(1.73)	(1.74)
Capital $Ratio_t$	0.018	0.019	0.018	0.023	0.018	0.019	0.017	0.017
	(0.05)	(0.06)	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.06)
Illiquidity $Ratio_t$	−0.178***	−0.178***	−0.180***	−0.173***	−0.180***	−0.176***	−0.180***	−0.182***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
International $Activity_t$	−0.037	−0.037	−0.035	−0.036	−0.037	−0.037	−0.037	−0.037
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Core $Deposits_t$	−0.023	−0.030	−0.027	−0.007	−0.024	−0.032	−0.026	−0.028
	(0.12)	(0.11)	(0.12)	(0.14)	(0.12)	(0.12)	(0.12)	(0.12)
Constant	53.930**	53.840**	52.640**	52.250**	53.340**	54.990**	55.590**	55.690**
	(17.28)	(16.37)	(17.08)	(16.68)	(17.29)	(16.06)	(17.87)	(17.97)
Observations	1,310	1,310	1,310	1,310	1,310	1,310	1,310	1,310
R^2	0.088	0.088	0.086	0.095	0.085	0.094	0.088	0.089

Notes: Standard errors are in parentheses. P-values for the sum of lags equal to zero are in squared brackets. * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 6. Results for Specification 2

	Prudential Index	Capital Requirements	Sector-Specific Capital Buffer	LTV Ratio	Reserve Requirements: Foreign	Reserve Requirements: Local	Interbank Exposure Limits	Concentration Ratios
$ExpP_t$	0.57	28.98	2.54	46.97	5385.00	9.79	9.77	18.67
	(21.19)	(28.96)	(35.94)	(144.80)	(63165.80)	(22.69)	(33.07)	(38.57)
$ExpP_{t-1}$	−43.41	−44.41	−18.98	152.50*	74248.20**	56.58**	−29.90*	−28.57
	(29.69)	(26.17)	(74.24)	(78.09)	(30125.20)	(18.37)	(13.41)	(16.92)
$ExpP_{t-2}$	−9.83	−17.53	67.32	−52.07	159355.00**	29.39	16.96	150.20**
	(8.31)	(13.57)	(50.99)	(35.75)	(65647.20)	(64.75)	(29.75)	(44.69)
$\Sigma ExpP_{t-s}$	−52.67	−32.96	50.88	147.42	238988.20***	95.75	−3.18	140.33
	[0.27]	[0.23]	[0.74]	[0.52]	[0.01]	[0.32]	[0.96]	[0.15]
Log Total $Assets_{t-1}$	−3.99	−4.56**	−3.89*	−3.06	−3.99**	4.04**	−4.11**	−3.77*
	(2.22)	(1.72)	(1.72)	(2.10)	(1.66)	(1.60)	(1.73)	(1.86)
Capital $Ratio_{t-1}$	0.01	−0.02	0.01	0.01	0.02	0.02	0.02	0.02
	(0.07)	(0.06)	(0.05)	(0.07)	(0.05)	(0.06)	(0.05)	(0.06)
Illiquidity $Ratio_{t-1}$	−0.17***	−0.17***	−0.18***	−0.18***	−0.18***	−0.17***	−0.18***	−0.18***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
International $Activity_{t-1}$	−0.04*	−0.05	−0.03	−0.03	−0.04	−0.04	−0.04	−0.03*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
Core $Deposits_{t-1}$	−0.050	−0.10	−0.03	0.004	−0.03	−0.04	−0.04	−0.08
	(0.16)	(0.16)	(0.12)	(0.14)	(0.12)	(0.13)	(0.11)	(0.08)
ΣExpP*Log Total Assets	3.89	3.85	−7.93	−9.53	−16289.41***	−4.87	−3.44	−15.18
	[0.36]	[0.41]	[0.59]	[0.57]	[0.02]	[0.56]	[0.65]	[0.10]
ΣExpP*Capital Ratio	0.18	−0.36	1.32	−3.47	−3432.19***	−0.40	0.016	−2.37*
	[0.76]	[0.24]	[0.38]	[0.10]	[0.01]	[0.79]	[0.99]	[0.09]
ΣExpP*Illiquidity Ratio	−0.10	−0.18	0.49	−0.98	−198.22	0.028	0.002	−0.09
	[0.78]	[0.34]	[0.64]	[0.30]	[0.48]	[0.97]	[0.99]	[0.69]
ΣExpP*International Activity	0.028	0.56*	−0.46	−0.14	648.31**	−0.18	0.11	−1.14
	[0.93]	[0.05]	[0.46]	[0.74]	[0.05]	[0.83]	[0.93]	[0.15]
ΣExpP*Core Deposits	0.05	0.22	−0.27	1.37	−216.30	−0.98	−0.04	1.84**
	[0.85]	[0.36]	[0.89]	[0.12]	[0.35]	[0.24]	[0.95]	[0.045]
Constant	53.70*	60.35**	52.55**	43.89*	53.54**	53.87**	54.92**	51.29**
	(22.99)	(18.04)	(17.73)	(22.12)	(17.14)	(16.69)	(17.88)	(19.15)
Observations	1,310	1,310	1,310	1,310	1,310	1,310	1,310	1,310
R^2	0.102	0.106	0.090	0.129	0.086	0.107	0.091	0.113

Notes: Standard errors are in parentheses. P-values for the sum of lags equal to zero are in squared brackets. * p < 0.1, ** p < 0.05, *** p < 0.01.

requirements in foreign currency are significant. Finally, table 7 shows the results for specification 3, which uses a cumulative variable to identify policy changes as well as credit and business cycle indicators. The results also show that the only prudential policy showing significant effects is the reserve requirement in foreign currency, and the interaction with the cycle variables is not significant for any policy measure.

As stated above, the results are not surprising for several reasons. The exposure to the jurisdiction implementing the policy measures analyzed is relatively small, with the exceptions of the policies that were implemented in Mexico.[6] Hence, the effects on credit, not surprisingly, are not significant. Even further, credit dynamics in Mexico in the period analyzed seem to be more responsive to macroeconomic variables, which are captured to some extent with the time dummies used in the framework. The significant coefficients for the reserve requirements in foreign currency are somewhat puzzling, given the low exposure to jurisdictions where this policy has been implemented. For instance, no home country of the banks analyzed has implemented this policy (table 4).

In a financial system such as Mexico's, where a significant fraction of the banks are domestic affiliates of foreign global banks, including some of the largest banks, a better avenue to test cross-border spillover effects is measuring the effects of prudential policies implemented in the home countries of subsidiaries operating in Mexico.

The second transmission channel examined considers the impact of regulation in the home country of each of the domestic affiliates of foreign global banks on lending growth in Mexico. As mentioned, five out of the seven largest banks in Mexico are domestic affiliates of foreign global banks. This specification provides a more interesting case, because it allows us to test in a more direct way the possible spillover effects on lending growth in Mexico taking into account home-country changes in policies and also (non-observable) possible changes in corporate policies or business strategies. Once again, following the research protocol established, the following specifications are estimated:

[6] Capital requirements, interbank exposure limits, and concentration limits.

Table 7. Results for Specification 3

	Prudential Index	Capital Requirements	Sector-Specific Capital Buffer	LTV Ratio	Reserve Requirements: Foreign	Reserve Requirements: Local	Interbank Exposure Limits	Concentration Ratios
$ExpP_t$	−0.023	0.134	−0.055	0.003	−0.418**	0.050	−0.008	−0.079
	(0.02)	(0.38)	(0.05)	(0.02)	(0.14)	(0.04)	(0.03)	(0.05)
Log Total $Assets_{t-1}$	−0.043**	−0.042***	−0.044**	−0.045***	−0.042**	−0.045**	−0.043***	−0.042**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Capital $Ratio_{t-1}$	0.0004	0.0003	0.0003	0.0004	0.0003	0.0002	0.0003	0.0004
	(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0004)	(0.0005)	(0.0004)	(0.0004)
Illiquidity $Ratio_{t-1}$	−0.002***	−0.002***	−0.002***	−0.002***	−0.002***	−0.002***	−0.002***	−0.002***
	(0.0001)	(0.00006)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
International $Activity_{t-1}$	−0.0004*	−0.0004*	−0.0003*	−0.0004	−0.0003*	−0.0004*	−0.0003**	−0.0004*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0001)
Core $Deposits_{t-1}$	0.0002	0.0003	0.0004	0.0003	0.0004	0.0006	0.0003	0.0002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$ExpP_t$*Output Gap_t	0.001	−0.040	−0.006	0.003	0.050	−0.004	0.009	0.002
	(0.01)	(0.13)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
$ExpP_t$*Credit Gap_t	0.0005	−0.0556	0.0167	−0.0265	0.1840**	0.0110*	0.008	−0.024
	(0.001)	(0.072)	(0.043)	(0.020)	(0.072)	(0.005)	(0.003)	(0.001)
Constant	0.526**	0.520**	0.536**	0.551***	0.525**	0.532**	0.534***	0.532**
	(0.17)	(0.15)	(0.18)	(0.16)	(0.17)	(0.19)	(0.15)	(0.16)
Observations	1,358	1,358	1,358	1,358	1,358	1,358	1,358	1,358
R^2	0.086	0.085	0.082	0.091	0.084	0.090	0.083	0.089

Notes: Standard errors are in parentheses. P-values for the sum of lags equal to zero are in squared brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

- Specification 4: $\Delta Y_{b,j,t} = \alpha_0 + (\alpha_1 HomeP_{j,t} + \alpha_2 HomeP_{j,t-1} + \alpha_3 HomeP_{j,t-2}) + \alpha_4 X_{b,j,t-1} + \alpha_5 Z_{j,t} + f_b + f_t + \varepsilon_{b,j,t}$
- Specification 5: $\Delta Y_{b,j,t} = \alpha_0 + (\alpha_1 HomeP_{j,t} + \alpha_2 HomeP_{j,t-1} + \alpha_3 HomeP_{j,t-2}) + \alpha_4 X_{b,j,t-1} + (\beta_1 HomeP_{j,t} X_{b,j,t-1} + \beta_2 HomeP_{j,t-1} X_{b,j,t-1} + \beta_3 HomeP_{j,t-2} X_{b,j,t-1}) + f_b + f_t + \varepsilon_{b,j,t}$
- Specification 6: $\Delta Y_{b,j,t} = \alpha_0 + \alpha_1 HomeP_{cum,j,t} + \alpha_2 X_{b,j,t-1} + \alpha_3 HomeP_{cum,j,t} Z_t + f_b + f_t + \varepsilon_{b,t}$

In the above specifications $\Delta Y_{b,j,t}$ is the log change of credit for bank b, in country j at time t; $HomeP_{j,t}$ is the change in policy in country j at time t; $HomeP_{cum,j,t}$ is the cumulative effect of policy in country j at time t; $X_{b,t}$ is a vector of controls (mostly balance sheet indicators); f_b and f_t are bank and time fixed effects, respectively; $ExpP_{cum,b,t}$ is the exposure-weighted cumulative change in prudential policies; and Z_t is a set of variables that capture the financial and business cycle conditions at the time. That is, the notation remains unchanged except for sub-index j, which indicates the home country of each bank. The spirit of each specification is the same as those used for the first transmission channel.

Tables 8, 9, and 10 show the estimation results. The lack of significant results for the effects of the prudential policies implemented in the home countries is noteworthy. The coefficients for most bank-specific controls are consistent and keep values that are roughly similar; however, the significance can vary. However, as can be seen in table 8, none of the policy indicator variables are significant. The case of specification 5 is not very different, though in this case there are some significant coefficients for the concentration limit variable with lags, though jointly not significant. And finally, specification 6 using the cumulative policy indicator variable and cycle variables yields significant coefficients in the interactions terms.

A closer examination of the data suggests two modifications to the framework that can improve the explanatory power of the model. First, the policy indicator variables can show a simultaneous application of the same policy in two jurisdictions at the same time. However, the indicator only identifies whether there have been changes or not, without providing further information on the relative magnitude of the policy measure. To account for this, instead of using the indicator variable, regressors for home country were used to identify

Table 8. Results for Specification 4

	Prudential Index	Capital Requirements	Sector-Specific Capital Buffer	LTV Ratio	Reserve Requirements: Foreign	Reserve Requirements: Local	Interbank Exposure Limits	Concentration Ratios
$ExpP_t$	0.758	3.682	0.717	0.312		−0.957	−8.632	−8.762
	(3.83)	(6.06)	(2.37)	(0.78)		(3.17)	(6.37)	(6.37)
$ExpP_{t-1}$	−2.085	−2.172	−0.770	−1.137		−0.535	−3.180	−4.372
	(4.06)	(7.41)	(3.08)	(1.17)		(4.08)	(3.16)	(2.96)
$ExpP_{t-2}$	−1.913	−4.991	−1.142	−3.025		17.28	0.314	−3.308
	(2.80)	(4.83)	(1.29)	(6.61)		(14.72)	(4.76)	(2.62)
$\Sigma ExpP_{t-s}$	−3.410	−3.692	−1.318	−4.124		16.481	−11.717	−16.761
	[0.72]	[0.82]	[0.83]	[0.61]		[0.45]	[0.40]	[0.21]
Log Total $Assets_{t-1}$	−2.418	−2.396	−2.416	−2.470	−2.414	−2.633	−2.487	−2.545
	(1.76)	(1.64)	(1.75)	(1.69)	(1.75)	(1.65)	(1.82)	(1.80)
Capital $Ratio_{t-1}$	0.032	0.031	0.032	0.031	0.032	0.029	0.031	0.030
	(0.05)	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Illiquidity $Ratio_{t-1}$	−1.377***	−1.375***	−1.383***	−1.380***	−1.383***	−1.367***	−1.382***	−1.382***
	(0.37)	(0.37)	(0.38)	(0.38)	(0.37)	(0.39)	(0.37)	(0.37)
Core $Deposits_{t-1}$	−0.008	−0.006	−0.013	−0.011	−0.012	−0.016	−0.015	−0.019
	(0.12)	(0.12)	(0.12)	(0.13)	(0.13)	(0.12)	(0.13)	(0.13)
Credit Gap_t	−0.067	−0.066	−0.069	−0.067	−0.069	−0.066	−0.071	−0.071
	(0.24)	(0.24)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Output Gap_t	−0.451	−0.492	−0.489	−0.476	−0.485	−0.568	−0.536	−0.588
	(1.31)	(1.23)	(1.41)	(1.42)	(1.40)	(1.44)	(1.45)	(1.48)
Constant	36.950*	36.720*	37.000*	37.500*	36.980*	39.170*	37.850*	38.490*
	(19.09)	(18.06)	(19.11)	(18.49)	(19.06)	(17.98)	(19.77)	(19.46)
Observations	1,310	1,310	1,310	1,310	1,310	1,310	1,310	1,310
R^2	0.085	0.087	0.084	0.085	0.084	0.088	0.086	0.086

Notes: Standard errors are in parentheses. P-values for the sum of lags equal to zero are in squared brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 9. Results for Specification 5

	Prudential Index	Capital Requirements	Sector-Specific Capital Buffer	LTV Ratio	Reserve Requirements: Foreign	Reserve Requirements: Local	Interbank Exposure Limits	Concentration Ratios
$ExpP_t$	12.67	31.95		−17.79			−7.39	−6.28
	(23.07)	(25.86)		(45.38)			(7.70)	(7.77)
$ExpP_{t-1}$	−16.41	−23.62		−46.81			1.21	38.96***
	(16.83)	(17.77)		(55.49)			(10.13)	(8.60)
$ExpP_{t-2}$	−16.50	−39.15		−222.90			−4.61	18.52**
	(11.79)	(21.59)		(169.70)			(18.16)	(7.04)
$\Sigma ExpP_{t-s}$	−20.24	−30.82		−287.55			−10.79	51.21
	[0.58]	[0.34]		[0.17]			[0.75]	[0.06]
Log Total Assets	−3.23	−2.95	−3.28	−3.90**	−3.27	−3.99**	−3.46	−3.38
	(2.08)	(1.95)	(1.89)	(1.64)	(1.88)	(1.60)	(1.96)	(1.97)
Capital $Ratio_{t-1}$	0.016	0.025	0.023	0.016	0.023	0.016	0.019	0.022
	(0.07)	(0.07)	(0.06)	(0.056)	(0.056)	(0.06)	(0.06)	(0.06)
Illiquidity $Ratio_{t-1}$	−0.20***	−0.20***	−0.20***	−0.20***	−0.20***	−0.20***	−0.20***	−0.20***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Core $Deposits_{t-1}$	−0.02	−0.02	−0.01	−0.03	−0.01	−0.04	−0.02	−0.03
	(0.11)	(0.12)	(0.12)	(0.11)	(0.12)	(0.11)	(0.12)	(0.12)
$\Sigma ExpP_{t-s}$*Log Total Assets	1.50	2.63		17.08		−22.49	−4.38	−14.68
	[0.50]	[0.12]		[0.16]		[0.00]	[0.16]	[0.00]
$\Sigma ExpP_{t-s}$*Capital Ratio	−0.05	−0.04		0.41		14.89	1.63	1.15
	[0.85]	[0.84]		[0.90]		[0.00]	[0.05]	[0.07]
$\Sigma ExpP_{t-s}$*Illiquidity Ratio	−0.13	−0.14	−0.19	2.94		5.69	0.14	0.64
	[0.20]	[0.20]	[0.69]	[0.05]		[0.00]	[0.39]	[0.00]
$\Sigma ExpP_{t-s}$*Core Deposits	0.31	0.23	0.35	−3.07		−5.54	0.88	4.07
	[0.13]	[0.19]	[0.65]	[0.11]		[0.00]	[0.27]	[0.00]
Output Gap_t	−0.71	−0.74	−0.62	−0.95	−0.62	−0.97	−0.85	−0.77
	(1.14)	(1.07)	(1.32)	(1.40)	(1.3)	(1.4)	(1.4)	(1.42)
Credit Gap_t	−0.06	−0.06	−0.06	−0.05	−0.06	−0.04	−0.059	−0.059
	(0.25)	(0.25)	(0.24)	(0.24)	(0.24)	(0.23)	(0.24)	(0.25)
Constant	44.33*	41.31*	44.66*	51.03**	44.65*	51.93**	46.65*	46.15*
	(22.10)	(20.91)	(20.16)	(17.45)	(20.09)	(17.01)	(20.87)	(20.93)
Observations	1,310	1,310	1,310	1,310	1,310	1,310	1,310	1,310
R^2	0.092	0.094	0.078	0.089	0.078	0.090	0.081	0.082

Notes: Standard errors are in parentheses. P-values for the sum of lags equal to zero are in squared brackets. * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 10. Results for Specification 6

	Prudential Index	Capital Requirements	Sector-Specific Capital Buffer	LTV Ratio	Reserve Requirements: Foreign	Reserve Requirements: Local	Interbank Exposure Limits	Concentration Ratios
$ExpP_t$	−0.092	−6.170	0.888	−1.016	0	4.702	4.184	−1.165
	(1.05)	(5.52)	(1.68)	(1.39)	(.)	(2.97)	(2.97)	(2.16)
Log Total $Assets_{t-1}$	−3.371*	−3.378**	−3.463*	−3.528*	−3.525*	−3.649**	−3.576**	−3.287*
	(1.49)	(1.33)	(1.63)	(1.53)	(1.54)	(1.50)	(1.09)	(1.40)
Capital $Ratio_{t-1}$	0.037	0.034	0.036	0.035	0.036	0.034	0.038	0.037
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Illiquidity $Ratio_{t-1}$	−0.192***	−0.190***	−0.198***	−0.199***	−0.198***	−0.198***	−0.198***	−0.182***
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Core $Deposits_{t-1}$	0.062	0.037	0.061	0.056	0.063	0.060	0.048	0.054
	(0.12)	(0.12)	(0.12)	(0.12)	(0.11)	(0.11)	(0.12)	(0.12)
Credit Gap_t	−0.087	−0.003	−0.066	−0.065	−0.065	−0.038	−0.094	−0.129
	(0.21)	(0.18)	(0.20)	(0.21)	(0.20)	(0.23)	(0.25)	(0.24)
Output Gap_t	−0.094	−1.230	−0.193	−0.167	−0.209	−0.377	0.045	0.397
	(1.32)	(1.38)	(1.30)	(1.30)	(1.31)	(1.25)	(1.36)	(1.32)
$\Sigma ExpP_{t-s}$*Credit Gap_t	0.0664	−0.367***	−0.132	0.191	0	0.127	0.132	0.375)
	(0.067)	(0.084)	(0.25)	(0.18)	(.)	(0.25)	(0.27)	(0.28)
$\Sigma ExpP_{t-s}$*Output Gap_t	−0.134	5.395**	−0.0445	0.536	0	−0.182	−0.496	−0.964**
	(0.15)	(1.67)	(0.25)	(0.37)	(.)	(0.55)	(0.45)	(0.29)
Constant	42.04*	42.90**	43.30*	44.01*	43.88*	45.75**	43.97**	40.71*
	(18.53)	(17.16)	(20.45)	(19.45)	(19.62)	(19.05)	(15.43)	(17.76)
Observations	1,358	1,358	1,358	1,358	1,358	1,358	1,358	1,358
R^2	0.78	0.82	0.76	0.78	0.76	0.77	0.80	0.83

Notes: Standard errors are in parentheses. P-values for the sum of lags equal to zero are in squared brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

when a given policy measure was taken. Second, another particularity of the Mexican banking system is that there are some banks that do not perform typical banking activities, so the amount of credit they provide is relatively small, and many of them are domestic affiliates of foreign global banks. Hence, banks with credit levels at less than 30 percent of their assets were dropped. At the end, twenty-six banks remained for the analysis, from six different countries.

We will name this specification 7, and it has the advantage of allowing us to identify whether there are differentiated patterns depending on the home country of the parent bank. Specification 7, analogous to specification 4, was estimated, and tables 11 and 12 show the results.

Table 11 shows that the limits to loan-to-value ratios in Canada had a positive significant effect in credit, as well as for Spain, with zero lags. Table 12 shows the effect of capital requirements in Japan. There is a negative, significant impact from limits to concentration ratios in Mexico and a negative, significant impact from capital requirements in the United States. Given the relative importance of U.S. subsidiaries in Mexico, this negative effect on bank lending growth can be a significant cross-border spillover, and it occurs regardless of the conditions of the Mexican financial system or the set of policy measures implemented locally.

5. Conclusions

The introduction of any regulation may have unintended effects besides the intended original targets of the regulation. These effects become even more problematic when the affected entities are not part of the jurisdiction of the authority enforcing the regulation. This is the case of prudential regulations; prudential policies are intended to regulate banks in a certain jurisdiction, yet, given the international activity of many banks and the fact that they are implemented in consolidated terms, the effects of these policies may find their way to different banking systems across the world. Until now there has been no systematic record or measurement of these unintended effects. This paper is part of a multi-national joint effort led by the IBRN to quantify the impact.

To achieve this measurement, a baseline protocol was established which used a panel of banks and a data set compiled by the IBRN

Table 11. Results for Specification 7, Part I

		Prudential Index	Capital Requirements	Sector-Specific Capital Buffer	LTV Ratio	Reserve Requirements: Local	Interbank Exposure Limits	Concentration Ratios
Canada	$ExpP_t$	-0.0200^{*}	-0.042		-0.005			
	$ExpP_{t-1}$	0.015	-0.017^{*}		0.023^{**}			
	$ExpP_{t-2}$	0.021^{*}	0.006		0.020^{**}			
	$\Sigma ExpP_{t-s}$	0.016	-0.052		0.037^{**}			
		[0.35]	[0.46]		[0.03]			
Spain	$ExpP_t$	-0.0002	-0.022	-0.002	0.028^{**}	-0.024		
	$ExpP_{t-1}$	0.005	-0.005	-0.017	0.024	0.008		
	$ExpP_{t-2}$	0.005	0.019	-0.075	0.017	0.208^{*}		
	$\Sigma ExpP_{t-s}$	0.010	-0.008	-0.094	0.069	0.012		
		[0.37]	[0.81]	[0.34]	[0.22]	[0.80]		
Great Britain	$ExpP_t$	0.013	0.011					
	$ExpP_{t-1}$	-0.007	0.018					
	$ExpP_{t-2}$	-0.051	-0.057					
	$\Sigma ExpP_{t-s}$	-0.045	-0.028					
		[0.51]	[0.67]					

Notes: Standard errors are in parentheses. P-values for the sum of lags equal to zero are in squared brackets.

Table 12. Results for Specification 7, Part II

		Prudential Index	Capital Requirements	Sector-Specific Capital Buffer	LTV Ratio	Reserve Requirements: Local	Interbank Exposure Limits	Concentration Ratios
Japan	$ExpP_t$	0.041^{**}	0.047^{**}					
	$ExpP_{t-1}$	-0.233^{***}	-0.235^{***}					
	$ExpP_{t-2}$	0.132^{***}	0.146^{***}					
	$\Sigma ExpP_{t-s}$	-0.060	-0.042					
		[0.28]	[0.55]					
Mexico	$ExpP_t$	0.014	0.049				-0.040	-0.040^{**}
	$ExpP_{t-1}$	-0.026	-0.033				-0.022	-0.022
	$ExpP_{t-2}$	-0.010	-0.027				-0.024	-0.024
	$\Sigma ExpP_{t-s}$	-0.022	-0.011				-0.085^{*}	-0.085^{*}
		[0.64]	[0.90]				[0.08]	[0.08]
United States	$ExpP_t$	-0.096	-0.108					
	$ExpP_{t-1}$	-0.059^{**}	-0.075^{*}					
	$ExpP_{t-2}$	-0.037^{***}	-0.038^{**}					
	$\Sigma ExpP_{t-s}$	-0.192^{*}	-0.221					
		[0.05]	[0.12]					

Notes: Standard errors are in parentheses. The p-value for the sum of lags equal to zero is in squared brackets.

including changes in prudential policies in sixty-four different countries. According to the findings of this paper, several policies have distorted the growth of Mexican credit in both directions. For example, increased capital requirements in the United States have had a negative effect on bank credit growth in Mexico, and this effect tends to show with more lags. It shows also that reserve requirements in foreign currency appear to have had a negative impact on credit growth when considering indirect transmission channels through banks' counterparties. Limits to loan-to-value ratios in Canada have had a positive effect in bank lending growth in Mexico. Other policies that were found to affect our variable of interest were interbank exposure limits and concentration ratios.

Further research should explore the possibility of recording spillover effects from these policies on risk taking by banks and other dimensions. Also, if available, micro data at the creditor level should be used in order to cross-validate the results found here.

References

Aiyar, S. W., C. Calomiris, and T. Wieladek. 2014. "Does Macroprudential Regulation Leak? Evidence from a UK Policy Experiment." *Journal of Money, Credit and Banking* 46 (s1): 181–214.

———. 2015. "Bank Capital Regulation: Theory, Empirics, and Policy." *IMF Economic Review* 63 (4): 955–83.

Akinci, O., and J. Olmstead-Rumsey. 2015. "How Effective Are Macroprudential Policies? An Empirical Investigation." International Finance Discussion Paper No. 1136 (May), Board of Governors of the Federal Reserve Board System.

Berrospide, J., R. Correa, L. Goldberg, and F. Niepmann. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from the United States." *International Journal of Central Banking* 13 (S1).

Berrospide, J. M., and R. M. Edge. 2010. "The Effects of Bank Capital on Lending: What Do We Know, and What Does It Mean?" *International Journal of Central Banking* 6 (4): 5–54.

Buch, C., and L. Goldberg. 2017. "Cross-Border Regulatory Spillovers: How Much? How Important? Evidence from the International Banking Research Network." *International Journal of Central Banking* 13 (S1).

Bussière, M., J. Schmidt, and F. Vinas. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from France." *International Journal of Central Banking* 13 (S1).

Cabezas, L., and A. Jara. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Chile." *International Journal of Central Banking* 13 (S1).

Cerutti, E., S. Claessens, and L. Laeven. 2015. "The Use and Effectiveness of Macroprudential Policies: New Evidence." IMF Working Paper No. 15/61 (March).

Damar, H. E., and A. Mordel. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Canada." *International Journal of Central Banking* 13 (S1).

Ho, K., E. Wong, and E. Tan. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Hong Kong." *International Journal of Central Banking* 13 (S1).

Frost, J., J. de Haan, and N. van Horen. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from the Netherlands." *International Journal of Central Banking* 13 (S1).

Ohls, J., M. Pramor, and L. Tonzer. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Germany." *International Journal of Central Banking* 13 (S1).

International Banking and Cross-Border Effects of Regulation: Lessons from Korea*

Hyunggeun Park and Jungyeoun Lee
Bank of Korea

This paper analyzes the inward spillover effects of overseas prudential policy changes through foreign bank affiliates in Korea. We do not find strong evidence of inward spillover effects: in general, a change in the prudential policies in the home countries of foreign bank affiliates has not led to significant changes in the lending behaviors of the bank affiliates in Korea. However, for some prudential measures such as sectoral-specific capital buffers and reserve requirements, we observe negative correlations between home countries' tightening of those instruments and the changes in their lending.

JEL Codes: G01, F34, G21, G28.

1. Introduction

International bank lending is becoming increasingly important for the safety of the global financial system, in that swings in cross-border bank lending can amplify domestic credit trends and thus trigger booms and busts in individual countries. For example, while the total foreign debt by Korea's depositary institutions tripled from 2006 to the second quarter of 2008 ($51.1 billion to $159.1 billion), it shrank by 34 percent to $104.6 billion in just half a year after the global financial crisis broke out in the third quarter of 2008. This sudden stop in cross-border loan supply brought a foreign-currency liquidity problem to these institutions, subsequently exacerbating the credit crunch in the financial markets during the period.

In the case of Korea, capital controls prior to the Asian financial crisis in 1997 limited the spillover of global monetary shocks,

*Author e-mails: hyungg@bok.or.kr (Park) and jyeoun@bok.or.kr (Lee).

but financial deregulation and capital liberalization after the crisis[1] increased the vulnerability to global shocks such as the monetary and financial policies of foreign countries on the domestic financial market. In particular, with the introduction of macroprudential policy after the global financial crisis—in Korea as well as in major countries—the cross-border spillover has become an important issue.

The footprint of foreign banks in Korea in terms of the number of banks and the scale of assets is still small. As of end-2014, foreign banks' total assets accounted for 15.5 percent of that of the whole Korean banking sector, of which bank loans accounted for 8.3 percent.

Foreign bank branches operate quite differently from domestic banks in terms of their business model. Their principal means of funding is borrowing from both their head offices abroad and the Korean financial market via currency/interest rate swap transactions. Deposits accounted for only 17.2 percent of their total funding as of end-2014.

Turning to their asset management, derivative transactions such as interest rate swaps and currency swaps are major business concerns, whereas loans are relatively minor. Loans accounted for 29.1 percent of foreign banks' total assets as of end-2014, which is quite small compared with that of domestic banks (73.7 percent).

The significance of foreign banks in Korea in terms of systemic risk seems unremarkable considering that their assets comprise only a small portion of the Korean banking industry. However, taking into account the fact that they provide an important source of foreign wholesale funding in the Korean financial system, and considering that their transactions with Korean financial institutions have a great impact on liquidity conditions in the Korean financial market, their systemic importance should not be overlooked.

On top of that, foreign banks' derivative activities through swap transactions are sensitive to foreign exchange rate and interest rate movement. This high sensitivity of foreign banks tends to make the Korean financial system fragile to any changes in the global financial

[1]For major changes in the capital account regulations in Korea before and after the 1997 crisis, refer to Yang-taek Lim, "Liberalization Process of Korean Capital Markets," *Investment Management and Financial Innovations* 1 (2004), 25–44.

market and to policy changes in foreign countries. In this sense, the investigation of the impact of prudential policies abroad on foreign banks in Korea will have important implications in terms of financial stability in Korea.

In this respect, we have explored in this paper the evidence of inward spillover effects of prudential policy changes in foreign countries through their affiliates in Korea. In general, the results suggest that changes in prudential measures in home countries do not have an effect on the lending behavior of foreign banks in Korea. Though we observed statistically significant coefficients for some prudential measures such as sectoral-specific capital buffers and reserve requirements, the results are not robust enough to provide consistent implications across different model specifications and confirm the existence of inward spillover effects in Korea.

The remainder of this paper is organized as follows. Section 2 discusses the empirical models utilized to analyze the impact of home countries' prudential policies on foreign banks' lending in Korea. Section 3 provides a brief description of the data used, while section 4 presents the empirical results. Section 5 concludes and presents some policy implications.

2. Data

We collect the bank-level statistics from the FAIRS[2] (Financial Analysis Information Retrieval System) database, which provides various data from the financial statements of Korean financial institutions. As of end-2013, the amount of loans from foreign banks, which is the main focus of the analysis, is relatively small compared with asset levels, as foreign banks occupy 8.1 percent of total banking loans in Korea. While subsidiaries and branches have a similar amount of total loans (subsidiaries 4.1 percent and branches 4.0 percent of total banking loans), the composition of the loans is strikingly different. Subsidiaries account for 4.0 percent of the total loans issued in Korean won, compared with only 0.5 percent

[2]FAIRS is a database developed by the Bank of Korea (BOK) using the data provided by the Financial Supervisory Service (FSS) in accordance to the memorandum of understanding on the information sharing between the FSS and the BOK.

for branches. In contrast, branches account for 14.6 percent of the loans denominated in foreign currency, compared with 1.4 percent for subsidiaries.

Among the forty-two foreign banks in Korea, we exclude those that had no balance in loans as of the end of 2013. Banks that have had at least one zero loan balance since 2000 are further excluded.[3] Lastly, banks from countries that are not included in the prudential database or the BIS cycle database are excluded. Applying these criteria, twenty-eight foreign banks are selected, including two subsidiaries and twenty-six branches. As of end-2013, these banks accounted for 98.6 percent of total foreign bank loans, and the twenty-six branches included in the sample made up 97.4 percent of total foreign bank branch loans. The sample period covers from 2000:Q1 to 2013:Q4.

For the prudential policy index, we use the International Banking Research Network (IBRN) Prudential Instruments Database described in Cerutti et al. (2017). The foreign banks included in the sample are from eleven countries: the United States, Canada, the United Kingdom, France, Germany, Australia, New Zealand, India, Singapore, Japan, and China. Each country operates prudential measures in a different way. The prudential database summary shows that emerging countries use prudential policies more frequently than advanced economies. For this reason, in the case of Korea the sample includes very few observations that have non-zero values in regulation index, as most of the parent banks of foreign banks in Korea are located in advanced countries. Changes in reserve requirements for foreign-currency-denominated deposits are observed only in one country, and we also identify only ten changes in sector-specific capital buffer and seven changes in interbank exposure limits among 1,423 observations.

The most widely used measure is capital requirements, of which there are twenty observations, since most countries in the sample have adopted Basel-type capital regulation schemes. There are ten episodes of loan-to-value (LTV) ratio limits, which are relatively large considering the fact that most of the observations are from a

[3]As of the end of 2013, more than ten banks had no loan balances in their balance sheet. The businesses of those banks are concentrated on incidental businesses, such as securities investment.

Table 1. Summary Statistics on Bank Characteristics

Balance Sheet Characteristics	Median	75th Percentile
Log Assets	14.84	16.01
Tier 1 Ratio	20.54	40.78
Illiquid Assets Ratio	46.62	70.09
Net Intragroup Funding/Liabilities	35.77	71.38
Deposits Ratio	3.42	11.42
Loans (Ln Change)	2.35	13.19

Notes: This table provides summary statistics for bank balance sheet and lending data. Data are observed quarterly from 2000:Q1 to 2013:Q4. Banking data come from the FSS and are reported at the unconsolidated level. The Net Intragroup Funding variable measures from the perspective of a bank's head office total net internal lending (or borrowing) vis-à-vis all its related domestic and international offices.

few countries. There are forty-one observations of reserve requirements for deposits denominated in local currency. For concentration ratio limits we have twenty-one observations in the sample, and three countries are implementing the instrument. Among 112 episodes in total, measures were tightened in ninety-four cases (84 percent) and loosened in 18 cases (16 percent).

The summary statistics on bank characteristics and changes in prudential instruments are shown in tables 1 and 2.

3. IBRN Baseline Model Specification

Our work follows the empirical approach set by the IBRN, which suggests four main model specifications. The first model is specified as follows:

$$\Delta Y_{b,j,t} = \alpha_0 + \alpha_i \sum_{i=1}^{3} HomeP_{j,t-1} + \alpha_4 X_{b,j,t-1} + \alpha_5 Z_{j,t} + f_b + f_t + \varepsilon_{b,j,t}. \quad (1)$$

$\Delta Y_{b,j,t}$ is the quarterly change in log loans of foreign bank b in Korea whose parent bank or head office is located in country j. Only the change in total loans is considered, as foreign bank branches do

Table 2. Summary Statistics on Changes in Prudential Instruments

Instrument	No. of Country-Time Changes	No. of Country-Time Changes (Tightening)	No. of Country-Time Changes (Loosening)	No. of Bank-Time Changes	Proportion $HomeP_t$ Non-zero
Prudential Index	108	89	19	256	0.180
General Capital Requirements	20	20	0	35	0.025
Sector-Specific Capital Buffer (Real Estate)	9	6	3	9	0.006
Sector-Specific Capital Buffer (Consumption)	2	1	1	2	0.001
Sector-Specific Capital Buffer (Other)	4	2	2	4	0.003
Loan-to-Value Ratio Limits	10	7	3	65	0.046
Reserve Requirements: Foreign	3	3	0	14	0.010
Reserve Requirements: Local	41	29	22	137	0.096
Interbank Exposure Limit	7	7	0	7	0.005
Concentration Ratio	21	21	0	51	0.036

Source: IBRN.

Notes: This table shows summary statistics on changes in prudential instruments for banks located in Korea over the period 2000–13. Data on the instruments come from the IBRN Prudential Instruments Database described in Cerutti et al. (2017) and are on the quarter level. The number of changes in prudential instruments is reported on several dimensions, i.e., on the country-time level and on the bank-time level. The last column of the table shows the share of prudential changes to total observations (i.e., the share of non-zero observations). The reported data are based on the regression sample.

not actively provide all types of loans in the Korean domestic credit market.

$HomeP_{j,t}$ is the quarterly change in a macroprudential policy index for country j at time t. $X_{b,j,t-1}$ is a vector of bank characteristics control variables and $Z_{j,t}$ represents the business and financial cycle indexes for country j, which are compiled by the Bank for International Settlements (BIS). The baseline model includes not only bank fixed effects (f_b) but also time fixed effects (f_t).

$$\Delta Y_{b,j,t} = \alpha_0 + \alpha_i \sum_{i=1}^{3} HomeP_{j,t-i+1} + \alpha_4 X_{b,j,t-1} + \alpha_5 Z_{j,t} + \beta_i \sum_{i=1}^{3} HomeP_{j,t-i+1} \cdot X_{b,j,t-1} + f_b + f_t + \varepsilon_{b,j,t}. \quad (2)$$

The second model above adds to model (1) interaction terms between prudential policy variables and bank-specific characteristics.

The third model is specified as follows:

$$\Delta Y_{b,j,t} = \alpha_0 + \alpha_i HomeP_{cum,b,j,t} + \alpha_2 X_{b,j,t-1} + \alpha_3 Z_{j,t} + \alpha_4 HomeP_{b,j,t} \cdot Z_{j,t} + f_b + f_t + \varepsilon_{b,j,t}. \quad (3)$$

$HomeP_{cum,b,j,t}$ is a cumulative macroprudential index showing the level of policy tightness of country j at time t. On top of that, $HomeP_{cum,b,j,t}$ interacts with home-country cycle indicators, $Z_{j,t}$ in the regression.

$$\Delta Y_{b,j,t} = \alpha_0 + \alpha_i \sum_{i=1}^{3} HomeP_{j,t-i+1} + \alpha_4 X_{b,j,t-1} + \alpha_5 Z_{j,t} + \alpha_6 Z_{host,t} + \beta_i \sum_{i=1}^{3} HomeP_{t-i+1} + f_b + \varepsilon_{b,j,t}. \quad (4)$$

The final model considers the variables of the host country (Korea). More specifically, $HostP_t$ represents changes in prudential measures in Korea at time t and $Z_{host,t}$ represents Korea's real and financial cycles. This reflects the fact that the activities of foreign

bank subsidiaries and branches are significantly influenced by the host country's economic situation and regulatory environment. In Korea in particular, where even foreign branches are regarded as independent legal entities and supervised by the FSS, it is natural to think that host-country variables may be more relevant.

4. Estimation Results

In this section, we discuss the empirical evidence presented in tables 3–6. In general, a foreign bank would respond to prudential regulations in its home country by adjusting its lending. However, the degree of this adjustment could vary depending on the country or type of regulation. In response to prudential policy, the parent bank in the home country could reduce its exposures to the country to which it has the most significant amount of exposures. In this case, loans may not decrease in countries such as Korea that host banks with smaller assets or banks that concentrate on business types other than loans. The resulting regulatory coefficients would not be negative.

If tight regulations are applied on a country-specific basis instead of being applied to every country, they can lead to changes in the lending behavior of banks. For instance, if LTV caps were to be tightened in a specific country, the parent bank could respond by reducing loans in that country and increasing loans in countries that have not tightened the caps.

As seen so far, the response of loans to changes in regulations, or the sign of the regulatory coefficient, could differ depending on the countries analyzed. This should be taken into account when analyzing the empirical results in Korea's case.

4.1 Reactions to Capital-Related Regulations and Reserve Requirements

For general capital requirements, the estimated coefficients show different patterns among the specifications, as can be seen in the second columns of tables 3–6. The sums of coefficients in the models show different signs (negative in the first and fourth models, positive in the second), and the result from the F-test to check the statistical

Table 3. Inward Transmission of Policy via Affiliates of Foreign-Owned Banks (I)

	All Instruments (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	Loan-to-Value Ratio (4)	Reserve Requirements: Foreign (5)	Reserve Requirements: Local (6)	Interbank Exposure Limits (7)	Concentration Ratios (8)
Prudential Policies ($HomeP_t$)	−0.044*	0.005	−0.104***	0.015	−0.213**	−0.041*	−0.077	−0.195**
	(0.023)	(0.046)	(0.017)	(0.036)	(0.089)	(0.021)	(0.192)	(0.081)
Prudential Policies ($HomeP_{t-1}$)	0.014	0.005	−0.031	0.011	−0.066	−0.033***	0.002	0.180**
	(0.022)	(0.049)	(0.023)	(0.027)	(0.082)	(0.009)	(0.034)	(0.059)
Prudential Policies ($HomeP_{t-2}$)	−0.011	−0.077	0.007	−0.075*	−0.043	0.021	0.090	−0.003
	(0.017)	(0.043)	(0.013)	(0.037)	(0.054)	(0.020)	(0.063)	(0.057)
Log Total $Assets_{t-1}$	−0.126***	−0.124***	−0.126***	−0.125***	−0.127***	−0.127***	−0.125***	−0.122***
	(0.030)	(0.030)	(0.031)	(0.031)	(0.028)	(0.029)	(0.031)	(0.029)
Tier 1 $Ratio_{t-1}$	−0.000	0.000	−0.000	0.000	−0.000	−0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Illiquid Assets $Ratio_{t-1}$	−0.360***	−0.360***	−0.359***	−0.357***	−0.363***	−0.362***	−0.359***	−0.355***
	(0.058)	(0.059)	(0.060)	(0.058)	(0.058)	(0.058)	(0.059)	(0.057)
Net Intragroup Funding $Ratio_{t-1}$	0.084	0.078	0.076	0.071	0.087	0.081	0.075	0.066
	(0.104)	(0.103)	(0.104)	(0.104)	(0.105)	(0.104)	(0.104)	(0.100)
Core Deposits $Ratio_{t-1}$	−0.118	−0.118	−0.122	−0.109	−0.103	−0.121	−0.121	−0.097
	(0.178)	(0.184)	(0.184)	(0.188)	(0.185)	(0.179)	(0.178)	(0.184)
Credit Gap (Home Country)	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Output Gap (Home Country)	0.000	−0.001	−0.000	−0.001	−0.003	−0.000	−0.001	−0.001
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Prudential Policies (Combined)	−0.041	−0.067	−0.128***	−0.049	−0.322	−0.053	0.015	−0.018
	[0.232]	[0.427]	[0.000]	[0.429]	[0.149]	[0.132]	[0.953]	[0.866]
Observations	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367
Adjusted R^2	0.138	0.137	0.138	0.138	0.139	0.138	0.137	0.144
No. of Banks	28	28	28	28	28	28	28	28

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in total loans. The data are quarterly from 2000:Q1 to 2013:Q4. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects. Standard errors are clustered by banks. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively. Standard errors are in parentheses. P-values are in squared brackets.

Table 4. Inward Transmission of Policy via Affiliates of Foreign-Owned Banks (II)

	All Instruments (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	Loan-to-Value Ratio (4)	Reserve Requirements: Foreign (5)	Reserve Requirements: Local (6)	Interbank Exposure Limits (7)	Concentration Ratios (8)
Prudential Policies ($HomeP_t$)	−0.022	0.075	−0.564**	−0.074	−0.815*	−0.080	−1.269*	−0.232
	(0.037)	(0.136)	(0.180)	(0.129)	(0.429)	(0.125)	(0.660)	(0.228)
Prudential Policies ($HomeP_{t-1}$)	0.024	−0.029	0.873***	−0.022	−0.321***	0.036	−0.821**	0.361**
	(0.046)	(0.127)	(0.163)	(0.121)	(0.099)	(0.099)	(0.325)	(0.147)
Prudential Policies ($HomeP_{t-2}$)	0.014	−0.020	0.710	−0.072	0.143	−0.093	0.106	−0.020
	(0.068)	(0.128)	(0.434)	(0.231)	(0.079)	(0.103)	(0.248)	(0.137)
Log Total $Assets_{t-1}$	−0.126***	−0.124***	−0.127***	−0.128***	−0.130***	−0.125***	−0.126***	−0.124***
	(0.031)	(0.030)	(0.031)	(0.032)	(0.029)	(0.029)	(0.032)	(0.030)
Tier 1 $Ratio_{t-1}$	−0.000	0.000	−0.000	−0.000	0.000	0.000	−0.000	−0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Illiquid Assets $Ratio_{t-1}$	−0.361***	−0.361***	−0.359***	−0.358***	−0.366***	−0.367***	−0.361***	−0.356***
	(0.060)	(0.061	(0.059)	(0.058)	(0.061)	(0.062)	(0.058)	(0.057)
Net Intragroup Funding $Ratio_{t-1}$	0.096	0.079	0.083	0.056	0.084	0.094	0.068	0.069
	(0.127)	(0.111)	(0.108)	(0.114)	(0.112)	(0.109)	(0.114)	(0.107)
Core Deposits $Ratio_{t-1}$	−0.177	−0.156	−0.132	−0.200	−0.166	−0.110	−0.128	−0.085
	(0.185)	(0.167)	(0.185)	(0.202)	(0.199)	(0.200)	(0.180)	(0.176)
Credit Gap (Home Country)	0.001	0.001	0.001	0.001	0.000	0.000	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Output Gap (Home Country)	0.001	−0.000	−0.002	−0.003	−0.004	−0.002	−0.003	−0.000
	(0.008)	(0.009)	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)
Log Total Assets* HomeP	0.000*	0.000*	0.000	0.000*	0.000*	0.000*	0.000**	0.000
	[0.081]	[0.009]	[0.152]	[0.061]	[0.053]	[0.078]	[0.013]	[0.360]
Tier 1 Ratio*HomeP	0.001	−0.005	−0.015	0.000	0.009	0.002**	−0.042***	0.005
	[0.128]	[0.141]	[0.089]	[0.867]	[0.274]	[0.025]	[0.000]	[0.303]

(*continued*)

Table 4. (Continued)

	All Instruments (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	Loan-to-Value Ratio (4)	Reserve Requirements: Foreign (5)	Reserve Requirements: Local (6)	Interbank Exposure Limits (7)	Concentration Ratios (8)
Illiquid Assets Ratio* HomeP	−0.155 [0.442]	0.654 [0.266]	1.015 [0.024]	−0.204 [0.576]	0.070 [0.862]	0.059 [0.661]	1.236** [0.012]	−0.566 [0.369]
Net Intragroup Funding Ratio*HomeP	−0.062 [0.764]	−0.251 [0.655]	−3.765 [0.000]	0.093 [0.584]	−0.449 [0.498]	−0.245 [0.140]	2.909* [0.052]	0.061 [0.941]
Core Deposits Ratio* HomeP	0.489** [0.026]	0.991 [0.353]	9.553 [0.000]	2.309* [0.064]	4.626** [0.011]	0.665*** [0.005]	7.981*** [0.008]	0.759 [0.310]
Prudential Policies (Combined)	0.016 [0.885]	0.026 [0.904]	1.019 [0.108]	−0.168 [0.568]	−0.993** [0.035]	−0.137 [0.356]	−1.984** [0.047]	0.109 [0.760]
Observations	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367
Adjusted R^2	0.143	0.141	0.144	0.146	0.143	0.144	0.146	0.151
No. of Banks	28	28	28	28	28	28	28	28

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in total loans. The data are quarterly from 2000:Q1 to 2013:Q4. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. For HomeP interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding F-statistics for joint significance in parentheses. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects. Standard errors are clustered by banks. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively. Standard errors are in parentheses. P-values are in squared brackets.

Table 5. Inward Transmission of Policy via Affiliates of Foreign-Owned Banks (III)

	All Instruments (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	Loan-to-Value Ratio (4)	Reserve Requirements: Foreign (5)	Reserve Requirements: Local (6)	Interbank Exposure Limits (7)	Concentration Ratios (8)
Prudential Policies ($\text{HomeP}_{\text{cum}}$)	−0.003	−0.030	−0.011	−0.008	−0.033	−0.006	0.084	−0.018
	(0.004)	(0.041)	(0.012)	(0.010)	(0.022)	(0.006)	(0.052)	(0.031)
Log Total Assets_{t-1}	−0.127***	−0.114***	−0.118***	−0.126***	−0.127***	−0.126***	−0.110***	−0.122***
	(0.030)	(0.029)	(0.034)	(0.028)	(0.030)	(0.029)	(0.032)	(0.032)
Tier 1 Ratio_{t-1}	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Illiquid Assets Ratio_{t-1}	−0.370***	−0.356***	−0.356***	−0.368***	−0.368***	−0.369***	−0.380***	−0.365***
	(0.070)	(0.058)	(0.059)	(0.070)	(0.069)	(0.069)	(0.054)	(0.066)
Net Intragroup Funding Ratio_{t-1}	0.012	0.044	0.044	0.014	−0.002	0.007	0.039	0.028
	(0.130)	(0.116)	(0.109)	(0.125)	(0.135)	(0.134)	(0.112)	(0.118)
Core Deposits Ratio_{t-1}	−0.229	−0.148	−0.157	−0.233	−0.202	−0.225	−0.111	−0.198
	(0.177)	(0.174)	(0.177)	(0.174)	(0.183)	(0.174)	(0.160)	(0.173)
Credit Gap (Home Country)	−0.001	0.001	0.001	−0.001	−0.001	−0.001	0.000	−0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Output Gap (Home Country)	0.001	0.000	0.001	0.002	0.000	0.001	−0.004	0.011
	(0.009)	(0.010)	(0.009)	(0.010)	(0.009)	(0.009)	(0.008)	(0.008)
Credit Gap*HomeP	0.000***	−0.000	0.001	0.001**	0.003***	0.001***	0.003***	0.002
	(0.000)	(0.002)	(0.002)	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)
Output Gap*HomeP	0.000	0.037*	0.010***	0.000	−0.002	−0.001	0.023**	−0.013***
	(0.001)	(0.018)	(0.002)	(0.003)	(0.005)	(0.002)	(0.008)	(0.004)
Observations	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395
Adjusted R^2	0.149	0.144	0.144	0.149	0.150	0.149	0.149	0.148
No. of Banks	28	28	28	28	28	28	28	28

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in total loans. The data are quarterly from 2000:Q1 to 2013:Q4. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects. Standard errors are clustered by banks. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively. Standard errors are in parentheses.

Table 6. Inward Transmission of Policy via Affiliates of Foreign-Owned Banks (IV)

	All Instruments (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	Loan-to-Value Ratio (4)	Reserve Requirements: Foreign (5)	Reserve Requirements: Local (6)	Interbank Exposure Limits (7)	Concentration Ratios (8)
Home Prudential Policies ($HomeP_t$)	−0.028	0.026	−0.096**	0.056**	−0.079	−0.013	−0.091	−0.145***
	(0.020)	(0.069)	(0.033)	(0.022)	(0.052)	(0.023)	(0.200)	(0.044)
Home Prudential Policies ($HomeP_{t-1}$)	0.012	−0.043	−0.005	−0.004	−0.009	−0.032	−0.062**	0.075*
	(0.017)	(0.051)	(0.013)	(0.011)	(0.071)	(0.028)	(0.022)	(0.036)
Home Prudential Policies ($HomeP_{t-2}$)	0.021	−0.046	0.022	−0.066**	−0.034**	0.040	0.060	0.048
	(0.020)	(0.037)	(0.021)	(0.026)	(0.014)	(0.036)	(0.057)	(0.057)
Log Total $Assets_{t-1}$	−0.095***	−0.090***	−0.091***	−0.088***	−0.094***	−0.090***	−0.093***	−0.091***
	(0.025)	(0.027)	(0.025)	(0.025)	(0.024)	(0.023)	(0.025)	(0.025)
Tier 1 $Ratio_{t-1}$	0.000	0.001	0.000	0.001	0.000	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Illiquid Assets $Ratio_{t-1}$	−0.331***	−0.330***	−0.329***	−0.330***	−0.330***	−0.328***	−0.329***	−0.329***
	(0.030)	(0.029)	(0.029)	(0.029)	(0.029)	(0.028)	(0.029)	(0.028)
Net Intragroup Funding $Ratio_{t-1}$	0.016	0.030	0.018	0.012	0.026	0.036	0.024	0.015
	(0.110)	(0.108)	(0.107)	(0.108)	(0.109)	(0.101)	(0.109)	(0.104)
Core Deposits $Ratio_{t-1}$	0.017	0.029	0.020	0.029	0.023	0.030	0.022	0.042
	(0.217)	(0.211)	(0.218)	(0.222)	(0.220)	(0.211)	(0.210)	(0.221)
Credit Gap (Home Country)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Output Gap (Home Country)	0.008	0.004	0.003	0.006	0.004	0.002	0.004	0.004
	(0.007)	(0.006)	(0.007)	(0.007)	(0.006)	(0.008)	(0.006)	(0.006)
Credit Gap (Host Country)	0.003**	0.003*	0.003*	0.003*	0.003**	0.003**	0.003**	0.003**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Output Gap (Host Country)	−0.008	−0.001	0.002	−0.004	−0.001	−0.000	−0.001	−0.001
	(0.006)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)

(*continued*)

Table 6. (Continued)

	All Instruments (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	Loan-to-Value Ratio (4)	Reserve Requirements: Foreign (5)	Reserve Requirements: Local (6)	Interbank Exposure Limits (7)	Concentration Ratios (8)
Host Prudential Policies ($HostP_t$)	0.033	−0.012	−0.097	0.026	NA	0.006	NA	NA
	(0.019)	(0.033)	(0.072)	(0.016)	NA	(0.042)	NA	NA
Host Prudential Policies ($HostP_{t-1}$)	−0.003	0.032	0.106*	−0.006	NA	−0.020	NA	NA
	(0.013)	(0.035)	(0.048)	(0.017)	NA	(0.081)	NA	NA
Host Prudential Policies ($HostP_{t-2}$)	0.047*	−0.002	0.030	0.042	NA	0.134	NA	NA
	(0.022)	(0.041)	(0.048)	(0.027)	NA	(0.148)	NA	NA
Home Prudential Policies (Combined)	0.005	−0.063	−0.079	−0.014	−0.122	−0.005	0.031	−0.022
	[0.872]	[0.598]	[0.100]	[0.678]	[0.343]	[0.917]	[0.894]	[0.816]
Host Prudential Policies (Combined)	0.077**	0.018	0.039	0.062*	NA	0.120	NA	NA
	[0.035]	[0.707]	[0.574]	[0.056]	NA	[0.462]	NA	NA
Observations	1,313	1,313	1,313	1,313	1,313	1,313	1,313	1,313
Adjusted R^2	0.105	0.098	0.102	0.104	0.096	0.101	0.096	0.107
No. of Banks	28	28	28	28	28	28	28	28

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in total loans. The data are quarterly from 2000:Q1 to 2013:Q4. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects. "NA" indicates that no data has been available for this instrument. Standard errors are clustered by banks. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively. Standard errors are in parentheses. P-values are in squared brackets.

significance of the joint hypothesis fails to present clear evidence for the inward spillover effect of capital requirements regulation (p-values are greater than 10 percent in all specifications).

These results may reflect the relatively small size of foreign banks in Korea. In other words, as the loan assets of foreign bank affiliates in Korea are of relatively little importance in the consolidated level, the changes in capital requirements in the home countries have not made a significant impact on the loan-supplying activities of those banks in Korea. In addition, in response to a change in capital requirements regulation, banks adjust the composition of their asset portfolios to manage the optimal level of risk. This process is done at the consolidated level, so the headquarters' decisions on the degree of adjustment at the foreign branch level depend on the relative importance of the branch in terms of the total exposure. In this sense, it is possible that foreign bank branches, which have a relatively small exposure in the consolidated view, are pushed back on the priority list when the parent banks redistribute their portfolios.

An alternative explanation for the weak results is that in terms of the capital requirements there may not have been great opportunities for regulatory arbitrage, as the development of global capital requirements regulation has been led by the BIS, and most countries included in the sample (including Korea) have followed the supervisory guidance agreed to among BIS member countries.

Meanwhile, it is discovered that foreign bank loans do not respond significantly to capital requirement changes in Korea. In Korea, foreign bank branches are also required to meet capital ratio regulations based on the same criteria as Korean domestic banks. However, they normally tend to resort to headquarter financing, directly adjusting regulatory capital rather than adjusting their asset portfolios.

For the sector-specific capital buffer, in models using policy variables only, without balance sheet variables interactions (i.e., in models 1, 3, and 4), it turns out that tightening the sector-specific capital buffer in the home country generally leads to a decrease in the lending growth of foreign banks in Korea, as shown in the third column of tables 3, 4, and 6. It is applied at the consolidated balance sheet level, so the negative sign of the coefficients can also be interpreted to reflect the tendency that international banks adjust their total

lending portfolios and simply redistribute the adjustments to their business units.[4]

With respect to reserve requirements, our analysis consistently shows that a tightening of reserve requirements in home countries, whether it be for local- or foreign-currency deposits, has a negative inward spillover effect on the lending activities of foreign banks in Korea, as we can observe in the fifth and sixth columns of tables 3–6. Like LTV ratio limits, reserve requirements also control the supply of credit by banks directly. Thus, it is possible that a tightening in reserve requirements reduces the lending capacity of the parent banks in general, which also undermines the financing of foreign affiliates from their parent banks. Considering the fact that foreign bank affiliates in Korea and foreign bank branches in particular depend heavily on financing from their headquarters, these results seem reasonable. In contrast, changes in Korea's reserve requirements have no significant impact on the changes in the loan supply of foreign banks in Korea. We see this result as a reflection of the low dependency on deposits of foreign bank branches in Korea.

4.2 Reactions to the Other Policy Instruments

In the analysis of LTV limits, as shown in the fourth columns of tables 3–6, there is no striking evidence observed in the estimation results. An LTV ratio limit is a measure that directly controls the quantity of the mortgage loan supply. Therefore, it is generally expected that a forced shrinkage in the domestic mortgage market caused by a tightening of LTV limits will encourage banks to seek opportunities abroad, thus leading to an increase in the lending of foreign bank branches. However, considering the lack of retail banking activities of foreign bank branches in Korea, the absence of linkage between loan supply from foreign banks and LTV limit changes in the home country is not surprising. The result that foreign bank branches in Korea do not respond to LTV limit changes

[4]Among the countries included in the analysis, only two countries have implemented this regulation, and policy changes occurred only ten times in total. Also, there are only two foreign bank branches from these countries, one from each country, and the loans supplied by these banks account for just 3 percent of total foreign bank branch loans.

of Korea also reflects this characteristic of the business activities of foreign bank branches.

For the last two dependent variables, interbank exposure limits and concentration ratio limits, this study does not find any connection between the lending behaviors of foreign banks in Korea and the changes in these regulations in home countries, as shown in the seventh and eighth columns of tables 3–6. Interbank exposure limits have been implemented by a very limited number of countries and have not changed frequently. In addition, this measure focuses on limiting the contagion channel of a failure of a globally important financial institution. Even though foreign banks in Korea are involved in various interbank activities in the Korean financial market, generally with Korean domestic banks, this regulation seems to have had little influence on their activities, since Korean domestic banks are not classified as "systemically important" from a global view. Regarding the concentration limits of home countries, it is difficult to find any plausible reason to think that they may change the business activities of the foreign affiliates, because those measures intend only to mitigate the market domination of big banks in their domestic banking industries.

4.3 Note on the Reactions to the Korean Financial Cycle

Among the other independent variables, we would like to take notice of cycle variables. In most of the specifications, the loan-supplying behavior of foreign affiliates in Korea turned out not to be influenced by home countries' financial and business cycles. In contrast to this, we observe statistically significant positive coefficients for the financial cycle of the host country (Korea) in table 6, which implies that foreign bank branches are more sensitive to changes in the macroeconomic situations of host countries than home countries. Meanwhile, home countries' cycle variables turn out to have marginal effects on the inward spillover of regulatory changes in some cases. In table 5, which displays the coefficients on the interaction term between the financial cycle and regulatory variables, we can observe statistically significant positive numbers for LTV, reserve requirements, and interbank exposure limits. This means that the negative (positive) effects of regulation tightening on log loan changes are weakened

(strengthened) when the measure is implemented in the expansionary phase of the financial cycle. The business cycle has also a similar effect on capital requirements, sector-specific capital buffers, and interbank exposure limits.

4.4 Spillover through the "Funding Channel"

Foreign banks in Korea may contribute to total bank lending by providing liquidity through swap operations with domestic Korean banks. (We will refer to this channel in Korea as the "funding channel.") Thus, we investigate whether there is a significant spillover through the funding channel—specifically, changes in the internal funding of foreign bank affiliates. We slightly modify the first model specification, using a change in the intragroup funding (borrowing from the head office) ratio to total liabilities as a dependent variable and keeping other explanatory variables except the net intragroup funding ratio in the model. In general, we fail to find strong evidence to confirm a meaningful change in the funding behavior of foreign banks in response to changes in prudential measures of home countries.

However, this does not mean that the foreign banks' swap operations have no effect on total bank lending in Korea, considering that our dependent variable includes only lending by foreign banks. Additional analysis will be necessary to verify the funding channel, although that is beyond the scope of this IBRN project on prudential regulation spillover through foreign banks.

Regarding the above analysis, it should be pointed out that the activities of foreign banks in Korea are heavily influenced by Korean regulation of cross-border capital flows. In Korea, prudential policies related to foreign exchange risk have been implemented since the global financial crisis.[5] As these measures change the funding conditions of foreign banks, it is possible that their business activities are more significantly influenced by these regulations in Korea than by the home countries' prudential measures.

[5]Leverage caps on banks' foreign exchange (FX) derivatives positions require banks to limit their FX derivatives positions at or below a targeted level. Furthermore, a macroprudential stability levy (MSL) aims to limit the level of banks' non-core FX liabilities.

5. Conclusion

Since the global financial crisis, most countries have been introducing or strengthening prudential policies to limit systemic risk in the financial sector to a manageable level. However, in a world where financial markets are being globally integrated and the nationality of money is becoming less and less important, the effectiveness of prudential policy in one country can be significantly restricted by policy actions of other countries. In this sense, a multilateral approach in designing an effective prudential policy scheme is very crucial.

This paper aims to find evidence of inward spillover effects of prudential policy changes through foreign bank affiliates in Korea. The general conclusion is that the evidence of inward spillover effects is not strong; that is, a change in prudential policies in home countries has not led to significant changes in the lending behaviors of foreign banks in Korea generally. However, with respect to some prudential measures, such as sectoral-specific capital buffers and reserve requirements, we observed negative correlations between the tightening of those instruments in home countries and the changes in the lending of foreign bank affiliates in Korea.

As we discussed in an earlier section, we conjecture that the generally weak evidence is mainly due to the business practices of foreign banks in Korea. Lending is not their primary business activity, even though foreign banks are steadily expanding their retail banking activities. Instead, their role as providers of foreign currencies in the Korean financial markets remains crucial. In addition, the business model of foreign banks differs by nationality. For example, foreign bank branches from the United States and Europe act as investment banks, while Asian banks are more actively involved in trade finance.

Additional analysis on whether macroprudential policies affect the funding of foreign banks from their headquarters and thus eventually affect foreign bank lending in Korea produced a negative result. In other words, we could not find support for the hypothesis that foreign bank lending is affected by variation in funding from home-country headquarters caused by any macroprudential policy change. Despite this result, we cannot completely discard the possibility that foreign banks' funding from headquarters affects the bank

lending of Korean banks that engage in swap transactions with foreign banks in Korea. However, clarification of this issue seems to be beyond the scope of the current IBRN project, and we would like to leave it for future research.

References

Cerutti, E., R. Correa, E. Fiorentino, and E. Segalla. 2017. "Changes in Prudential Policy Instruments—A New Cross-Country Database" *International Journal of Central Banking* 13 (S1).

International Banking and Cross-Border Effects of Regulation: Lessons from the Netherlands*

Jon Frost,[a,b] Jakob de Haan,[a,c,d] and Neeltje van Horen[a,e]
[a]De Nederlandsche Bank, Amsterdam, The Netherlands
[b]VU University, Amsterdam, The Netherlands
[c]University of Groningen, Groningen, The Netherlands
[d]CESifo
[e]CEPR

The large and concentrated international activities of Dutch banks make the Netherlands particularly relevant for assessing the outward transmission of prudential policies. Analysis of the quarterly international claims of twenty-five Dutch banks in sixty-three countries over 2000–13 indicates that Dutch banks increase lending in countries that tighten prudential regulation. This result is driven particularly by larger banks, by banks with higher deposit ratios, by lending to advanced economies, and by lending in the post-crisis period. The result is not significant in most other subsamples. These findings suggest that banks react to changes in local prudential regulation via foreign lending—which could come either from regulatory arbitrage or from signaling effects of prudential policy on country risk. This contributes to the case for the reciprocation of macroprudential policy.

JEL Codes: F42, F44, G15, G21.

1. Introduction

In response to the global financial crisis, microprudential and macroprudential regulations have been tightened in most countries to

*The authors thank Linda de Zeeuw, Jairo Rivera Rozo, Pieter Stam, and Marjo de Jong for providing confidential bank data, and Henk van Kerkhoff for help with data compilation. Comments by Linda Goldberg, Claudia Buch, Matthieu Bussière, Guzel Valitova, Peter Wierts, Gertjan van der Hoeven, and an anonymous referee are gratefully acknowledged. The views expressed here are those of the authors and do not necessarily reflect those of De Nederlandsche Bank.

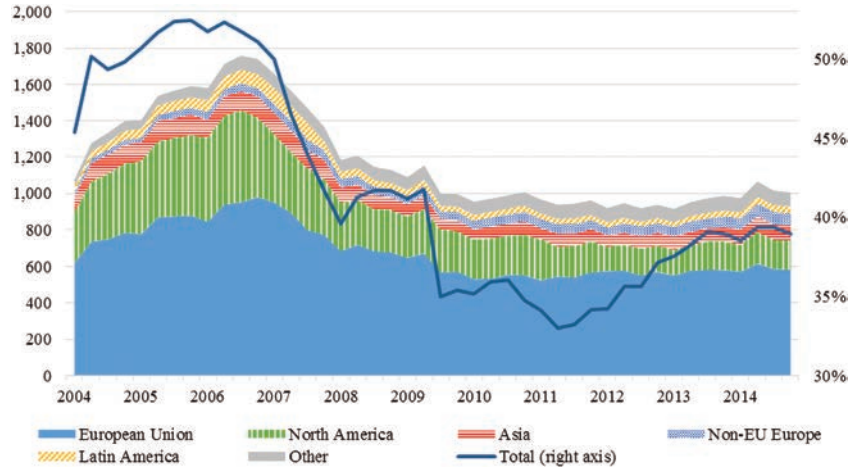
strengthen the stability and resilience of the banking system (Aiyar, Calomiris, and Wieladek 2015). This, in turn, has led to a discussion about the spillover effects of regulation (see Buch and Goldberg 2017 for a review of relevant studies). The Netherlands presents a unique testing ground for analyzing the outward transmission of prudential regulation, i.e., the impact of changing prudential regulation in country j on lending growth by international banks to country j.

The Dutch economy has a large banking sector relative to GDP (De Nederlandsche Bank 2015). After peaking at 562 percent of GDP in 2007, Dutch banking-sector assets have since fallen to around 380 percent of GDP by the end of 2015, still well above the euro-area average. The sector is very concentrated: the largest three banks—ING, Rabobank, and ABN Amro—hold 80 percent of overall Dutch deposits and also have dominant market shares in the mortgage and business loan markets. While foreign-owned banks hold only about 10 percent of domestic banking-sector assets in the Netherlands, several Dutch banks have significant foreign activities. Together, such foreign claims amount to over €1 trillion, or about 39 percent of Dutch banks' consolidated total assets in 2015. This share, too, has fallen since the crisis, following the acquisition and breakup of ABN Amro by a banking consortium consisting of the Royal Bank of Scotland, Santander, and Fortis in 2008,[1] and the sale of some of the foreign business units of ING, which was required by the European Commission as a condition for state support in 2008 (see figure 1).

The Dutch banking sector has gone through some important regulatory changes over the period, most particularly after the crisis, when bank capital requirements were raised significantly and binding loan-to-value and debt-service-to-income ratios were instituted for domestic mortgages. Yet these measures were often taken contemporaneously, meaning that there is relatively little variation in the domestic prudential index. Due to this feature and the relatively limited domestic activities of foreign banks in the Dutch banking system, we do not study inward transmission, which is the focus of a number of other country chapters.

[1]The Dutch parts of Fortis and ABN Amro were nationalized in 2009; at the end of 2015 the Dutch government sold part of its shares to the private sector in an initial private offering. The remaining shares will—at some point—also be sold.

Figure 1. Foreign Activities of the Dutch Banking Sector by Geography, 2004–15



Note: The figure shows the geographical distribution of foreign activities of Dutch banks; foreign activities are defined as foreign claims of the consolidated banking sector on an ultimate-risk basis. Left axis: € billions; right axis: percentage of total assets.

Notably, the Dutch banks' foreign activities are relatively diversified. In contrast to many other national banking sectors, which often have a strong regional focus, Dutch banks have a global footprint (see chapter 10 in de Haan, Oosterloo, and Schoenmaker 2015). While the European Union (EU) accounts for 58 percent of foreign activities, Dutch banks are also active across North American, Asian, and Latin American markets. Therefore, studying the behavior of Dutch banks can provide important insights into how changes in prudential regulation in destination countries affect foreign lending activities, both cross-border and through local branches and subsidiaries. Overall, we find evidence that Dutch banks increase their foreign lending in countries that tighten prudential regulation. Looking at relevant subsamples, we find that this result is driven particularly by larger banks, by banks with higher deposit ratios, by lending to advanced economies, and by lending in the post-crisis period. The results are not significant in most other subsamples.

We offer two competing interpretations for these results. The first is that Dutch banks engage in regulatory arbitrage: when domestic

banks in destination markets are constrained by prudential policy measures, Dutch banks, not bound by such measures, may have seen an opportunity to increase lending and gain market share. An alternative, and more benign, interpretation is that Dutch banks view the tightening of prudential measures as a positive signal about the regulatory quality of the respective country. Perceived country risk may decrease when authorities take measures to combat systemic risk, and this in turn could persuade Dutch banks' risk-management functions to increase country lending limits. For both interpretations, it is clear that the increase in lending runs counter to the intended effects of the prudential measure. As such, this supports the case for the reciprocation by the home authorities of macroprudential measures in the host country in line with recent policy initiatives in Europe (European Systemic Risk Board 2015).

The rest of this paper is organized as follows. Section 2 presents the data and stylized facts. Section 3 presents the methodology and key results in both the pooled sample and relevant subsamples. Section 4 concludes with some further discussion of the interpretation of our results and the policy implications.

2. Data and Stylized Facts for the Netherlands

2.1 Bank-Level Data

The bank-level data for this project are taken from bank-specific reporting to De Nederlandsche Bank (DNB), which acts both as the national central bank and as the prudential supervisor of the Dutch financial system (banks, insurers, pension funds, and investment funds). As a member of the Eurosystem and a reporter to the Bank for International Settlements (BIS) international banking statistics, DNB collects data using internationally comparable templates. Confidential data for twenty-five internationally active Dutch banks in sixty-three countries have been collected for the period 2000:Q1 to 2013:Q4. The data on the foreign activities of Dutch banks, necessary for the dependent variable, are taken from bank-specific reporting to DNB for the BIS international banking statistics. We use the claims on all sectors, based on the sum of cross-border lending, local lending in foreign currency, and local lending in domestic currency. These bank-specific data are accessible within

DNB for research and policy purposes, but are not shared publicly.[2] The aggregated data on such foreign claims are available on the DNB website[3] and are included in external publications of the BIS. Our dependent variable, foreign loans, captures the quarterly growth in such claims (measured by taking the log difference), i.e., $\Delta Y_{b,j,t}$ for Dutch bank b in destination country j in quarter t.

Bank balance sheet data, necessary for the construction of independent variables, come from regulatory financial reporting (FinRep).[4] These include the size of the bank captured by the log of total assets; its core deposits ratio, measured by core deposits over total assets; the unweighted tier 1 capital ratio, i.e., tier 1 capital divided by total assets, without any risk weighting; and the international activity ratio, which is defined as total foreign claims over total assets. All data are on a consolidated basis.

Table 1 offers some descriptive statistics. Across the sample, Dutch banks received only 30 percent of overall funding in the form of deposits, reflecting the relatively high use of wholesale funding. The median unweighted tier 1 capital ratio was 5 percent of total assets, and foreign activities accounted for 30 percent of the median bank's balance sheet, but with a relatively wide standard deviation. The median quarterly change in foreign activities is close to balance at 0 percent.[5]

Table 2 shows the correlations between the key bank-specific variables. Notably, among our sample of twenty-five Dutch banks, we see that larger banks tend to have lower deposit ratios (i.e., more wholesale funding), higher tier 1 capital ratios, and lower international

[2]Under certain restrictions (anonymized) micro data are available for visiting scholars for specific research projects or to replicate research results. Interested parties may contact Jakob de Haan (j.de.haan@dnb.nl).

[3]See http://www.dnb.nl/en/statistics/statistics-dnb/financial-institutions/banks/consolidated-banking-statistics-supervisory/index.jsp, table 5.9, "Consolidated Assets of Domestic Credit Institutions: International Claims on Immediate Borrower Basis."

[4]Because the relevant reporting templates have changed over time, it has been necessary to merge the bank balance sheet time-series data from different reporting standards (2000–04, 2004–07, and 2008–13). The commitment ratio and net due to/net due from foreign office are not available in the relevant data sources.

[5]In line with the International Banking Research Network (IBRN) project methodology, and in order to correct for structural breaks, values of the dependent variable larger than 100 percent and smaller than –100 percent have been dropped.

Table 1. Descriptive Statistics of the Dutch Banks in the Sample

	Observations	Mean	25th Percentile	Median	75th Percentile	Standard Deviation
Foreign Loans (Ln Change*100)	24,247	0.067	−9.037	0.000	9.060	28,465
Log Total Assets	35,475	17.165	15.577	16.730	19.780	2.278
Core Deposits Ratio (%)	35,447	6.783	3.262	30.160	50.750	7.826
Tier 1 Capital Ratio (Unweighted, %)	35,459	31.579	8.453	5.010	6.650	24.708
International Activity Ratio (%)	35,475	49.690	36.000	30.160	50.750	26.482

Notes: The core deposits ratio, tier 1 capital ratio, and international activity ratio are defined, respectively, as core deposits (entrusted savings and other funds entrusted), tier 1 capital, and total foreign claims over total assets. Median values may diverge significantly from the (weighted) mean of indicators across the Dutch banking sector. See the appendix for further details on the construction of variables.

Table 2. Correlations between Data on the Dutch Banks in the Sample

	Log Total Assets	Deposits	Tier 1	International Activity
Foreign Loans (Ln Change)	0.001	0.009	0.011	0.007
Log Total Assets		−0.299	0.289	−0.373
Core Deposits Ratio (%)			−0.280	0.119
Tier 1 Capital Ratio (Unweighted, %)				−0.139
International Activity Ratio (%)				

Notes: The core deposits ratio, tier 1 capital ratio, and international activity ratio are defined, respectively, as core deposits (entrusted savings and other funds entrusted), tier 1 capital, and total foreign claims over total assets. Median values may diverge significantly from the (weighted) mean of indicators across the Dutch banking sector. See table 7 in the appendix for further details on the construction of variables.

activities (reflecting a few small banks with a very high share of activities abroad). The correlations are still low enough that the variables can be included together without any worries about multicollinearity.

2.2 Data on Prudential Instruments

Data for prudential instruments in destination countries draw on the IBRN Prudential Instruments Database described in Cerutti et al. (2017). As in other papers that are part of the IBRN project and that focus on outward transmission, we use "destination-country regulation" ($DestP_{j,t}$) to capture tightening or loosening of prudential measures in destination country j and time t. $DestP_{j,t}$ has a value of +1 when prudential measures are tightened and –1 when measures are loosened. Over the course of the sample period there have been 419 changes in prudential regulation—both tightening and loosening—in the sixty-three countries in which Dutch banks' foreign activities are examined.

Table 3 shows the breakdown by instrument. Overall the whole sample, especially capital requirements, loan-to-value (LTV) limits on mortgages, and foreign-currency and local-currency reserve

Table 3. Summary Statistics on Changes in Prudential Instruments in Destination Countries

Instrument	No. of Changes (Tightening)	No. of Changes (Loosening)
All Instruments	273	146
General Capital Requirements	61	0
Sector-Specific Capital Buffer	34	11
Loan-to-Value (LTV) Ratio Limits	58	22
Foreign-Currency (FX) Reserve Requirements	65	37
Local-Currency (LC) Reserve Requirements	93	117
Interbank Exposure Limit	19	1
Concentration Ratio	25	3

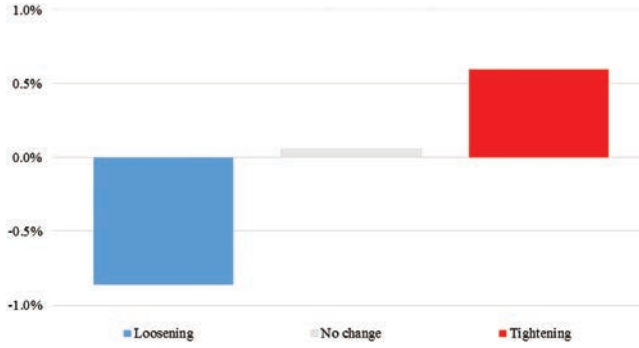
Notes: Tightening (+1) refers to, e.g., an increase in capital or reserve requirements or a reduction in exposure limits; these changes make regulation more binding. Moves in the other direction are loosening (–1). The "All Instruments" variable is a tightening or loosening of *any* of the seven subcategories of instruments in a given quarter.

requirements have been tightened. As an illustration, many emerging market economies tightened local-currency reserve requirements before the global financial crisis (e.g., Brazil and Turkey in 2002, China several times in 2006–08), and most advanced economies increased capital requirements at least once in 2011 and 2012. Several EU countries tightened interbank exposure limits or concentration limits during the sample period (though this data is missing for a substantial number of countries). Local-currency reserve requirements have also been loosened in a large number of cases—for example, in the euro-area countries, where the reserve requirements were lowered for all currency union members in 2000 and 2012.

2.3 Macroeconomic and Financial Controls

One obstacle in the analysis of Dutch banks is the relatively small number of banks active in each country. While the twenty-five banks

Figure 2. Changes in Foreign Claims after Tightening, Loosening, and Neutral Quarters



Note: The figure shows the change in foreign claims of Dutch banks after changes in prudential policies in destination countries (mean changes in the dependent variable, $\Delta Y_{b,j,t}$, in the quarter after a change in $DestP_{j,t}$) over the full sample.

in our sample all have foreign activities, there are significant differences between institutions. The largest banks are generally active on some scale in all of the sixty-three countries for which policy and macro data are available, while the smaller banks are in general active in only ten to twenty of the possible foreign markets. This makes it difficult to control for country-quarter effects. In order to ensure that loan demand effects and other macroeconomic factors are taken into account, we control for the business cycle using the output gap and the financial cycle using the credit-to-GDP gap as constructed by the BIS. Both measures are available at quarterly frequency.

2.4 Stylized Facts

An initial look at the data shows a clear result even without controlling for relevant macroeconomic and bank-specific characteristics (see figure 2). Dutch banks seem to have increased their foreign claims by about 0.6 percent within one quarter in countries which tightened prudential policy. They decreased claims by 0.86 percent within one quarter after policies were loosened. This offers a priori evidence of our key result on outward transmission. Yet notably,

the economic relevance of this effect is relatively small—only about 0.02 standard deviations of the dependent variable. Examining this relationship while controlling for relevant macroeconomic and bank-specific characteristics is the focus of the next section.

3. Empirical Method and Regression Results

Following the approach to examining outward transmission described by Buch and Goldberg (2017), we use the following regression to explain how changes in prudential policies in a destination country affect changes in Dutch banks' lending growth to that country:

$$\Delta Y_{b,j,t} = \alpha_0 + \sum_{k=0}^{2} \alpha_{k+1} DestP_{j,t-k} + \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + f_j + f_t + f_b + \varepsilon_{b,j,t},$$

where $\Delta Y_{b,j,t}$ denotes quarterly changes in the log of claims of Dutch bank b to destination country j in quarter t. $DestP_{j,t}$, $DestP_{j,t-1}$, and $DestP_{j,t-2}$ are changes in prudential policies in the destination country in, respectively, the current quarter, the previous quarter, and two quarters previously. Meanwhile $X_{b,t-1}$ is a vector of lagged bank-level controls, namely size tier 1 capital ratio international activity ratio and core deposits ratio; $Z_{j,t}$ is country-level controls (output gap and credit gap); and f_i, f_t, and f_b are destination-country, quarter and bank fixed effects.

3.1 Baseline Analysis of Outward Transmission of Prudential Policies

The empirical results confirm that Dutch banks increase their activities in countries that tighten prudential regulation after one quarter. As shown in table 4 (column 1), the coefficient of all measures combined is positive and statistically significant at the 5 percent level. These findings are in line with the evidence for French banks reported by Bussière, Schmidt, and Vinas (2017), and for the foreign branches and cross-border lending of Italian banks reported by Caccavaio, Carpinelli, and Marinelli (2017). The index is not significant contemporaneously, or two quarters after the measures are

Table 4. Effect of Changes in Prudential Policies on Dutch Banks' Foreign Exposures

	All Instruments (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	FX Reserve Requirements (5)	LC Reserve Requirements (6)	Interbank Exp. Limits (7)	Concentration Limits (8)
Prudential Policies ($DestP_t$)	−0.487	−2.469	−0.207	−0.543	−0.098	0.620	−4.005**	−1.310
	(0.505)	(1.781)	(1.101)	(1.353)	(0.757)	(0.703)	(1.949)	(2.754)
Prudential Policies ($DestP_{t-1}$)	1.348**	2.961**	0.104	0.838	0.537	1.097*	1.318	−1.541
	(0.558)	(1.380)	(1.183)	(1.209)	(0.775)	(0.563)	(2.590)	(1.953)
Prudential Policies ($DestP_{t-2}$)	0.532	−0.285	0.512	−0.761	0.522	0.868	1.540	−2.546*
	(0.524)	(1.554)	(0.697)	(1.506)	(0.647)	(0.597)	(1.564)	(1.540)
Log Total $Assets_{t-1}$	−2.371***	−2.349***	−2.350***	−4.180***	−2.354***	−2.380***	−0.918	−1.747
	(0.827)	(0.823)	(0.826)	(1.331)	(0.825)	(0.830)	(1.036)	(1.089)
Tier 1 $Ratio_{t-1}$	−0.207	−0.208	−0.208	−0.189	−0.209	−0.207	−0.342	−0.271
	(0.135)	(0.135)	(0.135)	(0.330)	(0.135)	(0.135)	(0.242)	(0.184)
International $Activity_{t-1}$	−0.012	−0.012	−0.012	0.002	−0.012	−0.012	−0.042	0.006
	(0.022)	(0.022)	(0.022)	(0.024)	(0.022)	(0.022)	(0.040)	(0.031)
Core Deposits $Ratio_{t-1}$	0.083**	0.083**	0.083**	0.059	0.083**	0.083**	0.031	0.051
	(0.033)	(0.033)	(0.033)	(0.059)	(0.033)	(0.033)	(0.061)	(0.041)
Credit Gap_{t-1}	0.017*	0.018*	0.018*	0.017**	0.018*	0.017*	0.047	0.024***
	(0.010)	(0.010)	(0.010)	(0.007)	(0.010)	(0.010)	(0.030)	(0.009)
Output Gap_{t-1}	0.396***	0.421***	0.420***	0.310*	0.415***	0.411***	0.777***	0.567***
	(0.150)	(0.150)	(0.150)	(0.175)	(0.150)	(0.153)	(0.289)	(0.173)
Observations	21,915	21,915	21,915	6,986	21,915	21,915	8,549	12,141
R^2	0.022	0.022	0.022	0.026	0.022	0.022	0.028	0.027
Adjusted R^2	0.016	0.016	0.016	0.010	0.016	0.016	0.015	0.017
Cumulative Effect of Prudential Policies over t, t–1, and t–2	1.393	0.207	0.409	−0.466	0.962	2.585	−1.147	−5.398

Notes: This table reports the effects of changes in destination-country regulation and firm characteristics on log changes in total claims on the destination country. The data are quarterly from 2000:Q1 to 2013:Q4 for a panel of twenty-five Dutch banks. Prudential policies refers to the changes in regulation in the destination country. For more details on the variables, see the appendix. Each column gives the result for the regulatory measure specified in the column headline. The "cumulative effect" is the sum of coefficients for $DestP_t$, $DestP_{t-1}$, and $DestP_{t-2}$. All specifications include destination-country, time, and bank fixed effects. Standard errors are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

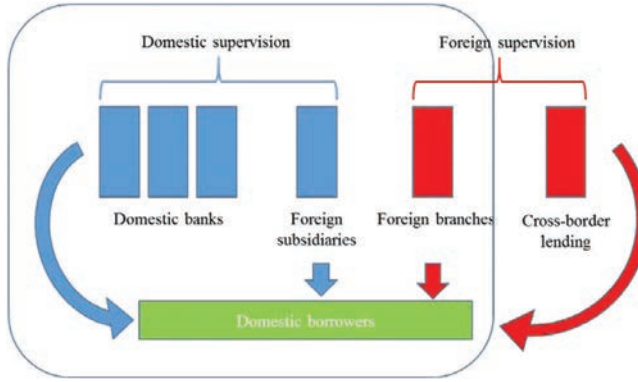
taken. In economic terms, a tightening of prudential policies in one quarter leads to a 1.35 percent increase in cross-border claims one quarter later—which is about twice the size of the unconditional results reported in section 2.4, but still relatively small compared with the sample variance.

Among individual measures (columns 2–8), we find that especially increased capital requirements and local-currency (LC) reserve requirements tend to precede higher activity in the host country, again after one quarter. A tightening of capital requirements leads to an increase of 2.96 percent in international claims. Most other measures have positive coefficients after one quarter, but are not statistically significant. Interestingly, interbank exposure limits actually have a significantly negative sign during the quarter of activation, while concentration limits have a significantly negative impact two quarters later. It is possible that these instruments have been designed in ways that are binding even for foreign banks (see below).

Our findings for capital requirements are similar to results reported by Ohls, Pramor, and Tonzer (2017) and Damar and Mordel (2017) for German and Canadian banks, respectively, while our results for local-currency requirements are in line with those of Avdjiev et al. (2017) which are based on sixteen banking systems and fifty-three counterparty countries. The latter authors argue that a tightening of local-currency reserve requirements in the destination country may lead to an increase in foreign affiliates' local lending for two reasons: foreign branches are not subject to the reserve requirements of the destination country, and foreign subsidiaries (which are subject to such requirements) can obtain funding from their parent if they get close to the regulatory minimum. So foreign branches and foreign subsidiaries are likely to step in and replace domestic banks when reserve requirements increase. Likewise, foreign banks may increase cross-border lending if domestic banks reduce their lending due to increased prudential regulation. Cerutti, Claessens, and Laeven (2015) find that the greater use of macroprudential policy is associated with more reliance on cross-border credit, in particular for open economies.

Among bank controls, we find that smaller banks and those with greater deposit funding tend to have higher loan growth in foreign countries. On the other hand, the tier 1 capital ratio and

Figure 3. Schematic View of the Application of Prudential Policies



international activity ratio are not significant.[6] Among the macroeconomic controls, we find—as expected—that Dutch banks tend to increase exposures in those countries where the business cycle and financial cycle are in an upturn phase.[7]

The results on prudential policies may be interpreted as evidence of regulatory arbitrage. Previous research on regulatory arbitrage reports that banks in countries that tighten banking regulations are induced to increase their claims on countries that are less regulated (Houston, Lin, and Ma 2012; Ongena, Popov, and Udell 2013). In our case, the story is slightly different. Because most prudential rules only apply to domestic banks and foreign subsidiaries, foreign banks active in a host country may circumvent local prudential regulation through branches and cross-border lending (figure 3). In our data set, which includes both local (branch and subsidiary) activities and

[6]Changes in the lag structure for bank balance sheet variables, such as lagging by two quarters, lead to a decline in significance for the coefficients of total assets and deposit funding, but not to any notable changes in the coefficient of the prudential policies variables (results available on request).

[7]It is possible that prudential policy variables will be determined in part based on credit market conditions—meaning an endogeneity problem with including the credit gap in our regressions. As an alternative, we have run the baseline without the credit gap. Results are very similar; only the coefficient for capital requirements loses statistical significance. Lagging the credit gap and output gap by one quarter does not lead to a change in the results (details available on request).

cross-border lending,[8] this would mean that Dutch banks increase their activities when domestic competitors are constrained by prudential policy. In this way, foreign banks operating through branches or direct cross-border lending can gain market share from domestic banks and foreign subsidiaries. These results are consistent with earlier studies for the United Kingdom (Aiyar, Calomiris, and Wieladek 2014; Reinhardt and Sowerbutts 2015) and with recent work on cross-sector substitution effects of macroprudential policy (Cizel et al. 2016).

An alternative, and more benign, interpretation is that Dutch banks see prudential measures as a signal of stronger regulatory quality. There is some evidence suggesting that regulatory quality is a pull factor for foreign direct investment by banks. For instance, Galindo, Micco, and Serra (2003) find that host-country banking regulations that converge toward international standards have a positive impact on foreign bank penetration. Likewise, Claessens and van Horen (2014) find that the absolute difference between home- and host-country regulation is significant in explaining bilateral foreign bank presence using a large database on 1,199 foreign banks from 75 home countries present in 110 host countries. In this case, the internal risk-management function of banks, which is responsible for setting country limits, may judge that prudential measures cause country risk to decline, or indicate a proactive stance by regulators that reflects well on overall country risk. This is consistent with the results of the controls for the output and credit gap. The fact that Dutch banks increase lending in countries experiencing strong GDP and credit growth may reflect both greater loan demand and greater risk appetite by Dutch banks in these countries. As will be discussed below, this is still problematic from a policy perspective, as it implies that banks tend to increase activities at precisely the moment that credit excesses are building up, which prudential policies are seeking to mitigate.

[8]Unfortunately, we are not able to distinguish between branches, subsidiaries, and cross-border lending. The breakdown that does exist in the BIS data is between cross-border lending and claims in foreign currency (i.e., domestic FX lending) on the one hand, and local claims in local currency (branches and subsidiaries) on the other. Because this conflates currency denomination with the type of bank operations, the breakdown is not useful for this analysis.

3.2 Bank Characteristics and Relevant Subsamples

In order to better understand the link between bank characteristics and prudential policies, we split our sample along the four bank characteristics analyzed in the baseline regression: total assets, tier 1 capital ratio, international activities ratio, and deposit ratio. In each case, banks are assigned to a "high" or "low" group depending on whether they are above or below the median value across the whole sample. The regression results (table 5) show that the impact of prudential policies in the previous quarter ($DestP_{j,t-1}$) is strongest among large banks (column 1) and those with high deposit ratios (column 7). The impact is also significant for banks with low tier 1 capital ratios (column 4) and for the subsamples with high (column 5) and low (column 6) international activities ratios.

It is difficult to gauge whether these results support the regulatory arbitrage or country risk signaling interpretation. For both narratives, large banks may be better placed than small banks to monitor changes in regulation and to respond quickly to them. Those with high deposit financing may find that they have more available liquidity to grow abroad in selected markets when opportune than banks that already depend to a large extent on wholesale funding. Yet each of these effects is possible in case of regulatory arbitrage or signaling.

As a final exercise, we also look into the results over relevant geographic and time subsamples—particularly in advanced and emerging market economies, and before and after the global financial crisis. The former are defined based on the International Monetary Fund's World Economic Outlook definition, while the break for the global financial crisis is 2008:Q1 (around the collapse of Bear Stearns, which marked a starting point for the buildup of financial market stress that culminated in September 2008 with the bankruptcy of Lehman Brothers). Table 6 shows that the coefficient for prudential policies only maintains statistical significance for advanced economies (column 1), and for the post-crisis period (column 4). It is not significant for emerging market economies (column 2) or the pre-crisis period (column 3). When splitting measures into tightening and loosening (column 5), the signs of the coefficients remain as expected: we find that tightening leads to greater cross-border lending by Dutch banks, while loosening leads to reduced lending of a roughly equal

Table 5. Regression Results Subsamples Based on Bank Characteristics

	Large Banks (1)	Small Banks (2)	High Tier 1 (3)	Low Tier 1 (4)	High International Activities (5)	Low International Activities (6)	High Deposits (7)	Low Deposits (8)
Prudential Policies ($DestP_t$)	−0.103	−0.978	−0.902	−0.334	−0.293	−1.038	−1.123	−0.165
	(0.708)	(0.755)	(1.015)	(0.561)	(0.585)	(0.823)	(1.214)	(0.553)
Prudential Policies ($DestP_{t-1}$)	1.800**	0.772	1.770	1.192*	1.172*	1.684*	2.554**	0.657
	(0.862)	(0.777)	(1.102)	(0.694)	(0.697)	(0.934)	(1.048)	(0.654)
Prudential Policies ($DestP_{t-2}$)	0.638	0.134	−0.772	1.036*	0.747	−0.011	0.011	0.703
	(0.775)	(0.737)	(0.975)	(0.608)	(0.566)	(0.853)	(1.091)	(0.620)
Log Total $Assets_{t-1}$	0.692	−2.813***	−0.768	−4.008***	−2.709**	−0.868	−2.355**	−2.552
	(2.617)	(0.973)	(1.318)	(1.434)	(1.250)	(1.542)	(1.173)	(1.958)
Tier 1 $Ratio_{t-1}$	0.091	−0.119	−0.019	−0.610*	−0.501	0.132	−0.216	−0.248
	(0.571)	(0.158)	(0.210)	(0.360)	(0.333)	(0.212)	(0.218)	(0.219)
International $Activity_{t-1}$	−0.052	−0.025	−0.102**	0.001	0.006	−0.194***	−0.008	−0.007
	(0.047)	(0.031)	(0.048)	(0.029)	(0.031)	(0.069)	(0.034)	(0.029)
Core Deposits $Ratio_{t-1}$	0.219***	0.035	−0.003	0.098***	0.093**	−0.064	0.018	0.154***
	(0.056)	(0.043)	(0.060)	(0.037)	(0.041)	(0.063)	(0.058)	(0.035)
Credit Gap_{t-1}	0.022	0.014	−0.003	0.024*	0.016	0.014	0.012	0.019
	(0.015)	(0.014)	(0.022)	(0.014)	(0.013)	(0.013)	(0.019)	(0.014)
Output Gap_{t-1}	0.478**	0.207	−0.126	0.510***	0.400**	0.269	0.169	0.473***
	(0.205)	(0.208)	(0.267)	(0.187)	(0.202)	(0.247)	(0.283)	(0.177)
Observations	9,260	12,655	6,865	15,050	13,355	8,560	7,836	14,079
R^2	0.044	0.022	0.036	0.024	0.028	0.029	0.024	0.037
Adjusted R^2	0.032	0.011	0.018	0.016	0.019	0.015	0.008	0.029
Cumulative Effect of Prudential Policies over t, t–1, and t–2	2.335	−0.072	0.095	1.895	1.626	0.634	1.442	1.195

Notes: This table reports the effects of changes in destination-country regulation and firm characteristics on log changes in total claims on the destination country. The data are quarterly from 2000:Q1 to 2013:Q4 for a panel of twenty-five Dutch banks. Prudential policies refers to the changes in regulation in the destination country. For more details on the variables, see the appendix. Each column gives the result for the subsample of banks specified in the column headline. The "cumulative effect" is the sum of coefficients for $DestP_t$, $DestP_{t-1}$, and $DestP_{t-2}$. All specifications include destination-country, time, and bank fixed effects. Standard errors are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 6. Regression Results for Other Relevant Subsamples

	Advanced Economies (1)	Emerging Market Economies (2)	Pre-crisis (2000–07) (3)	Post-crisis (2008–13) (4)	Tightening/ Loosening (5)
Prudential Policies ($DestP_t$)	−0.762	−0.923	−0.900	−0.271	
	(0.838)	(0.776)	(0.757)	(0.736)	
Prudential Policies ($DestP_{t-1}$)	1.485*	0.555	0.862	1.669**	
	(0.795)	(0.712)	(0.923)	(0.757)	
Prudential Policies ($DestP_{t-2}$)	0.288	0.419	1.718	−0.069	
	(0.978)	(0.461)	(1.090)	(0.690)	
Tightening ($DestP_{t-1} = 1$)					−1.598
					(1.017)
Loosening ($DestP_{t-1} = -1$)					1.220
					(0.742)
Log Total $Assets_{t-1}$	−3.099***	−1.052	−9.273***	−3.029*	−2.286***
	(0.803)	(2.527)	(2.674)	(1.732)	(0.838)
Tier 1 $Ratio_{t-1}$	−0.158	−0.453*	−0.490)	−0.119	−0.232*
	(0.158)	(0.240)	(0.417)	(0.273)	(0.135)
International $Activity_{t-1}$	−0.037	0.081*	−0.011	−0.076	−0.012
	(0.025)	(0.047)	(0.031)	(0.047)	(0.022)
Core Deposits $Ratio_{t-1}$	0.064*	0.173***	0.003	0.074	0.086***
	(0.039)	(0.046)	(0.060)	(0.049)	(0.033)
Credit Gap_{t-1}	0.015	0.029	−0.003	0.001	0.016*
	(0.010)	(0.034)	(0.032)	(0.023)	(0.009)
Output Gap_{t-1}	0.124	0.653***	0.621***	0.233	0.381***
	(0.202)	(0.141)	(0.140)	(0.220)	(0.147)
Observations	15,896	6,019	11,334	10,581	22,246
R^2	0.021	0.047	0.029	0.024	0.022
Adjusted R^2	0.014	0.030	0.019	0.014	0.016
Cumulative Effect of Prudential Policies over t, t–1, and t–2	1.010	0.051	1.680	1.329	

Notes: This table reports the effects of changes in destination-country regulation and firm characteristics on log changes in total claims on the destination country. The data are quarterly from 2000:Q1 to 2013:Q4 for a panel of twenty-five Dutch banks. Prudential policies refers to the changes in regulation in the destination country. For more details on the variables, see the appendix. Each column gives the result for the subsample specified in the column headline. The "cumulative effect" is the sum of coefficients for $DestP_t$, $DestP_{t-1}$, and $DestP_{t-2}$. All specifications include destination-country, time, and bank fixed effects. Standard errors are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

magnitude (symmetric effect). Yet with t-values of 1.57 and 1.64, both coefficients are just shy of statistical significance at the 10 percent level.

4. Concluding Remarks

Our results show that Dutch banks increase their local and cross-border lending in countries that tighten prudential policies, and decrease such lending after the loosening of policies. These results can be interpreted in terms of regulatory arbitrage or country risk signaling. Distinguishing between these two explanations will require further quantitative and qualitative analysis. Yet in either case, our results imply that Dutch banks have ramped up their exposures precisely when host authorities intend to put a brake on excessive lending through prudential measures. This is likely to undo part of the intended effects of the policy measures.

As such, our results support the case for reciprocation of macroprudential measures. Reciprocity means that the macroprudential authority in one country applies the measures of another jurisdiction for the activities of its banks in that jurisdiction. Right now, reciprocity of macroprudential instruments is largely voluntary and, even within the EU, has been very rare.[9] The European Systemic Risk Board (ESRB) recently adopted a recommendation for a reciprocity framework in the EU, based on a "comply or explain" mechanism (ESRB 2015). This should lead to more reciprocity decisions within the EU and greater cross-country experience to build on at a global level. If reciprocity dampens the substitution of domestic credit by foreign bank lending after macroprudential measures are tightened, such a framework may contribute to greater effectiveness of macroprudential policy in the future.

[9]EU member states may reciprocate measures of other member states based on an explicit passage in the European Capital Markets Directive and Regulation (CRD IV/CRR). Yet of the fifty substantive macroprudential measures taken in the EU in 2014, only three were voluntarily reciprocated: the Estonian systemic risk buffer (SRB), which was reciprocated by Sweden and Denmark; the Swedish countercyclical capital buffer (CCB of 1 percent), reciprocated by Denmark, Slovakia, Finland, and the United Kingdom; and the Belgian risk weights for mortgages, reciprocated by the Netherlands (DNB).

Table 7. Definition of Balance Sheet Independent Variables

Variable Name	Description	Data Source
Log Assets	Log (Balance Sheet Total)	FinRep (De Nederlandsche Bank)
Core Deposits Ratio	Funds Entrusted/ Total Assets (in %)	FinRep (De Nederlandsche Bank)
Tier 1 Capital Ratio	Tier 1 Equity Capital/ Total Assets (in %)	FinRep (De Nederlandsche Bank)
International Activity	Foreign Claims/Total Assets (in %)	BIS Reporting and FinRep (De Nederlandsche Bank)

Appendix

The dependent variable, $\Delta Y_{b,j,t}$, denotes the change in foreign claims by bank b in destination country b in quarter t. All values greater than 100 percent and less than –100 percent have been removed. This controls for the restructuring of certain banking groups and the sale of foreign activities in specific countries during the sample period. Data come from bank-specific reporting to DNB for the BIS international banking statistics. We use the claims on all sectors, based on the sum of cross-border lending, local lending in foreign currency, and local lending in domestic currency.

Table 7 details the construction of bank-specific variables. The ratio of illiquid assets and the net due to/due from head office are not available in the regulatory databases. All data are on a consolidated basis, and thus include the assets of foreign branches and subsidiaries as well as cross-border lending. Because reporting templates have changed during the sample period, we have merged time-series data over the periods 2000:Q1 to 2004:Q3, 2004:Q4 to 2007:Q4, and 2008:Q1 to 2013:Q4. Luckily, the definitions of our variables of interest have remained constant across the reporting templates such that they do not contribute to trend breaks. All data are reporting in (current) thousands and are not corrected for inflation or exchange rate movements.

References

Aiyar, S., C. W. Calomiris, and T. Wieladek. 2014. "Does Macro-Prudential Regulation Leak? Evidence from a UK Policy Experiment." *Journal of Money, Credit and Banking* 46 (s1): 181–214.

———. 2015. "Bank Capital Regulation: Theory, Empirics, and Policy." *IMF Economic Review* 63 (4): 955–83.

Avdjiev, S., C. Koch, P. McGuire, and G. von Peter. 2017. "International Prudential Policy Spillovers: A Global Perspective." *International Journal of Central Banking* 13 (S1).

Buch, C., and L. Goldberg. 2017. "Cross-Border Regulatory Spillovers: How Much? How Important? Evidence from the International Banking Research Network." *International Journal of Central Banking* 13 (S1).

Bussière, M., J. Schmidt, and F. Vinas. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from France." *International Journal of Central Banking* 13 (S1).

Caccavaio, M., L. Carpinelli, and G. Marinelli. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Italy." *International Journal of Central Banking* 13 (S1).

Cerutti, E., S. Claessens, and L. Laeven. 2015. "The Use and Effectiveness of Macroprudential Policies." Forthcoming in *Journal of Financial Stability*.

Cerutti, E., R. Correa, E. Fiorentino, and E. Segalla. 2017. "Changes in Prudential Policy Instruments—A New Cross-Country Database." *International Journal of Central Banking* 13 (S1).

Cizel, J., J. Frost, A. Houben, and P. Wierts. 2016. "Effective Macroprudential Policy: Cross-Sector Substitution of Price and Quantity Measures." IMF Working Paper No. 16/94.

Claessens, S., and N. van Horen. 2014. "Location Decisions of Foreign Banks and Competitor Remoteness." *Journal of Money, Credit and Banking* 46 (1): 145–70.

Damar, H. E., and A. Mordel. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Canada." *International Journal of Central Banking* 13 (S1).

de Haan, J., S. Oosterloo, and D. Schoenmaker. 2015. *Financial Markets and Institutions: A European Perspective.* Cambridge: Cambridge University Press.

De Nederlandsche Bank. 2015. "Perspective on the Structure of the Dutch Banking Sector: Efficiency and Stability through Competition and Diversity." June.

European Systemic Risk Board (ESRB). 2015. "Recommendation on the Assessment of Cross-Border Effects of and Voluntary Reciprocity for Macroprudential Policy Measures." Recommendation ESRB/2015/2, December 15.

Galindo, A., A. Micco, and C. Serra. 2003. "Better the Devil that You Know: Evidence on Entry Costs Faced by Foreign Banks." Working Paper No. 477, Inter-American Development Bank.

Houston, J., C. Lin, and Y. Ma. 2012. "Regulatory Arbitrage and International Bank Flows." *Journal of Finance* 67 (5): 1845–95.

Ohls, J., M. Pramor, and L. Tonzer. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Germany." *International Journal of Central Banking* 13 (S1).

Ongena, S., A. Popov and G. F. Udell. 2013. "'When the Cat's Away the Mice Will Play': Does Regulation at Home Affect Bank Risk-Taking Abroad?" *Journal of Financial Economics* 108 (3): 727–50.

Reinhardt, D., and R. Sowerbutts. 2015. "Regulatory Arbitrage in Action: Evidence from Banking Flows and Macroprudential Policy." Staff Working Paper No. 546, Bank of England.

International Banking and Cross-Border Effects of Regulation: Lessons from Poland*

Krzysztof Gajewski and Oskar Krzesicki
Narodowy Bank Polski

The main goal of this paper is to determine whether foreign banks adjust their lending in Poland in response to changes to regulatory policy in their home countries. Poland, with its conservative, predominately foreign-owned banks concentrated on domestic activities, is an interesting case to study the existence of inward policy spillovers. Bank-level data and fixed-effect panel models are used to assess the impact of home-country regulations on the quarterly growth rate of lending to the domestic non-financial private sector. We especially focus on the changes in capital requirements, as they have been expected by Polish regulators to negatively affect the operations of foreign-owned banks in Poland. We find that tightening capital requirements in the home countries of Polish foreign-owned banks has a significant, negative effect on credit extension in Poland; however, when we also account for Polish regulations in this area, the impact of home-country changes is no longer significant, which suggests that local regulatory actions are more important for banks. We also document the impact of cumulative changes in prudential policies that differs depending on cycle conditions in the home countries of foreign-owned banks.

JEL Codes: F42, G18, G21.

*The views expressed here are those of the authors and do not reflect the official position of the Narodowy Bank Polski. The authors would like to thank Piotr Bańbuła, Tomasz Chmielewski, Adam Głogowski, Piotr Olański, the IBRN country teams from the United Kingdom and South Korea, and the anonymous referees for their valuable comments and suggestions. All remaining errors are our own.

1. Introduction

The increase in the number of regulatory actions across the globe (especially after the global financial crisis) has sparked concerns over the cross-border effects of such policies (see Buch and Goldberg 2017 for a review of the literature). This is especially important for many emerging economies which are hosts to international banks and therefore are highly vulnerable to potential cross-border deleveraging.[1] The aim of this paper is to verify the existence of inward policy spillovers in the Polish context and to determine whether international banks adjust their lending growth in Poland in response to changes in the regulatory policy in their home countries. This question is especially important from a Polish perspective, as the banking system in Poland is dominated by foreign-owned banks. Over the analyzed period (2002–14), the share of such institutions in the assets of the banking sector has never fallen below 50 percent. International banks operate in Poland mostly as subsidiaries of large banking groups; branches of foreign banks have never played a significant role in the Polish market, with their combined share in assets rarely exceeding 5 percent. At the end of 2014, the most important foreign-owned institutions were banks with headquarters located in Italy (13 percent of assets), Germany (10.3 percent of assets), Spain (9.1 percent of assets), and the Netherlands (9 percent of assets)—see Narodowy Bank Polski (2015). Such a structure leaves the Polish banking sector exposed not only to local (i.e., Polish) prudential regulations but also to home-country prudential policy that affects the functioning of the consolidated banking groups.

The potential regulatory spillovers have been debated in Poland, especially right after the outbreak of the global financial crisis and during the European Union (EU) negotiations about the CRDIV/CRR package. There were fears that the need to comply with tightened regulatory requirements after the crisis, together with the worsening financial situation of the banking groups, would affect the ability and willingness of Polish foreign-owned banks to extend

[1] For example, the report published by the Financial Stability Board (2016) notes that "Some EMDEs report continuing concerns about cross-border spillovers that may be reducing the presence and activities of global banks in their domestic markets. These concerns ... also reflect how home jurisdictions of hosted global banks are implementing the reforms."

credit to the local economy. The end of new foreign bank financing after the crisis was considered one of the key threats, and possible contagion channel in Poland and in other countries in the Central and Eastern Europe region.

There are several features of the Polish banking sector that make it a unique testing ground for regulatory spillovers. First, there is relatively big variation in the home countries of foreign banks operating in Poland. At the end of 2014, owners of Polish foreign-owned banks were from sixteen different countries. Since these countries differ in the intensity and timing of prudential actions, the spillover effect can be easily identified. At the same time, there are still some big domestically owned institutions that can be treated as a control group that helps in the identification process. Second, nearly all the activity of Polish banks is domestic, so the only policies that may directly affect their credit growth are those in the home countries of foreign-owned banks and Polish regulations (a lack of substantial foreign operations is the reason for choosing not to study outward transmission in this paper). Finally, the business model of Polish banks, both domestic and foreign owned, is conservative (assets consist mainly of loans granted to non-financial customers; operations on financial markets are not a significant part of their business activity), and therefore, by looking at credit extension we capture most of the variation in the bank activities.

Data for the study come from supervisory reporting. In principle, all types of commercial banks are included in the sample (foreign and domestically owned, subsidiaries and branches); however, several small adjustments have been made and some banks have been omitted to avoid the results being affected by outliers. All data were collected at the individual level.

The results of the study show that tightening capital requirements in home countries has a significant negative impact on credit extension in Poland; however, this effect is only significant when we do not explicitly control for the Polish regulations in this area. This means that foreign-owned banks have not contributed to a credit crunch in Poland in the sample period by transmitting changes in their domestic regulations into the Polish market.

The paper is structured as follows. First we present several facts about the Polish banking sector and describe the empirical

methodology and data. We then present our results, including various robustness checks. The paper ends with conclusions.

2. Empirical Methodology and Data

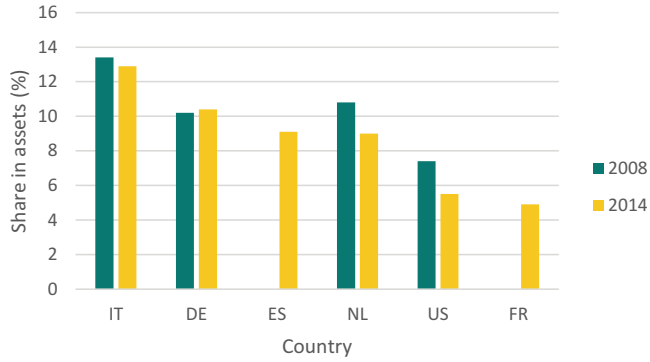
2.1 Stylized Facts for Poland

The high importance of the regulatory spillovers in a Polish context is a result of the dominance of foreign-owned banks in the banking sector. Any changes in the domestic regulations of such banks (i.e., changes in the regulations in their home countries) therefore potentially affect credit availability in the Polish economy, either directly (for example, if foreign-owned banks engage in cross-border deleveraging to meet stricter regulatory criteria imposed at the consolidated level) or indirectly (through the impact of regulatory changes on the economic condition of banks).

The role of foreign-owned banks in the Polish banking sector during the period analyzed has been evolving. Initially, their market share was rising as a result of the privatization process in Poland (similarly to other emerging countries, Poland decided to privatize most of its previously state-owned banks by selling them to the large multi-national banking groups that were able to provide adequate capital and know-how[2]). Since the outbreak of the crisis, there have been some adjustments along the extensive margin. A small number of foreign-owned banks decided to leave Poland (for example, Belgian KBC or Nordic Nordea), sometimes in response to government interventions in their home countries—for example, Irish AIB Group had to put its Polish subsidiary up for sale after receiving state support in Ireland. The buyers were either domestic banks or other foreign investors (for example, Santander bought a subsidiary in Poland from KBC). Such adjustments during the period analyzed have not been big—at the end of 2014 the share of foreign-owned banks was still high (over 60 percent of the total assets of the Polish banking

[2]Funding received from parent institutions helped Polish banks expand their activity during this pre-crisis period—for example, by granting mortgage loans denominated in foreign currency (available data suggest that it was foreign-owned banks that introduced such products to the Polish market; see Głogowski and Szpunar 2012).

Figure 1. Largest Foreign Investors in the Polish Banking System



Source: Data from the Polish Financial Supervision Authority.

sector compared with 72 percent at the end of 2008) and the number of countries from which owners of Polish banks originate remains stable (seventeen countries at the end of 2014, the same as in 2008), with the largest investors coming mostly from the EU (see figure 1).

Two types of regulations in home countries have been expected by policymakers to be particularly important for Polish foreign-owned banks—capital requirements and liquidity regulations (see Jakubiak 2012 and Kwaśniak 2012). Increased capital standards have been believed to lead to cross-border deleveraging, either in the form of reducing lending activity in other than domestic markets to reduce consolidated risk-weighted assets or by selling foreign subsidiaries. The initial proposals of the CRDIV/CRR package assumed centralized liquidity management in a banking group. From the perspective of host-country regulators, this created the risk of transferring the liquidity from subsidiaries to their headquarters and leaving Polish banks as dummy companies (see Gadomski 2011). Similar concerns reemerged in 2013 with the creation of the Single Supervisory Mechanism. The speech given in Dublin by Constancio (2013) was understood as an announcement of the forthcoming centralized capital and liquidity management in banking groups (see Narodowy Bank Polski 2014).

During the analyzed period, the operation of banks in Poland has also been influenced by a number of local prudential regulations

aimed at limiting excessive growth in lending to households (mainly mortgage related, such as debt-service-to-income and loan-to-value limits or increased risk weights). Regulatory measures in Poland have been implemented in the form of recommendations issued by the Polish Financial Supervision Authority (PFSA). They have been applicable to all banks, both Polish and foreign owned (including branches). Even though they formally have a microprudential character, they have been issued with a reference to the systemic risk. A more detailed description of the Polish experience with tools limiting credit growth can be found in Bierut et al. (2015). Other prudential actions taken in Poland include implementations of the EU regulations (CRDI-CRDIV), short- and long-term liquidity limits introduced in 2008, recommendations to maintain higher minimum capital ratios, and dividend restrictions.

2.2 Empirical Methodology

In the empirical analysis we examine whether Polish banks modify their activity in response to regulations in their home countries. The analysis explores the effect of changes in regulation on banks' loan growth, following the approach described in Buch and Goldberg (2017). We begin with the following regression specification (1):

$$\Delta Y_{b,j,t} = \alpha_0 + (\alpha_1 HomeP_{j,t} + \alpha_2 HomeP_{j,t-1} + \alpha_3 HomeP_{j,t-2}) + \alpha_4 X_{b,j,t-1} + \alpha_5 Z_{j,t} + f_b + f_t + \epsilon_{b,j,t}, \quad (1)$$

where $\Delta Y_{b,j,t}$ is a quarterly growth rate of loans, and $X_{b,j,t-1}$ is a vector of control variables that captures the degree to which a bank b is exposed to changes in regulation of country j through ex ante balance sheet composition and market access. $Z_{j,t}$ represents the financial and business cycle variables for country j. Bank and time fixed effects are included.[3] The prudential policy changes are captured by $HomeP_j$ prudential policy in the home country of the parent bank. Detailed definitions of the variables used can be found in table 10 in the appendix.

The above specification does not take into account the possibility that the response to home-country policy may not be homogenous

[3]In the Polish case, as we focused only on inward transmission, this specification accounts also for the time-country fixed effect.

across all banks in the sample. To do this, we supplement the previous specification with the interactions. As the model includes bank and time fixed effects, the coefficient on the interaction term $HomeP_j \cdot X_b$ measures how the structure of banks' balance sheets affects the response of bank lending to changes in regulation. The specification looks as follows:

$$\begin{aligned}\Delta Y_{b,j,t} = \alpha_0 &+ (\alpha_1 HomeP_{j,t} + \alpha_2 HomeP_{j,t-1} + \alpha_3 HomeP_{j,t-2}) \\ &+ \alpha_4 X_{b,j,t-1} + \alpha_5 Z_{j,t} + (\beta_1 HomeP_{j,t} \cdot X_{b,t-1} \\ &+ \beta_2 HomeP_{j,t-1} \cdot X_{b,t-1} + \beta_3 HomeP_{j,t-2} \cdot X_{b,t-1}) \\ &+ f_b + f_t + \epsilon_{b,j,t}. \end{aligned} \tag{2}$$

Next, we use cumulative changes to identify whether a change in the policy restrictiveness since 2000 influences banks' credit extension. The interactions of prudential policy with the cycle allow us to assess whether the reaction to cumulative policy changes is stronger in the different phases of the real or financial cycle. The specification is given by

$$\begin{aligned}\Delta Y_{b,j,t} = \alpha_0 &+ \alpha_1 HomeP_{cum,b,t} + \alpha_2 X_{b,j,t-1} + \alpha_3 Z_{j,t} \\ &+ \alpha_4 HomeP_{cum,j,t} \cdot Z_{j,t} + f_b + f_t + \epsilon_{b,j,t}. \end{aligned} \tag{3}$$

Finally, we modify the first regression by substituting time fixed effects with host-country policy and cycle variables to determine whether explicitly accounting for domestic regulatory environment affects the results. The specification now looks as follows:

$$\begin{aligned}\Delta Y_{b,j,t} = \alpha_0 &+ (\alpha_1 HomeP_{j,t} + \alpha_2 HomeP_{j,t-1} + \alpha_3 HomeP_{j,t-2}) \\ &+ \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + \alpha_6 Z_{host,t} + (\beta_1 HostP_t \\ &+ \beta_2 HostP_{t-1} + \beta_3 HostP_{t-2} + f_b + \epsilon_{b,j,t}. \end{aligned} \tag{4}$$

2.3 Bank-Level Data

The main dependent variable used in this analysis is the change in log claims in the domestic private non-financial sector (measured at the individual level). We focus on lending to the private non-financial sector, as intrafinancial system loans do not play a significant role in Poland (at the end of 2014, claims on the financial sector of banks in

the sample accounted for less than 10 percent of all claims). We chose to analyze a broader category of claims (instead of only loans) mainly due to data availability; however, the results can be easily interpreted in terms of loans, since they represent the vast majority of claims on the non-financial sector (around 90–95 percent, depending on the period).

A set of standard International Banking Research Network (IBRN) bank controls is used as explanatory variables (proxies of size, liquidity, capitalization, and international funding all measured at the individual level) with two modifications. First, we use the capital adequacy ratio (total regulatory capital to risk-weighted assets) instead of the tier 1 ratio due to data availability. Secondly, we modified the construction of the *Net Intragroup Funding*$_{b,t-1}$ variable—which is here defined from the perspective of Polish banks (not head office), so bigger values mean the greater reliance of Polish subsidiaries on funds obtained from foreign headquarters (since we do not have data on intragroup flows, we use liabilities toward all foreign banks as a proxy). We believe that such a definition is more appropriate and intuitive in the context of a Polish banking sector that imports liquidity from abroad rather than exports it, and for the aim of this research (analysis of inward transmission through foreign-owned banks).[4] The precise definitions of the variables used, together with the data sources, can be found in table 10 in the appendix.

We used quarterly supervisory reporting data on Polish commercial banks from the 2002–14 period for our baseline regressions. In principle, all commercial banks (both domestic and foreign owned) were included in the sample; however, adjustments were made to ensure that the results were not affected by outliers. First, special-case banks (state-owned special-purpose banks and affiliating banks) were removed from the sample. Second, to account for the impact of mergers on a bank's balance sheets, a new entity with a new identifier was created every time two banks merged. Third, any observations for which quarterly lending growth exceeded 100 percent were dropped. Fourth, remaining outliers were excluded by removing the

[4] At the same time, our definition is not very different from that of the standard IBRN and therefore this modification should not affect the comparability of results.

Table 1. Descriptive Statistics

Variable	Mean	Median	SD
Δ Domestic Claims	2.7	2.3	6.4
Log Total Assets	15.5	15.4	1.7
Capital Adequacy Ratio (%)	17.7	13.9	14.5
Illiquid Assets Ratio (%)	83.3	85.6	14.5
Net Intragroup Funding (%)	6.5	0.0	22.2
Core Deposits Ratio (%)	22.4	19.2	21.7

Table 2. Correlations between Banks' Characteristics

	Log Total Assets	Capital Adequacy Ratio	Illiquid Assets Ratio	Net Due To
Capital Adequacy Ratio	−0.3763	1.0000		
Illiquid Assets Ratio	−0.4254	0.1493	1.0000	
Net Due To	−0.0310	−0.0695	0.1118	1.0000
Core Deposits Ratio	0.4799	−0.2486	−0.2195	−0.2118

Note: See table 10 in the appendix for the definitions of variables.

10 percent of observations with the highest absolute quarterly change in claims. Finally, series with less than eight consecutive quarters of observations were dropped. The remaining banks account for around 80 percent of total claims on the non-financial sector.

Table 1 presents the descriptive statistics of the variables used. They confirm that the Polish banking system is relatively traditional—assets mostly comprise loans to the non-financial sector, which is reflected in a high illiquid assets ratio. Most of the funding comes in the form of retail deposits—as documented by a relatively high core deposits ratio. Although in general, foreign (intragroup) funding does not play a great role, it is important for some banks (as reflected in the high standard deviation). As table 2 shows, bigger banks tend to be less liquid (as they focus on granting long-term loans), to be less dependent on foreign financing, and to rely more on deposit funding.

2.4 Data on Prudential Instruments

The main explanatory variables of interest in this study are those that capture changes in prudential policies in the home countries of Polish foreign-owned banks, as given in Cerutti et al. (2017). Different policy variables that we use capture the change either in the individual instruments or in the overall prudential policy (through a prudential index that indicates whether any of the seven individual prudential policies is being changed in a given quarter). All policy indicators are discrete variables with values varying between –1 and 1, with one exception—reserve requirements in local currency vary between –3 and +5 to capture the change intensity. Not all the individual instruments are, however, taken into account in the regressions—in some cases, there is no variation in the instrument (either it has never been introduced or this type of policy has never been tightened or relaxed in the sample period), so it cannot be included in the regressions.

Table 3 presents the statistics for the use of prudential policies by the regulators in individual countries over the 2000–14 period. They show that the most frequently changed regulations were general capital requirements and loan-to-value (LTV) limits. At the other end are the reserve requirements in foreign currency, which have not been changed since 2000 and are therefore not included in the analysis.

The host-country (Polish) policy is also explicitly controlled for in this paper. Again, both the general prudential policy measure and the individual instruments are included in the regressions, provided that there is any variation in a given type of policy (there is at least one change in the sample period). Reserve requirements in foreign currencies and interbank exposure limits in Poland were not changed in the sample period and therefore are not taken into account.

3. Regression Results

3.1 Baseline Analysis of Inward Transmission of Prudential Policies

Our empirical results show that tightening of prudential regulations in home countries does not impact credit growth in Poland—all the coefficients next to contemporaneous and lagged prudential index are

Table 3. Summary Statistics on Changes in Prudential Instruments

Instrument	No. of Country-Time Changes	No. of Country-Time Changes (Tightening)	No. of Country-Time Changes (Loosening)	No. of Bank-Time Changes
Prudential Index	52	43	9	110
General Capital Requirements	28	28	0	53
Sector-Specific Capital Buffer (Real Estate)	4	3	1	5
Loan-to-Value Ratio Limits	12	8	4	19
Reserve Requirements: Foreign Currency	0	0	0	0
Reserve Requirements: Local Currency	9	0	9	23
Interbank Exposure Limit	5	5	0	30
Concentration Ratios	8	8	0	24

Source: IBRN.
Notes: This table shows summary statistics on changes in prudential instruments for banks located in Poland over the period 2000–14. Data on the instruments come from the IBRN Prudential Instruments Database, described in Cerutti et al. (2017), and are on a quarterly level. The number of changes in prudential instruments is reported on several dimensions: on the country-time level and on the bank-time level. The reported data are based on the regression sample.

not significant (see table 4; the results are based on the first specification described in section 2.2). The prudential index, however, is an aggregate measure and does not inform us about the type of policy being changed. Therefore, as we may expect that individual regulatory actions will have a different impact on the credit extension in Poland (see, for example, table 1 in Buch and Goldberg 2017), we have to consider each instrument separately as well. Out of the six different regulations that we control for in our analysis, we focus in particular on the selected instruments that may have the biggest impact on credit extension in Poland.

Changes in consolidated capital requirements may negatively affect credit growth of Polish banks if parent banks decide to decrease groups' risk-weighted assets by shrinking portfolios of their subsidiaries. Buch and Goldberg (2017) also show that global banks may increase international activities and move to less regulated markets if the requirements are not imposed at the consolidated level or are not binding; however, we do not expect this mechanism to be important in the Polish case. Reserve requirements serve as funding restrictions, but they can also be treated as an alternative to change in capital requirements (see, for example, Buch and Goldberg 2017) and therefore can affect credit extension in other than domestic jurisdictions as well. Restrictions on interbank exposures and concentration limits aim at decreasing interconnectedness and limiting potential contagion stemming from the default of a single client, and therefore we do not expect them to have a direct impact on the cross-border operations of the whole banking group. The same applies to loan-to-value limits that are product-level regulations and are unlikely to affect credit extension in Poland (see Buch and Goldberg 2017).

We find that tightening capital requirements in home countries significantly decreases lending growth of Polish banks by nearly 1.4 percentage points two quarters after the policy change. Such result could reflect the locational pecking-order strategy of international banks (a hypothesis formulated in Cetorelli and Goldberg 2012) which, in response to tighter regulatory standards in home countries, choose to save their home markets and cut lending in foreign locations first. Yet, we do not know from our analysis whether there is a difference between lending activity of the same bank in different locations, and caution is needed when interpreting the results in

Table 4. Inward Transmission of Policy via Affiliates of Foreign-Owned Banks

	Prudential Index (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Requirements: Local Currency (5)	Interbank Exposure Limits (6)	Concentration Ratios (7)
Prudential Policy$_t$	0.476	−0.638	−2.337	1.195	3.506**	−0.598	1.051
	(0.431)	(0.734)	(2.310)	(1.575)	(1.502)	(0.693)	(0.765)
Prudential Policy$_{t-1}$	0.723	0.257	−1.032	−0.524	3.002**	0.203	1.350
	(0.731)	(0.739)	(2.400)	(0.925)	(1.210)	(0.797)	(0.963)
Prudential Policy$_{t-2}$	−0.467	−1.377**	0.984	2.637***	1.472	−1.624**	−0.964
	(0.432)	(0.583)	(1.925)	(0.749)	(1.261)	(0.587)	(0.737)
Observations	1,909	1,909	1,909	1,909	1,909	1,909	1,909
R^2	0.309	0.309	0.308	0.309	0.310	0.308	0.309
Adjusted R^2	0.258	0.258	0.257	0.259	0.260	0.258	0.258
No. of Banks	72	72	72	72	72	72	72

Notes: This table reports the effects of changes in regulation on log changes in total claims on the domestic non-financial sector. The data are quarterly from 2002:Q1 to 2014:Q4. Each column gives the result for the change in the regulatory measure specified in the column headline in the home (i.e., parent-bank) country of foreign affiliates. For more details on the variables, see the online appendix at http://www.ijcb.org. All specifications include time and bank fixed effects. Standard errors are shown in parentheses and are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively. All banking data are at the individual level. Both domestic and foreign-owned banks are included in the sample. Only selected results (variables) are presented here; full results are available in the online appendix.

this way. The effect is also in line with the findings of Aiyar et al. (2014), who document the negative impact of home-country capital requirements on the cross-border operations of banks (their research shows that increasing capital ratios by 100 basis points reduces growth rate in cross-border lending of U.K. banks by 5.5 percentage points).

The positive relationship between tightening reserve requirements in local currency in home countries and credit extension in Poland that we find (see table 4) is counterintuitive and difficult to explain. Reserve requirements are used by prudential authorities to limit credit growth (see, for example, Tovar, Garcia-Escribano, and Martin 2012 or Cordella et al. 2014 for a discussion and evidence on the use of reserve requirements for macroprudential purposes). As they work in a similar way to capital buffers, we were expecting the coefficient to have the same (negative) sign as the one next to the capital requirements. This result can be, however, biased—in our sample there was no single event of tightening in reserve requirements in local currency in any of the home countries of Polish banks (see table 3).

Among the individual characteristics of banks that can shape their response to the home-country regulations, we find that banks that hold more illiquid assets or to a bigger extent rely on intragroup funding react more to the tightening of capital requirements (see table 5). When international banks decide to deleverage, subsidiaries relying on funding from parent institutions are naturally more vulnerable to changes in the home-country regulations. If, at the same, they do not have enough liquid assets, they may find it hard to substitute this funding, e.g., with repo transactions. Also, the low illiquid assets ratio means that a balance sheet comprises mostly liquid assets (for example, government bonds or central bank bills) and the loan portfolio is relatively small. Thus, scaling down lending growth of such banks would not bring large benefits to the group. That could potentially explain why banks with a relatively bigger loan portfolio and higher illiquid assets ratio are more sensitive to the tightening of capital regulations in home countries of their parent banks. The share of illiquid assets in a bank's balance sheet is also found to affect the transmission of reserve requirements. In this setting, however, we do not find a significant average impact of changes in any of the regulations in home country on credit extension

Table 5. Inward Transmission of Policy with Banks' Characteristics

	Prudential Index (1)	**Capital Requirements (2)**	**LTV Ratio (3)**	**Reserve Requirements: Local (4)**	**Interbank Exposure Limits (5)**	**Concentration Ratios (6)**
Prudential Policy$_t$	−25.95***	−6.218	−51.59	−21.50	−26.02***	8.834
	(7.431)	(6.054)	(42.11)	(15.18)	(5.505)	(11.15)
Prudential Policy$_{t-1}$	−7.217	10.48	−27.29	−12.88	16.72***	−26.82
	(13.73)	(11.10)	(52.35)	(12.17)	(5.435)	(24.28)
Prudential Policy$_{t-2}$	−12.94	16.50	27.90	−26.60***	7.159*	14.79
	(7.601)	(17.26)	(47.47)	(5.298)	(3.788)	(21.95)
Log Total Assets* Prudential Policy	2.575	0.529	0.389	1.998	0.997	−0.362
p-value	*0.00569*	*0.655*	*0.966*	*0.141*	*0.161*	*0.778*
Capital Adequacy Ratio* Prudential Policy	0.220	0.183	0.0644	0.132	0.209	−0.262
p-value	*0.0217*	*0.172*	*0.903*	*0.586*	*0.172*	*0.337*
Illiquid Assets Ratio* Prudential Policy	0.0731	−0.350	0.472	0.409	−0.206	0.246
p-value	*0.606*	*0.0103*	*1.14e-05*	*0.00273*	*0.00181*	*0.228*
Net Intragroup Funding* Prudential Policy	−0.0914	−0.132	0.115	0.0191	−0.127	−0.181
p-value	*0.122*	*0.0833*	*0.642*	*0.747*	*0.215*	*0.0835*

(*continued*)

Table 5. (Continued)

	Prudential Index (1)	Capital Requirements (2)	LTV Ratio (3)	Reserve Requirements: Local (4)	Interbank Exposure Limits (5)	Concentration Ratios (6)
Core Deposits Ratio* Prudential Policy	−0.0944	−0.153	0.336	−0.0257	0.0329	−0.0697
p-value	*0.140*	*0.166*	*0.622*	*0.783*	*0.714*	*0.736*
Observations	1,836	1,836	1,836	1,836	1,836	1,836
R^2	0.326	0.326	0.321	0.322	0.321	0.319
Adjusted R^2	0.270	0.269	0.265	0.266	0.265	0.263
No. of Banks	72	72	72	72	72	72
Net Effect	1.060	−1.228	3.800	5.963	−0.267	4.322
p-value	*0.417*	*0.415*	*0.456*	*0.114*	*0.895*	*0.217*

Notes: This table reports the effects of changes in regulation and their interactions with bank characteristics on log changes in claims on the domestic non-financial sector. The data are quarterly from 2002:Q1 to 2014:Q4. Each column gives the results for the change in the regulatory measure specified in the column headline in the home (i.e., parent-bank) country of foreign affiliates. For more details on the variables, see the online appendix. All specifications include time and bank fixed effects. Standard errors are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively. All banking data are at the individual level. Both domestic and foreign-owned banks are included in the sample. Sectoral-specific capital buffers are not included due to collinearity. Reported interactions are the sum of interactions of contemporaneous and lagged coefficients next to policy variables with respective bank control; p-values shown are reported from an F-test that the given linear combination is equal to 0. The net effect is the linear combination of all instrument coefficients (contemporaneous and lagged) with interacted controls fixed at their mean levels; p-values are reported from an F-test that the given linear combination is equal to 0.

of Polish banks—the net effect, which is the linear combination of all instrument coefficients with interacted controls fixed at their mean levels, is not significant for any instrument (see the last row of table 5 for the F-statistics and p-value).

As a next step we consider how cumulative changes in prudential policies affect lending growth in different phases of the real and financial cycle. We find that the cumulative tightening of policy (as measured with the cumulative prudential index) significantly decreases the growth rate of lending in Poland by 0.8 percentage points (see table 6). Both financial and real financial cycle conditions in home countries matter for the transmission; the business cycle amplifies the transmission of prudential policy more than the financial cycle. Among the individual instruments, cumulative changes in capital requirements work in a similar fashion as found previously (for example, table 4)—their tightening reduces the quarterly lending growth of Polish banks by nearly 1.7 percentage points (regardless of the cycles).

Finally, we explicitly control for the host-country (i.e., Polish) prudential policy in our regression (see specification (4) in section 2.2 and table 7). International banks operate in Poland mostly through subsidiaries and are subject not only to home-country policy but also (primarily) to Polish prudential regulations. Thus it is important to explicitly control for them in the regressions. In each case we put in the regression the same type of home- and host-country regulations. For example, when we investigate the impact of changes in capital requirements in home countries, we include also changes in capital requirements in Poland. In this setting, tightening capital requirements no longer affects credit extension in Poland. At the same time, Polish regulations in this area are found to be significant (they decrease lending growth by nearly 2.7 percentage points). This suggests that the decrease in credit growth can be attributed to changes in host-country capital requirements (that we did not properly control for in previous analysis) rather than in home-country policy. Recent actions taken by some international banks present in Poland suggest that in response to tightened capital policy at home, international banks might be more willing to decrease their cross-border operations and sell some of their subsidiaries.[5]

[5]For example, Italian Unicredito is said to have put its Polish subsidiary (Pekao S.A.) up for sale to meet higher capital requirements in response to the 2016 European Banking Authority EU-wide stress tests.

Table 6. Inward Transmission of Cumulative Policy Changes

	Prudential Index (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Requirements: Local (5)	Interbank Exposure Limits (6)	Concentration Ratios (7)
Cumulative Change in Prudential Policy	−0.825**	−1.653***	−2.736	0.220	1.065	−0.382	0.0243
	(0.289)	(0.366)	(1.824)	(0.533)	(0.698)	(0.807)	(0.481)
BIS Financial Cycle	−0.000976	0.0250	0.0212	0.00484	0.0384	−0.00936	0.0225
	(0.0301)	(0.0404)	(0.0484)	(0.0436)	(0.0569)	(0.0331)	(0.0381)
BIS Business Cycle	0.503**	0.346	0.220	0.279	0.319	0.364	0.282
	(0.208)	(0.249)	(0.249)	(0.217)	(0.296)	(0.269)	(0.244)
BIS Financial Cycle* Cumulative Change in Prudential Policy	0.0196**	−0.0578	0.0193	0.0310	0.0301	0.113	−0.0406
	(0.00679)	(0.0386)	(0.0320)	(0.0200)	(0.0379)	(0.0648)	(0.0367)
BIS Business Cycle* Cumulative Change in Prudential Policy	−0.240**	−0.384	0.306*	−0.0641	0.0729	0.0578	−0.449***
	(0.100)	(0.323)	(0.158)	(0.373)	(0.198)	(0.118)	(0.140)
Observations	1,972	1,972	1,972	1,972	1,972	1,972	1,972
R^2	0.301	0.296	0.294	0.292	0.293	0.303	0.294
Adjusted R^2	0.252	0.247	0.245	0.243	0.243	0.254	0.245
No. of Banks	72	72	72	72	72	72	72
Net Effect	−0.772	−1.624	−2.776	0.250	1.072	−0.322	0.0753
p-value	*0.0190*	*0.000621*	*0.152*	*0.621*	*0.142*	*0.703*	*0.873*

Notes: This table reports the effects of cumulative changes in regulation and their interactions with financial and business cycles on log changes in claims on the domestic non-financial sector. The data are quarterly from 2002:Q1 to 2014:Q4. Each column gives the results for the change in the regulatory measure specified in the column headline in the home (i.e., parent-bank) country of foreign affiliates. For more details on the variables, see the online appendix. All specifications include time and bank fixed effects. Standard errors are shown in parentheses and are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively. All banking data are at the individual level. Both domestic and foreign-owned banks are included in the sample. The net effect is the linear combination of all instrument coefficients with interacted controls fixed at their mean levels; p-values are reported from an F-test that the given linear combination is equal to 0. Only selected results (variables) are presented here; full results are available in the online appendix.

Table 7. Inward Transmission of Policy after Controlling for Host-Country Regulations

	Prudential Index (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Requirements: Local (5)	Concentration Ratios (6)
Home-Country Prudential Policy$_t$	0.361	−0.924	−2.398	0.557	4.486***	0.381
	(0.561)	(0.836)	(2.298)	(1.693)	(0.379)	(0.882)
Home-Country Prudential Policy$_{t-1}$	0.886	0.512	−1.573	0.213	0.545	1.261
	(0.787)	(1.118)	(2.667)	(0.926)	(0.838)	(1.271)
Home-Country Prudential Policy$_{t-2}$	0.135	−1.184	1.285	2.809***	1.949*	−1.033
	(0.525)	(0.925)	(2.423)	(0.917)	(0.914)	(0.617)
Host-Country Prudential Policy$_t$	−0.0136	−2.765**	0.231	0.278	1.235**	−1.079
	(0.181)	(1.203)	(0.151)	(1.130)	(0.498)	(0.965)
Host-Country Prudential Policy$_{t-1}$	0.318	0.622	−0.305*	1.210	−0.161	2.137**
	(0.276)	(0.976)	(0.147)	(1.548)	(0.507)	(0.911)
Host-Country Prudential Policy$_{t-2}$	0.287	−0.943	−0.525*	0.254	0.629	3.134***
	(0.257)	(0.636)	(0.247)	(0.883)	(0.503)	(0.880)
Observations	1,836	1,836	1,836	1,836	1,836	1,836
R^2	0.256	0.262	0.257	0.256	0.263	0.263
Adjusted R^2	0.220	0.226	0.221	0.220	0.228	0.227
No. of Banks	72	72	72	72	72	72

Notes: This table reports the effects of changes in parent-country regulation and firm characteristics on log changes in claims on the domestic non-financial sector. The data are quarterly from 2002:Q1 to 2014:Q4. Each column gives the results for the change in the regulatory measure specified in the column headline in the home (i.e., parent-bank) country of foreign affiliates and in the host country (i.e., Poland). For more details on the variables, see the online appendix. All specifications include bank fixed effects only. Standard errors are reported in parentheses and clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively. All banking data are at the individual level. Interbank exposure limits are dropped due to collinearity. Both domestic and foreign-owned banks are included in the sample. Only selected results (variables) are presented here; full results are available in the online appendix.

3.2 Robustness Checks and Country-Specific Issues

In this section we explore the robustness of our findings and consider whether they hold after taking into account specific features of the Polish banking sector. First, as a large share of a loan portfolio is denominated in foreign currencies (mainly CHF) and therefore is vulnerable to changes in the exchange rate, we run baseline specifications using change in claims net of exchange rate fluctuations as a dependent variable. The conclusions do not change significantly (see table 8, columns 1–4)—we find a significant, negative impact of cumulative changes in prudential policy and lagged capital requirements.

Next, we investigate policy spillovers in the post-crisis period only. There are two motivations for that: the majority of the prudential actions were taken after 2008, and this was the post-crisis period when the public debate in Poland concentrated on the possible drawbacks of the dominance of foreign-owned banks (see section 2.3). Differences in credit extension between domestic and foreign-owned banks were also noted during this period (the median growth rate of claims in the post-crisis period for foreign-owned banks was –0.14 compared with 2.97 for Polish-owned banks). Table 8, columns 5–6, presents the results. Changing the sample does not significantly affect the conclusions from the baseline regressions. Capital requirements still seem to have a negative impact on lending (now only in the peak of the financial cycle), but we no longer find an impact of the cumulative changes in general prudential policy.

We then examined whether changes in the regulatory policy in home countries influenced the risk taking of Polish banks. We build on a vast literature related to the risk-taking channel of monetary policy. In line with Laeven and Levine (2009) or Houston et al. (2010), we proxy risk taking with the logarithm of a z-score (defined as return on assets (ROA) plus capital-to-assets ratio, divided by the standard deviation of ROA—see table 10 in the appendix for details). The higher the z-score, the less the bank is likely to default (less risky). Significant and negative coefficients could therefore be interpreted as supporting the risk-shifting hypothesis formulated by Ongena, Popov, and Udell (2013) and suggest that banks compensate for the inability to take more risks at home by increasing lending in less regulated locations. Table 9 provides some evidence that tightening reserve requirements or capital ratios in the home country

Table 8. Robustness Checks

	Capital Requirements (1)	Prudential Index (2)	Capital Requirements (3)	Prudential Index (4)	Capital Requirements (5)	Prudential Index (6)
Home-Country Regulation$_t$			−0.949	0.152		
			(0.741)	(0.542)		
Home-Country Regulation$_{t-1}$			−0.291	1.017		
			(0.696)	(0.684)		
Home-Country Regulation$_{t-2}$			−1.393*	−0.168		
			(0.764)	(0.542)		
Cumulative Change in Prudential Policy	−2.190***	−0.991***			0.215	−0.281
	(0.323)	(0.270)			(0.520)	(0.401)
BIS Financial Cycle* Cumulative Change in Prudential Policy	−0.0657	0.0148			−0.0653*	−0.00192
	(0.0492)	(0.0122)			(0.0343)	(0.0152)
BIS Business Cycle* Cumulative Change in Prudential Policy	−0.571	−0.181**			−0.351	−0.320
	(0.444)	(0.0799)			(0.272)	(0.229)
Observations	1,972	1,972	1,972	1,858	832	832
R^2	0.309	0.312	0.328	0.328	0.455	0.454
Adjusted R^2	0.263	0.265	0.280	0.280	0.397	0.396
No. of Banks	72	72	72	72	50	50
Time Period	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2009:Q1–2014:Q4	2009:Q1–2014:Q4
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
LHS Variable	FX Adjusted Claims	FX Adjusted Claims	FX Adjusted Claims	FX Adjusted Claims	Claims	Claims
Sample	Full	Full	Full	Full	Post-crisis	Post-crisis

Notes: Each column gives the results for the change in the regulatory measure specified in the column headline in the home (i.e., parent-bank) country of foreign affiliates. For more details on the variables, see the online appendix. All specifications include bank fixed effects as specified in the lower part of the table. Standard errors are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 9. Impact of Regulations on Risk Taking

	Capital Requirements (1)	Reserve Requirement Local (2)	LTV Ratio (3)	Reserve Requirements: Local (4)	Interbank Exposure Limits (5)	Concentration Ratios (6)
Home-Country Regulation$_t$	−0.911*	−0.351***				
	(0.438)	(0.0358)				
Home-Country Regulation$_{t-1}$	−1.019**	−0.453***				
	(0.465)	(0.0403)				
Home-Country Regulation$_{t-2}$	−0.967**	−0.504***				
	(0.435)	(0.0386)				
Cumulative Home-Country Regulation			0.00601	0.0193	−0.255	0.0295
			(0.0246)	(0.0548)	(0.153)	(0.0555)
BIS Financial Cycle* Cumulative Home-Country Regulation			−0.00422	0.0191	−0.0306*	0.0101
			(0.0146)	(0.0163)	(0.0152)	(0.00709)
BIS Business Cycle* Cumulative Home-Country Regulation			−0.000661	−0.00497	−0.0196	−0.00231
			(0.00176)	(0.00547)	(0.0139)	(0.00529)
Observations	2,261	2,261	2,309	2,309	2,309	2,309
R^2	0.730	0.695	0.928	0.929	0.931	0.928
Adjusted R^2	0.719	0.681	0.924	0.924	0.926	0.924
No. of Banks	72	72	72	72	72	72
Time Fixed Effects	No	No	No	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
LHS Variable	Risk Taking	Risk Taking	Risk Taking	Risk Taking	Risk Taking	Risk Taking

Notes: This table reports the effects of changes in parent-country regulation and firm characteristics on risk taking, depending on specification. The data are quarterly from 2002:Q1 to 2014:Q4. Each column gives the results for the change in the regulatory measure specified in the column headline in the home (i.e., parent-bank) country of foreign affiliates and in the host country (i.e., Poland). For more details on the variables, see the online appendix. All specifications include bank fixed effects as specified in the lower part of the table. Standard errors are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively. All banking data are at the individual level.

leads to an increase in risk taking in the Polish banking sector. This may reflect the strategy of compensating for the inability to increase ROA at home.

Finally, all the policy instruments except for the prudential index are put into an equation to examine how good the index is as a proxy for overall policy change, and to see if the baseline conclusions regarding the impact of cumulative changes in general policy hold. The results (not reported here) suggest that none of the policy variables is significant; however, during economic recovery, a tightening of concentration regulations may decrease the credit expansion of Polish banks, while stricter LTV limits in the peak of the financial cycle may increase lending growth.

4. Concluding Remarks

In many economies that are host countries to international banks, policymakers have to take into account the possibility that the operation of banks (mainly credit extension) can be affected by the changes in regulatory environment in the home countries of foreign-owned banks (inward transmission of prudential policy). It is especially important for countries like Poland, where foreign banks have a dominant market position. After the global financial crisis, the debate in Poland reflected concerns about possible negative effects of several home-country regulations (mainly capital requirements) on the supply of credit in Poland.

Our results do not confirm the existence of a strong significant negative impact of home-country regulations on the dynamics of credit extension in Poland. When we control for domestic regulations that are binding for most of the banks in our sample, we do not find a significant impact of changes in the home-country capital requirements. However, it looks as if these are not single changes in regulations that may impact credit extension, but rather cumulative restrictiveness of regulatory environment.

For Polish regulators, the lack of significant inward transmission of prudential policy, together with the significance of local prudential actions, is a favorable situation. It means that changes in regulatory environment in different locations are not contributing to the credit crunch in Poland (the credit growth is not negatively affected), as international banks seem to take into account the situation in individual locations when trying to comply with the regulatory restrictions at home.

Appendix

Table 10. Construction of Balance Sheet Independent Variables

Variable Name	Description	Data Source
$\Delta Y_{b,t}$	Change in Claims on the Domestic Non-financial Sector = ln(Claims on Domestic Non-financial Sector) – Lag.ln(Claims on Domestic Non-financial Sector)	Supervisory Reporting
z-score$_{b,t}$	$z\text{-}score_{b,t} = \frac{ROA_{b,t} + \frac{capital_{b,t}}{assets_{b,t}}}{\sigma(ROA_b)}$, where $ROA_{b,t}, capital_{b,t}$, and $assets_{b,t}$ are measured for each bank and each quarter; $\sigma(ROA_b)$ is a standard deviation of ROA calculated for the whole sample period. ROA is calculated as a net profit of a given quarter relative to mean assets in a given quarter.	Supervisory Reporting
Log Total Assets$_{b,t-1}$	Logarithm of Total Assets	Supervisory Reporting
Capital Adequacy Ratio$_{b,t-1}$	Capital Adequacy Ratio = Regulatory Capital/ Risk-Weighted Assets, in %	Supervisory Reporting
Illiquid Assets Ratio$_{b,t-1}$	Illiquid Assets/Total Assets, in %, where Illiquid Assets = Total Assets, Government Bonds, Central Bank Bonds, Cash	Supervisory Reporting
Net Intragroup Funding$_{b,t-1}$	(Liabilities Toward Non-resident Banks Claims on Non-resident Banks)/Assets, in %	Supervisory Reporting
Core Deposits$_{b,t}$	Core Deposits/Assets, in %, where Core Deposits = Deposits from the Resident Household Sector	Supervisory Reporting

References

Aiyar, S., C. W. Calomiris, J. Hooley, Y. Korniyenko, and T. Wieladek. 2014. "The International Transmission of Bank Capital Requirements: Evidence from the UK." *Journal of Financial Economics* 113 (3): 368–82.

Bierut, B., T. Chmielewski, A. Głogowski, and A. Stopczyński. 2015. "Implementing Loan-to-Value and Debt-to-Income Ratios: Learning from Country Experiences. The Case of Poland." Working Paper No. 212, National Bank of Poland.

Buch, C., and L. Goldberg. 2017. "Cross-Border Regulatory Spillovers: How Much? How Important? Evidence from the International Banking Research Network." *International Journal of Central Banking* 13 (S1).

Cerutti, E., R. Correa, E. Fiorentino, and F. Segalla. 2017. "Changes in Prudential Policy Instruments—A New Cross-Country Database." *International Journal of Central Banking* 13 (S1).

Cetorelli, N., and L. Goldberg. 2012. "Banking Globalization and Monetary Transmission." *Journal of Finance* 67 (5): 1811–43.

Constancio, V. 2013. "Banking Union and the Future of Banking." Speech at the IIEA Conference on "The Future of Banking in Europe," Dublin, December 2.

Cordella, T., P. M. Federico, C. A. Vegh, and G. Vuletin. 2014. "Reserve Requirements in the Brave New Macroprudential World." World Bank Study.

Financial Stability Board. 2016. "Implementation and Effects of the G20 Financial Regulatory Reforms." 2nd Annual Report. August 31.

Gadomski, W. 2011. "Nowe regulacje unijne mogą nam zrobić z banków wydmuszki [New EU Regulations Can Transform Polish Banks into Dummy Companies]." Available at http://www.obserwatorfinansowy.pl/tematyka/bankowosc/nowe-regulacje-banki-crd-iv-nadzor-bankowy-unia-europejska/.

Głogowski, A., and P. Szpunar. 2012. "Lending in Foreign Currencies as a Systemic Risk." ESRB Commentary No. 4 (December).

Houston, J., C. Lin, P. Lin, and Y. Ma. 2010. "Creditor Rights, Information Sharing, and Bank Risk Taking." *Journal of Financial Economics* 96 (3): 485–512.

Jakubiak, A. 2012. "Wpływ Bazylei III i innych nowych regulacji unijnych i polskich na politykę kredytową i sytuację instytucjonalną sektora bankowego w Polsce. [Impact of Basel III and Other New European and Polish Regulations on the Credit Policy and Institutional Situation of Poland's Banking Sector.]" In *Zmiany regulacji a rozwój sektora bankowego. [Impact of the Regulation Changes on Development of the Banking Sector.]* Zeszyty BRE Bank-CASE No. 120.

Kwaśniak, W. 2012. "'Polskie banki jako element międzynarodowych holdingów bankowych — szansa czy zagrożenie? [The Polish Banks as an Element of the International Bank-Holdings — An Opportunity or a Threat?]" In *Kondycja banków w Europie i Polsce. Czy problemy finansowe inwestorów strategicznych wpłyną na zaostrzenie polityki kredytowej w spółkach-córkach w Polsce? [The Condition of Banks in Europe and Poland. Will Financial Problems of Strategic Investors Incur Tightening the Credit Policy for Affiliated Companies in Poland?]* Zeszyty BRE Bank-CASE No. 119.

Laeven, L., and R. Levine. 2009. "Bank Governance, Regulation and Risk Taking." *Journal of Financial Economics* 93 (2): 259–75.

Narodowy Bank Polski. 2014. "The Economic Challenges of Poland's Integration with the Euro Area." Available at http://www.nbp.pl/en/publikacje/inne/The-economic-challenges-of-Poland-s-integration-with-the-euro-area.pdf.

———. 2015. "Financial System in Poland 2014."

Ongena, S., A. Popov, and G. Udell. 2013. "'When the Cat's Away the Mice Will Play': Does Regulation at Home Affect Bank Risk-taking Abroad?" *Journal of Financial Economics* 108 (3): 727–50.

Tovar, C. E., M. Garcia-Escribano, and M. V. Martin. 2012. "Credit Growth and the Effectiveness of Reserve Requirements and Other Macroprudential Instruments in Latin America." IMF Working Paper No. 12/142.

Online Appendix to International Banking and Cross-Border Effects of Regulation: Lessons from Poland

Krzysztof Gajewski and Oskar Krzesicki
Narodowy Bank Polski

Table A1. Summary Statistics

Balance Sheet Characteristics	**Median**	**75th Percentile**
Log Total Assets	15.4	16.7
Capital Adequacy Ratio	13.9	19.5
Illiquid Assets Ratio	85.6	94.6
Net Due To Affiliates/Liabilities	0.0	8.8
Core Deposits Ratio	19.16	35.9
Loans (Ln Change)	2.3	7.1
Domestic Loans (Ln Change)	2.3	7.1
Foreign Loans (Ln Change)	—	—

Table A2. Summary Statistics on Changes in Prudential Policies

Inward: Specification B					
Instrument	**No. of Country-Time Changes**	**No. of Country-Time Changes (Tightening)**	**No. of Country-Time Changes (Loosening)**	**No. of Bank-Time Changes**	**Proportion HomeP$_t$ Non-zero**
Prudential Index	52	43	9	110	0.052
General Capital Requirements	28	28	0	53	0.025
Sector-Specific Capital Buffer	4	3	1	5	0.002
Loan-to-Value Ratio Limits	12	8	4	19	0.009
Reserve Requirements: Foreign	0	0	0	0	0.000
Reserve Requirements: Local	9	0	9	23	0.011
Interbank Exposure Limit	5	5	0	30	0.014
Concentration Ratio	8	8	0	24	0.011

Source: IBRN.
Notes: This table shows summary statistics on changes in prudential instruments for banks located in Poland over the period 2000–13. Data on the instruments come from the IBRN Prudential Instruments Database described in Cerutti et al. (2017) and are on the quarterly level. The number of changes in prudential instruments is reported on several dimensions, i.e., on the country-time level and on the bank-time level. The last column shows the share of prudential changes to total observations (i.e., the share of non-zero observations). The reported data are based on the regression sample.

Table A3. Inward Transmission of Home Macroprudential Policy via Affiliates

$$\Delta Y_{b,j,t} = \alpha_0 + (\alpha_1 HomeP_{j,t} + \alpha_2 HomeP_{j,t-1} + \alpha_3 HomeP_{j,t-2}) + \alpha_4 X_{b,j,t-1} + \alpha_5 Z_{j,t} + f_b + f_t + \epsilon_{b,j,t}$$

	HomeP = Prudential IndexC (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Requirements: Local (5)	HomeP = Interbank Exposure Limits (6)	HomeP = Concentration Ratios (7)
Home-Country Regulation HomeP_{t}	0.476 (0.431) 0.288	−0.638 (0.734) 0.399	−2.337 (2.310) 0.329	1.195 (1.575) 0.461	3.506** (1.502) 0.035	−0.598 (0.693) 0.402	1.051 (0.765) 0.191
Home-Country Regulation HomeP_{t-1}	0.723 (0.731) 0.339	0.257 (0.739) 0.733	−1.032 (2.400) 0.674	−0.524 (0.925) 0.580	3.002** (1.210) 0.026	0.203 (0.797) 0.803	1.350 (0.963) 0.183
Home-Country Regulation HomeP_{t-2}	−0.467 (0.432) 0.298	−1.377** (0.583) 0.033	0.984 (1.925) 0.617	2.637*** (0.749) 0.003	1.472 (1.261) 0.262	−1.624** (0.587) 0.015	−0.964 (0.737) 0.212
Log Total Assets_{t-1}	−1.327 (1.038) 0.222	−1.321 (1.040) 0.225	−1.306 (1.036) 0.228	−1.304 (1.043) 0.232	−1.304 (1.042) 0.231	−1.315 (1.037) 0.225	−1.322 (1.039) 0.224
Capital Adequacy Ratio_{t-1}	−0.032 (0.023) 0.193	−0.030 (0.023) 0.221	−0.031 (0.023) 0.206	−0.031 (0.023) 0.204	−0.030 (0.024) 0.235	−0.030 (0.023) 0.213	−0.031 (0.023) 0.201
Illiquid Assets Ratio_{t-1}	−0.009 (0.029) 0.772	−0.009 (0.029) 0.770	−0.009 (0.029) 0.754	−0.009 (0.029) 0.759	−0.008 (0.028) 0.775	−0.009 (0.029) 0.773	−0.009 (0.029) 0.758
Net Due To (Head Office)$_{t-1}$	0.005 (0.013) 0.718	0.006 (0.013) 0.641	0.005 (0.014) 0.711	0.004 (0.014) 0.796	0.007 (0.014) 0.656	0.005 (0.014) 0.708	0.005 (0.014) 0.706
Core Deposits Ratio_{t-1}	0.069 (0.055) 0.235	0.067 (0.054) 0.235	0.067 (0.055) 0.242	0.068 (0.055) 0.237	0.065 (0.055) 0.251	0.068 (0.055) 0.235	0.068 (0.055) 0.233

(*continued*)

Table A3. (Continued)

	HomeP = Prudential IndexC (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Requirements: Local (5)	HomeP = Interbank Exposure Limits (6)	HomeP = Concentration Ratios (7)
BIS Financial Cycle (Home Country)	0.018 (0.036) 0.625	0.017 (0.036) 0.636	0.019 (0.037) 0.621	0.019 (0.037) 0.618	0.017 (0.036) 0.651	0.016 (0.036) 0.660	0.018 (0.036) 0.633
BIS Business Cycle (Home Country)	0.251 (0.228) 0.291	0.272 (0.233) 0.262	0.273 (0.228) 0.252	0.279 (0.227) 0.239	0.254 (0.228) 0.283	0.287 (0.226) 0.224	0.255 (0.236) 0.297
Observations	1,909	1,909	1,909	1,909	1,909	1,909	1,909
R^2	0.309	0.309	0.308	0.309	0.310	0.308	0.309
Adjusted R^2	0.258	0.258	0.257	0.259	0.260	0.258	0.258
No. of Banks	72	72	72	72	72	72	72
Time Period	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LHS Variable: Loans	1	1	1	1	1	1	1
LHS Variable: Other	(Name Other)	(Name Other)	(Name Other)	(Name Other)	(Name Other)	(Name Other)	(Name Other)
Sample of Banks: Domestic Owned	0	0	0	0	0	0	0
Sample of Banks: Foreign Owned	0	0	0	0	0	0	0
Sample of Banks: Domestic and Foreign Owned	1	1	1	1	1	1	1
Sum ($HomeP_t + HomeP_{t-1} + HomeP_{t-2} = 0$)	2.391	4.123	−2.391	6.617	4.360	−0.469	1.913
F-test ($HomeP_t + HomeP_{t-1} + HomeP_{t-2} = 0$)	0.360	0.434	0.584	0.169	0.564	0.840	0.420

Notes: This table reports the effects of changes in parent-country regulation and firm characteristics on log changes in total loans. The data are quarterly from 2002:Q1 to 2014:Q4. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. For more details on the variables, see table 10 in the appendix of the main paper. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the table. Standard errors are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table A4. Inward Transmission of Home Macroprudential Policy via Affiliates—Bank Variables Interactions

$$\Delta Y_{b,j,t} = \alpha_0 + (\alpha_1 HomeP_{j,t} + \alpha_2 HomeP_{j,t-1} + \alpha_3 HomeP_{j,t-2}) + \alpha_4 X_{b,j,t-1} + \alpha_5 Z_{j,t} + (\beta_1 HomeP_{j,t} \cdot X_{b,t-1} + \beta_2 HomeP_{j,t-1} \cdot X_{b,t-1} + \beta_3 HomeP_{j,t-2} \cdot X_{b,t-2}) + f_b + f_t + \epsilon_{b,j,t}$$

	HomeP = Prudential IndexC (1)	HomeP = Capital Requirements (2)	HomeP = LTV Ratio (3)	HomeP = Reserve Requirements: Local (4)	HomeP = Interbank Exposure Limits (5)	HomeP = Concentration Ratios (6)
Home-Country Regulation HomeP_{t}	−25.95***	−6.218	−51.59	−21.50	−26.02***	8.834
	(7.431)	(6.054)	(42.11)	(15.18)	(5.505)	(11.15)
	0.00359	0.322	0.241	0.179	0.000325	0.441
Home-Country Regulation HomeP_{t-1}	−7.217	10.48	−27.29	−12.88	16.72***	−26.82
	(13.73)	(11.10)	(52.35)	(12.17)	(5.435)	(24.28)
	0.607	0.361	0.610	0.308	0.00820	0.288
Home-Country Regulation HomeP_{t-2}	−12.94	16.50	27.90	−26.60***	7.159*	14.79
	(7.601)	(17.26)	(47.47)	(5.298)	(3.788)	(21.95)
	0.111	0.355	0.566	0.000187	0.0797	0.511
Log Total Assets_{t-1}	−1.424	−1.135	−1.327	−1.239	−1.360	−1.341
	(1.027)	(1.077)	(1.093)	(1.117)	(1.063)	(1.079)
	0.187	0.309	0.245	0.286	0.221	0.234
Capital Adequacy Ratio_{t-1}	−0.0409	−0.0377	−0.0332	−0.0346	−0.0399	−0.0357
	(0.0270)	(0.0279)	(0.0251)	(0.0260)	(0.0254)	(0.0247)
	0.152	0.198	0.208	0.205	0.139	0.169
Illiquid Assets Ratio_{t-1}	−0.00889	0.00178	−0.0138	−0.000149	−0.00538	−0.00956
	(0.0280)	(0.0260)	(0.0283)	(0.0263)	(0.0276)	(0.0278)
	0.755	0.947	0.632	0.996	0.848	0.736
Net Due To (Head Office)$_{t-1}$	0.0121	0.00920	0.00632	0.00347	0.00893	0.00720
	(0.0133)	(0.0165)	(0.0157)	(0.0160)	(0.0136)	(0.0141)
	0.378	0.586	0.693	0.831	0.521	0.617

(*continued*)

Table A4. (Continued)

	HomeP = Prudential IndexC (1)	**HomeP = Capital Requirements (2)**	**HomeP = LTV Ratio (3)**	**HomeP = Reserve Requirements: Local (4)**	**HomeP = Interbank Exposure Limits (5)**	**HomeP = Concentration Ratios (6)**
Core Deposits Ratio$_{t-1}$	0.0847	0.0798	0.0794	0.0760	0.0791	0.0812
	(0.0533)	(0.0534)	(0.0550)	(0.0534)	(0.0539)	(0.0545)
	0.134	0.157	0.171	0.177	0.164	0.158
BIS Financial Cycle (Home Country)	0.0158	0.0177	0.0155	0.0142	0.0122	0.0144
	(0.0376)	(0.0377)	(0.0371)	(0.0366)	(0.0374)	(0.0363)
	0.681	0.646	0.682	0.705	0.750	0.697
BIS Business Cycle (Home Country)	0.184	0.220	0.275	0.215	0.296	0.236
	(0.235)	(0.237)	(0.232)	(0.239)	(0.233)	(0.241)
	0.447	0.370	0.257	0.383	0.224	0.344
Log Total Assets*HomeP	2.575	0.529	0.389	1.998	0.997	−0.362
F-test p-value	*0.00569*	*0.655*	*0.966*	*0.141*	*0.161*	*0.778*
Capital Adequacy Ratio*HomeP	0.220	0.183	0.0644	0.132	0.209	−0.262
F-test p-value	*0.0217*	*0.172*	*0.903*	*0.586*	*0.172*	*0.337*
Illiquid Assets Ratio*HomeP	0.0731	−0.350	0.472	0.409	−0.206	0.246
F-test p-value	*0.606*	*0.0103*	*1.14e-05*	*0.00273*	*0.00181*	*0.228*
Net Due To (Head Office)*HomeP	−0.0914	−0.132	0.115	0.0191	−0.127	−0.181
F-test p-value	*0.122*	*0.0833*	*0.642*	*0.747*	*0.215*	*0.0835*
Core Deposits Ratio*HomeP	−0.0944	−0.153	0.336	−0.0257	0.0329	−0.0697
F-test p-value	*0.140*	*0.166*	*0.622*	*0.783*	*0.714*	*0.736*
Observations	1,836	1,836	1,836	1,836	1,836	1,836
R^2	0.326	0.326	0.321	0.322	0.321	0.319
Adjusted R^2	0.270	0.269	0.265	0.266	0.265	0.263
No. of Banks	72	72	72	72	72	72
Time Period	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

(*continued*)

Table A4. (Continued)

	HomeP = Prudential IndexC (1)	**HomeP = Capital Requirements (2)**	**HomeP = LTV Ratio (3)**	**HomeP = Reserve Requirements: Local (4)**	**HomeP = Interbank Exposure Limits (5)**	**HomeP = Concentration Ratios (6)**
LHS Variable: Loans LHS Variable: Other	1 (Name Other)	(1/0) (Name Other)	(1/0) (Name Other)	(1/0) (Name Other)	(1/0) (Name Other)	(1/0) (Name Other)
Sample of Banks: Domestic Owned	0	0	0	0	0	0
Sample of Banks: Foreign Owned	0	0	0	0	0	0
Sample of Banks: Domestic and Foreign Owned	1	1	1	1	1	1
Sum ($HomeP_t + HomeP_{t-1} + HomeP_{t-2} = 0$)	−46.10	20.77	−50.98	−60.99	−2.135	−3.199
F-test ($HomeP_t + HomeP_{t-1} + HomeP_{t-2} = 0$)	0.0690	0.470	0.717	0.0566	0.864	0.906
Net Effect	1.060	−1.228	3.800	5.963	−0.267	4.322
p-value	*0.417*	*0.415*	*0.456*	*0.114*	*0.895*	*0.217*
Contemporaneous Net Effect	0.910	−0.128	1.791	2.423	−0.328	3.097
p-value	*0.0594*	*0.872*	*0.467*	*0.176*	*0.687*	*0.000669*

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in total loans. The data are quarterly from 2002:Q1 to 2014:Q4. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. For HomeP interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding F-statistics for joint significance in parentheses. For more details on the variables, see table 10 in the appendix of the main paper. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects. Standard errors are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table A5. Inward Transmission of Home Macroprudential Policy via Affiliates—Cycle Interactions

$$\Delta Y_{b,j,t} = \alpha_0 + \alpha_1 HomeP_{cum,b,t} + \alpha_2 X_{b,j,t-1} + \alpha_3 Z_{j,t} + \alpha_4 HomeP_{cum,j,t} \cdot Z_{j,t} + f_b + f_t + \epsilon_{b,j,t}$$

	HomeP = Prudential IndexC (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Requirements: Local (5)	HomeP = Interbank Exposure Limits (6)	HomeP = Concentration Ratios (7)
Cumulative Home-Country Regulation $\text{HomeP}_{\text{cum}}$	-0.825^{**} (0.289) 0.0126	-1.653^{***} (0.366) 0.000486	-2.736 (1.824) 0.156	0.220 (0.533) 0.686	1.605 (0.698) 0.149	-0.382 (0.807) 0.643	0.0243 (0.481) 0.960
Log Total Assets_{t-1}	-1.325 (0.878) 0.154	-1.349 (0.939) 0.173	-1.555 (0.997) 0.141	-1.421 (0.932) 0.149	-1.408 (0.956) 0.163	-1.530 (0.973) 0.138	-1.338 (0.940) 0.176
Capital Adequacy Ratio_{t-1}	-0.0490^{*} (0.0271) 0.0923	-0.0506^{*} (0.0273) 0.856	-0.0612^{*} (0.0299) 0.0597	-0.0578^{*} (0.0280) 0.0575	-0.0573^{*} (0.0296) 0.0734	-0.0491 (0.0297) 0.120	-0.0590^{*} (0.0293) 0.0634
Illiquid Assets Ratio_{t-1}	-0.0126 (0.0273) 0.652	-0.00795 (0.0252) 0.757	-0.00695 (0.0265) 0.797	-0.00714 (0.0264) 0.791	-0.00663 (0.0290) 0.823	-0.0110 (0.0270) 0.690	-0.00629 (0.0269) 0.818
Net Due To (Head Office)$_{t-1}$	0.00837 (0.0139) 0.557	0.00380 (0.0133) 0.780	-0.00625 (0.0126) 0.629	-0.00260 (0.0133) 0.848	-0.000515 (0.0143) 0.972	0.000748 (0.0135) 0.956	-0.00233 (0.0137) 0.867
Core Deposits Ratio_{t-1}	0.0603 (0.0632) 0.357	0.0714 (0.0589) 0.245	0.0792 (0.0611) 0.216	0.0782 (0.0603) 0.216	0.0679 (0.0598) 0.276	0.0675 (0.0597) 0.277	0.0740 (0.0595) 0.234
BIS Financial Cycle (Home Country)	-0.000976 (0.0301) 0.975	0.0250 (0.0404) 0.546	0.0212 (0.0484) 0.669	0.00484 (0.0436) 0.913	0.0384 (0.0569) 0.511	-0.00936 (0.0331) 0.781	0.0225 (0.0381) 0.564

(*continued*)

Table A5. (Continued)

	HomeP = Prudential IndexC (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Requirements: Local (5)	HomeP = Interbank Exposure Limits (6)	HomeP = Concentration Ratios (7)
BIS Business Cycle (Home Country)	0.503**	0.346	0.220	0.279	0.319	0.364	0.282
	(0.208)	(0.249)	(0.249)	(0.217)	(0.296)	(0.269)	(0.244)
	0.0296	0.186	0.392	0.219	0.300	0.197	0.268
BIS Financial Cycle* $\text{HomeP}_{\text{cum}}$	0.0196**	−0.0578	0.0193	0.0310	0.0301	0.113	−0.0406
	(0.00679)	(0.0386)	(0.0320)	(0.0200)	(0.0379)	(0.0648)	(0.0367)
	0.0120	0.157	0.556	0.143	0.441	0.103	0.287
BIS Business Cycle* $\text{HomeP}_{\text{cum}}$	−0.240**	−0.384	0.306*	−0.0641	0.0729	0.0578	−0.449***
	(0.100)	(0.323)	(0.158)	(0.373)	(0.198)	(0.118)	(0.140)
	0.0312	0.254	0.0732	0.866	0.718	0.631	0.00642
Observations	1,972	1,972	1,972	1,972	1,972	1,972	1,972
R^2	0.301	0.296	0.294	0.292	0.293	0.303	0.294
Adjusted R^2	0.252	0.247	0.245	0.243	0.243	0.254	0.245
No. of Banks	72	72	72	72	72	72	72
Time Period	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LHS Variable: Loans	1	1	1	1	1	1	1
LHS Variable: Other	(Name Other)	(Name Other)	(Name Other)	(Name Other)	(Name Other)	(Name Other)	(Name Other)
Sample of Banks: Domestic Owned	0	0	0	0	0	0	0
Sample of Banks: Foreign Owned	0	0	0	0	0	0	0
Sample of Banks: Domestic and Foreign Owned	1	1	1	1	1	1	1

Notes: This table reports the effects of changes in regulation and firm characteristics, business and financial cycles, and their interactions on log changes in total loans. The data are quarterly from 2002:Q1 to 2014:Q4. HomeP_{cum} refers to the cumulative changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. For more details on the variables, see table 10 in the appendix of the main paper. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the table. Standard errors are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table A6. Inward Transmission of Home versus Host Macroprudential Policy via Affiliates

$$\Delta Y_{b,j,t} = \alpha_0 + (\alpha_1 HomeP_{j,t} + \alpha_2 HomeP_{j,t-1} + \alpha_3 HomeP_{j,t-2}) + \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + \alpha_6 Z_{host,t} + (\beta_1 HostP_t + \beta_2 HostP_{t-1} + \beta_3 HostP_{t-2}) + f_b + \epsilon_{b,j,t}$$

	HomeP = Prudential IndexC (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Requirements: Local (5)	HomeP = Concentration Ratios (6)
Home-Country Regulation HomeP_t	0.361 (0.561) 0.530	−0.924 (0.836) 0.288	−2.398 (2.298) 0.314	0.557 (1.693) 0.747	4.486*** (0.379) 1.12e-08	0.381 (0.882) 0.672
Home-Country Regulation HomeP_{t-1}	0.886 (0.787) 0.280	0.512 (1.118) 0.654	−1.573 (2.667) 0.565	0.213 (0.926) 0.822	0.545 (0.838) 0.526	1.261 (1.271) 0.338
Home-Country Regulation HomeP_{t-2}	0.135 (0.525) 0.800	−1.184 (0.925) 0.222	1.285 (2.423) 0.604	2.809*** (0.917) 0.00841	1.949* (0.914) 0.0512	−1.033 (0.617) 0.116
Log Total Assets_{t-1}	−1.950* (1.099) 0.0977	−1.703 (1.022) 0.118	−1.743 (1.005) 0.105	−1.913 (1.144) 0.117	−1.757 (0.999) 0.100	−1.784* (0.999) 0.0958
Capital Adequacy Ratio_{t-1}	−0.0432 (0.0399) 0.297	−0.0366 (0.0383) 0.356	−0.0393 (0.0376) 0.314	−0.0429 (0.0411) 0.314	−0.0394 (0.0376) 0.312	−0.0396 (0.0374) 0.308
Illiquid $\text{Assets Ratio}_{t-1}$	−0.0117 (0.0283) 0.685	−0.0117 (0.0268) 0.669	−0.0109 (0.0280) 0.702	−0.0118 (0.0284) 0.684	−0.00860 (0.0266) 0.751	−0.0120 (0.0277) 0.671
Net Due To (Head Office)$_{t-1}$	−0.0291** (0.0133) 0.0468	−0.0221 (0.0131) 0.115	−0.0270* (0.0136) 0.0667	−0.0298** (0.0138) 0.0489	−0.0236 (0.0142) 0.119	−0.0231 (0.0141) 0.124

(*continued*)

Table A6. (Continued)

	HomeP = Prudential IndexC (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Requirements: Local (5)	HomeP = Concentration Ratios (6)
Core Deposits Ratio$_{t-1}$	0.0444 (0.0511) 0.400	0.0474 (0.0485) 0.345	0.0433 (0.0499) 0.400	0.0429 (0.0520) 0.424	0.0439 (0.0496) 0.391	0.0478 (0.0500) 0.355
BIS Financial Cycle (Home Country)	0.0240 (0.0351) 0.505	0.0189 (0.0340) 0.588	0.0214 (0.0338) 0.537	0.0236 (0.0342) 0.503	0.0202 (0.0345) 0.568	0.0198 (0.0339) 0.568
BIS Business Cycle (Home Country)	0.574*** (0.127) 0.000477	0.607*** (0.127) 0.000300	0.649*** (0.125) 0.000139	0.622*** (0.131) 0.000320	0.559*** (0.133) 0.000877	0.577*** (0.138) 0.000920
BIS Financial Cycle (Host Country)	0.0779 (0.0679) 0.270	0.0566 (0.0609) 0.368	0.0676 (0.0637) 0.307	0.0752 (0.0668) 0.279	0.0689 (0.0620) 0.285	0.0567 (0.0615) 0.372
BIS Business Cycle (Host Country)	0.601** (0.218) 0.0153	0.650** (0.240) 0.0171	0.524** (0.216) 0.0292	0.580** (0.226) 0.0223	0.650** (0.220) 0.0104	0.715** (0.252) 0.0132
Host-Country Regulation HostP$_t$	−0.0136 (0.181) 0.941	−2.765** (1.203) 0.0375	0.231 (0.151) 0.149	0.278 (1.130) 0.809	1.235** (0.498) 0.0264	−1.079 (0.965) 0.283
Host-Country Regulation HostP$_{t-1}$	0.318 (0.276) 0.268	0.622 (0.976) 0.534	−0.305* (0.147) 0.0564	1.210 (1.548) 0.448	−0.161 (0.507) 0.756	2.137** (0.911) 0.0343
Host-Country Regulation HostP$_{t-2}$	0.287 (0.257) 0.284	−0.943 (0.636) 0.160	−0.525* (0.247) 0.0518	0.254 (0.883) 0.778	0.629 (0.503) 0.231	3.134*** (0.880) 0.00314

(*continued*)

Table A6. (Continued)

	HomeP = Prudential IndexC (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Requirements: Local (5)	HomeP = Concentration Ratios (6)
Observations	1,836	1,836	1,836	1,836	1,836	1,836
R^2	0.256	0.262	0.257	0.256	0.263	0.263
Adjusted R^2	0.220	0.226	0.221	0.220	0.228	0.227
No. of Banks	72	72	72	72	72	72
Time Period	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4	2002:Q1–2014:Q4
Home-Country Fixed Effects	No	No	No	No	No	No
Time Fixed Effects	No	No	No	No	No	No
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
LHS Variable: Loans	1	1	1	1	1	1
LHS Variable: Other	(Name Other)	(Name Other)	(Name Other)	(Name Other)	(Name Other)	(Name Other)
Sample of Banks: Domestic Owned	0	0	0	0	0	0
Sample of Banks: Foreign Owned	0	0	0	0	0	0
Sample of Banks: Domestic and Foreign Owned	1	1	1	1	1	1
Sum ($HomeP_t + HomeP_{t-1} + HomeP_{t-2} = 0$)	1.382	−1.596	−2.686	3.578	6.980	0.609
F-test ($HomeP_t + HomeP_{t-1} + HomeP_{t-2} = 0$)	0.411	0.542	0.679	0.292	0.00268	0.778
Sum ($HostP_t + HostP_{t-1} + HostP_{t-2} = 0$)	0.591	−3.086	−0.599	1.742	1.702	4.192
F-test ($HostP_t + HostP_{t-1} + HostP_{t-2} = 0$)	0.177	0.244	0.163	0.578	0.167	0.0407

Notes: This table reports the effects of changes in parent-country regulation and firm characteristics on log changes in total loans. The data are quarterly from 2002:Q1 to 2014:Q4. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. HostP refers to the changes in regulation in the host country of foreign affiliates and thus changes only over time. For more details on the variables, see table 10 in the appendix of the main paper. Each column gives the result for the regulatory measure specified in the column headline. All specifications include bank fixed effects as specified in the lower part of the table. Standard errors are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table A7. Inward and Outward Transmission of Macroprudential Policy—Including All Instruments Jointly

	P = ExpP Inward A1 (1)	**P = HomeP Inward B1 (2)**	**P = DestP Outward 1 (3)**
Log Total Assets$_{t-1}$		−1.289	
		(1.051)	
		0.240	
Tier 1 Ratio$_{t-1}$		−0.030	
		(0.024)	
		0.237	
Illiquid Assets Ratio$_{t-1}$		−0.008	
		(0.028)	
		0.777	
Net Due To (Head Office)$_{t-1}$		0.006	
		(0.014)	
		0.674	
Core Deposits Ratio$_{t-1}$		0.066	
		(0.054)	
		0.242	
BIS Financial Cycle		0.018	
		(0.036)	
		0.630	
BIS Business Cycle		0.286	
		(0.216)	
		0.207	
P = Capital Requirements		−2.005	
F-test p-value		*0.744*	
P = Sector-Specific Capital Buffer		0.0816	
F-test p-value		*0.969*	
P = Loan-to-Value Ratio		2.844	
F-test p-value		*0.216*	
P = Reserve Requirements: Foreign			
F-test p-value			
P = Reserve Requirements: Local		8.040	
F-test p-value		*0.0736*	
P = Interbank Exposure Limits		−2.313	
F-test p-value		*0.193*	
P = Concentration Ratios		1.016	
F-test p-value		*0.523*	

(*continued*)

Table A7. (Continued)

	P = ExpP Inward A1 (1)	P = HomeP Inward B1 (2)	P = DestP Outward 1 (3)
Observations		1,909	
R^2		0.315	
Adjusted R^2		0.259	
No. of Destination Countries			
No. of Banks		72	
Time Period		2002:Q1–2014:Q4	
Destination-Country Fixed Effects	No	No	Yes
Time Fixed Effects	No	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes
LHS Variable: Loans	(1/0)	(1/0)	(1/0)
LHS Variable: Other	(Name Other)	(Name Other)	(Name Other)
Sample of Banks: Domestic Owned	(1/0)	(1/0)	(1/0)
Sample of Banks: Foreign Owned	(1/0)	(1/0)	(1/0)
Sample of Banks: Domestic and Foreign Owned	(1/0)	(1/0)	(1/0)

Notes: This table reports the effects of changes in regulation and firm characteristics on log changes in total loans by destination country. The data are quarterly from 2002:Q1 to 2014:Q4 for a panel of bank holding companies. The columns report results on the different specifications: inward A1, inward B1, and outward 1. Foreign-exposure-weighted regulaton ExpP is calculated as the weighted average of changes in foreign regulation where the weights are total assets and liabilities of the bank in the respective foreign country. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. DestP refers to the changes in regulation in the destination country of the loan. For each prudential measure P, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding F-statistics for joint significance in parentheses. For more details on the variables, see table 10 in the appendix of the main paper. All specifications include fixed effects as specified in the lower part of the table. Standard errors are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

International Banking and Cross-Border Effects of Regulation: Lessons from Portugal*

Diana Bonfim and Sónia Costa
Banco de Portugal

This paper offers a contribution to understand the cross-border effects of bank regulation using data on Portuguese banks. We find that the effect of foreign regulation on domestic credit growth depends on the type of regulation, on the channel of transmission, and on the legal form of the bank. Our results show that a tightening in foreign regulation leads to a decrease in the growth of domestic credit in the case of concentration ratios and capital requirements and has the opposite effect in the case of sector-specific capital buffers and reserve requirements in foreign currencies. We also find significant cross-border effects for the loan-to-value limits. In this case, cross-border spillovers work in different ways for domestic banks with international activity and for foreign banks: after a tightening in this instrument abroad, domestic banks decrease credit growth in Portugal while foreign banks increase it. Finally, we show that the cross-border effects of capital requirements work differently through branches and subsidiaries.

JEL Codes: F42, G21, G28.

*We would like to thank António Antunes, Luísa Farinha, Steven Ongena, Francisca Rebelo, Eric Wong, and the members of the IBRN Polish and Swiss teams for relevant comments and suggestions. We would also like to thank Margarida Brites, João Falcão, Ricardo Martinho, Ana Beatriz Matos, Nuno Moraes Sarmento, and Fátima Silva for their help in collecting the data and in the interpretation of some results. These are our views and do not necessarily reflect those of the Banco de Portugal or the Eurosystem.

1. Introduction

This paper is part of the joint research project of the International Banking Research Network (IBRN), which offers a unique opportunity to study the cross-border effects of banking regulation. The project looks at this issue from two angles: how foreign regulation affects domestic lending and how destination-country regulation affects lending of domestic banks abroad. We focus our analysis on the former, which is labeled the inward transmission channel.

The Portuguese banking system provides an interesting setting to analyze this issue. The international dimension of the Portuguese banking system is relevant in two dimensions. First, domestic banks have important activities abroad, and are thus exposed to foreign regulation through their branches and subsidiaries abroad. Second, foreign banks have a meaningful presence in the Portuguese banking system. Recent consolidation developments within the Banking Union suggest that this presence may be reinforced in the near future. Furthermore, Portugal is part of the European Monetary Union, and thus does not have a domestically targeted monetary policy. Within this setting, macroprudential policy may play a key role in the management of country-specific imbalances. It is thus essential to understand the transmission of prudential policy through bank lending. However, it is not enough to consider domestic prudential policy, as foreign regulation may also play an important role. The goal of this paper is precisely to gather evidence on this latter mechanism. This is a very relevant issue for policymakers, most notably when considering the large number of macroprudential policy measures being adopted worldwide.

Foreign banking regulation may have two opposing effects on domestic credit. On one hand, we could expect that there are cross-border complementary effects arising from regulation: a tightening in foreign regulation targeted at constraining lending in the home country may also lead to less lending in other countries. On the other hand, there may be cross-border substitution effects: when facing a tightening in foreign regulation, banks may actually increase lending in other countries to diversify their exposures and to maximize profitability.

To analyze the effects of foreign regulation on domestic credit, we consider two possible channels. First, we analyze the effect of foreign

regulation on the credit granted in Portugal by Portuguese banks with activity abroad (specification A). We find that a tightening in foreign regulation yields an increase in the growth of loans granted by domestic banks in Portugal. This substitution effect works through sector-specific capital requirements and reserve requirements in foreign currencies. For the loan-to-value (LTV) ratio, the results show the opposite sign, thus supporting the cross-border complementary effects hypothesis. For this instrument a tightening might imply a decline in the profitability of the affiliates of Portuguese banks, which can lead to a reduction in the domestic activity due to the reduction in profits for the banking group as a whole. In this case there are cross-border complementary effects of foreign regulation, i.e., its effects on constraining credit go beyond borders. Alternatively, it is also possible that this result is explained by the setting under which loan-to-values are usually tightened, which often corresponds to periods of booms in markets in which short-term profitability might be very high despite the tightening of this instrument. If this is the case, given that banks have limited resources, they may prefer to increase credit abroad rather than continue to lend domestically.

Second, we analyze the influence of foreign regulation on the growth of credit granted in Portugal by the foreign banks operating in the country (specification B). In this case we find that a tightening abroad is associated with a decline in credit growth in Portugal in the case of general capital requirements and concentration ratios, while for the loan-to-value ratio we find the opposite effect. In this specification, we would expect that a tightening in regulation in the home country of a given bank should constrain the whole activity of the banking group, including the activity of its affiliates abroad, most notably for instruments that are applied at the consolidated level. This is consistent with the result we obtain for general capital requirements and for concentration ratios. The result we obtain for the loan-to-value ratio is possibly related to substitution effects between the home and host country. In fact, loan-to-value limits are probably applied only at the domestic level, thus making the substitution effects plausible. Additionally, given that regulators usually tighten these instruments when home real estate markets are booming and risks are building up, the substitution for credit in the host country might reflect a diversification of exposures internationally. Foreign banks may be worried about the building up of risks in

their home country and thus increase credit abroad to diversify their exposures and thus mitigate risk.

The results presented above are part of the core analysis common to all country teams participating in the IBRN project and are part of the input for the meta-analysis in Buch and Goldberg (2017). In addition to these results, our paper focuses on one important additional dimension of analysis: the potentially heterogeneous role of branches and subsidiaries in the cross-border effects of regulation. More specifically, we use specification B to zoom in on the cross-border transmission of regulation and ask whether the regulation implemented in the home countries of foreign banks operating in Portugal has different effects on the credit granted in Portugal through foreign branches and subsidiaries. This distinction is relevant if we consider the differences in the legal form of these two types of institutions: whereas branches are legally part of the parent foreign bank, subsidiaries are legally independent entities and might be allowed to fail on their own. This distinction has important regulatory consequences. For instance, deposits held at subsidiaries are guaranteed by the host country, while those of branches are guaranteed by the home country. Furthermore, and perhaps more relevant for the purposes of our study, branches of European Union banks are exempt from capital requirements in the host country. We find that the negative effects of tighter capital requirements in the home country of a foreign bank on credit growth in the host country work only through branches. In the case of the loan-to-value, the increase in credit growth associated with a tightening operates as expected through both branches and subsidiaries.

This paper is organized as follows. In section 2, we describe the data and present some stylized facts. In section 3 we discuss the empirical methodology and our results. Finally, in section 4 we present a few concluding remarks.

2. Data and Stylized Facts for Portugal

2.1 Bank-Level Data

We collect bank-level data from quarterly supervisory reports. We use solo-basis data, which allows us to focus the analysis on the

effect of foreign regulation on credit granted in Portugal. If we used consolidated data, we would be considering the effects of foreign regulation on all credit granted by Portuguese banks, which includes credit granted by affiliates abroad. Further, all bank controls would refer to this larger perimeter of activity. We considered that this could undermine the interpretation of the results.

Our analysis period begins in 2006:Q1 and ends in 2014:Q4. Some of the variables could be computed for earlier periods. However, before 2005, banks used a different accounting system. Using a longer period would imply important breaks in some series, which are hard to address without compromising the quality of the data. Furthermore, the quality of analysis could also be compromised if many more years were included, as the beginning of that decade was dominated by a merger wave that substantially changed the landscape in the Portuguese financial system (for details, see Barros et al. 2014). During the analysis period, the structure of the Portuguese banking system was relatively stable. Furthermore, most of the changes in foreign regulation affecting Portuguese banks were implemented during the sample period.

We collect detailed information on key bank characteristics. All financial institutions are classified as domestic or foreign, depending on their ownership status. Foreign institutions are classified as branches or subsidiaries and there is information on the country of origin. Our data set only includes monetary financial institutions (i.e., banks in their classic definition, as these are the only institutions authorized to receive deposits from the public). We exclude non-monetary financial institutions from the analysis, as there are important differences in their funding models and in their regulation that may hamper the interpretation of the results. From a practical point of view, another reason to exclude these institutions is that there is no information on their exposures to foreign countries. In addition, this choice enhances the comparability of the results with those of other countries participating in the project.

In order to have data on the international activity of banks, we merge the supervisory bank database with the bank-level data underlying the international banking statistics reported to the Bank for International Settlements (BIS). In particular, we use the BIS data, on a consolidated basis (i.e., excluding intragroup positions)

and on an immediate borrower basis, for the local claims and liabilities of the branches and subsidiaries of the Portuguese banks. Additionally, we use bank-level data collected for the construction of the euro-area monetary financial statistics to obtain information on assets and liabilities against the banks of the same banking group located abroad. The use of these two alternative data sources implied the exclusion of the mutual agricultural credit banks from the sample, as in these sources the data for this type of institution are aggregated at a consolidated level. In any case, given that these institutions are devoted mainly to local activities and have a small weight on the total credit (around 3.75 percent over the sample period), we believe that their inclusion in the sample would not be relevant for the purpose of this study.[1]

We also merge the bank database with other data sources common to the project, namely with the IBRN Prudential Instruments Database, described in section 2.2 (and, in more detail, in Cerutti et al. 2017) and with economic and financial cycle data (obtained, respectively, from BIS 2014 and Drehmann, Borio, and Tsatsaronis 2011). In both databases there is no information for Angola, so we had to delete from our sample all banks belonging to Angolan banking groups, which have a weight on the domestic credit lower than 0.05 percent.

The final data set includes fifty-seven banks (twenty-five domestic and thirty-two foreign), which account on average over the sample period for 96 percent of the credit granted by banks in Portugal.

2.1.1 Dependent Variables

In both specifications A and B, our dependent variable is $\Delta Y_{b,t}$, which is defined as the quarterly change in credit granted by bank b to non-financial residents in Portugal in quarter t, measured in log percentage points.

2.1.2 Balance Sheet Characteristics

To ensure the consistency in the IBRN project, it is of utmost importance to guarantee that the explanatory variables used are as close

[1] All the bank-level data are subject to confidentiality rules.

as possible in the papers of each country team and described in Buch and Goldberg (2017). The variables considered in our specifications are the percentage of a bank's portfolio of assets that is illiquid ($IlliquidAssetsRatio_{b,t-1}$), the percentage of the bank's balance sheet financed with core deposits ($CoreDepositsRatio_{b,t-1}$), a bank's capital-to-asset ratio ($CapitalRatio_{b,t-1}$), the percentage of the bank's net external intragroup funding relative to its total liabilities $\left(NetIntragroupFunding_{b,t-1}\right)$, the log of total assets ($LogTotalAssets_{b,t-1}$), and the percentage of the assets plus liabilities of a bank's affiliates abroad relative to total assets plus total liabilities ($InternationalActivity_{b,t-1}$). All the variables are defined in detail in table 6 in the appendix. Table 1 summarizes these indicators for the full sample of banks operating in Portugal, as well as for domestic and foreign banks separately. Domestic banks are larger, better capitalized, less illiquid, and rely more on core deposits and less on net external intragroup funding than foreign banks.

2.2 Data on Prudential Instruments

We use the IBRN Prudential Instruments Database, which is described in Cerutti et al. (2017). The database includes quarterly information on the timing of tightening or loosening of a number of prudential tools in sixty-four countries over the period 2000–14.

The prudential tools considered are capital requirements, sectoral-specific capital buffers (which include an aggregate index as well as indexes for real estate, consumption, and other loans), loan-to-value limits, foreign and local reserve requirements, interbank exposure limits, and concentration ratios. The database also includes some summary measures of all the above tools. For each prudential tool, the database includes one index for its change, where a negative value corresponds to a loosening, a positive value corresponds to a tightening, and zero signals that no change has occurred in the quarter.

In specification A we want to evaluate the impact of the prudential regulation implemented in the countries where the Portuguese banks have branches and subsidiaries. Thus, in line with the harmonized methodology for the IBRN project, we construct for each Portuguese bank and prudential instrument an index ($ExpP_{b,t}$) for the change of the host countries' regulation ($HostP_{i,t}$), weighted

Table 1. Summary Statistics on Bank Credit and Characteristics

Variable	All Banks (N = 57)			Portuguese Banks (N = 25)			Foreign Banks (N = 32)		
	Mean	**Median**	**SD**	**Mean**	**Median**	**SD**	**Mean**	**Median**	**SD**
Balance Sheet Data (for Each Bank i and Quarter t)									
Dependent Variables:									
Domestic Credit (Ln Change) (%)	0.318	−0.169	15.34	0.380	−0.293	14.13	0.266	−0.0720	16.30
Independent Variables:									
Log Assets	7.278	7.088	1.952	7.805	7.538	2.090	6.831	6.881	1.705
Capital Ratio (%)	6.459	5.116	12.77	8.580	6.517	15.30	4.660	3.436	9.799
Illiquid Assets Ratio (%)	79.95	89.88	24.13	78.61	88.16	24.04	81.09	92.57	24.17
International Activity (%)	—	—	—	2.429	0	4.075	—	—	—
Net Intragroup Funding (%)	25.36	4.763	42.48	1.297	0	9.798	45.77	56.42	48.85
Core Deposits Ratio (%)	16.22	10.34	18.30	25.29	22.59	20.72	8.522	2.386	11.22

Notes: The table provides summary statistics for bank balance sheet and credit data. Data are observed quarterly from 2006:Q1 to 2014:Q4. Banking data are reported at the solo level. All variables are defined in table 6 in the appendix.

by the bank foreign exposures to the host countries ($\varnothing_{b,i,t-1}$). In the calculation we used the weights data on the previous four quarters.

$$ExpP_{b,t} = \sum_i HostP_{i,t}\varnothing_{b,i,t-1}$$

$$\varnothing_{b,i,t-1} = \frac{\sum_{t=t-4}^{t-1} exposure_{b,i,t}}{\sum_i \sum_{t=t-4}^{t-1} exposure_{b,i,t}}$$

The exposure of the domestic bank b to country i is measured by the claims plus liabilities of the branches and subsidiaries of that bank on country i, denominated in local currency (i.e., in the currency of country i) and on an immediate borrower basis.

In the construction of these exposure-weighted prudential policy indexes, only exposures to countries with data available in the prudential database could be considered. In our sample, this means we are taking into account 87 percent of the total foreign exposures of the Portuguese banks, through their affiliates abroad.

With specification B we are interested in evaluating the impact of the regulation adopted in the home country of each foreign bank with branches and subsidiaries in Portugal. Thus, in this case the regulation variables used in the regressions correspond to the indexes of the prudential database for the change in the prudential instruments in the countries of the parent banks ($HomeP_{j,t}$).

Table 2 reports some descriptive statistics on the prudential policy variables. Around 18 percent of the observations in the sample of Portuguese banks (used in specification A) and around 14 percent in the sample of foreign banks (used in specification B) are associated with some change in the prudential variables.[2] We exclude from the analysis the indexes referring to the decomposition of the sectoral-specific capital buffer as well as other regulatory measures

[2]The sample used in specification B includes both domestic and foreign banks, but the statistics for the incidence of regulation were calculated using only foreign banks. In fact, since we are interested in estimating the impact of foreign regulation, the regulation variable was set to zero for Portuguese banks in the regressions of specification B. This means regulation in Portugal is not explicitly included in the regressions, although its effects are embedded in the time fixed effects.

Table 2. Summary Statistics on Changes in Prudential Instruments

Inward: Specification A						
	Base Data (Before Aggregating to Exposure-Weighted Measures)					Exposure-Weighted Observations
Instrument	**No. of Country-Time Changes**	**No. of Country-Time Changes (Tightening)**	**No. of Country-Time Changes (Loosening)**	**No. of Bank-Time Changes**	**Proportion Base-MPP Non-zero**	**Proportion $ExpP_t$ Non-zero**
Prudential Index	107	80	27	209	0.014	0.175
General Capital Requirements	30	30	0	55	0.003	0.035
Sector-Specific Capital Buffer	17	15	2	36	0.002	0.052
Sector-Specific Capital Buffer (Real Estate)	10	10	0	19	0.001	0.031
Sector-Specific Capital Buffer (Consumption)	6	5	1	15	0.001	0.019
Sector-Specific Capital Buffer (Other)	4	3	1	9	0.001	0.012
Loan-to-Value Ratio Limits	18	11	7	36	0.002	0.049
Reserve Requirements: Foreign	19	10	9	31	0.002	0.036
Reserve Requirements: Local	32	13	19	60	0.004	0.070
Interbank Exposure Limit	11	11	0	16	0.001	0.014
Concentration Ratios	8	7	1	17	0.001	0.023

(*continued*)

Table 2. (Continued)

Inward: Specification B						
Instrument	**No. of Country-Time Changes**	**No. of Country-Time Changes (Tightening)**	**No. of Country-Time Changes (Loosening)**	**No. of Bank-Time Changes**	**Proportion HomeP$_t$ Non-zero**	
Prudential Index	41	30	11	136	0.142	
General Capital Requirements	15	15	0	48	0.050	
Sector-Specific Capital Buffer	10	8	2	21	0.022	
Sector-Specific Capital Buffer (Real Estate)	5	5	0	16	0.017	
Sector-Specific Capital Buffer (Consumption)	3	2	1	3	0.003	
Sector-Specific Capital Buffer (Other)	2	1	1	2	0.002	
Loan-to-Value Ratio Limits	3	0	3	23	0.024	
Reserve Requirements: Foreign	4	2	2	4	0.004	
Reserve Requirements: Local	14	5	9	29	0.030	
Interbank Exposure Limit	6	6	0	12	0.013	
Concentration Ratio	3	3	0	19	0.020	

Notes: This table shows summary statistics on the changes in the regulation on prudential instruments used in our sample. In the panel for specification A, the data refer to changes in regulation in the countries where the branches and subsidiaries of the Portuguese banks are located over the period 2005:Q4–2014:Q4. In the panel for specification B, the data refer to changes in regulation in the home countries of the foreign banks operating in Portugal over the period 2005:Q4–2014:Q4. Data on the instruments come from the IBRN Prudential Instruments Database described in Cerutti et al. (2017) and are on the quarter level. The number of changes in prudential instruments is reported on several dimensions, i.e., on the country-time level and on the bank-time level. The table also shows the share of prudential changes to total observations (i.e., the share of non-zero observations). In the top panel, the column "Exposure-Weighted Observations" is based on the underlying data on prudential changes in foreign countries (columns under the "Base Data" heading). The reported data are based on the regression sample.

(the interbank exposure limit and, in the case of approach B, also the reserve requirements in foreign currencies) with a sample variation less than 2 percent, given that for these measures we were not able to obtain robust results.

In the case of capital requirements, as explained in Cerutti et al. (2017), all the changes correspond to tightening movements, since they refer to the implementation of Basel. For the sectoral-specific capital buffer and the concentration limits, most of the changes in our sample also correspond to tightening movements. By contrast, for the reserve requirements in both specifications, and for the loan-to-value limits in specification A, both tightening and loosening movements occurred during the sample period.

2.3 Stylized Facts

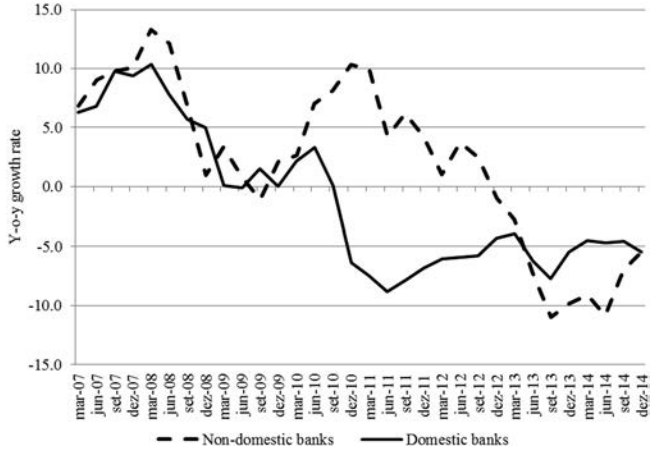
In the period under analysis, credit granted in Portugal witnessed strong movements. While in the mid-2000s credit was expanding quickly, it started to decelerate in 2008–09 during the global financial crisis and has been declining since the beginning of the euro-area sovereign debt crisis and the Economic and Financial Assistance Programme to Portugal. Figure 1 shows that the evolution of credit in our sample is broadly consistent with the aggregate data of the monetary financial statistics. In this period, the behavior of domestic and foreign banks operating in Portugal has not always been alike (see figure 2). In particular, while in the years 2010–11 domestic institutions faced with the increase in funding difficulties and the need to deleverage started to reduce credit, foreign banks continued to expand the credit granted in Portugal (Costa and Farinha 2011). In the most recent years, foreign banks have also cut their activity in Portugal. Nevertheless, their market share in the credit market remained around 25 percent, which is slightly higher than what was observed before the crisis.

The Portuguese banking system is highly concentrated. The five largest banking groups accounted for around 75 percent of bank credit to non-financial residents in Portugal in the last quarter of 2014. One of these five groups is part of a large foreign banking group. The rest of the Portuguese banking system comprises many small and medium-sized banks. Most of these banks are small-scale universal banks, competing directly with the five largest banking

Figure 1. Credit Granted by Banks in Portugal

Notes: The figure depicts the year-on-year growth rate of credit granted by domestic and foreign banks operating in Portugal. The solid line refers to data used in this paper, which were compiled from supervisory reports, while the dashed line refers to data from the monetary and financial statistics published by Banco de Portugal.

Figure 2. Credit Granted by Domestic and Foreign Banks in Portugal



Note: The figure depicts the year-on-year growth rate of credit granted by domestic and foreign banks operating in Portugal in solid and dashed lines, respectively, for the banks in the sample used in this paper.

groups. A few of them have specialized business models, offering only specific products such as consumer loans or asset management services.

By ownership nationality, Spanish banks dominate the market with a weight on the total credit granted by foreign banks of more than 65 percent over the period under analysis. The other countries with a non-negligible presence in the Portuguese credit market are the United Kingdom, Germany, and France.

Spain has also a dominant weight in the international activity of Portuguese banks, accounting for around 30 percent of the total foreign exposure through affiliates over the period 2006–14. Additionally, domestic banks were, during our sample period, significantly exposed to Poland and to a lesser extent to Greece, France, and some emerging market economies, such as Brazil, Angola, and Mozambique.

3. Empirical Method and Regression Results

In this section we discuss the results of our empirical estimations, trying to understand how foreign regulation affected the evolution of credit granted in Portugal. In section 3.1 we present the results of the baseline specifications, which are common to all country teams analyzing the inward transmission mechanism. In section 3.2 we discuss the results of an extension to the baseline analysis, where we explore in depth the results from specification B to try to understand whether the transmission of foreign regulation through foreign banks operating in Portugal is different for branches and subsidiaries. Finally, in section 3.3 we describe some of the robustness analyses and minor extensions done on these baseline specifications.

3.1 Baseline Analysis of Inward Transmission of Prudential Policies

3.1.1 Empirical Approach

The empirical approach we use to analyze the inward transmission of foreign regulation on loans granted by banks in Portugal is described

in detail in Buch and Goldberg (2017) and includes two different specifications.[3]

In specification A, the objective is to understand how foreign regulation affects the evolution of credit granted by domestic banks. The channel in focus in this specification comes from the exposures that domestic banks have abroad. To capture this, the regressions are estimated only for domestic banks. In this specification, the following regression is estimated:

Specification A: *Exposure-weighted inward transmission of regulation (see table 3).*

$$\Delta Y_{b,t} = \sum_{k=0}^{2} \alpha_{k+1} ExpP_{b,t-k} + \alpha_4 X_{b,t-1} + \sum_{k=0}^{2} \beta_{k+1} ExpP_{b,t-k} X_{b,t-k} + f_b + f_t + \varepsilon_{b,t}, \quad (1)$$

where $\Delta Y_{b,t}$ is the quarterly log change in domestic credit of bank b at time t (measured in percentage). The prudential policy changes are captured by $ExpP_{b,t-k}$, which measures exposure-weighted prudential policy outside Portugal. $X_{b,t-1}$ is the vector of bank control variables. Its interaction with $ExpP_{b,t-k}$ captures the degree to which a bank is exposed to changes in regulation through ex ante balance sheet composition and market access. These regressions include bank and time fixed effects.

In specification B, the goal is to understand how foreign regulation affects the growth of credit granted in Portugal by branches and subsidiaries of foreign branches. In this second approach, the following specification is estimated:

[3]The IBRN project considers two mechanisms for the cross-border transmission of prudential policies: inward and outward. We chose not to analyze the outward transmission channel because the regulation of the Portuguese banking system did not change significantly during the sample period and an important part of the international activity of Portuguese banks relates to emerging market economies not covered in the prudential database.

Specification B: *Inward transmission of home prudential policy via affiliates (see table 4).*

$$\Delta Y_{b,j,t} = \alpha_0 + \sum_{k=0}^{2} \alpha_{k+1} HomeP_{j,t-k} + \alpha_4 X_{b,j,t-1} + \alpha_5 Z_{j,t} + \sum_{k=0}^{2} \beta_{k+1} HomeP_{j,t-k} X_{b,j,t-k} + f_b + f_t + \varepsilon_{b,j,t}, \quad (2)$$

where $\Delta Y_{b,j,t}$ is the quarterly change in log loans extended by bank b, from country j, to residents in Portugal at time t (in percentage). The prudential policy changes are captured by $HomeP_{j,t-k}$ prudential policy in the home country j of the parent bank. $X_{b,j,t-k}$ is the vector of bank control variables. Its interaction with $HomeP_{j,t-k}$ captures the degree to which a bank b is exposed to changes in regulation of country j through ex ante balance sheet composition and market access. $Z_{j,t}$ represents the economic and credit cycle variables for country j. These regressions include bank and time fixed effects. Standard errors are clustered by country.

Besides controlling for time fixed effects, as in equation (1), these regressions control for macroeconomic and financial conditions in the home country of foreign banks. The regressions are estimated for the full sample, including domestic banks. However, for this latter group, the regulation variables and the financial and business cycle variables are set to zero. This allows all the identification on the regulation and cycle variables to come from foreign banks. Domestic banks enter the regressions to provide more strength on the conclusions regarding the effect of bank characteristics on credit growth.

3.1.2 Main Results

Table 3 presents the results of the estimation of equation (1). We consider contemporaneous effects and two lags for the regulation variable. In the first lines of the table we report the results for these three terms and in the bottom of the table the results for the sum of the three coefficients. Given space constraints, for the interactions of regulation with the bank control variables we report only the joint economic and statistical significance of these three coefficients,

Table 3. Inward Transmission of Policy through International Exposures of Domestic Banks

	ExpP = Prudential IndexC (1)	ExpP = Capital Require-ments (2)	ExpP = Sector-Specific Capital Buffer (3)	ExpP = LTV Ratio (4)	ExpP = Reserve Require-ments: Foreign (5)	ExpP = Reserve Require-ments: Local (6)	ExpP = Concen-tration Ratios (7)
$ExpP_t$	41.57***	−58.08***	13.91	29.59	1.467**	0.644	−1.444***
	(9.994)	(19.08)	(22.83)	(25.49)	(533.8)	(24.57)	(382.0)
$ExpP_{t-1}$	10.82	41.58	37.61	−156.3*	390.6	15.04	−57.00
	(21.03)	(39.24)	(40.59)	(79.69)	(372.3)	(28.38)	(266.2)
$ExpP_{t-2}$	28.97	1.331	58.39**	−112.5**	−408.2	19.97	−166.5
	(17.73)	(21.62)	(27.30)	(47.77)	(304.7)	(43.10)	(147.2)
Log Total $Assets_{t-1}$	2.109	1.895	1.062	3.002	1.083	1.439	1.331
	(2.633)	(2.653)	(2.513)	(2.960)	(2.329)	(2.398)	(2.364)
Capital $Ratio_{t-1}$	0.0671	0.0539	0.0768	0.0676	0.106*	0.0823	0.0886*
	(0.0692)	(0.5334)	(0.0585)	(0.0625)	(0.0539)	(0.0509)	(0.0478)
Illiquid Assets $Ratio_{t-1}$	0.0337	0.0419	0.0543	0.0256	0.0451	0.0386	0.0346
	(0.117)	(0.109)	(0.107)	(0.118)	(0.109)	(0.109)	(0.109)
International $Activity_{t-1}$	0.141	0.828**	0.347	0.763**	0.567	0.452	0.507
	(0.245)	(0.310)	(0.282)	(0.326)	(0.352)	(0.423)	(0.337)
Net Intragroup $Funding_{t-1}$	0.0915	0.0955	0.0576	0.137**	0.0659	0.0841	0.0846
	(0.0672)	(0.0648)	(0.0683)	(0.0663)	(0.0655)	(0.0621)	(0.0627)
Core Deposits $Ratio_{t-1}$	0.101	0.0768	0.108	0.0680	0.0673	0.0770	0.0892
	(0.135)	(0.125)	(0.130)	(0.136)	(0.124)	(0.129)	(0.129)
Log Total Assets*ExpP	−6.19***	4.45***	−2.41	40.13***	−106.59***	−6.32	−70.90
	(8.6511)	(11.2928)	(0.6192)	(5.0245)	(9.4879)	(1.5684)	(0.8783)
Capital Ratio*ExpP	0.04	2.35***	−0.02	2.20	1.7***	0.32	−4.33*
	(0.2869)	(10.7245)	(0.0961)	(1.9921)	(33.6121)	(0.2125)	(2.786)
Illiquid Assets Ratio*ExpP	−0.34	−0.48	−0.95**	−0.75	−7.35***	0.10	16.39***
	(0.5509)	(1.782)	(3.4517)	(1.1176)	(9.4271)	(0.5166)	(6.0442)

(*continued*)

Table 3. (Continued)

	ExpP = Prudential IndexC (1)	ExpP = Capital Require-ments (2)	ExpP = Sector-Specific Capital Buffer (3)	ExpP = LTV Ratio (4)	ExpP = Reserve Require-ments: Foreign (5)	ExpP = Reserve Require-ments: Local (6)	ExpP = Concen-tration Ratios (7)
International Activity*ExpP	2.74*	1.41**	0.72	−0.92	35.55*	1.65*	34.29*
	(2.9003)	(3.9663)	(1.9943)	(1.1751)	(2.8248)	(2.9011)	(2.5488)
Net Intragroup Funding*ExpP	0.34	0.48**	0.82	−3.44**	0.1*	0.03	3.98
	(1.6361)	(4.414)	(1.9257)	(3.1076)	(2.8478)	(0.2281)	(1.4908)
Core Deposits Ratio*ExpP	−0.08	−0.68***	−0.27***	−4.12**	3.08	0.55	19.7**
	(1.185)	(7.725)	(9.2166)	(3.3567)	(0.7987)	(1.0793)	(4.0381)
ExpP ($ExpP_t$+$ExpP_{t-1}$ +$ExpP_{t-2}$)	81.3531**	−15.17	109.9069***	−239.2609*	1449.29	35.65	−1367.1461**
F-statistics	(4.9682)	(0.0839)	(8.8012)	(4.2453)	(2.3015)	(0.448)	(4.828)
p-values	0.04	0.77	0.01	0.05	0.14	0.51	0.04
Average Marginal Effects of ExpP:							
For All Banks	11.32	−12.32	11.97*	−71.63**	196.99**	13.36	−93.32
For Banks/Periods with Changes in ExpP	10.87***	0.95	8.04*	−10.04	67.85***	7.85	−4.55
Observations	703	703	703	703	703	703	703
Adjusted R^2	0.04	0.04	0.02	0.03	0.03	0.01	0.01
No. of Banks	25	25	25	25	25	25	25

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in domestic loans. The data are quarterly from 2006:Q1 to 2014:Q4 for a panel of domestic banks. Foreign-exposure-weighted regulation ExpP is calculated as the weighted average of changes in foreign regulation where the weights are assets and liabilities of the bank affiliates in the respective foreign country. For ExpP interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding F-statistics for joint significance in parentheses. For more details on the variables, see table 6 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects. Standard errors are not clustered. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

i.e., the results for the sum of the interactions with the contemporaneous and lagged regulation. In order to have an idea of the impact of regulation when both the direct effect and the interactions effects are taken into account, at the bottom of the table we also include the average marginal effects of changes in regulation. The marginal effects are calculated both for all banks and for only the banks/periods subject to changes in regulation in our sample.

The first column reports the results for the aggregate prudential index (*PrudentialIndexC*) and the remaining columns show the results for each prudential tool individually. By examining the lines of the table with the marginal effects, we can conclude that foreign regulation affects the evolution of loans granted domestically through the international exposures of domestic banks. This effect is statistically significant for the aggregate prudential index. This aggregate effect seems to work through specific instruments, for which we obtain statistically significant marginal effects: sector-specific capital requirements, loan-to-value ratios, and reserve requirements on foreign currencies. For the remaining instruments (general capital requirements, reserve requirements on local currencies, and concentration ratio), the effects of foreign regulation on the growth of credit granted by Portuguese banks are not statistically significant.

Analyzing the statistical significance of the marginal effects allows us to establish that there are cross-border spillovers of regulation. However, it is also very important to understand in which direction these spillovers go. Does a tightening in regulation abroad lead to more or less credit at home? In aggregate terms, we find that a tightening in foreign regulation yields an increase in the growth of loans granted by domestic banks in Portugal. This result suggests that Portuguese banks operating internationally divert their resources to internal markets when they face tougher regulation abroad. This aggregate effect is coming from the sector-specific capital requirements and the reserve requirements on foreign currencies. For the loan-to-value ratio the effect is the opposite: a tightening of this instrument abroad decreases credit growth domestically. For these instruments a tightening might imply a decline in the profitability of the affiliates, which can lead to a reduction in the domestic activity. It is also possible to argue that despite tighter loan-to-value limits, banks still find it profitable to lend abroad, given

that this instrument is usually tightened when credit and real estate markets are booming and hence (short-term) profitability might be very high. Assuming that resources are limited, this might imply a constraint in domestic credit. Cerutti et al. (2017) find that there is a positive correlation between credit growth and the increase of loan-to-value limits, thus supporting this hypothesis.

The magnitude of the marginal effects reflects the average impact (in percentage points) on the growth rate of credit of a simultaneous tightening in regulation in all countries where Portuguese banks have affiliates. Thus, we have computed the economic effects of these changes by rescaling the marginal effects for the average value of the exposure-weighted prudential measure observed in our sample in the periods of regulatory changes. After a tightening in the sector-specific capital requirements, a tightening in the reserve requirements on foreign currencies, and a loosening in the loan-to-value ratio, on average, the quarterly loan growth rate for the banks/periods exposed to the regulatory changes in our sample increased 3.1, 12.2, and 3.6 percentage points, which is around 35 percent, 144 percent, and 44 percent of the mean absolute change of credit for these banks/periods. These large effects should be interpreted with caution given the small number of regulatory changes analyzed.

Though the signal of the effects of foreign regulation on the evolution of domestic credit is of primary interest, it is also relevant to understand exactly through which mechanisms these effects are transmitted across borders. Our specification allows us to do that through the analysis of the interaction terms. The substitution effects of foreign regulation leading to an increase in domestic credit growth, which work through sectoral capital buffers and foreign reserve requirements, are stronger for smaller banks, as well as for banks with more liquid assets and with more intense international activity. In turn, the complementary effects arising from a tightening in the loan-to-value ratio are reinforced for smaller banks and for banks with more net external intragroup funding and a higher core deposits ratio. Banks' size and liquidity thus seem to play an important role in how foreign regulation affects domestic credit.

Table 4 presents the results of the estimation of equation (2), i.e., specification B. In this case, the goal is to understand how foreign regulation affects credit granted in Portugal by branches and

Table 4. Inward Transmission of Policy via Affiliates of Foreign-Owned Banks

	HomeP = Prudential IndexC (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Requirements: Local (5)	HomeP = Concentration Ratios (6)
HomeP_t	1.156	−10.19	13.78	82.47***	−3.993	8.657
	(6.126)	(12.15)	(10.62)	(22.66)	(11.82)	(7.127)
HomeP_{t-1}	22.92**	24.61*	34.93**	18.43***	−0.673	−33.31***
	(7.832)	(11.28)	(13.15)	(3.501)	(10.82)	(8.197)
HomeP_{t-2}	−2.691	−12.66**	31.46*	18.15**	10.08	−46.09***
	(5.456)	(5.555)	(15.82)	(6.553)	(16.26)	(7.925)
Log Total Assets_{t-1}	−1.814	−1.300	−1.709	−1.514	−1.465	−1.432
	(1.586)	(1.557)	(1.581)	(1.558)	(1.580)	(1.532)
Capital Ratio_{t-1}	0.0713*	0.0835*	0.0798*	0.0753**	0.0790*	0.0785*
	(0.0341)	(0.0374)	(0.0396)	(0.0329)	(0.0368)	(0.0366)
Illiquid Assets Ratio_{t-1}	−0.0416	−0.0577	−0.0436	−0.0739	−0.0578	−0.0531
	(0.0755)	(0.0074)	(0.0744)	(0.0775)	(0.0755)	(0.0732)
Net Intragroup Funding_{t-1}	−0.0427	−0.0408	−0.0578	−0.0376	−0.0546	−0.0525
	(0.0488)	(0.0448)	(0.0484)	(0.0410)	(0.0472)	(0.0467)
Core Deposits Ratio_{t-1}	0.106*	0.0842	0.0922	0.0973*	0.0803	0.0780
	(0.0557)	(0.0651)	(0.0643)	(0.0492)	(0.0656)	(0.0662)
Financial Cycle (Home Country)	−0.0332*	−0.0405*	−0.0438	−0.0350	−0.0473	−0.0537*
	(0.0155)	(0.0209)	(0.0256)	(0.0209)	(0.0276)	(0.0246)
Business Cycle (Home Country)	1.214**	1.375**	1.489**	1.246**	1.456**	1.577***
	(0.443)	(0.470)	(0.506)	(0.495)	(0.496)	(0.476)
Log Total Assets*HomeP	0.51	0.23	1.51	1.10	1.10	−0.90
	(0.2744)	(0.0124)	(0.7981)	(2.1151)	(0.1272)	(0.2443)
Capital Ratio*HomeP	0.03	−0.54	−0.91**	2.44***	0.58	1.6**
	(0.0056)	(1.2924)	(7.3717)	(28.9896)	(1.0358)	(6.2872)
Illiquid Assets Ratio*HomeP	−0.15	0.16	−1.09***	−1.51***	−0.18	0.49***
	(1.2312)	(0.7227)	(24.3021)	(17.74)	(1.6279)	(12.2658)
Net Intragroup Funding*HomeP	−0.16	−0.37*	0.24*	0.31***	0.08	0.18***
	(1.6166)	(3.9579)	(4.8046)	(14.68)	(1.1721)	(14.1518)
Core Deposits Ratio*HomeP	−0.55*	−0.41	−0.43	−0.54***	−0.48	3.04***
	(3.3943)	(1.6546)	(0.6513)	(87.823)	(1.8278)	(56.9368)

(*continued*)

Table 4. (Continued)

	HomeP = Prudential IndexC (1)	**HomeP = Capital Requirements (2)**	**HomeP = Sector-Specific Capital Buffer (3)**	**HomeP = LTV Ratio (4)**	**HomeP = Reserve Requirements: Local (5)**	**HomeP = Concentration Ratios (6)**
HomeP ($HomeP_t$+$HomeP_{t-1}$+$HomeP_{t-2}$)	21.38*	1.75	80.17***	119.05***	5.41	−70.75***
F-statistics	(4.6434)	(0.0171)	(43.432)	(20.3492)	(0.0582)	(16.4792)
P-values	0.06	0.90	0.00	0.00	0.81	0.00
Average Marginal Effects of HomeP:						
For Foreign Banks	1.00	−7.1*	4.87	24.91***	0.99	5.49
For Foreign Banks/Periods with Changes in HomeP	1.08	−6.73*	3.69	11.1***	2.36	−5.21**
Observations	1,619	1,619	1,619	1,619	1,619	1,619
Adjusted R^2	0.050	0.046	0.046	0.052	0.038	0.034
No. of Banks	57	57	57	57	57	57

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in domestic loans. The data are quarterly from 2006:Q1 to 2014:Q4. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. For HomeP interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding F-statistics for joint significance in parentheses. For the Portuguese banks the regulation variables and the financial and business cycle variables are zero. For more details on the variables, see table 6 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects. Standard errors are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

subsidiaries of foreign banks. As shown in equation (2), we consider contemporaneous effects and two lags for the foreign regulation variable. As in the previous table, the reported coefficients for interaction effects are the sum of the contemporaneous term and two lags. For the direct effects we report both the coefficients of the three *HomeP* terms (in the first lines of the table) and their sum (at the bottom of the table). The table also includes the average marginal effects of changes in regulation and their significance, calculated for all the foreign banks and for only the foreign banks/periods subject to changes in regulation in our sample.

As in table 3, the first column reports the results for the aggregate prudential index and the remaining columns show the results for each prudential tool individually. At the aggregate level, changes in foreign regulation do not affect credit granted in Portugal in this specification. This is possibly because of the mixed directions of effects coming from different prudential tools. While for the loan-to-value ratio a tightening abroad is associated with more credit growth in Portugal, for the general capital requirements and the concentration ratios we find the opposite. After a tightening in the capital requirements, a tightening in the concentration ratio and a loosening in the loan-to-value limit, on average, the quarterly loan growth rate for the banks/periods with changes in these regulatory measures in our sample declined 6.7, 5.2, and 11.1 percentage points, which is around 75 percent, 81 percent, and 138 percent of the mean absolute change for these subsamples. As before, the magnitude of these effects should be interpreted with caution.

To better understand these results, it is important to discuss our expectations of this transmission channel. When regulation is tightened in the home country of a given bank, this might affect the whole activity of the banking group, including its affiliates abroad if the regulation is applied at the consolidated level. So, while in the previous specification domestic banks could to some extent substitute between foreign and domestic credit when regulation was tightened or loosened abroad, in this specification this substitution might be more likely to occur in the case of regulations that are not applied at the consolidated level. The results we obtain are in line with this reasoning. In fact, both capital requirements and concentration ratios are usually applied at the consolidated level, while limits to the loan-to-value ratio are most often applied at the local level, when specific risks are building up in the home country of the bank, where

most of its activity is usually concentrated. To be more effective, these instruments are typically targeted to the vulnerabilities they want to address and thus do not cover the international activity of banks.

As before, our empirical strategy allows us to understand through which channels these mechanisms are working by exploring the interaction terms in the regressions. The negative effect of tighter capital requirements on credit growth in Portugal by foreign banks is mitigated when banks have less intragroup external net debt. Other indicators of banks' financial strength and business models are not statistically significant. For concentration ratios the negative effect on credit growth is mitigated by higher capital ratios, more illiquid assets, more net intragroup external debt, and more core deposits, thus not providing a very clear picture about how the financial health of a banks' affiliate affects this cross-border effect. Looking at the positive effect of a tightening in the loan-to-value ratio, we find that this effect is stronger when the affiliate becomes better capitalized and more liquid. This suggests that foreign banks with better financial standing substitute some of the credit granted abroad by domestic loans when lending requirements become tighter at home. Additionally, the substitution effect is stronger for the affiliates that rely more on intragroup funding and less on deposits from residents in the host country.

In sum, the results suggest that the cross-border effects of regulation depend on the prudential tool considered as well as on the channel of transmission. A tightening in foreign regulation leads to a decrease in domestic credit growth in the case of concentration ratios and capital requirements. These effects operate through foreign banks located in Portugal. By contrast, in the cases of sector-specific capital buffers and foreign reserve requirements, a tightening in foreign regulation leads to an increase in credit growth in Portugal. These effects operate through the domestic banks with international activity. We also find significant cross-border effects for the loan-to-value limits. In this case, it is interesting to note that the cross-border spillovers work in different ways for domestic banks with international activity and for foreign banks—after a tightening in this instrument abroad, domestic banks decrease credit growth in Portugal while foreign banks increase it. Since the tightening of loan-to-value limits generally occurs when real estate markets

are booming, one possible explanation for these different effects is that Portuguese banks might constrain their domestic credit growth to be able to increase credit abroad, while foreign banks might be more worried with the building up of risks in the home country (where most of their activity is concentrated) and thus increase credit growth abroad.

3.2 Further Exploring Cross-Border Spillovers of Prudential Policies

In this section we extend our previous analysis in several directions with two purposes: to gain further insight on some issues and to test the robustness of the results to different specifications.

The most important extension is related to an effort to understand how the cross-border transmission of prudential policy works through different types of foreign banks. More specifically, we look separately at the transmission through foreign branches and subsidiaries located in Portugal, as their legal form has implications for the way regulation is applied. In this analysis we will focus on the prudential tools for which we find evidence of transmission through foreign banks to the domestic economy and for which we have enough variation in our data: capital requirements and loan-to-value limits.

Afterwards, we summarize the results of the extensive battery of robustness tests we conducted on the baseline results.

3.2.1 Cross-Border Spillovers through Branches and Subsidiaries

A bank might be present in a foreign country through two different legal forms: a branch or a subsidiary. A branch is not a legally autonomous entity and belongs directly to the parent bank. In turn, a subsidiary is a legally independent institution in the host country. In legal terms, it works in a very similar way to the domestic banks operating in that country, with the main difference being that its capital is held by a foreign bank. For an uninformed customer the differences between a branch and a subsidiary would not be perceptible, as the management of their operations and their relationships with customers have no reason to differ. However, important differences apply in regulatory terms due to the legal nature

of each institution. For instance, deposits held by customers in a branch are guaranteed by the deposit guarantee scheme of the home country, while for the subsidiary the responsibility lies entirely with the host country. More importantly for the purposes of our study, some prudential instruments are applied differently for branches and subsidiaries. Cerutti, Dell'Ariccia, and Martínez Pería (2007), Dell'Ariccia and Marquez (2010), Focarelli and Pozzolo (2005), and Goldberg and Saunders (1981) discuss in more detail some of the differences between branches and subsidiaries and the way banks choose to expand internationally, while Peek and Rosengren (1997, 2000) analyze the implications on the transmission of shocks.

The most relevant example in the European Union is perhaps the case of capital requirements: branches of EU banks are exempt from fulfilling capital requirements in the host country, but are directly subject to capital requirements in the home country. In this setting, the cross-border implications of regulations may be differentiated. While both branches and subsidiaries are affected by the capital requirements implemented in the home country, only subsidiaries are affected by changes in capital requirements in the host country. In contrast, loan-to-value ratios are usually applied directly to exposures in markets in which there are concerns regarding the buildup of risks in real estate markets. Thus, if the regulator applies this measure in the home country, the loans granted by home-country affiliates abroad should not be directly affected.

Given these important differences, the cross-border effects of regulation may depend on the legal form of foreign banks. To analyze this, we adapt equation (2) and estimate the following regression:

Specification B1: *Inward transmission of home prudential policy via branches and subsidiaries (see table 5).*

$$\Delta Y_{b,j,t} = \alpha_0 + \sum_{k=0}^{2} \alpha_{k+1} HomeP_{j,t-k} Branch_{b,t} + \sum_{k=0}^{2} \alpha_{k+4} HomeP_{j,t-k} Subsidiary_{b,t} + \alpha_7 X_{b,j,t-1} + \alpha_8 Z_{j,t} + \sum_{k=0}^{2} \beta_{k+1} HomeP_{j,t-k} X_{b,j,t-k} Branch_{b,t}$$

$$+ \sum_{k=0}^{2} \beta_{k+4} HomeP_{j,t-k} X_{b,j,t-k} Subsidiary_{b,t}$$
$$+ f_b + f_t + \varepsilon_{b,j,t} \quad (3)$$

All the variables and estimation restrictions are the same as in equation (2). The only difference is that the prudential variable is interacted with a categorical variable for branches and subsidiaries. The omitted category is the one referring to domestic banks. These regressions include bank and time fixed effects. Standard errors are clustered by country.

The results of this approach are presented in table 5.[4] The results in table 4 show that tighter capital requirements in the home country of a foreign bank are associated with less credit growth in the host country. By looking at the marginal effects in table 5, we are able to find that this cross-border spillover of regulation works only through branches. As discussed above, the impact of foreign regulation should in theory affect both types of foreign banks. One possible explanation for this difference might be the different way branches and subsidiaries are affected by capital regulation. Branches are only affected by their home-country regulation, and so it makes sense to find this statistically significant spillover. In turn, subsidiaries are simultaneously affected by home and host regulation. Capital requirements were higher in Portugal than in most other European countries during a large part of the sample period. These measures were taken to strengthen the resilience of the Portuguese banking system amidst an environment of erosion of trust. Given this backdrop, when capital requirements were tightened in the home countries, their effect on subsidiaries was possibly not felt, as they were already subject to more demanding capital requirements due to host regulation.

Regarding the loan-to-value ratio, in table 4 we reported that a tightening in the home country implies more credit growth in the host country through foreign banks. In table 5, we report positive marginal effects both for branches and subsidiaries, which supports our hypothesis that this instrument should affect in the same way the two types of institutions.

[4] Given space constraints, we do not report the coefficients of the direct effects of bank control variables.

Table 5. Inward Transmission of Policy via Affiliates of Foreign-Owned Banks—Branches vs. Subsidiaries

	HomeP = Prudential IndexC (1)	HomeP = Capital Requirements (2)	HomeP = LTV Ratio (3)
$HomeP_t$*Subsidiaries	−12.01	−54.73	−43.82***
	(6.677)	(39.71)	(4.802)
$HomeP_t$*Branches	37.28*	11.66	25.66***
	(17.57)	(26.87)	(7.122)
$HomeP_{t-1}$*Subsidiaries	4.114	−81.43*	26.55***
	(11.40)	(44.36)	(4.560)
$HomeP_{t-1}$*Branches	30.25**	28.41	34.83***
	(9.970)	(16.16)	(8.106)
$HomeP_{t-2}$*Subsidiaries	−6.396	−81.46***	−14.57
	(25.72)	(22.70)	(10.21)
$HomeP_{t-2}$*Branches	−13.75	−8.625	46.35***
	(9.495)	(7.357)	(8.019)
Financial Cycle (Home Country)	−0.0251	−0.0348	−0.0286
	(0.0164)	(0.0232)	(0.0234)
Business Cycle (Home Country)	1.231**	1.398**	1.235**
	(0.441)	(0.492)	(0.508)
Log Total Assets*HomeP*Subsidiaries	3.100	24.7664***	2.768
	(1.2878)	(39.8632)	(1.4382)
Log Total Assets*HomeP*Branches	−3.0592*	−2.801	13.9214***
	(4.434)	(1.5096)	(61.3848)
Capital Ratio*HomeP*Subsidiaries	0.497	4.4552***	6.6972***
	(0.7014)	(10.9829)	(28.8127)
Capital Ratio*HomeP*Branches	−0.308	−0.787	−0.7752**
	(0.1381)	(0.9531)	(7.3751)
Illiquid Assets Ratio*HomeP*Subsidiaries	−0.056	−0.125	−0.120
	(0.0503)	(0.0443)	(0.0799)
Illiquid Assets Ratio*HomeP*Branches	−0.275	0.125	−2.2814***
	(1.2421)	(0.2071)	(89.1302)
Net Intragroup Funding*HomeP*Subsidiaries	0.046	−0.045	0.111
	(0.0798)	(0.8222)	(0.2571)
Net Intragroup Funding*HomeP*Branches	−0.158	−0.4185*	0.2852*
	(1.4909)	(4.6719)	(4.9366)

(*continued*)

Table 5. (Continued)

	HomeP = Prudential IndexC (1)	**HomeP = Capital Requirements (2)**	**HomeP = LTV Ratio (3)**
Core Deposits Ratio*HomeP*Subsidiaries	−0.5017*	−0.6817*	−0.6982***
	(4.8538)	(3.3879)	(20.8261)
Core Deposits Ratio*HomeP*Branches	−0.636	−1.226	0.364
	(1.0467)	(3.2624)	(2.0952)
HomeP ($HomeP_t$+$HomeP_{t-1}$+$HomeP_{t-2}$)*Subsidiaries	−14.297	−217.6286***	−31.847
	(0.2149)	(15.244)	(3.088)
	0.654	0.004	0.113
HomeP ($HomeP_t$+$HomeP_{t-1}$+$HomeP_{t-2}$)*Branches	53.7754**	31.448	106.8409***
	(6.4632)	(1.2814)	(34.985)
	0.032	0.287	0.000
Average Marginal Effects of HomeP for Foreign Banks:			
For Subsidiaries	5.4672*	1.038	44.2201***
For Branches	−3.112	−12.222***	27.8768***
Average Marginal Effects of HomeP Foreign Banks/Periods with Changes in HomeP:			
For Subsidiaries	6.0252**	−2.269	13.214***
For Branches	−2.605	−8.5557***	8.1721***
Observations	1,619	1,619	1,619
Adjusted R^2	0.056	0.047	0.055
No. of Banks	57	57	57

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in domestic loans. The data are quarterly from 2006:Q1 to 2014:Q4. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. For HomeP interaction effects with bank characteristics, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding F-statistics for joint significance in parentheses. For the Portuguese banks the regulation variables and the financial and business cycle variables are zero. For more details on the variables, see table 6 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects. Standard errors are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

3.2.2 Further Extensions and Robustness Tests

To be sure of the validity of the results presented above, we did several further extensions to the analysis.[5]

On the construction of the data set, we estimated the baseline regressions using a sample with all explanatory variables winsorized at the 1st and 99th percentile. The results are broadly consistent. Further, we tested the implications of excluding the smallest banks in the sample from the analysis. When we exclude banks with a market share smaller than 0.05 percent in the loan market, there are some changes in the results. One possible reason for this might be that when we exclude these small banks, there is much less variation in foreign regulation, thereby affecting the precision of the estimation of the cross-border effects of regulation. This happens because even though these banks are very small, they represent an important share of the number of observations (the total number of banks in the sample decreases from fifty-seven to thirty-one).

Since we decided to use solo data from supervisory reports instead of consolidated data, we considered that a relevant robustness test would be to estimate the regressions including banking group fixed effects. The results are consistent in qualitative terms.

Another issue that could affect the results is the treatment of missing observations in the IBRN Prudential Instruments Database. In the baseline specifications, the missing observations are treated as zeros. If we keep them as missing, thereby losing some observations, the results are consistent.

One issue in which we differ significantly from the approach used in other countries participating in the IBRN project is the definition of the capital ratio. We use an unweighted accounting capital ratio instead of regulatory tier 1 risk-based capital. Using tier 1 capital would eliminate from the sample all branches exempt from capital requirements in Portugal. Nevertheless, given the important differences between the two variables, we also estimated whenever possible the regressions with tier 1 capital for a subsample, excluding foreign branches for which there is no data on regulatory capital. The differences we find in the results are attributable to the change in the sample and not to change in the definition of the capital ratio.

[5]The results are not reported, but are available upon request.

In specification B we chose to include all banks, domestic and foreign. All the observations concerning the home cycle and the home regulation were set to zero for Portuguese banks. For robustness purposes, we estimate the regressions in specification B only for foreign banks. We find some differences in the results, including the lack of significance of the negative marginal effect associated with a tightening of capital requirements. However, we would like to note that the estimations with foreign banks rely on a much smaller sample of banks, most of which are relatively small. Furthermore, there is a lot of heterogeneity in the business models of these banks, with some being more targeted to consumer loans, others to asset management and investment banking, and others to local retail activities, for instance. The volatility generated by this smaller sample is the main reason to justify our inclusion of domestic banks in the baseline regressions.

Finally, as discussed before, there is a strong integration between the Spanish and the Portuguese banking systems. Recent consolidation trends within the European Union will possibly reinforce this integration. As such, it might be interesting to focus in more depth on the transmission of regulation implemented in Spain. We reestimate specification B including only changes in Spanish regulation, and our previous results are much stronger: we find significant cross-border effects of regulation for all the instruments considered. For the aggregate prudential index, we find that tighter regulation in Spain is associated with more credit growth in Portugal, thus showing the existence of non-negligible substitution effects between these two highly integrated banking markets. These effects work mainly through loan-to-value ratios and local reserve requirements. In contrast, a tightening in general and sectoral capital requirements in Spain leads to a decrease in the growth of credit granted in Portugal.

Still focusing in Spain, there is one prudential instrument that deserves further analysis: dynamic provisions. As discussed in Jiménez et al. (2015), this is one of the few time-varying regulatory tools in the world. This tool was introduced in Spain in July 2000 to improve the regulatory coverage of credit risk. The previously existing provisioning system was highly procyclical, increasing in bad times, and one of the main goals of the new tool was to reduce that procyclicality (Trucharte and Saurina 2013). Given the prominent role that the countercyclical capital buffer plays in the Basel III framework and its similarities with the spirit of dynamic

provisions, this analysis offers a key input by providing for the first time evidence on the cross-border effects of a cyclical regulatory tool. We do not find a significant effect of changes in the dynamic provisioning system on Portuguese banks working through their exposures in Spain (specification A), but when we consider the credit behavior of the affiliates of Spanish banks in Portugal, we find that when dynamic provisions are loosened in Spain, the growth of credit granted by these affiliates increases in Portugal, thereby showing that this measure has significant cross-border spillovers (specification B). However, it should be noted that our sample period includes only two episodes in which the regime of dynamic provisions was loosened, both during the global financial crisis. As such, these results should be interpreted with some reservations.

4. Concluding Remarks

The IBRN offers a unique opportunity to explore a common research question with a common methodology across different countries, using high-quality data available at central banks worldwide. In this paper we offer a contribution to the IBRN project on the cross-border impacts of prudential regulation. This contribution entails the estimation of the baseline specifications common to the project on the inward transmission of foreign prudential regulation. This is the basis of the meta-analysis conducted in Buch and Goldberg (2017).

We find that a tightening in foreign regulation yields an increase in the growth of credit granted by domestic banks in Portugal, which suggests the presence of substitution effects. This effect works through the sector-specific capital requirements and the reserve requirements on foreign currencies (and only through the foreign exposures of domestic banks). For the loan-to-value ratio, we obtain the opposite sign, thus suggesting the existence of complementary effects. Indeed, a tightening of the loan-to-value ratio abroad is associated with a decrease in the growth of domestic loans granted by Portuguese banks. This result might stem from the reduction in profits for the banking group as a whole. Alternately it might reflect the conditions under which this instrument is usually applied, i.e., periods of booms in real estate markets. Having limited resources, banks may prefer to limit domestic lending to continue to lend abroad if this market still yields high profitability despite the tighter regulation.

When we analyze the influence of foreign regulation on the growth of credit granted in Portugal by the foreign banks operating in the country, the effects are mixed. A tightening of general capital requirements and concentration ratios is associated with less credit growth in Portugal, while a tightening in loan-to-value ratios has the opposite effect, reflecting possible substitution effects. These results are in line with what could be expected given that when regulation is tightened in the home country of a given bank, substitution effects are more likely to occur if regulation is applied at the local level than if it is applied at the consolidated level. It is interesting to note that for the loan-to-value ratio the cross-border spillovers work in different ways for domestic banks with international activity and for foreign banks.

Our contribution also tries to understand whether the transmission of foreign prudential policy through foreign banks operating in a given country works differently through branches or subsidiaries. We find, as expected, that in the case of the loan-to-value ratio the positive effect works both through branches and through subsidiaries. By contrast, the negative effect of tighter capital requirements, in the home country of a foreign bank, on credit in the host country works only through branches. One possible explanation for this difference might be the fact that when capital requirements were tightened in the home countries, their effect on subsidiaries was possibly not felt, as these banks were already subject to more demanding capital requirements due to Portuguese regulation. These results show that the legal form of credit institutions plays an important role in the cross-border transmission of prudential regulation, most notably due to differences in the scope and perimeter of application of the instruments.

With increasingly harmonized regulation across the world, this project contributes to an understanding of how changes in prudential tools in one country might affect the evolution of credit granted in another country. This is relevant to thinking about intended and unintended international spillovers when designing regulation. With increased pressure for international reciprocity between regulators (as set out, for instance, in the countercyclical capital buffer framework), having at hand empirical evidence on the way regulation affects lending in other countries will certainly be highly valuable for policymakers.

Appendix

Table 6. Construction of Balance Sheet Independent Variables

Variable Name	Description	Comments	Data Source
Illiquid Assets Ratio	(1 – (Cash and Claims on Central Banks and Credit Institutions/Total Assets)) (in %)	The definition is different from that used in other IBRN country teams due to differences in the supervisory reporting templates. Their correlation should nonetheless be high.	Supervisory Data (Banco de Portugal)
Log Assets	Ln (Total Assets/GDP Deflator 2012)		Supervisory Data (Banco de Portugal) and National Accounts (Statistics Portugal)
Core Deposits Ratio	(Time Deposits from Residents + Deposits Redeemable at Notice from Residents + Savings Deposits from Residents)/ Total Assets (in %)		Supervisory Data (Banco de Portugal)
Capital Ratio	Equity Capital/Total Assets (in %)	This variable differs significantly from the regulatory tier 1 risk-based capital used by other IBRN country teams. We decide to use accounting capital mainly because we do not want to exclude from the sample foreign banks exempt from fulfilling capital requirements in Portugal (such as the branches from EU countries), as these institutions play an important role for the analysis of the cross-border transmission of bank regulation. The regulatory capital ratio also has the disadvantage of being affected by changes in definition during our sample period.	Supervisory Data (Banco de Portugal)

(*continued*)

Table 6. (Continued)

Variable Name	Description	Comments	Data Source
Net Intragroup Funding	(Deposits of Banks of the Same Banking Group Located Abroad – Credit, Debt Securities Shares, and Other Equity to Banks of the Same Banking Group Located Abroad)/Total Liabilities (in %)		Monthly Balance Sheet Statistics and Supervisory Data (Banco de Portugal)
International Activity	Local Claims + Local Liabilities (Denominated in Local Currency) of the Branches and Subsidiaries (of the Portuguese Banks) Located Outside Portugal/(Total Assets and Total Liabilities of the Parent Bank + Local Claims and Liabilities of the Branches and Subsidiaries Located Outside Portugal) (in %)		Bank-Level Data on a Consolidated Basis Underlying the Report to the International Banking Statistics of the BIS and Supervisory Data (Banco de Portugal)

References

Bank for International Settlements. 2014. "Debt and the Financial Cycle: Domestic and Global." In *84th Annual Report*, 65–84 (chapter IV) Basel, Switzerland: Bank for International Settlements.

Barros, P. B., D. Bonfim, M. Kim, and N. Martins. 2014. "Counterfactual Analysis of Bank Mergers." *Empirical Economics* 46 (1): 361–91.

Buch, C., and L. Goldberg. 2017. "Cross-Border Prudential Policy Spillovers: How Much? How Important? Evidence from the International Banking Research Network." *International Journal of Central Banking* 13 (S1).

Cerutti, E., R. Correa, E. Fiorentino, and E. Segalla. 2017. "Changes in Prudential Policy Instruments: A New Cross-Country Database." *International Journal of Central Banking* 13 (S1).

Cerutti, E., G. Dell'Ariccia, and M. S. Martínez Pería. 2007. "How Banks Go Abroad: Branches or Subsidiaries?" *Journal of Banking and Finance* 31 (6): 1669–92.

Costa, S., and L. Farinha. 2011. "The Behaviour of Domestic and Non-domestic Banks in the Housing Credit Market: An Analysis Based on Microeconomic Data." In *Financial Stability Report*, November, 167–83. Banco de Portugal.

Dell'Ariccia, G., and R. Marquez. 2010. "Risk and the Corporate Structure of Banks." *Journal of Finance* 65 (3): 1075–96.

Drehmann, M., C. Borio, and K. Tsatsaronis. 2011. "Anchoring Countercyclical Capital Buffers: The Role of Credit Aggregates." *International Journal of Central Banking* 7 (4): 189–240.

Focarelli, D., and A. Pozzolo. 2005. "Where Do Banks Expand Abroad? An Empirical Analysis." *Journal of Business* 78 (6): 2435–64.

Goldberg, L., and A. Saunders. 1981. "The Growth of Organizational Forms of Foreign Banks in the U.S.: Note." *Journal of Money, Credit and Banking* 13 (3): 365–74.

Jiménez, G., S. Ongena, J. L. Peydró, and J. Saurina. 2017. "Macroprudential Policy, Countercyclical Bank Capital Buffers, and Credit Supply: Evidence from the Spanish Dynamic Provisioning Experiments." Forthcoming in *Journal of Political Economy*.

Peek, J., and E. Rosengren. 1997. "The International Transmission of Financial Shocks: The Case of Japan." *American Economic Review* 87 (4): 495–505.

———. 2000. "Collateral Damage: Effects of the Japanese Bank Crisis on Real Activity in the United States." *American Economic Review* 90 (1): 30–45.

Trucharte, C., and J. Saurina. 2013. "Spanish Dynamic Provisions: Main Numerical Features." *Estabilidad Financiera* (Banco de España) 25 (November): 11–47.

International Banking and Cross-Border Effects of Regulation: Lessons from Turkey*

Yusuf Soner Başkaya,[a] Mahir Binici,[a] and Turalay Kenç
[a]Central Bank of the Republic of Turkey

How do regulatory changes in a foreign country affect the lending growth in another country? This paper addresses this question using bank-level data from Turkey and macroprudential measures from fifty-six countries over a sample period of 2006–13. We offer evidence for the existence of the inward transmission of foreign prudential regulations by showing that the macroprudential tightening abroad leads to lending growth by the banks in Turkey. We find that domestic affiliates of foreign banks play a more prominent role in this transmission. We show that the existence and the magnitude spillovers differ across bank characteristics or the prudential instruments. Finally, our results indicate that the spillovers depend on the financial cycles.

JEL Codes: F42, F44, G15, G21.

1. Introduction

How do regulatory changes in one country affect the lending growth in other countries? Given the globalization of the financial and banking systems, do domestic policies aiming at financial stability in an economy generate cross-border externalities such as an increase in the lending growth in the countries experiencing capital flows? With the recent global financial crisis, microprudential and macroprudential regulations implemented in many countries for increasing the stability and resilience of their financial system have made these questions even more important. Given the possibility of cross-border

*Comments by Claudia Buch, Matthieu Bussière, Linda Goldberg, Şebnem Kalemli-Özcan, and an anonymous referee are gratefully acknowledged. The views expressed here are those of the authors and do not necessarily reflect those of the Central Bank of the Republic of Turkey. Kenç was deputy governor of the Central Bank of the Republic of Turkey when this paper was written.

spillovers, these questions have taken center stage in the efforts for a more resilient and stable global financial system.[1]

In order to provide a better understanding of these questions, this paper analyzes the inward transmission of foreign prudential regulations into the Turkish economy via changes in lending growth by the banks operating in Turkey. To establish a causal link running from regulatory changes in one country to the lending growth in another country through cross-border spillovers, Turkey offers a valuable example as a small open economy with a fully liberal capital account regime and banking sector composed of both domestic banks and domestic affiliates of foreign banks with full access to international money and capital markets.[2]

In the last fifteen years, the Turkish economy experienced substantial gross capital inflows due to both external push factors such as the abundance of global liquidity and internal pull factors such as improvements in the fundamentals of the country as a result of comprehensive reforms. Capital inflows have been mostly intermediated through the banking sector, which, in turn, led to substantial loan growth, except for a brief contraction in the aftermath of the global financial crisis.[3] With high capital adequacy and liquidity ratios, and low non-performing loan (NPL) ratios, the Turkish banking sector was well positioned to intermediate capital flows to domestic loans. Despite their balance sheet strengths and international activities, none of the domestic banks in Turkey are large on the global scale. Therefore, we believe that domestic banks have a limited capacity to channel the changes in the Turkish macroprudential regulation abroad. On the other hand, with the strong links to the global financial markets, they have a potential for transmitting the effects of the

[1]See Buch and Goldberg (2017) for a review of literature on the cross-border spillover effects of the prudential regulations. Also, see the Financial Stability Board's (2015) annual report and see Freixas, Laeven, and Peydro (2015). Also, among others, Aiyar, Calomiris, and Wieladek (2014) and Forbes, Reinhardt, and Wieladek (2015) provide evidence for the existence of cross-border spillovers of prudential regulations.

[2]Turkey is among few emerging market countries that does not impose any form of capital account restrictions. For a review of literature on capital controls and their effectiveness, see Binici, Hutchinson, and Schindler (2010).

[3]Başkaya et al. (2017a, 2017b) show that low interest rates and a high liquidity environment driven by quantitative easing in advanced countries in the post-crisis period leads to higher credit growth in Turkey.

prudential regulations abroad (i.e., home country) on the lending behavior of the banks in Turkey (i.e., the host country).

To summarize the findings, we first provide some evidence for the inward transmission of foreign prudential regulations. However, the significance of a particular prudential tool depends on the specification that we use. Depending on the specification, we find that changes in LTV limits, reserve requirement ratios, interbank exposure limits, and concentration ratios can have a significant cross-border spillover.

Second, we find that the ownership structure of the banks is not immaterial in the transmission of the regulatory spillovers from abroad. We document significant heterogeneities with respect to whether the effect is transmitted by domestic banks or the domestic affiliates of foreign banks in Turkey. In three out of four specifications estimated with the sample of domestic affiliates of the foreign banks, we observe that the macroprudential tightening as measured with a composite macroprudential policy index (MPI) leads to higher loan growth in Turkey. In contrast, such a spillover effect is not supported by the estimation results obtained with the sample of all banks, as we do not observe such a cross-border spillover effect. This is consistent with the findings of existing studies on the role of inward transmission of foreign banks, such as the analysis of differential role of foreign banks in transmitting effects of U.S. monetary policy in Mexico by Bernardo, Peydro, and Ruiz (2015).

We also test (i) whether the degree of inward transmission varies over the business cycles and financial cycles and (ii) whether bank characteristics play a key role in the transmission. In general, the effect differs from one prudential regulation to the other. Regarding the first question, we observe that the positive spillover effect of the prudential regulation in the home country is more pronounced when the home country is in the expansionary phase of the financial cycle. As to the second question, the lending growth by the large banks is less sensitive to the prudential regulations in the home country, whereas the banks with higher share of illiquid assets or higher international activity face a higher lending growth in response to prudential tightening in the home country.[4]

[4]Among others, Cetorelli and Goldberg (2011) and Wagner (2014) underline the role of international operational banks in the cross-border transmission of the effects of prudential regulations on lending growth.

The rest of this paper is organized as follows. Section 2 provides data and the stylized facts, section 3 presents the empirical analysis, and section 4 presents the concluding remarks.

2. Data and Stylized Facts for Turkey

The Turkish banking sector comprises fifty-two active institutions as of the third quarter of 2015. Among those fifty-two, thirty-four banks are classified as deposit banks and thirteen are investment and development banks. In terms of ownership structure, there are both private banks and state-owned banks in each of these categories. Besides conventional banking services, five banks, categorized as the participation banks, solely offer Islamic banking services.

In terms of ownership and affiliations, the banking industry is highly diverse. Global banks are active in Turkey through their affiliates and branches. The major share of deposit banking services is provided by foreign banks. Based on the classification of the Banking Regulation and Supervision Agency (BRSA) in Turkey, twenty deposit banks (out of thirty-four), four investment and development banks (out of thirteen), and three participation banks (out of five) have a majority of foreign ownership, defined as having foreign share larger than 50 percent of common equity capital. Among foreign banks, six of them operate as branches and the rest as subsidiaries.

During the sample period of our analysis, i.e., the first quarter of 2006 to the second quarter of 2013, we cover a total of forty-one banks for which we have collected data on locational banking statistics. Over the sample of analysis, there are very few mergers, acquisitions, and buyouts. We carefully addressed changes in bank ownership structure and corresponding parent-country macroprudential changes. Due to mergers and acquisitions (M&A) events, the number of banks that could be classified as domestic versus foreign (depending on the majority of equity capital) could have changed over time, leading to the number of twenty-one and twenty-four, respectively.[5] Additionally, as discussed in detail below, a few banks

[5]Over the sample period, there has not been a major change in the extensive margin neither due to mergers and acquisitions. In addition, the global financial crisis of 2008–09 did not lead to any bankruptcy in the Turkish banking system. The latter fact can be explained by the comprehensive set of banking-sector

classified as foreign banks could have multiple affiliations, for which we consider all countries having share in the bank when we conduct the exercise of transmission of home macroprudential policies through domestic affiliates of foreign banks.[6]

The bank-level data are collected by two authorities in Turkey, namely the Banking Regulation and Supervision Agency (BRSA) and the Central Bank of the Republic of Turkey (CBRT). The BRSA is the main microprudential authority and collects data for supervisory purposes. The CBRT collects bank-level data for financial stability purposes, among others. For this study, we mainly use data collected by the CBRT that includes monthly balance sheets and income statements as well as locational banking statistics as a part of balance-of-payment (BOP) statistics. The data used in this paper are confidential and not available to the public.

In the baseline empirical model presented in the next section, we report the results for all banks, including a comparative analysis across domestic versus foreign banks as well as subsidiaries versus branches. We use the International Banking Research Network (IBRN) Prudential Instruments Database described in Cerutti et al. (2017) for prudential regulations. The rest of the data come from the CBRT and are used in an unconsolidated way in the paper. Finally, all indicators are deflated with 2006 base-year prices (GDP deflator) and winsorized at 5 percent; quarterly growth rates (in log terms) are used.

Summary statistics for all banks used in the empirical exercise are presented in table 1, and further additional information is reported in table 8 in the appendix. Since balance sheet data are presented in Turkish lira (TL) and foreign borrowing in U.S. dollars, for consistency we converted all data to Turkish lira.

2.1 Data on Prudential Instruments

Data for prudential instruments for the countries with which the banks in Turkey are engaged in cross-border borrowing have been

reforms starting from the early 2000s as well as effective macroeconomic and prudential policies implemented during the sample period.

[6]Details on the ownership structure of both domestic banks and affiliates of foreign banks operating in Turkey are provided by the BRSA and the Turkish Banking Association.

Table 1. Descriptive Statistics

Balance Sheet Characteristics	Mean	Median	75th Percentile	Standard Deviation
Log Total Assets	15.06	15.08	16.86	2.33
Capital Ratio (%)	23.07	13.58	23.29	21.24
Illiquid Assets Ratio (%)	53.42	60.89	68.91	22.31
International Ratio (%)	3.98	0.00	5.82	7.13
Deposits Ratio (%)	38.88	52.97	62.19	28.38
Loans (Ln Change * 100)	6.98	7.39	12.16	17.70

taken from the IBRN Prudential Instruments Database described in Cerutti et al. (2017). We use data on six classes of prudential changes, including capital requirements, capital buffers, loan-to-value (LTV) ratios, reserve requirements for local currency, interbank exposure limit, and concentration ratio. All prudential instruments, except reserve requirements on foreign-currency liabilities, display sufficient variation and are used in our regression analysis (table 2). Over the sample period, Turkish authorities also implemented several regulatory measures, particularly on reserve requirements and risk weighting.

In the construction of foreign-exposure-weighted regulation ($ExpP$), we used total asset and liabilities from the host country as a weighting metric, multiplying prudential measure at time t with lagged weight (from $t-1$ to $t-3$) to avoid simultaneity. Further discussion on specific regression models and construction of exposure-weighted prudential measures are described by Buch and Goldberg (2017).

2.2 Stylized Facts

Several features of Turkey's recent past make it interesting to carry out an empirical analysis on the impact of international regulatory changes on the lending behavior of the banks in Turkey. First, Turkey experienced strong credit growth. Annual credit growth rates reached 40 percent in the third quarter of 2011 in nominal terms following the quantitative easing of the Federal Reserve and a brief

Table 2. Summary Statistics on Changes in Prudential Instruments

Inward: Specification A						
	Base Data (Before Aggregating to Exposure-Weighted Measures)					Exposure-Weighted Observations
Instrument	**No. of Country-Time Changes**	**No. of Country-Time Changes (Tightening)**	**No. of Country-Time Changes (Loosening)**	**No. of Bank-Time Changes**	**Proportion Base-MPP Non-zero**	**Proportion $ExpP_t$ Non-zero**
Prudential Index	334	241	93	2,887	17.38	79.16
General Capital Requirements	63	63	0	874	3.70	23.22
Sector-Specific Capital Buffer	50	37	13	341	2.60	25.14
Loan-to-Value Ratio Limits	68	51	17	723	9.20	45.16
Reserve Requirements: Foreign	66	43	23	284	3.43	22.67
Reserve Requirements: Local	155	82	73	910	8.06	40.40
Interbank Exposure Limit	18	17	1	360	2.88	20.20
Concentration Ratios	22	21	1	262	2.07	23.95
Inward: Specification B						
Instrument	**No. of Country-Time Changes**	**No. of Country-Time Changes (Tightening)**	**No. of Country-Time Changes (Loosening)**	**No. of Bank-Time Changes**	**Proportion $HomeP_t$ Non-zero**	
Prudential Index	56	47	9	57	10.487	
General Capital Requirements	17	17	0	18	3.881	
Sector-Specific Capital Buffer	8	8	0	6	1.498	
Loan-to-Value Ratio Limits	7	6	1	7	7.527	
Reserve Requirements: Foreign	1	1	0	1	0.187	
Reserve Requirements: Local	17	3	14	16	3.184	
Interbank Exposure Limit	7	7	0	7	2.389	
Concentration Ratio	15	15	0	15	4.076	

Source: IBRN.
Notes: This table shows summary statistics on changes in prudential instruments for banks located in Turkey over the 2006–13 period. Data on the instruments come from the IBRN Prudential Instruments Database described in Cerutti et al. (2017) and are at the quarter level. The number of changes in prudential instruments is reported on several dimensions, i.e., on the country-time level and on the bank-time level. The last column of each panel shows the share of prudential changes to total observations (i.e., the share of non-zero observations). The column "Exposure-Weighted Observations" is based on the underlying data on prudential changes in foreign countries (columns under the "Base Data" heading). The reported data are based on the regression sample.

credit crunch in the wake of the Lehman Brothers collapse in 2008.[7] In more recent years, both external factors and domestic countercyclical policies including macroprudential measures led to significant slowdown in credit growth, bringing its annual growth rate to around 15 percent. The loan-to-GDP ratio accordingly increased substantially over the last ten years, namely from 40 percent in 2006 to 88 percent at the end of 2014.

Second, the capital inflows are an important source for bank lending in Turkey. The debt liabilities as a share of total assets of the banking sector are 23 percent as of late 2014. These external funds included outright bank loans (15.4 percent of total assets), syndicated loans (2.6 percent), securitization finance (1.4 percent), deposits (52.7 percent), repos (6.7 percent), and issuances (4.3 percent) as of October 2015. The diverse nature of the Turkish banking sector played certain roles in the banks' preferences for these different types of funds. The diversity ranges from state-owned banks (with a share of 31.7 percent in the banking sector in terms of asset size) to local private banks (48.6 percent), and foreign bank subsidiaries and branches (19.6 percent).[8] The main providers of the external funding to banks in Turkey are commercial banks, investment banks, and asset-management firms. Overall, the banking sector in Turkey has maintained strong balance sheets with high capital adequacy and liquidity ratios, low leverage ratios, and low NPL ratios.

Third, various macroprudential measures, together with the conventional policies, have been introduced to slow down the aggregate credit growth as well as to change the composition of credit in favor of commercial loans, as higher consumer loan growth is associated with higher external imbalance risk in the economy by widening the current account deficit.[9] There are distinctive prudential rules in Turkey, most of which were introduced in the last decade.

[7]Data on credit growth as well as other main financial developments across countries and their expert analyses can be found in annual reports of the Bank for International Settlements.

[8]Based on the Banking Regulation and Supervision Agency's classification using monthly balance sheet data from October 2015.

[9]See Basci and Kara (2011) for the changes in the policy framework of the CBRT considering the risks to financial stability in the post–global financial crisis period.

For example, households are allowed to borrow neither at flexible interest rates nor in foreign-currency-denominated loans. Likewise, small and medium-size enterprises with no foreign-currency revenues are regulated with no foreign-currency borrowings. In addition, the CBRT imposed required reserves on banks' liabilities with aims of not only placing quantity constraints on the bank funding available for loans but also achieving lower leverage ratios, longer maturity for liabilities, and higher foreign-currency reserves. The Financial Stability Committee, established in the wake of the global financial crisis, introduced several macroprudential measures, including quantity-based and price-based ones.

Fourth, there were also the episodes of tightening global financial conditions, such as the global financial crisis of 2008–09, the euro-zone sovereign debt crisis, and the 2013 taper tantrum. Turkey experienced capital outflows during these episodes and introduced countercyclical policies, including easing the macroprudential policies.

3. Empirical Method and Regression Results

3.1 Baseline Analysis of Inward Transmission of Prudential Policies

In our baseline analysis, we estimate the effect of the exposure-weighted macroprudential regulations in foreign countries, denoted by $ExpP_{b,t}$, on the quarterly growth rate of the total lending of the domestic global banks in Turkey (i.e., the host country) using the following specification:

$$\Delta Y_{b,t} = \alpha_0 + (\alpha_1 ExpP_{b,t} + \alpha_2 ExpP_{b,t-1} + \alpha_3 ExpP_{b,t-2}) + \alpha_4 X_{b,t-1} + f_b + f_t + \varepsilon_{b,t}, \quad (1)$$

where $\Delta Y_{b,t}$ denotes the logarithmic change in the total loans extended by domestic global bank b in Turkey. The foreign-exposure-weighted regulation, $ExpP_{b,t}$, is calculated as the weighted average of changes in foreign regulation where the weight of each country j is determined considering the total assets and liabilities of the bank b in the respective foreign country at time $t-1$. $X_{b,t-1}$ denotes the set of controls for Turkish banks' characteristics, such as their illiquid

assets as a ratio to their portfolio, percentage of the balance sheet financed with total deposits, percentage of their equity capital as a ratio to total assets, logarithm of total real assets, and a measure of international activity expressed as the percentage of their foreign assets relative to total assets. Finally, f_b and f_t denote the bank and time fixed effects, controlling for the unobserved time-invariant bank characteristics and the common shocks to all banks, respectively.

Using the sample of all banks, columns 1–7 of table 3 show how lending growth changes in response to variations in the MPI and six individual regulatory measures, such as capital requirements, sector-specific capital buffer, LTV ratio, local-currency reserve requirements, interbank exposure limits, and the concentration ratios. According to the results on this specification, the prudential regulations abroad do not have a significant effect on the lending growth in Turkey, as we fail to reject H_0: $\alpha_1 + \alpha_2 + \alpha_3 = 0$ in all columns of table 3 even at the 10 percent significance level.

Next we explore the role of the domestic affiliates of foreign banks in transmitting the effect of the macroprudential regulations taking place in the home country of the foreign global bank using equation (2):

$$\Delta Y_{b,j,t} = \alpha_0 + (\alpha_1 HomeP_{j,t} + \alpha_2 HomeP_{j,t-1} + \alpha_3 HomeP_{j,t-2}) + \alpha_4 X_{b,j,t-1} + \alpha_5 Z_{j,t} + f_b + f_t + \varepsilon_{b,j,t}, \quad (2)$$

where $\Delta Y_{b,j,t}$ is the quarterly rate of change in the lending at time t by the foreign bank b in Turkey with a parent bank located in country j, and the variable $HomeP_{j,t-1}$ is the prudential regulation at time $t-$ l conducted in home country j. Finally, $Z_{j,t}$ denotes the home-country business and financial cycles.

Column 1 of table 4 shows that the macroprudential tightening in the home country as measured with the MPI leads to higher loan growth by the domestic affiliates of foreign banks operating in Turkey. Comparing the results in column 1 of table 3 and table 4, we observe that these banks play an important role in the transmission of the cross-border effects of the macroprudential regulations implemented in the country of their parent banks. In terms of the magnitude, tightening abroad through a one-unit increase in the MPI results in a total of 4.2 percentage point higher growth rate in the lending by the domestic affiliates of the foreign banks within

Table 3. Exposure-Weighted Inward Transmission of Regulation

	Prudential Index (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	LC Reserve Requirements (5)	Interbank Exposure Limits (6)	Concentration Ratios (7)
Foreign-Exposure-Weighted Regulation $ExpP_{sum}$	−3.925	−6.107	−3.524	−1.220	−9.549	−3.873	26.95
	(3.438)	(4.787)	(7.789)	(4.737)	(6.126)	(8.752)	(22.690)
Foreign-Exposure-Weighted Regulation $ExpP_t$	−0.160	0.091	0.528	−0.861	−3.693	−3.722	23.380
	(1.768)	(2.183)	(6.507)	(3.253)	(2.759)	(4.386)	(18.120)
Foreign-Exposure-Weighted Regulation $ExpP_{t-1}$	−2.755**	−4.071*	−3.042	0.552	−5.692**	−1.556	1.639
	(1.137)	(2.135)	(4.842)	(1.713)	(2.749)	(4.875)	(5.210)
Foreign-Exposure-Weighted Regulation $ExpP_{t-2}$	−1.011	−2.127	−1.011	−0.911	−0.164	1.405	1.928
	(1.763)	(2.524)	(3.392)	(1.326)	(2.016)	(3.653)	(2.467)
Log Total $Assets_{t-1}$	−13.262***	−13.210***	−13.196***	−13.216***	−13.197***	−13.181***	−12.688***
	(2.039)	(2.100)	(2.066)	(2.075)	(2.041)	(2.099)	(2.272)
Tier 1 $Ratio_{t-1}$	−0.401***	−0.397***	−0.403***	−0.402***	−0.401***	−0.399***	−0.388***
	(0.073)	(0.074)	(0.073)	(0.073)	(0.073)	(0.073)	(0.078)
Illiquid Assets $Ratio_{t-1}$	−0.046	−0.046	−0.047	−0.046	−0.044	−0.045	−0.051
	(0.042)	(0.043)	(0.043)	(0.043)	(0.042)	(0.042)	(0.044)
International $Activity_{t-1}$	−0.075	−0.074	−0.074	−0.076	−0.063	−0.066	−0.055
	(0.063)	(0.059)	(0.062)	(0.061)	(0.060)	(0.066)	(0.65)
Core Deposits $Ratio_{t-1}$	0.132**	0.127**	0.134**	0.135**	0.132**	0.139**	0.133**
	(0.066)	(0.064)	(0.068)	(0.065)	(0.067)	(0.065)	(0.062)
Observations	936	936	936	936	936	936	936
R^2	0.399	0.399	0.396	0.396	0.399	0.397	0.410
Adjusted R^2	0.349	0.349	0.346	0.346	0.349	0.347	0.360

Notes: This table reports the effects of changes in regulation and firm characteristics on log changes in total loans. The data are quarterly from 2006:Q1 to 2013:Q3 for a panel of forty-one domestic banks and domestic affiliates of foreign banks. ExpP is calculated as the weighted average of changes in foreign regulation where the weights are total assets and liabilities of the bank in the respective foreign country. For more details on the variables, see table 7 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects. Standard errors are clustered by banks. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 4. Inward Transmission of Home Macropruential Policy via Affiliates

	HomeP = Prudential IndexC (1)	HomeP = Capital Require-ments (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Require-ments: Local (5)	HomeP = Interbank Exposure Limits (6)	HomeP = Concen-tration Ratios (7)
Home-Country	4.202^{**}	3.225	-2.841	-5.800^{***}	7.875^{*}	-30.860^{**}	7.244
Regulation $\text{HomeP}_{\text{sum}}$	(1.935)	(3.769)	(7.409)	(0.589)	(4.721)	(13.290)	(4.873)
Home-Country	3.266^{***}	1.418	6.160^{***}	-0.490^{**}	4.357	1.482	12.209^{***}
Regulation HomeP_{t}	(1.046)	(1.438)	(0.923)	(0.234)	(2.895)	(3.637)	(4.183)
Home-Country	0.623	1.148	-5.562	-1.288^{***}	3.935	-28.385^{**}	-4.615^{*}
Regulation $\text{HomeP}_{\text{t}-1}$	(1.074)	(1.186)	(6.214)	(0.314)	(2.563)	(12.647)	(2.775)
Home-Country	0.314	0.659	-3.439^{**}	-4.022^{***}	-0.418	-3.959	-0.350
Regulation $\text{HomeP}_{\text{t}-2}$	(0.774)	(1.444)	(1.704)	(0.512)	(2.963)	(3.127)	(1.627)
Log Total $\text{Assets}_{\text{t}-1}$	-11.774^{***}	-12.454^{***}	-12.421^{***}	-6.096^{*}	-11.922^{***}	-17.648^{***}	-7.692
	(3.668)	(3.688)	(3.573)	(3.387)	(3.662)	(3.427)	(4.736)
Tier 1 $\text{Ratio}_{\text{t}-1}$	-0.380^{*}	-0.409^{*}	-0.399^{*}	1.107^{***}	-0.392^{*}	-0.752^{***}	-0.063
	(0.229)	(0.230)	(0.229)	(0.301)	(0.234)	(0.185)	(0.314)
Illiquid Assets $\text{Ratio}_{\text{t}-1}$	-0.164^{*}	-0.173^{*}	-0.163^{*}	-0.229	-0.163^{*}	-0.349^{***}	-0.032
	(0.099)	(0.092)	(0.096)	(0.194)	(0.093)	(0.117)	(0.118)
Core Deposits $\text{Ratio}_{\text{t}-1}$	0.096	0.093	0.076	-0.305^{***}	0.087	0.067	0.022
	(0.092)	(0.101)	(0.097)	(0.032)	(0.100)	(0.099)	(0.140)
BIS Financial Cycle	0.074^{*}	0.080	0.064	-0.030	0.077	0.641^{***}	0.095
(Home Country)	(0.043)	(0.051)	(0.044)	(0.072)	(0.049)	(0.219)	(0.117)
BIS Business Cycle	0.153	0.173	0.155	-1.052^{***}	0.176	-0.910	-1.010
(Home Country)	(0.194)	(0.194)	(0.199)	(0072)	(0.200)	(0.948)	(1.261)
Observations	393	393	393	63	393	246	264
R^2	0.406	0.393	0.396	0.893	0.394	0.529	0.516
Adjusted R^2	0.315	0.301	0.304	0.699	0.302	0.418	0.408

Notes: This table reports the effects of changes in parent-country regulation and firm characteristics on log changes in total loans. The data are quarterly from 2006:Q1 to 2013:Q3. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. For more details on the variables, see table 7 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include bank fixed effects as specified in the lower part of the table. Standard errors are clustered by banks. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

three quarters, where a 3.2 percentage point increase takes place within the quarter of the increase in the MPI. To put this number into perspective, this is slightly below half of the median quarterly lending growth rate in Turkey over the sample period.

In terms of the effects of the individual policies, we find that the changes in capital requirements, sector-specific capital buffers, and the concentration ratios do not have a significant cross-border spillover transmitted via domestic affiliates of foreign banks. On the other hand, we find that a decrease in interbank exposure limits abroad leads to a lower lending growth rate in Turkey, suggesting that interbank liquidity is an important channel for transmitting the cross-border spillovers of the prudential regulations. Finally, the results with equation (2) on the effects of LTV ratios and the reserve requirement ratios seem to be at odds with our expectations. In particular, we find that the tightening via lower LTV ratios and the relaxation via lower reserve requirement ratios decrease the growth rate of the loans intermediated by the domestic affiliates of foreign banks in Turkey.

3.2 Differential Role of Banks Characteristics

Using equation (3), table 5 presents results on whether bank characteristics, such as log total assets, core deposits ratio, capital ratio, international activity, and illiquid assets ratio, play a role in the inward transmission of prudential tightening abroad:

$$\begin{aligned}\Delta Y_{b,t} = \alpha_0 &+ (\alpha_1 ExpP_{b,t} + \alpha_2 ExpP_{b,t-1} + \alpha_3 ExpP_{b,t-2}) + \alpha_4 X_{b,t-1} \\ &+ (\beta_1 ExpP_{b,t} \cdot X_{b,t-1} + \beta_2 ExpP_{b,t-1} \cdot X_{b,t-1} \\ &+ \beta_3 ExpP_{b,t-2} \cdot X_{b,t-1}) + f_b + f_t + \varepsilon_{b,t}. \qquad (3)\end{aligned}$$

In this setup, the total effect of foreign macroprudential tightening on the change in the lending growth is equal to

$$\frac{\partial \Delta Y_{b,t}}{\partial ExpP_{b,t}} = \alpha_1 + \alpha_2 + \alpha_3 + (\beta_1 + \beta_2 + \beta_3) \cdot X_{b,t-1}, \qquad (3')$$

which depends on the bank characteristics. Using the estimates presented in table 4 to evaluate the expression in equation (3′) at the median values of the bank characteristics, we find that none of the

Table 5. Exposure-Weighted Inward Transmission of Regulation—Bank Variables Interactions

	Prudential IndexC (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Requirements: Local (5)	Interbank Exposure Limits (6)	Concentration Ratios (7)
Foreign-Exposure-Weighted Regulation (ExpP)	103.7	6.634	109.8	77.49	-19.88	212.6	86.66
	(82.190)	(80.100)	(362.900)	(188.800)	(94.430)	(138.600)	(141.700)
Log Total Assets$_{t-1}$	−12.803***	−13.030***	−13.556***	−12.835***	−13.045***	−13.757***	−12.373***
	(2.266)	(1.532)	(2.180)	(2.014)	(1.854)	(2.371)	(2.398)
Tier 1 Ratio$_{t-1}$	−0.331***	−0.364***	−0.400***	−0.413***	−0.382***	−0.330***	−0.296***
	(0.087)	(0.084)	(0.076)	(0.072)	(0.073)	(0.090)	(0.100)
Illiquid Assets Ratio$_{t-1}$	−0.052	−0.062	−0.050	−0.047	−0.045	−0.031	−0.040
	(0.038)	(0.042)	(0.047)	(0.042)	(0.043)	(0.041)	(0.046)
International Activity$_{t-1}$	−0.064	−0.051	−0.089	−0.076	−0.063	−0.036	−0.082
	(0.052)	(0.058)	(0.062)	(0.065)	(0.068)	(0.075)	(0.062)
Core Deposits Ratio$_{t-1}$	0.146**	0.024	0.138**	0.123*	0.073	0.185***	0.120**
	(0.067)	(0.059)	(0.070)	(0.064)	(0.050)	(0.066)	(0.057)
Log Total Assets*ExpP	−5.384	−6.129*	−4.53	−1.016	8.561*	−4.33	6.889
	(4.725)	(3.170)	(18.530)	(9.341)	(4.749)	(8.048)	(9.671)
Tier 1 Ratio*ExpP	−0.832	2.002	−1.316	−0.59	−3.397***	−3.319***	−4.268*
	(0.795)	(1.265)	(1.817)	(1.669)	(1.643)	(1.220)	(2.365)
Illiquid Assets Ratio*ExpP	0.0423	0.968**	−0.541	−0.713	−1.087*	−0.768**	−1.907**
	(0.280)	(0.382)	(1.620)	(0.950)	(0.629)	(0.359)	(0.782)
International Activity*ExpP	0.483	1.497***	3.68	−0.32	−1.437*	−0.144	2.202
	(0.443)	(0.534)	(3.610)	(0.921)	(0.809)	(0.721)	(3.046)
Core Deposits Ratio*ExpP	−0.214	−0.0456	−0.0683	−0.0554	−0.177	−0.837**	−0.131
	(0.210)	(0.317)	(0.628)	(0.941)	(0.261)	(0.412)	(0.676)
Observations	936	936	936	936	936	936	936
R^2	0.417	0.450	0.403	0.409	0.430	0.426	0.427
Adjusted R^2	0.357	0.393	0.342	0.349	0.372	0.367	0.369

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in total loans. The data are quarterly from 2006:Q1 to 2013:Q3 for a panel of forty-one domestic banks and domestic affiliates of foreign banks. Foreign-exposure-weighted regulation ExpP is calculated as the weighted average of changes in foreign regulation where the weights are total assets and liabilities of the bank in the respective foreign country. For ExpP and its interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding F-statistics for joint significance in parentheses. For more details on the variables, see table 7 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include bank and time fixed effects. Standard errors are clustered by banks. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

prudential instruments has a significant effect on the lending growth by the domestic banks in Turkey (see table 7 in the appendix).

While the overall effects of the MPI and the individual prudential tools evaluated at the median value of the bank characteristics are not significant, a number of findings regarding bank-level heterogeneities may be worth mentioning. First, everything else constant, we find that larger banks face a smaller increase in the lending growth rate than smaller banks in the response to the macroprudential tightening via higher capital requirements or smaller reserve requirements abroad. Second, banks with higher illiquid assets or higher international activity are associated with higher lending growth in response to prudential tightening via higher capital requirements. In response to higher capital requirements abroad, the lending growth increases by 8 percentage points for the banks at the 75th percentile of the illiquid assets ratio distribution, and by 10.7 percentage points for the banks at the 75th percentile of the international activity distribution, compared with the median banks of the corresponding distributions. In a similar manner, having a higher level of international activity or a higher illiquid assets ratio also leads to a higher negative effect on the domestic lending growth in response to an increase in the reserve requirements abroad.

Table 6 presents the estimation results for equation (3) using the sample of domestic affiliates of foreign banks in Turkey. Evaluating equation (3′) at the median value of the bank characteristics, we find that the prudential tightening via higher sector-specific capital buffers, higher local-currency reserve requirement ratios, or lower interbank exposure limits abroad leads to lower loan growth rates. Both of these findings underlie the importance of an international liquidity channel for the cross-border spillovers. On the other hand, the effects of all other prudential regulations evaluated at the median value of the bank characteristics are not significantly different from zero.

In terms of the heterogeneous effect at the bank level, the results in table 6 show that being a large bank again has a mitigating effect for all three prudential regulations mentioned above, in that the larger banks among the domestic affiliates of foreign banks experience lower decline in lending growth in response to prudential tightening abroad via higher sector-specific capital buffers, local-currency reserve requirement ratios, or lower interbank exposure limits. We

Table 6. Inward Transmission of Home Macropruential Policy via Affiliates—Bank Variables Interactions

	HomeP = Prudential IndexC (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Requirements: Local (5)	HomeP = Interbank Exposure Limits (6)	HomeP = Concentration Ratios (7)
Home-Country Regulation $HomeP_{sum}$	−2.526	−41.06	−129.00***	71.71***	−72.84	−772.8	−90.45
	(46.900)	(59.940)	(40.100)	(4.436)	(31.900)	(190.900)	(60.780)
Home-Country Regulation $HomeP_t$	8.646	−14.152	−111.807**	81.221***	−48.656***	98.985	−120.594*
	(16.146)	(18.049)	(43.542)	(5.408)	(10.282)	(83.953)	(65.916)
Home-Country Regulation $HomeP_{t-1}$	11.389	−7.232	−7.565	−4.785**	−5.774	−601.737***	50.640
	(18.877)	(15.690)	(4.913)	(2.205)	(14.263)	(100.155)	(41.888)
Home-Country Regulation $HomeP_{t-2}$	−22.561	−19.677	−9.676*	−4.725***	−18.408	−270.034***	−20.501
	(24.302)	(39.228)	(4.967)	(0.337)	(23.077)	(34.542)	(27.144)
Log Total $Assets_{t-1}$	−12.619***	−13.109***	−3.883	−1.710***	−12.554***	−17.285***	−6.444
	(3.417)	(3.377)	(9.948)	(0.335)	(3.738)	(3.335)	(5.544)
Tier 1 $Ratio_{t-1}$	−0.335	−0.442**	−0.249	0.815***	−0.414*	−0.708***	0.054
	(0.233)	(0.221)	(0.262)	(0.096)	(0.238)	(0.173)	(0.300)
Illiquid Assets $Ratio_{t-1}$	−0.183	−0.180*	−0.444*	−0.228	−0.198**	−0.307**	0.018
	(0.122)	(0.103)	(0.230)	(0.144)	(0.094)	(0.127)	(0.124)
Core Deposits $Ratio_{t-1}$	0.111	0.078	0.248*	−0.335***	0.094	0.132	0.041
	(0.088)	(0.103)	(0.148)	(0.032)	(0.101)	(0.105)	(0.126)
BIS Financial Cycle (Home Country)	0.094**	0.084	0.148	−0.015	0.113**	0.622***	0.088
	(0.048)	(0.060)	(0.093)	(0.030)	(0.055)	(0.225)	(0.113)
BIS Business Cycle (Home Country)	0.180	0.233	−0.511	−0.893***	0.306	−0.715	−0.619
	(0.180)	(0.213)	(0.774)	(0.087)	(0.212)	(0.909)	(1.213)
Log Total Assets*HomeP	2.462	−0.170	7.209***	−3.618***	7.144***	60.03***	21.69***
	(1.695)	(3.184)	(2.686)	(0.818)	(0.828)	(13.03)	(8.824)
Tier 1 Ratio*HomeP	−0.714	0.550			0.612	0.549	−2.188***
	(0.536)	(0.860)			(0.867)	(0.917)	(0.893)
Illiquid Assets Ratio*HomeP	−0.145	0.774			−0.108	−3.920***	−2.925***
	(0.429)	(0.597)			(0.180)	(0.885)	(0.956)
Core Deposits Ratio*HomeP	−0.355	−0.156		−0.397***	−0.850**	−1.192***	−0.799
	(0.349)	(0.780)		(0.150)	(0.376)	(0.373)	(0.584)
Observations	393	393	393	63	393	246	264
R^2	0.431	0.421	0.280	0.881	0.405	0.599	0.578
Adjusted R^2	0.320	0.308	0.167	0.633	0.289	0.471	0.453

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in total loans. The data are quarterly from 2006:Q1 to 2013:Q3 for foreign affiliates of domestic banks. The number of bank changes across specifications ranges from sixteen to four. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. For HomeP interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding standard errors for joint significance in parentheses. For more details on the variables, see table 7 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects. Standard errors are clustered by banks. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

find that domestic affiliates with higher illiquid asset ratios face a larger decline in lending growth rates in response to a decline in interbank exposure limits in the countries of the parent banks. In addition, we observe that smaller banks experience a higher loan growth rate in response to the lower LTV ratio abroad.

3.3 Differential Role of Business Cycles and Financial Cycles

Table A1 (in the online appendix to this paper)[10] shows whether the effect of the foreign macroprudential regulations on cross-border borrowing of banks in Turkey depend on the phases of the business cycle and financial cycle in Turkey based on the following specification:

$$\Delta Y_{b,t} = \alpha_0 + \alpha_1 ExptP_{cum,b,t} + \alpha_2 X_{b,t-1} + \alpha_3 ExpP_{cum,b,t} \cdot Z_t + f_b + f_t + \varepsilon_{b,t}, \quad (4)$$

where $ExpP_{cum,b,t-1}$ is the cumulative foreign-exposure-weighted regulation and Z_t is the vector of business cycle and financial cycle indicators, higher values of which correspond to expansionary phases of the respective cycles. In particular, we can evaluate the effect of the prudential regulation on the loan growth rate in Turkey as

$$\frac{\partial \Delta Y_{b,t}}{\partial ExpP_{b,t}} = \alpha_1 + \alpha_3 \cdot Z_t, \quad (4')$$

where $\alpha_3 \neq 0$ implies that the effect of the prudential regulations differs with respect to the phases of the business and/or the financial cycles.

We start by showing whether the value of the expression in equation (4′) evaluated at the mean values of the cycle variables is significantly different from zero or not. Using the sample of entire banks, we find that the macroprudential tightening abroad, as measured by the macroprudential policy index, leads to a higher loan growth rate in Turkey. Regarding the individual prudential regulations, prudential tightening abroad via lower LTV ratios or lower concentration ratios is associated with higher loan growth rates. In terms of the heterogeneous effects with respect to cycle, we find that business

[10]Tables A1–A4 are available at http://www.ijcb.org.

cycles in Turkey do not matter for the transmission of the foreign prudential policies to the loan growth rates. On the other hand, the expansionary effect of tightening via LTV ratios or concentration ratios is lower at the time of expansionary financial cycles, which is measured as a positive credit gap. In contrast, when the credit gap in Turkey is negative, the loan growth rate accelerates at a higher rate in response to prudential tightening abroad.

Table A2 presents the estimation results for equation (4) with the sample of domestic affiliates of foreign banks. In contrast to the analysis presented in table 5, we ask whether the effect of the prudential regulation abroad differs with respect to the business and financial cycles in the home country, i.e., the country which takes the policy action.

When we look at the effect of macroprudential tightening abroad evaluated at the median value of the business and financial cycle measures abroad, we first observe that the prudential tightening abroad measured with MPI leads to higher loan growth rates for the domestic affiliates of foreign banks at the median value of the financial and business cycle measures. For example, at the median values, prudential tightening abroad corresponding to a one-unit increase in MPI increases the lending growth rate by 1.3 percentage points, or by 18 percent of the median value of the quarterly lending growth rate over our sample period. In terms of the specific prudential tools, we find that a lower value of LTV ratio, a higher value of reserve requirement ratio, and a lower value of concentration ratios abroad lead to a higher loan growth rate, whereas a tightening via lower interbank exposure limits abroad decreases the growth rate of lending for the domestic affiliates of foreign banks. On the other hand, the changes in capital requirements or the sector-specific capital buffers do not have a significant effect. In general, these results are in line with our expectations except for the effect of the reserve requirement ratio.

In terms of the heterogeneous effects with respect to business and financial cycles in the countries of policy action, the positive effect of the macroprudential tightening abroad via a higher value of the index, a lower value of the LTV ratio, or a higher required reserve ratio is higher when the home country experiences an expansionary financial cycle as measured by a positive credit gap. On the other hand, we find that the expansionary effect of prudential

tightening via lower LTV ratios or concentration ratios is lower when the home country is in the expansionary phase of the business cycle. In other words, the prudential tightening via these policies leads to a higher loan growth rate by the domestic affiliates of foreign banks when the home countries experience a recession, which presumably corresponds to lower credit demand period in the economy.

3.4 Controlling for Domestic and Foreign Macroprudential Policies Simultaneously

Finally, we assess how cross-border borrowing varies with the foreign and domestic macroprudential regulations by using

$$\begin{aligned}\Delta Y_{b,j,t} = \alpha_0 &+ (\alpha_1 HomeP_{j,t} + \alpha_2 HomeP_{j,t-1} + \alpha_3 Home_{j,t-2}) \\ &+ \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + \alpha_6 Z_{host,t} + (\beta_1 HostP_t \\ &+ \beta_2 HostP_{t-1} + \beta_3 HostP_{t-2}) + f_b + \varepsilon_{b,j,t}, \end{aligned} \tag{5}$$

where $HostP_{t-1}$ is the prudential regulation in Turkey implemented at time $t-1$. In this specification $\alpha_1+\alpha_2+\alpha_3$ and $\beta_1+\beta_2+\beta_3$ denote the overall effect of the foreign and Turkish macroprudential policies on total lending, respectively. On the other hand, it is important to note that equation (5) does not control for time fixed effects, as they would be perfectly collinear with domestic macroprudential regulations. Therefore, this specification may lead to biased results with respect to causal effects of the prudential policies of home and host countries.

Column 1 of table A3 presents the results using the macroprudential policy indexes for both the foreign country (i.e., the home country) and Turkey (i.e., the host country), using the sample of domestic affiliates of foreign banks in Turkey. These results suggest that prudential tightening in both the foreign countries and Turkey is associated with higher domestic loan growth. The effect of the foreign prudential regulations can be explained along the lines of cross-border spillovers. On the other hand, the positive correlation between the macroprudential tightening in Turkey and the loan growth rate is counterintuitive. However, we believe that this result reflects the coincidence between the substantial increase in the credit growth rate in the post–global financial crisis period and the

macroprudential tightening in this period in response to the increase in global liquidity and loan growth rate.[11]

Looking at how specific policies are correlated with the loan growth rate in Turkey, we find no significant association between the outcome variable and the changes in capital requirements, LTV ratio, and the reserve requirement ratio on the local-currency liabilities. For the remaining instruments, we show in column 3 of table A3 that the macroprudential tightening via higher sector-specific capital buffers abroad is associated with a higher loan growth rate, whereas higher sector-specific capital buffers in Turkey are associated with a lower credit growth rate. The results in column 5 suggest that prudential tightening abroad via higher reserve requirement ratios on the foreign deposits dampens the loan growth rate. In contrast, higher reserve requirement ratios in a host country are associated with a faster loan growth rate, which again possibly reflects the fact that Turkey implemented prudential tightening in the 2011–13 period mostly in response to higher credit growth in Turkey induced by the quantitative easing in advanced countries in the post-2008 period.[12] Finally, in columns 7 and 8, we show that macroprudential tightening via lower interbank exposure limits or lower concentration ratios abroad is associated with faster loan growth by the domestic affiliates of foreign banks. On the other hand, it is worth noting that the results on the effects of the interbank exposure limits are counterintuitive and at odds with the results presented in tables A1 and A2. We believe that this difference can be attributed to the lack of controls for time fixed effects in specifications in table 4, the

[11]See Basci and Kara (2011) for the incorporating macroprudential tools to the monetary policy framework of the CBRT. See also the analysis by Başkaya et al. (2017a, 2017b) with the loan-level data showing the effect of global liquidity on domestic credit growth.

[12]This finding is likely to reflect the increases in the reserve options coefficients (ROC) as part of the reserve options mechanism (ROM) in Turkey that took place along with increases in reserve requirement rates on the FX-denominated deposits. In particular, the option given by the CBRT to the banks to meet their TL denominated reserve requirement liabilities with FX and gold may have induced them to increase their cross-border foreign-currency borrowing at lower global rates. See Alper, Kara, and Yörükoğlu (2013) for more discussion on the reserve options mechanism. See also Miniane et al. (2013) for the supporting evidence that higher ROC may have induced domestic banks to borrow FX-denominated funds from abroad.

inclusion of which could have controlled for the omitted common shocks, both at the country and global level, faced by the banks in our sample.

3.5 Including All Policies Simultaneously

Finally, we investigate the effects of the prudential regulations in a specification which controls for all the prudential regulations. In particular, the first and second columns of table A4 correspond to the specifications presented in equation (1), and the third column follows equation (2), except for the fact that all the policies are controlled for simultaneously.

The first column uses the sample of all banks. This specification does not control for the time fixed effects. Among the prudential regulations that we control for, we find that the LTV ratio and the interbank exposure limits have statistically significant coefficients, whereas the coefficients on the rest of the prudential instruments are insignificant. While the sign of the coefficient on the LTV is in line with our expectations, suggesting that lower LTV abroad increases the domestic lending growth in Turkey, the coefficient on the interbank exposure limits is counterintuitive. On the other hand, when we include the time fixed effects in the second column of the table, none of the individual policies seem to have a significant effect, which is consistent with the findings presented in table 3.

In the third column, we show with the sample of domestic affiliates of foreign banks that prudential regulation abroad through lower interbank limits decrease the lending growth rate. It is important to note that the negative effect of the lower interbank exposure limits on lending growth has also been observed in all specifications using the sample of domestic affiliates of foreign banks (see tables 4, 6, and A2). Similar to our findings using equation (4), we also find that lower concentration ratios abroad lead to higher loan growth by these banks. However, the rest of the individual prudential regulations do not seem to have a significant effect.

4. Conclusions

The global financial crisis has highlighted the importance of financial stability, and hence the need for prudential measures.

Particularly, during and in the aftermath of the crisis, many countries started implementing various prudential tools to deal with financial vulnerabilities and to mitigate systemic risk. While most of the recent literature has focused on the effectiveness of prudential policies within a country, a growing literature focuses also on the cross-border spillover effects of the prudential regulations and their implications for global financial stability.

This paper complements the literature on the cross-border spillover of prudential regulations by analyzing how the prudential regulations abroad affect the lending growth in Turkey. We document a number of findings: First, we provide some evidence for the existence of the cross-border spillover effects of the foreign prudential regulations on the loan growth rates in Turkey. However, the findings on the effects of some of the individual policy tools differ across the specifications. While lower LTV ratios or concentration ratios abroad in general lead to a higher domestic loan growth rate, lower interbank exposure limits or higher reserve requirements result in a smaller loan growth rate. Second, both with composite macroprudential policy indexes and with a number of specific prudential instruments, such as interbank exposure limits, concentration ratios, or loan-to-value ratios, we find that the domestic affiliates of foreign banks in Turkey play an important role for the inward transmission of the prudential regulations abroad. Third, the responses to change in macroprudential tools differ among banks depending on their balance sheet characteristics. For example, we observe that the bank size usually plays a mitigating role for the transmission of the foreign prudential regulations on domestic loan growth, whereas having a higher illiquid assets ratio or a higher level of international activity amplifies the effect of particular prudential regulations abroad on the domestic loan growth. Finally, we find some evidence that the magnitude of the cross-border spillovers of the foreign prudential regulations may differ across the phases of financial cycles, but not as much across the business cycles.

Appendix

Table 7. Net Effects

Exercise	Coefficient Sum	Prudential IndexC	Capital Requirements	Sector-Specific Capital Buffer	LTV Ratio	Reserve Requirements: Local	Interbank Exposure Limits	Concentration Ratios
Equation (3) (All Banks)	$\sum_{i=1}^{3}(\alpha_i+\beta_i\cdot\bar{X}_{b,t-1})$	2.450 (0.750)	−2.066 (0.816)	−13.000 (0.668)	7.817 (0.589)	−12.460 (0.141)	11.070 (0.232)	9.567 (0.612)
Equation (3) (Affiliates of For. Banks)	$\sum_{i=1}^{3}(\alpha_i+\beta_i\cdot\bar{X}_{b,t-1})$	−1.479 (0.786)	0.540 (0.960)	−12.380 (0.078)	1.022 (0.756)	−8.423 (0.099)	−148.400 (0.000)	−3.065 (0.563)
Equation (4) (All Banks)	$(\alpha_1+\alpha_3\cdot\bar{Z}_{j,t})$	0.728 (0.093)	2.324 (0.385)	−2.360 (0.437)	2.059 (0.022)	−0.336 (0.489)	−2.181 (0.198)	6.138 (0.010)
Equation (4) (Affiliates of For. Banks)	$(\alpha_1+\alpha_3\cdot\bar{Z}_{j,t})$	1.269 (0.004)	−0.220 (0.890)	3.527 (0.269)	2.331 (0.000)	1.928 (0.000)	−7.046 (0.064)	3.597 (0.008)

Notes: Net effects of MPP values are reported for exercises which include interaction terms, as the linear combination of instrument coefficients with interacted controls fixed at their mean levels. The numbers in parentheses in rows 1 and 2 are the p-values for the hypothesis that the value of equation (3) evaluated at the median values of bank characteristics is equal to zero. The numbers in parentheses in rows 3 and 4 are the p-values for the hypothesis that the value of equation (4) evaluated at the median values of cycle variables is equal to zero. For non-cumulative regressions, a contemporaneous/impact effect is also calculated.

Table 8. Construction of Bank Characteristics

Variable Name	Description	Data Source
Illiquid Assets Ratio	(Loans and Securities Held to Maturity)/Assets (in %)	Monthly Balance Sheet Statistics (CBRT)
Log Assets	Log (Balance Sheet Total/GDP Price Deflator)	Monthly Balance Sheet Statistics (CBRT)
Core Deposits Ratio	Total Deposits/Assets (in %)	Monthly Balance Sheet Statistics (CBRT)
Capital Ratio	Equity Capital/Assets (in %)	Monthly Balance Sheet Statistics (CBRT)
International Activity	Ratio of Foreign Assets to Total Assets (in %)	External Positions Reports (CBRT)

References

Aiyar, S., C. Calomiris, and T. Wieladek. 2014. "Does Macro-Prudential Regulation Leak? Evidence from a UK Policy Experiment." *Journal of Money, Credit and Banking* 46 (1): 181–214.

Alper, K., H. Kara, and M. Yörükoğlu. 2013. "Reserve Options Mechanism." *Central Bank Review* 13 (1): 1–14.

Basci, E., and H. Kara. 2011. "Financial Stability and Monetary Policy." Working Paper No. 1108, Research and Monetary Policy Department, Central Bank of the Republic of Turkey.

Başkaya, Y., J. di Giovanni, Ş. Kalemli-Özcan, J.-L. Peydro, and M. F. Ulu. 2017a. "Capital Flows and the International Credit Channel." Forthcoming in *Journal of International Economics*. Available at http://dx.doi.org/10.1016/j.jinteco.2016.12.003.

Başkaya, Y., J. di Giovanni, Ş. Kalemli-Özcan, and M. F. Ulu. 2017b. "International Spillovers and Local Credit Cycles." NBER Working Paper No. 23149.

Bernardo, M., J.-L. Peydro, and C. Ruiz. 2015. "The International Bank Lending Channel of Monetary Policy Rates and QE: Credit Supply, Reach-for-Yield, and Real Effects." International Finance Discussion Paper No. 1137, Board of Governors of the Federal Reserve System.

Binici, M., M. Hutchinson, and M. Schindler. 2010. "Controlling Capital? Legal Restrictions and the Asset Composition of

International Financial Flows." *Journal of International Money and Finance* 29 (4): 666–84.

Buch, C., and L. Goldberg. 2017. "Cross-Border Regulatory Spillovers: How Much? How Important? Evidence from the International Banking Research Network." *International Journal of Central Banking* 13 (S1).

Cerutti, E., R. Correa, E. Fiorentino, and E. Segalla. 2017. "Changes in Prudential Instruments—A New Cross-Country Database." *International Journal of Central Banking* 13 (S1).

Cetorelli, N., and L. Goldberg. 2011. "Global Banks and International Shock Transmission: Evidence from the Crisis." *IMF Economic Review* 59 (1): 41–76.

Financial Stability Board. 2015. "First FSB Annual Report." January.

Forbes, K., D. Reinhardt, and T. Wieladek. 2015. "The Spillovers, Interactions and (Un)intended Consequences of Monetary and Regulatory Policies." Mimeo, Bank of England.

Freixas, X., L. Laeven, and J.-L. Peydro. 2015. *Systemic Risk, Crises and Macroprudential Regulation.* Boston, MA: MIT Press.

Miniane, J., I. Rial, S. Tambunlertchai, and R. Tchaidze. 2013. "Turkey: Selected Issues." IMF Country Report No. 13/364.

Wagner, W. 2014. "Unintended Consequences of Macroprudential Policies." In *Macroprudentialism*, ed. D. Schoenmaker. London: CEPR Press.

Online Appendix to International Banking and Cross-Border Effects of Regulation: Lessons from Turkey

Yusuf Soner Başkaya,[a] Mahir Binici,[a] and Turalay Kenç
[a]Central Bank of the Republic of Turkey

Table A1. Exposure-Weighted Inward Transmission of Regulation—Cycle Interactions

	Prudential IndexC (1)	Capital Require-ments (2)	Sector-Specific Capital Buffer (3)	LTV Ratio (4)	Reserve Require-ments: Local (5)	Interbank Exposure Limits (6)	Concen-tration Ratios (7)
Cumulative Foreign-Exposure-Weighted Regulation ($ExpP_{cum}$)	−0.639	15.812	−2.883	5.036**	−3.130	−9.971**	14.315***
	(1.101)	(13.056)	(5.548)	(2.209)	(1.963)	(4.221)	(5.251)
Log Total $Assets_{t-1}$	−12.136***	−12.702***	−12.956***	−12.179***	−12.517***	−12.409***	−14.259***
	(2.082)	(2.072)	(2.135)	(2.098)	(2.072)	(2.201)	(2.324)
Tier 1 $Ratio_{t-1}$	−0.370***	−0.390***	−0.402***	−0.377***	−0.385***	−0.369***	−0.457***
	(0.076)	(0.074)	(0.081)	(0.075)	(0.074)	(0.083)	(0.097)
Illiquid Assets $Ratio_{t-1}$	−0.051	−0.031	−0.049*	−0.032	−0.032	−0.051	−0.072*
	(0.042)	(0.043)	(0.028)	(0.043)	(0.040)	(0.036)	(0.043)
International $Activity_{t-1}$	−0.078	−0.092	−0.057	−0.064	−0.072	−0.076	0.003
	(0.053)	(0.066)	(0.055)	(0.056)	(0.066)	(0.061)	(0.064)
Core Deposits $Ratio_{t-1}$	0.142***	0.130*	0.129*	0.120**	0.127*	0.105*	0.097*
	(0.054)	(0.069)	(0.068)	(0.058)	(0.067)	(0.055)	(0.053)
BIS Financial Cycle (Host Country)*$ExpP_{cum}$	0.141	−1.555	0.375	−0.338**	0.283	0.816***	−0.836**
	(0.099)	(1.217)	(0.447)	(0.146)	(0.188)	(0.302)	(0.399)
BIS Business Cycle (Host Country*$ExpP_{cum}$	−0.052	2.093	−3.076*	0.411	−0.061	−0.427*	0.248
	(0.140)	(2.046)	(1.802)	(0.296)	(0.194)	(0.254)	(0.382)
Observations	1,004	1,004	1,004	1,004	1,004	1,004	1,004
R^2	0.388	0.388	0.391	0.387	0.387	0.395	0.404
Adjusted R^2	0.340	0.339	0.343	0.339	0.338	0.347	0.356

Notes: This table reports the effects of changes in regulation and firm characteristics, business and financial cycles, and their interactions on log changes in total loans. The data are quarterly from 2006:Q1 to 2013:Q3 for a panel of forty-one domestic banks and domestic affiliates of foreign banks. Cumulative foreign-exposure-weighted regulation $ExpP_{cum}$ is calculated as the weighted average of cumulative changes in foreign regulation weighted with total assets and liabilities of that bank in the respective foreign country. The unilateral cycle variables are controlled for by the fixed effects. For more details on the variables, see table 7 in the appendix in the main paper. Each column gives the result for the regulatory measure specified in the column headline. All specifications include bank and time fixed effects. Standard errors are clustered by banks. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table A2. Inward Transmission of Home Macroprudential Policy via Affiliates—Cycle Interactions

	HomeP$_{cum}$ = Prudential IndexC (1)	**HomeP$_{cum}$ = Capital Requirements (2)**	**HomeP$_{cum}$ = Sector-Specific Capital Buffer (3)**	**HomeP$_{cum}$ = LTV Ratio (4)**	**HomeP$_{cum}$ = Reserve Requirements: Local (5)**	**HomeP$_{cum}$ = Interbank Exposure Limits (6)**	**HomeP$_{cum}$ = Concentration Ratios (7)**
Cumulative Home-Country Regulation (HomeP$_{cum}$)	0.990***	0.198	3.995	1.726***	1.366***	−4.996	2.463*
	(0.369)	(1.408)	(3.242)	(0.408)	(0.283)	(3.739)	(1.418)
Log Total Assets$_{t-1}$	−14.689***	−10.638***	−11.531***	−0.667	−12.109***	−22.147***	−16.891***
	(3.321)	(3.603)	(3.306)	(1.493)	(3.439)	(7.435)	(6.403)
Tier 1 Ratio$_{t-1}$	−0.535**	−0.366	−0.369	0.401*	−0.440*	−0.579*	−0.411
	(0.248)	(0.239)	(0.229)	(0.218)	(0.226)	(0.329)	(0.343)
Illiquid Assets Ratio$_{t-1}$	−0.199***	−0.221**	−0.178**	−0.557***	−0.219**	−0.542***	−0.214***
	(0.074)	(0.092)	(0.090)	(0.102)	(0.103)	(0.185)	(0.069)
Core Deposits Ratio$_{t-1}$	0.072	0.109	0.082	0.011	0.049	0.072	0.084
	(0.096)	(0.099)	(0.091)	(0.040)	(0.078)	(0.116)	(0.107)
BIS Financial Cycle (Home Country)	0.131*	0.143*	0.095	0.244***	0.216***	0.948***	0.128
	(0.079)	(0.075)	(0.058)	(0.045)	(0.076)	(0.227)	(0.131)
BIS Business Cycle (Home Country)	0.213	0.639**	0.204	−1.908***	1.093**	−0.075	−1.921*
	(0.368)	(0.257)	(0.191)	(0.367)	(0.503)	(1.405)	(1.042)
BIS Financial Cycle *HomeP$_{cum}$	0.057	−0.044	−0.113	0.157***	0.114**	−0.543***	0.256***
	(0.040)	(0.042)	(0.125)	(0.020)	(0.057)	(0.127)	(0.096)
BIS Business Cycle *HomeP$_{cum}$	0.353*	−1.464***	−0.204	0.024	0.747**	0.186	0.907***
	(0.211)	(0.514)	(1.945)	(0.116)	(0.313)	(0.524)	(0.312)
Observations	404	404	404	67	404	256	272
R^2	0.416	0.415	0.408	0.915	0.416	0.494	0.513
Adjusted R^2	0.328	0.326	0.318	0.766	0.328	0.376	0.405

Notes: This table reports the effects of changes in regulation and firm characteristics, business and financial cycles, and their interactions on log changes in total loans. The data are quarterly from 2006:Q1 to 2013:Q3 for foreign affiliates of domestic banks. The number of bank changes across specifications ranges from sixteen to five. HomeP$_{cum}$ refers to the cumulative changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. For more details on the variables, see table 7 in the appendix in the main paper. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects. Standard errors are clustered by banks. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table A3. Inward Transmission of Home vs. Host Macroprudential Policy via Affiliates

	HomeP = HostP = Prudential IndexC (1)	HomeP = HostP = Capital Require-ments (2)	HomeP = HostP = Sector-Specific Capital Buffer (3)	HomeP = HostP = LTV Ratio (4)	HomeP = HostP = Reserve Requirements: Foreign (5)	HomeP = HostP = Reserve Requirements: Local (6)	HomeP = HostP = Interbank Exposure Limits (7)	HomeP = HostP = Concen-tration Ratios (8)
Home-Country Regulation ($HomeP_{sum}$)	4.512***	−1.983	4.862**	4.745	−9.679***	−2.825	10.23***	12.78**
	(1.700)	(3.996)	(2.507)	(3.549)	(2.332)	(2.352)	(2.742)	(6.338)
Host-Country Regulation ($HostP_{sum}$)	2.096***	1.972	−5.815***	2.606	6.035***	1.004		
	(0.668)	(2.694)	(1.877)	(2.098)	(0.746)	(0.834)		
Log Total $Assets_{t-1}$	−6.701**	−6.153**	−7.347***	−22.567***	−8.430***	−7.465***	−7.921***	−6.748***
	(2.187)	(2.678)	(2.065)	(6.859)	(2.076)	(2.232)	(2.642)	(2.493)
Tier 1 $Ratio_{t-1}$	−0.174	0.080	0.030	2.598***	−0.244	−0.125	−0.149	0.208
	(0.207)	(0.207)	(0.205)	(0.905)	(0.239)	(0.210)	(0.219)	(0.219)
Illiquid Assets $Ratio_{t-1}$	−0.141	−0.132	−0.144*	−0.698***	−0.174**	−0.172*	0.016	0.066
	(0.087)	(0.090)	(0.085)	(0.153)	(0.088)	(0.093)	(0.142)	(0.111)
Core Deposits $Ratio_{t-1}$	0.027	0.009	0.034	−0.070	0.043	0.029	−0.156	0.015
	(0.094)	(0.103)	(0.085)	(0.153)	(0.095)	(0.109)	(0.145)	(0.135)
BIS Financial Cycle (Home Country)	0.001	−0.060	−0.014	0.074***	0.039	0.009	−0.052	−0.118*
	(0.048)	(0.063)	(0.053)	(0.009)	(0.045)	(0.049)	(0.154)	(0.068)
BIS Business Cycle (Home Country)	−0.122	−0.123	0.023	−2.595**	−0.057	−0.149	−1.666	−1.129*
	(0.196)	(0.277)	(0.194)	(1.178)	(0.180)	(0.276)	(1.223)	(0.628)
BIS Financial Cycle (Host Country)	1.080***	0.807***	1.120***	2.214***	1.016***	1.286***	0.834***	0.695***
	(0.264)	(0.251)	(0.238)	(0.179)	(0.253)	(0.220)	(0.145)	(0.113)
BIS Business Cycle (Host Country)	0.653***	0.720***	0.831***	−1.058*	0.572***	0.742***	1.274**	1.092***
	(0.131)	(0.165)	(0.162)	(0.580)	(0.132)	(0.156)	(0.629)	(0.344)
Observations	393	393	393	27	393	393	246	264
R^2	0.297	0.225	0.251	0.876	0.289	0.281	0.244	0.311
Adjusted R^2	0.240	0.163	0.192	0.731	0.233	0.233	0.173	0.248

Notes: This table reports the effects of changes in parent-country regulation and firm characteristics on log changes in total loans. The data are quarterly from 2006:Q1 to 2013:Q3 for domestic affiliates of foreign banks. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. HostP refers to the changes in regulation in the host country of foreign affiliates and thus changes only over time. For more details on the variables, see table 7 in the appendix in the main paper. Each column gives the result for the regulatory measure specified in the column headline. All specifications include time and bank fixed effects. Standard errors are clustered by banks. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table A4. Inward and Outward Transmission of Macroprudential Policy—Including All Instruments Jointly

	P = ExpP Inward A1 (1)	P = ExpP Inward A1 (2)†	P = HomeP Inward B1 (3)
Log Total Assets$_{t-1}$	−8.802***	−10.606***	−20.132***
	(1.175)	(3.040)	(3.372)
Tier 1 Ratio$_{t-1}$	−0.096	−0.314	−0.954***
	(0.168)	(0.236)	(0.227)
Illiquid Assets Ratio$_{t-1}$	−0.082	−0.095	−0.363**
	(0.098)	(0.108)	(0.155)
Core Deposits Ratio$_{t-1}$	−0.035	−0.024	0.080
	(0.097)	(0.100)	(0.141)
BIS Financial Cycle	−0.408***	9.679***	1.179***
	(0.086)	(2.755)	(0.135)
BIS Business Cycle	1.779***	−14.617***	−3.260***
	(0.231)	(3.845)	(1.009)
P = Capital Requirements	−9.932	−21.29*	−12.420
	(11.540)	(12.630)	(10.230)
P = Sector-Specific Capital Buffer	11.260	1.812	
	(12.020)	(16.250)	
P = Loan-to-Value Ratio	17.080*	10.790	
	(9.438)	(9.073)	
P = Reserve Requirements: Local	11.510	−15.110	21.810
	(9.199)	(12.530)	(14.020)
P = Interbank Exposure Limits	27.370**	3.036	−42.170***
	(8.667)	(12.870)	(8.184)
P = Concentration Ratios	28.810	22.470	19.530***
	(30.130)	(23.900)	(3.780)
Observations	500	500	170
R^2	0.293	0.370	0.731
Adjusted R^2	0.220	0.269	0.608

Notes: This table reports the effects of changes in regulation and firm characteristics on log changes in total loans by destination country. The data are quarterly from 2006:Q1 to 2013:Q3 for all domestic banks and domestic affiliates of foreign banks. The columns report results on the different specifications: Inward specification, table 3 and Inward table 6. Foreign-exposure-weighted regulation ExpP is calculated as the weighted average of changes in foreign regulation where the weights are total assets and liabilities of the bank in the respective foreign country. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. DestP refers to the changes in regulation in the destination country of the loan. For each prudential measure P, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding standard errors for joint significance in parentheses. For more details on the variables, see table 7 in the appendix of the main paper. All specifications include bank fixed effects, and specifications 2 and 3 also include time fixed effects. Standard errors are clustered by banks. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively. †Specification 1 includes only bank fixed effects, while specification 2 includes both bank and time fixed effects.

International Banking and Cross-Border Effects of Regulation: Lessons from the United Kingdom*

Robert Hills,[a] Dennis Reinhardt,[a] Rhiannon Sowerbutts,[a] and Tomasz Wieladek[b]
[a]Bank of England
[b]Barclays Capital

This paper examines whether U.K.-owned banks' domestic lending is affected by prudential actions in other countries where the banks have exposures. We also examine the impact of a change in prudential policy in a foreign-owned U.K.-resident bank's home jurisdiction on its lending to the United Kingdom. Our results suggest that prudential actions taken abroad do not have significant spillover effects on bank lending in the U.K. economy as a whole. But there are more disaggregated sectoral effects: for instance, when a foreign authority tightens loan-to-value standards, U.K. affiliates of banks owned from that country expand their lending to U.K. households.

JEL Codes: F32, F34, G21.

1. Introduction

In recent years, central banks and supervisors in many countries have been given new instruments and legal powers to address systemic

*We are grateful to James Benford, Claudia Buch, Matthieu Bussière, Linda Goldberg, Glenn Hoggarth, Friederike Niepmann, and Matthew Willison for excellent comments. We would like to thank the country teams of South Korea and Mexico for providing referee reports. We thank John Lowes and colleagues in the Bank's Statistics and Regulatory Data Division for answering many data-related questions. All errors remain ours. Any views expressed are solely those of the authors and so should not be taken to represent those of the Bank of England or its policies. Author e-mails: Robert.hills@bankofengland.co.uk, Dennis.reinhardt@bankofengland.co.uk, Rhiannon.sowerbutts@bankofengland.co.uk, tomaszwieladek@gmail.com. Tomasz Wieladek is currently at Barclays Capital but started this work while at the Bank of England.

risk, frequently referred to as "macroprudential" policies and instruments. In this paper, we examine the effect, when these instruments are used overseas, on U.K.-resident banks' lending behavior. Specifically, we look at how changes in "macroprudential" instruments in another country affect domestic lending in the United Kingdom, either via affiliates of banks from the country implementing macroprudential policy or via U.K.-owned banks that are exposed to that country.

This study represents the United Kingdom's contribution to the second project of the International Banking Research Network (IBRN) (Buch and Goldberg 2017). Some country contributions, like ours, focus on the *inward* transmission of foreign prudential policy; others focus on the *outward* transmission of domestic policy actions. Each country contribution runs the same core set of regressions, plus additional country-specific specifications as appropriate.

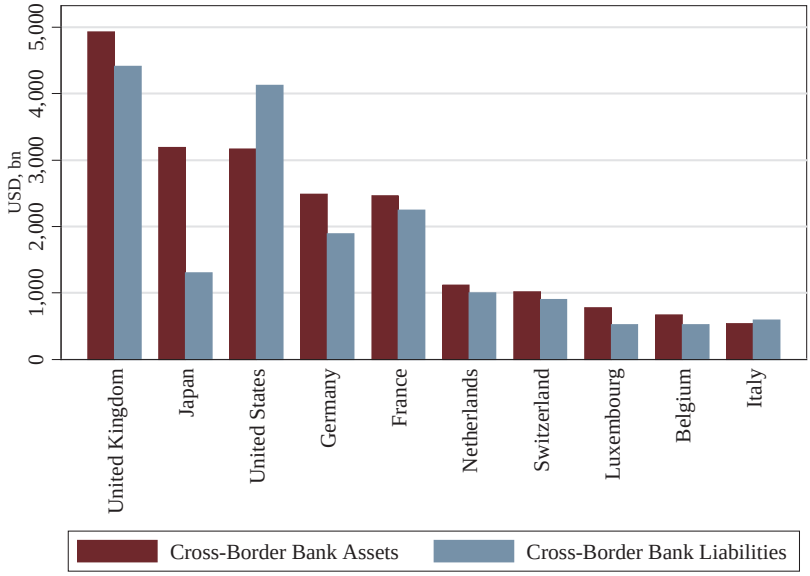
In this paper, we exploit the new IBRN Prudential Instruments Database (Cerutti et al. 2017), which covers seven different types of prudential policy actions taken in sixty-four countries. This rich database allows us to explore whether the implementation of any of these policies abroad affects lending to the U.K. economy.

Exploring the heterogeneity of prudential regulation is related to a recent paper by Reinhardt and Sowerbutts (2015), who find that domestic non-banks borrow more from abroad after an increase in capital requirements, but not after an increase in lending standards. They provide evidence that this is most likely the case because foreign branches are not subject to domestic capital regulations. This paper, however, used aggregate bank data and only focused on the effect of foreign banks' lending after a domestic macroprudential policy action.

The United Kingdom is a major global financial hub. Figure 1 illustrates how large and open the United Kingdom is, with the largest amount of cross-border assets and liabilities in nominal terms in the world. The U.K. banking system is notable in that there is a very high concentration in terms of banking system assets in a few banks with global operations; but also there is a large presence of foreign banks.

Foreign banks account for nearly half of total banking system assets in the United Kingdom, amounting to around 250 percent of GDP (of which around three-quarters is accounted for by branches,

Figure 1. Cross-Border Bank Assets and Liabilities across Countries



Source: BIS international banking statistics, 2013:Q4.

Note: The figure includes countries with more than US$500 billion cross-border bank assets.

and the remainder by subsidiaries). And U.K.-owned banks in aggregate have significant foreign exposures. This means that there are a large number of prudential actions taken abroad which may spill over to the United Kingdom, which explains this project's focus on inward spillovers. Equally, though, this diversity means that the potential impact of a policy action taken in a single country would not necessarily have a major impact on the United Kingdom.

Our results suggest that banks do not cut their lending significantly to the U.K. economy as a whole following a prudential action. This result holds for both U.K.-owned and foreign banks. Given that the United Kingdom is a core country within the international banking system, it is perhaps unsurprising that policy decisions taken by an individual foreign authority would have a

limited impact on lending to the United Kingdom. Aiyar et al. (2014) show the importance of core vs. non-core status in assessing regulatory spillovers. Specifically, they find that, faced with an increase in capital requirements, banks tend to favor their most important country relationships, so that the negative cross-border credit supply response in "core" countries is significantly less than in others.

Nevertheless, these aggregate results do appear to conceal important sectoral heterogeneity. The key result that stands out is that foreign affiliates in the United Kingdom expand their lending to households following a tightening of loan-to-value (LTV) standards in their home country. Foreign banks are only a small part of the market in the United Kingdom, so this does not materially affect the aggregate quantity of household lending. In addition, we find that U.K.-owned banks appear to demand less wholesale funding domestically and more from foreign sources if they are exposed to a country tightening LTV regulations.

These results are consistent with Ongena, Popov, and Udell (2013), who show that banks increase their lending abroad when faced with restrictions at home. The authors examine the spillovers of regulation via large international banks, examining business lending in Eastern Europe, and find that lower barriers to entry, tighter restrictions on bank activities, and higher minimum capital requirements in the parent market are associated with lower bank lending standards abroad.

In a similar vein, Houston, Lin, and Ma (2012) use aggregated country data and show that bank capital inflows increase to a particular country if that country has relatively fewer regulations; essentially, looser regulation acts as a "pull" factor for capital flows. Our focus on sectoral data is also motivated by Danisewicz, Reinhardt, and Sowerbutts (2015), who explore how branches and subsidiaries react differently to changes in prudential policy in their parent country, distinguishing between affiliates' interbank and non-bank lending. The sectoral results in this paper underscore the need for future research to examine the impact of prudential policies in a more disaggregated manner.

The paper proceeds as follows: section 2 describes the specific features of the U.K. data set and sets out the empirical specification, section 3 presents the headline results, and section 4 concludes.

2. Data and Stylized Facts—United Kingdom

2.1 Bank-Level Data and Balance Sheet Characteristics

The key features of our individual bank data set are described in detail in annex A2 of Hoggarth, Hooley, and Korniyenko (2013) and appendix 1 of Aiyar et al. (2014). Raw data from the Bank of England's regulatory reporting forms were collected at a quarterly frequency, covering the balance sheets of 360 individual U.K.-resident banks (excluding building societies) over the period 2000:Q1–2014:Q4 (the data are therefore confidential and available only to employees of the Bank of England). Bank nationality is determined by where its ultimate parent (e.g., holding company) is located and not by the nationality of the largest shareholder. For example, a "U.K.-owned" bank simply means that its ultimate parent is incorporated in the United Kingdom. Table 10 in the appendix describes the construction of variables and their sources.

2.1.1 Dependent Variable

In our main (IBRN-wide) specification, the dependent variable ($\Delta Y_{b,t}$) is the exchange-rate-adjusted log change in the stock of loans. To take into account the volatility of this series, we cut the edges of the distribution so that observations of growth rates outside of +/– 100 percent are dropped.[1] For the U.K.-specific part of this paper, we also explore whether lending to various sectors is affected differently, and so the dependent variable is the exchange-rate-adjusted log change in lending for interbank, private non-financial corporations (PNFC) and household loans. We also look at banks' borrowing and explore the log change in the short-term funding of U.K. banks from wholesale sources (see table 10 for details).

2.1.2 Balance Sheet Control Variables

For balance sheet characteristics, we have used the following variables:

[1]This drops 4 percent of the sample in the case of total loan growth and a sample including both U.K.-headquartered and non-U.K.-headquartered banks.

- Log real assets—i.e., the log of a bank's total assets in levels, deflated by CPI inflation, which we loosely interpret as "size" (and which will also probably pick up other factors such as the risk-taking behavior of banks, to the extent that this reflects too-big-to-fail subsidies ($LogAssets_{i,t-1}$)
- Bank's tier 1 capital to asset ratio ($Tier1Ratio_{i,t-1}$)
- Fraction of a bank's portfolio of assets that is illiquid (1 − holdings of cash and gilts divided by total assets) ($IlliquidAssetsRatio_{i,t-1}$)
- Ratio of total commitments divided by total assets ($CommitmentRatio_{i,t-1}$)
- Core funding, i.e., the fraction of time and sight deposits from domestic residents, divided by total liabilities less tier 1 capital ($CoreDepositsRatio_{i,t-1}$)

2.2 Data on Prudential Instruments

The data on prudential actions come from a new database put together with the expertise of individual central banks participating in the IBRN, together with the International Monetary Fund and the Bank for International Settlements (see Lim et al. 2011, Buch and Goldberg 2017, and Cerutti et al. 2017).

Summary statistics of the count of each type of regulation are presented in table 2 below. Specification A shows the count of the number of changes in regulation in any country in which a U.K. bank has operations for each type of regulation; for example, there are ninety-six capital requirement changes in countries to which the U.K. banking system lends, affecting 1,109 bank-time observations. In specification B, we examine changes in a foreign-owned bank's home country; for example, there are forty-five changes in capital requirements in countries where a foreign-owned bank which operates in the United Kingdom has a parent, affecting 196 bank-time observations. The nature of the United Kingdom's banking system, with U.K. banks holding diversified foreign portfolios and the large number of foreign banks, means that there are a large number of foreign policy actions to take into consideration. The exception is for the interbank exposure limit, where there are too few actions, and the concentration ratio, where there are too few actions for specification B, when we examine the impact of regulation in the home country of a foreign affiliate. Each macroprudential action is treated

as a dummy variable which takes the value of 1 if macroprudential policy is tightened, –1 if macroprudential policy is loosened, and 0 otherwise.

We use two separate specifications to examine the impact of prudential actions. The first is an exposure-weighted index. This is constructed for U.K.-owned banks only and weights are generated using the average of the assets to a particular country, averaged over the four quarters preceding the policy action. For example, if bank X has half of its exposures to country A, bank Y has one-tenth of its exposures to country A, and country A tightens capital requirements, and no other country takes an action, then the exposure-weighted index for capital requirements will be 0.5 for bank X and 0.1 for bank Y. If, however, country B, to which bank Y has one-fifth of its exposures, also tightens capital requirements, this exposure-weighted index becomes 0.3 for bank Y (i.e., 0.1 plus 0.2). When country B loosens requirements, this becomes 0.1 again for bank Y.

The second specification is applicable to banks with a foreign parent. In this case the index takes a value of 1 when the country of the parent bank tightens regulation and –1 when regulation is loosened.

- Regulation weighted by foreign exposures: All exposures of the banks *outside* the home and destination country
- $ExpP_{b,t-1}$: Foreign-exposure-weighted regulation
- $ExpP_{cum,b,t-1}$: Cumulative foreign-exposure-weighted regulation

For the second measure of prudential policy, we use an indicator for when regulation is taken in the parent country for foreign banks only.

- Home-country regulation: Home = country of the parent bank
- $HomeP_{j,t-1}$: Home-country regulation
- $HomeP_{cum,b,t-1}$: Cumulative home-country regulation

2.3 Summary Statistics for the Data Set

Table 1 shows summary statistics for U.K. and foreign-owned banks. U.K. and foreign-owned banks are of comparable size, although

Table 1. Summary Statistics on Bank Lending and Characteristics

Balance Sheet Characteristics (all in %)	Median	25th Percentile	75th Percentile	N
U.K.-Owned Banks:				
Total Loans (Ln Change)	1.805	−1.403	5.030	1,360
Interbank Loans (Ln Change)	1.420	−4.804	7.919	1,320
PNFC Loans (Ln Change)	0.892	−2.770	5.431	1,203
Household Loans (Ln Change)	1.260	−0.962	4.117	1,209
Wholesale Funding Domestic (Ln Change)	1.992	−7.709	13.681	1,264
Wholesale Funding Foreign (Ln Change)	1.102	−4.822	9.018	1,224
Log Total Assets	16.638	15.204	18.448	1,360
Tier 1 Ratio	10.555	7.198	15.256	1,356
Illiquid Assets Ratio	75.655	54.130	86.378	1,354
International Ratio	17.425	6.730	34.616	1,360
Deposits Ratio	42.948	25.974	59.740	1,359
Foreign-Owned Banks:				
Total Loans (Ln Change)	0.394	−10.906	11.666	8,613
Interbank Loans (Ln Change)	0.069	−19.596	18.636	7,590
PNFC Loans (Ln Change)	−0.075	−8.032	7.130	4,860
Household Loans (Ln Change)	0.000	−8.004	6.597	4,117
Wholesale Funding Domestic (Ln Change)	0.000	−18.493	17.938	6,375
Wholesale Funding Foreign (Ln Change)	0.997	−8.639	11.100	6,482
Log Total Assets	14.937	13.484	16.181	8,613
Tier 1 Ratio	4.456	1.957	12.546	8,355
Illiquid Assets Ratio	54.903	30.876	79.151	8,520
International Ratio	63.153	43.676	74.845	8,528
Deposits Ratio	6.344	1.292	16.646	8,595

Notes: This table provides summary statistics for bank balance sheet and lending data. Data are observed quarterly from 2000:Q1 to 2013:Q4. Banking data come from the Bank of England (BoE) BT and AL forms and are reported at a quarterly frequency. Banks are split into subgroups—U.K.-owned banks and foreign banks—on the basis of the ownership of a parent firm. Information on banks' ownership comes from the BoE. Variable definitions and sources are given in table 10 in the appendix.

Table 2. Summary Statistics on Changes in Prudential Instruments

Inward: Specification A					
	Base Data (Before Aggregating to Exposure-Weighted Measures)				Exposure-Weighted Observations
Instrument	No. of Country-Time Changes	No. of Country-Time Changes (Tightening)	No. of Country-Time Changes (Loosening)	No. of Bank-Time Changes	Proportion $ExpP_t$ Non-zero
Prudential Index	546	365	181	5,804	0.677
General Capital Requirements	96	96	0	1,109	0.135
Sector-Specific Capital Buffer	72	53	19	804	0.276
Loan-to-Value Ratio Limits	94	70	24	1,174	0.407
Reserve Requirements: Foreign	122	76	46	984	0.340
Reserve Requirements: Local	277	126	151	2,681	0.474
Interbank Exposure Limit	22	21	1	343	0.122
Concentration Ratio	33	31	2	430	0.196
Inward: Specification B					
Instrument	No. of Country-Time Changes	No. of Country-Time Changes (Tightening)	No. of Country-Time Changes (Loosening)	No. of Bank-Time Changes	Proportion $HomeP_t$ Non-zero
Prudential Index	253	189	64	867	0.101
General Capital Requirements	45	45	0	196	0.023
Sector-Specific Capital Buffer	39	32	7	136	0.016
Loan-to-Value Ratio Limits	70	52	18	252	0.029
Reserve Requirements: Foreign	40	25	15	61	0.007
Reserve Requirements: Local	108	58	50	324	0.038
Interbank Exposure Limit	12	12	0	94	0.011
Concentration Ratio	19	19	0	67	0.008

Source: IBRN.
Notes: This table shows summary statistics on changes in prudential instruments for banks located in the United Kingdom over the period 2000–13. Data on the instruments come from Cerutti et al. (2017) and are a quarterly basis. The number of changes in prudential instruments is reported on several dimensions, i.e., on the country-time level and on the bank-time level. The last column of each panel shows the share of prudential changes to total observations (i.e., the share of non-zero observations). The column "Exposure-Weighted Observations" is based on the underlying data on prudential changes in foreign countries. The reported data are based on the regression sample.

foreign-owned banks have lower and more varied loan growth. Foreign banks are often non-retail banks and do not raise deposits in the United Kingdom, as shown by their much lower deposit ratio, which might help to explain the limited aggregate spillover effects we find. The tier 1 capital ratio appears lower for foreign-owned banks, although this partly reflects the fact that many foreign affiliates are branches and so do not have capital located in the United Kingdom (for branches that do not report their own balance sheet, we set tier 1 ratios to zero).

3. Empirical Method and Estimation Results

3.1 Empirical Method

In this section, we describe our empirical model that we use to examine regulatory spillovers from abroad. Specifically, following Buch and Goldberg (2017), we use the following regression model:

$$\Delta Y_{b,t} = \alpha_0 + \sum_{k=1}^{3} \alpha_j ExpP_{b,t+1-k} + \alpha_4 X_{b,t-1} + f_b + f_t + \epsilon_{b,t}, \quad (1)$$

where $\Delta Y_{b,t}$ is the (exchange-rate-adjusted) change in log stock of loans to U.K. residents of bank b at time t, and $ExpP_{b,t}$ is an exposure-weighted measure of the prudential policy actions taken outside the United Kingdom. The weights are based on the average share in total lending of the individual banks' cross-border lending to the affected country in the four quarters before the policy was implemented. Note that $ExpP_{b,t}$ enters the model contemporaneously and with two lags. This is to allow prudential policy changes abroad to affect U.K. lending over the course of three quarters. $X_{b,t-1}$ is the vector of balance sheet characteristics listed in section 2.2. f_b and f_t are bank and time effects, respectively.

In addition to these regressions, which all countries that participate in the IBRN were asked to estimate on their own national data sets, we also explore angles which are unique to the United Kingdom. Given that London is one of the world's largest financial centers, two notable features are that a large fraction of bank lending in the United Kingdom is interbank or to other financial entities, and that foreign-owned banks account for about two-thirds of total

activity. This type of lending might clearly react differently to regulatory spillovers than either real economy or mortgage lending. We therefore also estimate model (1) for lending to four different sectors of the economy: the financial sector, the commercial real estate sector, the household sector, and the PNFC sector.

The United Kingdom, as a global financial center, is also a funding source for foreign banks and U.K. banks, and so we also investigate whether banks increase their funding from the United Kingdom after a prudential action is taken elsewhere.

It is of course plausible that certain bank characteristics could mitigate or amplify the transmission of external prudential policy actions to U.K. bank lending. To exploit this hypothesis, we use the following model:

$$\Delta Y_{b,t} = \alpha_0 + \sum_{k=1}^{3} \alpha_j ExpP_{b,t+1-k} + \alpha_4 X_{b,t-1} + \sum_{k=1}^{3} \beta_j ExpP_{b,t+1-j} - X_{b,t-1} + f_b + f_t + \epsilon_{b,t}. \quad (2)$$

Model (2) is identical to model (1), with the difference that the exposure index is now interacted with individual bank characteristics.

Finally, the impact of the changes in policy could also be dependent on the business or credit cycle; we use the following model to investigate if this is the case:

$$\Delta Y_{b,t} = \alpha_0 + \alpha_1 ExpP_{cum,b,t-1} + \alpha_2 X_{b,t-1} + \alpha_3 ExpP_{cum,b,t-1} Z_t + f_b + f_t + \epsilon_{b,t}, \quad (3)$$

where Z_t is either the output or credit gap and $ExpP_{cum,b,t-1}$ is a cumulative measure of the credit or business cycle index, cumulated over the last three quarters. Models (1)–(3) assume that prudential policy abroad affects lending in the United Kingdom (specification A) through banks' portfolio exposure to countries that implemented these policies. Another plausible channel of transmission is that those banks that are headquartered in the country that implemented

the policies transmit the change in regulation. We therefore reestimate models (1)–(3), replacing $ExpP_{b,t}$ with the indicator of prudential policy in the affected bank's home country $HomeP_{j,t}$ (specification B), where j stands for a bank's home country j. Given that foreign banks have a large market share in the U.K. financial system, it seems important to test for the effects of both U.K.-headquartered banks (specification A) and foreign-headquartered banks operating in the United Kingdom (specification B).[2]

3.2 Baseline Analysis of Transmission of Prudential Policies to the United Kingdom

Table 3 shows the results for the baseline regressions which examine the effect of exposure-weighted changes in regulation on log changes in total loans of U.K.-owned banks to U.K. financial and non-financial sectors. Our results suggest that prudential actions taken abroad do not have significant spillover effects on bank lending in the U.K. economy as a whole. A change in capital requirements and sector-specific capital requirements have a small contemporaneous impact on lending to the United Kingdom; but this becomes insignificant after the first period, and the F-test of the contemporaneous term and its two lags suggests that there are no significant spillovers to U.K. lending over a three-quarter period.

There is a puzzle in the sign of these point estimates. A reduction in lending to the United Kingdom following a tightening of capital requirements abroad is consistent with the hypothesis that the bank becomes more capital constrained after an increase in capital requirements and so cuts lending across the globally consolidated group as a whole. However, the sign is different for sectoral capital requirements which only apply to domestic lending (such as on domestic real estate); this may be due to the fact that the

[2]As specification B focuses on the specific links between affiliates and their home countries, we can also include the business and credit cycle variables of the affiliate's home country as a control variable in all of the specifications. This should help to account for possible endogeneity driven by the fact that macropru is often tightened in the upswing, which could lead to different lending patterns abroad independently of macropru, especially with regard to the lending of foreign affiliates.

Table 3. Exposure-Weighted Inward Transmission of Regulation

	ExpP = Prudential IndexC (1)	**ExpP = Capital Requirements (2)**	**ExpP = Sector-Specific Capital Buffer (3)**	**ExpP = LTV Ratio (4)**	**ExpP = Reserve Requirements: Foreign (5)**	**ExpP = Reserve Requirements: Local (6)**	**ExpP = Interbank Exposure Limits (7)**	**ExpP = Concentration Ratios (8)**
Foreign-Exposure-Weighted Regulation $ExpP_t$	−0.00369	−0.147**	0.0804*	0.0335	0.454**	0.208*	−0.180	−0.348*
	(0.0338)	(0.0697)	(0.0438)	(0.0482)	(0.221)	(0.121)	(0.170)	(0.191)
Foreign-Exposure-Weighted Regulation $ExpP_{t-1}$	0.0277	0.185	−0.0129	−0.0582	−0.218	−0.158	0.136	−0.0798
	(0.0424)	(0.150)	(0.0404)	(0.0388)	(0.273)	(0.136)	(0.114)	(0.0796)
Foreign-Exposure-Weighted Regulation $ExpP_{t-2}$	−0.00304	−0.208	0.0188	0.0818	0.185	0.149	−0.0843	−0.0845
	(0.0550)	(0.222)	(0.0330)	(0.0669)	(0.356)	(0.101)	(0.0789)	(0.139)
Sum of Coefficients	*0.0210*	*−0.170*	*0.0864*	*0.0571*	*0.421**	*0.198***	*−0.128*	*−0.512***
F-Test	*0.195*	*1.263*	*1.151*	*0.374*	*2.919*	*3.750*	*0.257*	*5.197*
p-value	*0.661*	*0.266*	*0.288*	*0.544*	*0.0935*	*0.0582*	*0.614*	*0.0268*
Log Total $Assets_{t-1}$	1.154	1.142	1.111	1.160	1.191	1.215	1.150	1.030
	(1.737)	(1.759)	(1.704)	(1.743)	(1.725)	(1.725)	(1.728)	(1.732)
Tier 1 $Ratio_{t-1}$	0.00742	0.00788	0.00816	0.0106	0.00754	0.00624	0.00373	−0.00136
	(0.0615)	(0.0651)	(0.0620)	(0.0596)	(0.0604)	(0.0631)	(0.0614)	(0.0615)
Illiquid $Assets\ Ratio_{t-1}$	0.106**	0.100**	0.108**	0.107**	0.105**	0.100**	0.105**	0.104**
	(0.0445)	(0.0427)	(0.0446)	(0.0446)	(0.0443)	(0.0431)	(0.0456)	(0.0444)
International $Activity_{t-1}$	0.0858	0.0757	0.0889	0.0874	0.0854	0.0917	0.0849	0.0853
	(0.0950)	(0.0911)	(0.0954)	(0.0967)	(0.0953)	(0.0979)	(0.0963)	(0.0949)
Core Deposits $Ratio_{t-1}$	0.114*	0.114*	0.116*	0.116*	0.118*	0.125*	0.117*	0.122*
	(0.0649)	(0.0651)	(0.0645)	(0.0650)	(0.0656)	(0.0674)	(0.0658)	(0.0640)
Observations	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360
R^2	0.088	0.106	0.089	0.089	0.090	0.096	0.088	0.091
Adjusted R^2	0.0419	0.0610	0.0429	0.0431	0.0441	0.0510	0.0427	0.0453
No. of Banks	53	53	53	53	53	53	53	53
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample of Banks: Domestic Owned	1	1	1	1	1	1	1	1

Notes: This table reports the effects of changes in regulation and firm characteristics on log changes in total loans. The data are quarterly from 2000:Q1 to 2013:Q4. (Cumulative) foreign-exposure-weighted regulation is calculated as the weighted average of (cumulative) changes in foreign regulation weighted with total assets and liabilities of that bank in the respective foreign country. For more details on the variables, see table 10 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the table. Standard errors are clustered by bank. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

relative-price effect dominates the income effect in this case. This warrants more investigation in future work.

We find that banks expand their lending to the United Kingdom following a reserve requirement action taken abroad, but although the test over the three-quarter period is significant, this seems to be driven again by the first quarter only.

When the bank-specific (table 4) and financial and business cycle (table 5) variables are interacted, these bank-specific and cycle controls rarely seem to have significant effects. This may be because the time and bank fixed effects already account for a lot of the variation in these variables.[3]

The small and only-contemporaneous effects for all instruments suggest that prudential actions taken abroad do not have a long-lasting impact on U.K.-owned banks' lending to the United Kingdom. This has a number of potential explanations. For instance, U.K. banks have diversified country exposures, meaning that the impact of one country's actions may be very small for the bank as a whole and the bank does not optimize or adjust its strategy in response to changes in regulation which only affect a small part of its balance sheet; alternatively banks could react to prudential policy by rebalancing, but not by changing lending to core markets (as suggested by Aiyar et al. 2014) and so U.K.-based banks do not cut lending to the United Kingdom; another possibility is that banks rebalance their portfolios across sectors, leaving overall lending unchanged. We do not have sufficient data or actions to test the first two hypotheses, but we do explore the final—sectoral rebalancing—hypothesis below.

Tables 6–8 show the results for the baseline regressions which examine the effects of a change in lending to the United Kingdom by foreign-owned affiliates after a change in regulation in their home country. Table 6 provides some weak evidence that regulatory tightening in affiliates' home countries has an impact on their lending

[3]However, the inclusion of fixed effects remains essential to help ascertain that the respective balance sheet characteristics are not capturing other unobservable differences between banks. Rerunning the regression in table 4, column 1 as a pooled regression with and without fixed effects reveals that they explain 11.67 percentage points of an overall R^2 of 15.36 percent (note the current table displays the "within" R^2). Likewise, in table 5, column 1, fixed effects explain 11.17 percentage points of the total 13.13 percent.

Table 4. Exposure-Weighted Inward Transmission of Regulation—Bank Variables Interactions

	ExpP = Prudential IndexC (1)	ExpP = Capital Require-ments (2)	ExpP = Sector-Specific Capital Buffer (3)	ExpP = LTV Ratio (4)	ExpP = Reserve Require-ments: Foreign (5)	ExpP = Reserve Require-ments: Local (6)	ExpP = Interbank Exposure Limits (7)	ExpP = Concen-tration Ratios (8)
Foreign-Exposure-Weighted Regulation (ExpP)	−0.424	−0.608	0.366	−0.0904	17.73*	−0.431	2.576	0.371
	0.413	0.885	0.0627	0.00389	3.900	0.332	0.685	0.0307
	0.524	0.351	0.803	0.950	0.0536	0.567	0.412	0.862
Log Total Assets_{t-1}	1.016	0.493	0.921	1.065	1.225	1.225	1.171	0.953
	(1.686)	(1.736)	(1.730)	(1.736)	(1.668)	(1.797)	(1.729)	(1.721)
Tier 1 Ratio_{t-1}	0.00876	−0.0242	0.0123	0.00909	0.0180	0.00527	−0.00524	0.00645
	(0.0623)	(0.0771)	(0.0638)	(0.0620)	(0.0578)	(0.0673)	(0.0634)	(0.0599)
Illiquid Assets Ratio_{t-1}	0.125**	0.126**	0.113**	0.106**	0.105**	0.101**	0.0977**	0.104**
	(0.0489)	(0.0525)	(0.0472)	(0.0459)	(0.0460)	(0.0446)	(0.0443)	(0.0453)
International Activity_{t-1}	0.0631	0.0550	0.0873	0.0862	0.0966	0.0961	0.0891	0.0899
	(0.0955)	(0.0914)	(0.0957)	(0.0986)	(0.0956)	(0.100)	(0.0947)	(0.0966)
Core Deposits Ratio_{t-1}	0.0993	0.0825	0.109	0.115*	0.134**	0.123*	0.123*	0.129*
	(0.0638)	(0.0622)	(0.0655)	(0.0678)	(0.0649)	(0.0672)	(0.0651)	(0.0662)
Log Total Assets*ExpP	0.0153	0.0283	0.00830	0.00372	−0.0881	0.0272	−0.0858	0.0190
	0.665	2.123	0.0142	0.00575	0.183	1.390	0.632	0.0519
	0.418	0.151	0.906	0.940	0.671	0.244	0.430	0.821
Tier 1 Ratio*ExpP	0.000612	−4.78e-05	−0.0153**	0.00891	−0.116	0.00160	0.0311	−0.00895
	0.0716	0.000134	4.066	0.677	1.424	0.241	1.763	0.247
	0.790	0.991	0.0489	0.415	0.238	0.625	0.190	0.621
Illiquid Assets Ratio*ExpP	−0.00279	−0.00651	−0.00541	0.00274	−0.0739**	0.00234	0.00686	−0.00192
	0.947	1.626	1.610	0.154	5.099	0.290	0.237	0.0291
	0.335	0.208	0.210	0.696	0.0282	0.592	0.628	0.865

(*continued*)

Table 4. (Continued)

	ExpP = Prudential IndexC (1)	ExpP = Capital Require-ments (2)	ExpP = Sector-Specific Capital Buffer (3)	ExpP = LTV Ratio (4)	ExpP = Reserve Require-ments: Foreign (5)	ExpP = Reserve Require-ments: Local (6)	ExpP = Interbank Exposure Limits (7)	ExpP = Concen-tration Ratios (8)
International Activity*ExpP	0.00588	0.00503	−0.000951	−0.00421	−0.100	0.00238	−0.0163	−0.0174
	1.315	1.187	0.0127	0.267	0.502	0.497	0.629	1.530
	0.257	0.281	0.911	0.608	0.482	0.484	0.431	0.222
Core Deposits Ratio*ExpP	0.00518	0.00686**	0.00373	−0.00245	−0.114	−0.00158	−0.0353**	−0.0113
	1.814	4.998	0.375	0.186	1.947	0.435	4.294	1.393
	0.184	0.0297	0.543	0.668	0.169	0.512	0.0432	0.243
Observations	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360
R^2	0.110	0.140	0.094	0.093	0.104	0.101	0.099	0.100
Adjusted R^2	0.0544	0.0866	0.0376	0.0359	0.0483	0.0451	0.0431	0.0435
No. of Banks	53	53	53	53	53	53	53	53
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample of Banks: Domestic Owned	1	1	1	1	1	1	1	1

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in total loans. Bank control variables are included as specified in the lower part of the table but not reported for the sake of brevity. For ExpP and its interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding F-stats for joint significance in parentheses. The data are quarterly from 2000:Q1 to 2013:Q4. (Cumulative) foreign-exposure-weighted regulation is calculated as the weighted average of (cumulative) changes in foreign regulation weighted with total assets and liabilities of that bank in the respective foreign country. For more details on the variables, see table 10 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the table. Standard errors are clustered by bank. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 5. Exposure-Weighted Inward Transmission of Regulation—Cycle Interactions

	$ExpP_{cum}$ = Prudential IndexC (1)	$ExpP_{cum}$ = Capital Require-ments (2)	$ExpP_{cum}$ = Sector-Specific Capital Buffer (3)	$ExpP_{cum}$ = LTV Ratio (4)	$ExpP_{cum}$ = Reserve Require-ments: Foreign (5)	$ExpP_{cum}$ = Reserve Require-ments: Local (6)	$ExpP_{cum}$ = Interbank Exposure Limits (7)	$ExpP_{cum}$ = Concen-tration Ratios (8)
Cumulative Foreign-Exposure-Weighted Regulation ($ExpP_{cum}$)	0.0250***	−0.870	0.0216*	0.0258**	0.270***	0.0289	0.0525	−0.00119
	(0.00831)	(0.747)	(0.0122)	(0.0129)	(0.0878)	(0.0278)	(0.0455)	(0.0395)
Log Total $Assets_{t-1}$	−0.514	−0.317	−0.422	−0.648	−0.00214	−0.221	−0.158	0.0582
	(1.517)	(1.652)	(1.576)	(1.597)	(1.610)	(1.745)	(1.794)	(1.715)
Tier 1 $Ratio_{t-1}$	−0.0311	−0.0338	−0.0609	−0.0332	−0.00406	−0.0434	−0.00380	0.00550
	(0.0659)	(0.0704)	(0.0756)	(0.0728)	(0.0755)	(0.0784)	(0.0845)	(0.0834)
Illiquid $Assets\ Ratio_{t-1}$	0.142**	0.141**	0.137**	0.141**	0.148**	0.136**	0.142**	0.154**
	(0.0559)	(0.0558)	(0.0540)	(0.0555)	(0.0554)	(0.0542)	(0.0595)	(0.0628)
International $Activity_{t-1}$	0.0981	0.0871	0.0856	0.0974	0.111	0.0989	0.0963	0.0913
	(0.0862)	(0.0866)	(0.0861)	(0.0872)	(0.919)	(0.0899)	(0.0908)	(0.0949)
Core $Deposits\ Ratio_{t-1}$	0.0751	0.0730	0.0731	0.0715	0.0809	0.0863	0.0693	0.0636
	(0.0536)	(0.0587)	(0.0582)	(0.0544)	(0.0586)	(0.0606)	(0.0537)	(0.0583)
BIS Financial Cycle (Host Country)*$ExpP_{cum}$	0.000166	−0.0373	−0.000149	−0.00125	0.00731	0.00151	−2.30e-05	−0.00257
	(0.000317)	(0.0309)	(0.000616)	(0.000988)	(0.00533)	(0.00106)	(0.00278)	(0.00181)
BIS Business Cycle (Host Country)*$ExpP_{cum}$	0.00413	−0.561	0.00238	0.00933	0.00900	0.00565	−0.0221	−0.00973
	(0.00419)	(0.413)	(0.00545)	(0.00728)	(0.0332)	(0.00928)	(0.0285)	(0.0126)
Observations	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363
R^2	0.078	0.085	0.074	0.076	0.076	0.075	0.075	0.075
Adjusted R^2	0.0337	0.0411	0.0302	0.0317	0.0315	0.0312	0.0304	0.0310
No. of Banks	57	57	57	57	57	57	57	57
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample of Banks: Domestic Owned	1	1	1	1	1	1	1	1

Notes: This table reports the effects of changes in regulation and business and financial cycles and firm characteristics on log changes in total loans. Unilateral cycle variables are controlled for by the fixed effects. The data are quarterly from 2000:Q1 to 2013:Q4. (Cumulative) foreign-exposure-weighted regulation is calculated as the weighted average of (cumulative) changes in foreign regulation weighted with total assets and liabilities of that bank in the respective foreign country. For more details on the variables, see table 10 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the table. Standard errors are clustered by bank. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 6. Inward Transmission of Home Prudential Policy via Affiliates

	HomeP = Prudential IndexC (1)	HomeP = Capital Require-ments (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Require-ments: Foreign (5)	HomeP = Reserve Require-ments: Local (6)	HomeP = Interbank Exposure Limits (7)	HomeP = Concen-tration Ratios (8)
Home-Country Regulation HomeP_{t}	−0.154	−0.830	2.037	−1.433	−5.587*	1.789	0.359	−5.065
	(1.140)	(2.139)	(1.772)	(2.160)	(3.256)	(2.247)	(2.146)	(4.001)
Home-Country Regulation HomeP_{t-1}	−1.932**	3.292	−0.406	−3.465*	2.107	−4.251***	0.737	−2.763
	(0.963)	(2.140)	(2.135)	(1.982)	(2.488)	(1.448)	(2.842)	(3.240)
Home-Country Regulation HomeP_{t-1}	0.697	1.754	−2.239	4.282**	5.018	1.472	−3.146	−2.913
	(0.996)	(1.907)	(2.012)	(2.056)	(4.023)	(1.600)	(2.384)	(3.470)
Sum of Coefficients	*−1.389*	*4.217*	*−0.608*	*−0.616*	*1.538*	*−0.989*	*−2.049*	*−10.74**
F-test	*1.154*	*1.161*	*0.0420*	*0.0419*	*0.240*	*0.220*	*0.234*	*3.374*
p-value	*0.284*	*0.282*	*0.838*	*0.838*	*0.624*	*0.640*	*0.629*	*0.0672*
Log Total Assets_{t-1}	−2.445***	−2.439***	−2.443***	−2.423***	−2.438***	−2.433***	−2.425***	−2.388***
	(0.827)	(0.826)	(0.827)	(0.825)	(0.826)	(0.825)	(0.828)	(0.828)
Tier 1 Ratio_{t-1}	0.104**	0.106**	0.104**	0.105**	0.104**	0.105**	0.105**	0.107**
	(0.0495)	(0.0493)	(0.0492)	(0.0492)	(0.0493)	(0.0493)	(0.0493)	(0.0492)
Illiquid Assets Ratio_{t-1}	0.0953***	0.0948***	0.0952***	0.0955***	0.0940***	0.0948***	0.0951***	0.0955***
	(0.0255)	(0.0254)	(0.0255)	(0.0254)	(0.0254)	(0.0255)	(0.0254)	(0.0254)
Core Deposits Ratio_{t-1}	−0.0283	−0.0268	−0.0268	−0.0279	−0.0270	−0.0272	−0.0273	−0.0279
	(0.0320)	(0.0319)	(0.0320)	(0.0318)	(0.0319)	(0.0319)	(0.0319)	(0.0318)
BIS Financial Cycle (Home Country)	0.0446*	0.0419*	0.0443*	0.0424*	0.0434*	0.0439*	0.0438*	0.0422*
	(0.0239)	(0.0238)	(0.0239)	(0.0241)	(0.0240)	(0.0240)	(0.0240)	(0.0240)
BIS Business Cycle (Home Country)	0.435*	0.403*	0.399*	0.427*	0.387*	0.402*	0.407*	0.413*
	(0.233)	(0.227)	(0.231)	(0.233)	(0.227)	(0.227)	(0.228)	(0.227)
Observations	8,613	8,613	8,613	8,613	8,613	8,613	8,613	8,613
R^2	0.019	0.019	0.019	0.019	0.019	0.019	0.018	0.019
Adjusted R^2	0.0117	0.0114	0.0115	0.0123	0.0118	0.0120	0.0113	0.0115
No. of Banks	312	312	312	312	312	312	312	312
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample of Banks: Domestic Owned	1	1	1	1	1	1	1	1

Notes: This table reports effects of changes in parent-country regulation and firm characteristics on log changes in total loans. HomeP refers to changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. The data are quarterly from 2000:Q1 to 2013:Q4. (Cumulative) foreign-exposure-weighted regulation is calculated as the weighted average of (cumulative) changes in foreign regulation weighted with total assets and liabilities of that bank in the respective foreign country. For more details on the variables, see table 10 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the table. Standard errors are clustered by bank. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

in the United Kingdom negatively: the coefficient on the first lag of the prudential index is negative and significant. A tightening in reserve requirements in foreign currency leads to a contemporaneous fall in the growth rate of lending to the United Kingdom, while lagged reserve requirement tightenings in domestic currency have a similar effect. This is consistent with the hypothesis that replacing reserves is costly, and as a result, banks cut back on their lending. The results on LTV tightening are inconclusive, indicating the possibility that banks rebalance their portfolios across sectors, which we will explore below. However, the F-test on the sum of coefficients to examine the effect of policies over three quarters indicates non-significant spillovers for the prudential index and all of its subcomponents. A possible explanation for the lack of significant results stems from the fact that the United Kingdom is a major international financial center and so is likely to be a core country for many banks and hence protected from a retrenchment in lending.

As above, the effect of the cycle- or bank-specific controls does not seem to be strong (tables 7 and 8). There is tentative evidence that a positive home-country financial cycle increases lending growth in the United Kingdom (table 6), suggesting that financial conditions abroad do spill over to the United Kingdom via lending of foreign affiliates.

Finally, in table 11 in the appendix, we explore our baseline results for including all instruments jointly. Point estimates, and in most cases their significance, are comparable to the just-discussed results on including the instruments separately. In specification A (U.K.-headquartered banks), the significance of changes in reserve requirements drops once including local- and foreign-currency reserve requirements jointly. This may be unsurprising, as regulators often tighten local and foreign reserve requirements jointly (see Cerutti et al. 2017).

3.3 Exploration of Sectoral Lending and Bank Funding

Table 9 summarizes the results when we repeat the analysis above at a sectoral level and also examine the role of funding (the results for interbank exposure limits and concentration ratios are excluded, given that table 2 shows that we do not have sufficient country-time changes in regulatory policies to draw reliable inferences). Turning

Table 7. Inward Transmission of Home Prudential Policy via Affiliates—Bank Variables Interactions

	HomeP = Prudential IndexC (1)	HomeP = Capital Requirements (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Requirements: Foreign (5)	HomeP = Reserve Requirements: Local (6)	HomeP = Interbank Exposure Limits (7)	HomeP = Concentration Ratios (8)
Home-Country Regulation HomeP_{t}	11.52	11.61	11.39	−9.816	68.10**	23.73	1.935	4.508
	(8.730)	(15.90)	(9.724)	(16.88)	(32.35)	(18.30)	(14.40)	(20.64)
Home-Country Regulation HomeP_{t-1}	−11.68	15.26	4.773	−28.91	49.00	6.586	−2.547	−50.60*
	(8.065)	(18.93)	(15.77)	(17.93)	(36.94)	(15.24)	(28.22)	(28.34)
Home-Country Regulation HomeP_{t-1}	−3.360	−23.35	−10.04	9.691	−54.38*	−4.594	−36.92**	0.0754
	(8.254)	(16.20)	(19.43)	(15.41)	(32.60)	(13.52)	(15.09)	(33.87)
Sum of Coefficients	*−3.517*	*3.517*	*6.117*	*−29.03*	*62.72**	*25.73*	*−37.53*	*−46.02*
F-test	*0.0890*	*0.0145*	*0.0597*	*1.785*	*2.891*	*0.872*	*1.570*	*0.780*
p-value	*0.766*	*0.904*	*0.807*	*0.183*	*0.0901*	*0.351*	*0.211*	*0.378*
Log Total Assets_{t-1}	−2.405***	−2.415***	−2.473***	−2.478***	−2.437***	−2.384***	−2.428***	−2.395***
	(0.818)	(0.820)	(0.828)	(0.824)	(0.828)	(0.819)	(0.830)	(0.831)
Tier 1 Ratio_{t-1}	0.0938*	0.111**	0.101**	0.0936*	0.0992**	0.111**	0.103**	0.118**
	(0.0506)	(0.0497)	(0.0500)	(0.0488)	(0.0490)	(0.0491)	(0.0490)	(0.0500)
Illiquid Assets Ratio_{t-1}	0.101***	0.0995***	0.0979***	0.0992***	0.0942***	0.0988***	0.0943***	0.0977***
	(0.0258)	(0.0253)	(0.0255)	(0.0255)	(0.0255)	(0.0254)	(0.0254)	(0.0257)
Core Deposits Ratio_{t-1}	−0.0274	−0.0252	−0.0332	−0.0270	−0.0266	−0.0236	−0.0267	−0.0294
	(0.0319)	(0.0321)	(0.0322)	(0.0315)	(0.0319)	(0.0315)	(0.0321)	(0.0321)
BIS Financial Cycle (Home Country)	0.0477**	0.0403*	0.0476**	0.0452*	0.0425*	0.0435*	0.0437*	0.0436*
	(0.0238)	(0.0238)	(0.0241)	(0.0241)	(0.0240)	(0.0241)	(0.0240)	(0.0241)
BIS Business Cycle (Home Country)	0.468**	0.394*	0.404*	0.458*	0.368	0.408*	0.398*	0.427*
	(0.233)	(0.228)	(0.230)	(0.236)	(0.230)	(0.228)	(0.228)	(0.229)
Log Total Assets*HomeP	0.179	0.803	0.0093	2.115	−6.046**	−2.166	1.707	3.173
	0.0586	0.241	0.00288	2.108	5.487	1.212	1.105	0.993
	0.809	0.623	0.957	0.148	0.0198	0.272	0.294	0.320
Tier 1 Ratio*HomeP	0.240	−0.0380	0.129	0.723***	0.659***	0.294	0.473	−0.244
	2.273	0.0164	0.142	7.223	8.518	0.911	1.759	0.144
	0.133	0.898	0.706	0.00759	0.00377	0.341	0.186	0.704

(*continued*)

Table 7. (Continued)

	HomeP = Prudential IndexC (1)	HomeP = Capital Require-ments (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Require-ments: Foreign (5)	HomeP = Reserve Require-ments: Local (6)	HomeP = Interbank Exposure Limits (7)	HomeP = Concen-tration Ratios (8)
Illiquid Assets Ratio*HomeP	−0.0589	−0.155	−0.248*	−0.165*	0.166	−0.00344	0.114	−0.169
	1.446	0.969	3.680	3.362	1.970	0.000970	0.361	0.703
	0.230	0.326	0.0560	0.0677	0.161	0.975	0.548	0.402
Core Deposits Ratio*HomeP	0.0180	−0.163	0.245**	0.0288	0.709***	0.0692	−0.0912	−0.0538
	0.157	1.707	5.784	0.0775	13.58	0.373	0.279	0.0633
	0.692	0.192	0.0168	0.781	0.000270	0.542	0.598	0.802
Observations	8,613	8,613	8,613	8,613	8,613	8,613	8,613	8,613
R^2	0.020	0.020	0.020	0.021	0.022	0.020	0.019	0.021
Adjusted R^2	0.0117	0.0112	0.0114	0.0128	0.0131	0.0119	0.0104	0.0127
No. of Banks	312	312	312	312	312	312	312	312
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample of Banks: Domestic Owned	1	1	1	1	1	1	1	1

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in total loans. HomeP refers to the changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. Bank control variables are included as specified in the lower part of the table but not reported for the sake of brevity. For HomeP interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding F-statistics for joint significance in parentheses. The data are quarterly from 2000:Q1 to 2013:Q4. (Cumulative) foreign-exposure-weighted regulation is calculated as the weighted average of (cumulative) changes in foreign regulation weighted with total assets and liabilities of that bank in the respective foreign country. For more details on the variables, see table 10 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the table. Standard errors are clustered by bank. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 8. Inward Transmission of Home Prudential Policy via Affiliates—Cycle Interactions

	HomeP = Prudential IndexC (1)	HomeP = Capital Require-ments (2)	HomeP = Sector-Specific Capital Buffer (3)	HomeP = LTV Ratio (4)	HomeP = Reserve Require-ments: Foreign (5)	HomeP = Reserve Require-ments: Local (6)	HomeP = Interbank Exposure Limits (7)	HomeP = Concen-tration Ratios (8)
Cumulative Home-Country Regulation $\text{HomeP}_{\text{cum}}$	0.128	0.0278	0.805	0.841*	−0.508	−0.266	−0.651	−0.447
	(0.211)	(1.434)	(0.675)	(0.493)	(0.872)	(0.410)	(0.687)	(1.066)
Log Total Assets_{t-1}	−2.753***	−2.626***	−2.694***	−2.762***	−2.676***	−2.584***	−2.706***	−2.610***
	(0.853)	(0.834)	(0.838)	(0.850)	(0.845)	(0.836)	(0.854)	(0.837)
Tier 1 Ratio_{t-1}	0.106**	0.109**	0.0991**	0.110**	0.110**	0.110**	0.108**	0.110**
	(0.0497)	(0.0494)	(0.0501)	(0.0506)	(0.0497)	(0.0501)	(0.0506)	(0.0491)
Illiquid Assets Ratio_{t-1}	0.0881***	0.0883***	0.0884***	0.0895***	0.0888***	0.0886***	0.0880***	0.0893***
	(0.0241)	(0.0241)	(0.0241)	(0.0243)	(0.0242)	(0.0241)	(0.0244)	(0.0240)
Core Deposits Ratio_{t-1}	−0.0272	−0.0254	−0.0280	−0.0235	−0.0259	−0.0244	−0.0250	−0.0238
	(0.0303)	(0.0309)	(0.0305)	(0.0312)	(0.0306)	(0.0304)	(0.0306)	(0.0307)
BIS Financial Cycle (Home Country)	0.0325	0.0385	0.0421*	0.0209	0.0355	0.0512*	0.0318	0.0447*
	(0.0254)	(0.0260)	(0.0241)	(0.0270)	(0.0243)	(0.0263)	(0.0250)	(0.0256)
BIS Business Cycle (Home Country)	0.402*	0.461**	0.519**	0.387	0.402*	0.430*	0.555**	0.412*
	(0.240)	(0.234)	(0.242)	(0.237)	(0.238)	(0.245)	(0.249)	(0.246)
BIS Financial Cycle*$\text{HomeP}_{\text{cum}}$	0.00504	0.0172	−0.0265	0.0135	0.0648	0.0167	0.0237	−0.0330
	(0.00835)	(0.0403)	(0.0359)	(0.0192)	(0.0585)	(0.0155)	(0.0381)	(0.0590)
BIS Business Cycle*$\text{HomeP}_{\text{cum}}$	−0.0302	−0.869	−0.412*	0.335	−0.221	0.0337	−0.432**	−0.0172
	(0.0865)	(1.004)	(0.233)	(0.222)	(0.405)	(0.161)	(0.220)	(0.240)
Observations	8,848	8,848	8,848	8,848	8,848	8,848	8,848	8,848
R^2	0.019	0.019	0.020	0.020	0.019	0.019	0.020	0.019
Adjusted R^2	0.0125	0.0124	0.0129	0.0133	0.0125	0.0124	0.0127	0.0124
No. of Banks	324	324	324	324	324	324	324	324
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LHS Variable: Other	Total Loans	Total Loans	Total Loans	Total Loans	Total Loans	Total Loans	Total Loans	Total Loans
Sample of Banks: Domestic Owned	1	1	1	1	1	1	1	1

Notes: This table reports the effects of changes in regulation and firm characteristics and their interactions on log changes in total loans. $\text{HomeP}_{\text{cum}}$ refers to the cumulative changes in regulation in the home (i.e., parent-bank) country of foreign affiliates. The data are quarterly from 2000:Q1 to 2013:Q4. (Cumulative) foreign-exposure-weighted regulation is calculated as the weighted average of (cumulative) changes in foreign regulation weighted with total assets and liabilities of that bank in the respective foreign country. For more details on the variables, see table 10 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the table. Standard errors are clustered by bank. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 9. Sectoral Lending

LHS Variable	ExpP = Prudential IndexC (1)	ExpP = Capital Requirements (2)	ExpP = Sector-Specific Capital Buffer (3)	ExpP = LTV Ratio (4)	ExpP = Reserve Requirements: Foreign (5)	ExpP = Reserve Requirements: Local (6)	Obs.	Sample of Banks
Exposure-Weighted Inward Transmission								
Interbank Loans	−0.155	−0.222*	−0.918	−0.203	0.250	0.177	1,319	Domestic
p-value	0.442	0.0977	0.837	0.326	0.647	0.211		Owned
PNFC Loans	0.131**	0.221**	0.0597	0.126	0.233	0.0278	1,228	Domestic
p-value	0.0380	0.0303	0.403	0.219	0.507	0.756		Owned
Household Loans	0.0212	0.0484	0.0814	0.121	−0.504	−0.0762	1,209	Domestic
p-value	0.658	0.496	0.348	0.327	0.112	0.471		Owned
Wholesale Funding (Domestic)	−0.257*	−0.342	−0.219	−0.535***	−0.390	0.571**	1,267	Domestic
p-value	*0.0920*	*0.191*	*0.251*	*0.00338*	*0.461*	*0.0310*		Owned
Wholesale Funding (Foreign)	0.141	−0.270	0.349***	0.375*	1.104**	0.0179	1,316	Domestic
p-value	*0.315*	*0.332*	*0.00282*	*0.0503*	*0.0411*	*0.905*		Owned
Home Macroprudential Policy via Affiliates								
Interbank Loans	−1.703	−5.215	−2.915	−3.921	−4.732	1.176	7,670	Foreign
p-value	0.442	0.377	0.499	0.256	0.325	0.739		Owned
PNFC Loans	1.725	3.070	2.400	6.251	−5.779***	1.728	4,975	Foreign
p-value	0.400	0.518	0.461	0.318	0.000843	0.559		Owned
Household Loans	3.082*	0.00346	1.633	12.49***	−2.402*	3.980	4,191	Foreign
p-value	0.0532	0.999	0.621	0.00172	0.0958	0.249		Owned
Wholesale Funding (Domestic)	−1.340	0.379	−8.562**	5.154	3.650	−2.363	6,641	Foreign
p-value	0.560	0.948	0.0135	0.211	0.721	0.453		Owned
Wholesale Funding (Foreign)	2.155**	4.589	0.461	−0.506	3.694	2.269	8,760	Foreign
p-value	0.0392	0.128	0.854	0.803	0.519	0.240		Owned
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports the effects of changes in regulation and firm characteristics on log changes in loans to the respective sectors. Dependent variable refers to lending growth in all cases except for "wholesale funding," which refers to the growth in borrowing from wholesale sources. The upper part of the table gives results for specification A on exposure-weighted inward transmission via the foreign exposures of U.K.-owned banks. The lower part of the table gives results for specification B on inward transmission via foreign affiliates exposed to regulation in their home countries. Each row gives the main result from six different regressions using model (1) for the regulatory measure specified in the row headline. The data are quarterly from 2000:Q1 to 2013:Q4. (Cumulative) foreign-exposure-weighted regulation is calculated as the weighted average of (cumulative) changes in foreign regulation weighted with total assets and liabilities of that bank in the respective foreign country. For more details on the variables, see table 10 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the table. Standard errors are clustered by bank. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

first to the sectoral lending of U.K.-owned banks (upper panel of table 9), we find that the insignificant aggregate results hide important sectoral heterogeneity. We find that banks cut interbank lending to the United Kingdom following an increase in capital requirements abroad, but increase their PNFC lending; in other words, the negative coefficient on total lending in table 3 appears to be driven by a reduction in interbank lending. The point estimates suggest a similar direction but are not significant for sectoral capital requirements. This is consistent with Aiyar et al. (2014), who document negative spillovers of capital requirement increases to banks abroad but find no response of lending to non-banks abroad—perhaps because relationships with such non-bank customers are longer term and more valuable.

Turning to wholesale funding, we find evidence for a reduction in wholesale funding from the United Kingdom after countries take LTV actions. This could be explained by U.K. banks reducing their lending to countries that tighten their LTV requirements, meaning less of a need for wholesale funding (which is out of the scope of this paper). Interestingly, wholesale funding of U.K. banks from foreign sources increases when they are exposed to countries tightening LTV regulations; this suggests that foreign banks might channel more lending to U.K. banks if regulation at home prevents them from expanding lending in their home countries (we would therefore expect banks resident in other countries to experience a similar phenomenon). This would be consistent with the findings of Ongena, Popov, and Udell (2013). Taken together, this is consistent with the possibility that banks shifted the source of their wholesale funding from domestic to foreign sources following LTV tightening in countries to which they have large exposures.[4]

We also uncover evidence for sectoral heterogeneity when we examine prudential policies taken in the parent country (lower panel of table 9). An LTV tightening in the parent country is associated with an increase in the lending to households in the United Kingdom. The point estimate on PNFC lending is also positive

[4]In columns 3 and 5 we find a similar result for U.K.-owned banks which are exposed to countries tightening sectoral capital requirements or reserve requirements in foreign currency. The result is notably different for reserve requirements in local currency.

though insignificant. The point estimate of LTV tightening on interbank lending is, on the other hand, negative though also insignificant. This indicates the possibility that banks rebalance their portfolios, which could lead to the insignificant result on total affiliate lending we observed in table 6. The result is consistent with the findings of Ongena, Popov, and Udell (2013), who show that banks increase their lending abroad to riskier borrowers when faced with restrictions at home. The results are also quantitatively important. The point estimates imply that the average LTV tightening abroad increases foreign affiliates' lending growth to U.K. households by 12 percentage points over a three-quarter period (although this represents a small proportion of their lending, so the impact on the U.K. economy may be small).

Finally, a tightening in foreign-currency reserve requirements is associated with a reduction in both household and PNFC lending, which is consistent with, though stronger than, the results on total lending discussed in the previous section. Again, the intuition is that replacing reserves is costly, and as a result, banks cut back on their lending.

4. Concluding Remarks

Our results suggest that most prudential actions taken abroad do not have a significant spillover effect on the United Kingdom. For total lending to all U.K. sectors, it is perhaps not surprising that prudential policy actions taken by a single foreign jurisdiction do not appear to affect the United Kingdom, given the United Kingdom's role as a major international financial center.

Nevertheless, the aggregate results conceal some sectoral heterogeneity. For example, our results suggest that when a foreign authority takes a lending standards action, U.K.-resident affiliates owned in that jurisdiction expand PNFC and household lending in the United Kingdom. This implies that focusing on aggregate variables may underestimate the spillovers of prudential policies and suggest a role for continued improvement of sectoral-level data. So far, research such as Lim et al. (2011) and Kuttner and Shim (2013) tended to focus on aggregate variables such as total lending. Our results suggest that investigating rebalancing at the domestic level may yield a deeper understanding of the transmission of prudential policies.

Appendix

Table 10. Construction of Variables

Variable Name	Definition	Source
Dependent Variables (Exchange-Rate-Adjusted Log Changes)		
Total Loan Growth	Loans to all U.K.-resident sectors (resident positions of BT23 and BT29)	Form BT and AL
Interbank Loan Growth	Loans to other U.K. banks (resident positions of BT23 plus ALL15, ALL16, and ALL17)	Form BT
Household Loan Growth	Loans to U.K. Households (ALL18)	Form AL
PNFC Loan Growth	Loans to U.K. PNFCs (ALL1 to ALL14)	Form AL
Short-Term Wholesale Funding Growth (Domestic or Foreign)	Deposits from the U.K. Monetary Financial Institutions + certificates of deposits and commercial paper issued + Repos ex. public sectors from domestic/resident or foreign/non-resident sources (Foreign: BT2J + BT3J + BT6J. Domestic: BT2B + BT2C + BT2D + BT3B + BT3C + BT3D + BT4 + BT5A + BT6B + BT6C + BT6D + BT6H)	Form BT
Independent Variables		
Illiquid Assets Ratio	1 minus holdings of liquid assets [(BT21 + BT23 + BT32D)/(BT20-BT19)]	Form BT
Commitments Ratio$_{t-1}$	Commitment ratio: Ratio of total commitments divided by total assets [BT43/BT40]. Includes overdraft, loan, acceptance, and other facilities outstanding.	Form BT
Log Real Assets$_{t-1}$	The log of a bank's total assets in levels (£1000s), deflated by CPI inflation [BT40]	Form BT
Core Deposits Ratio $_{t-1}$	[Total time and sight deposit from domestic residents]/(Liabilities – balance sheet capital)	Form BT
Tier 1 Ratio$_{t-1}$	(Tier 1 capital)/Assets	Form BT
BIS Financial Cycle	Country-specific credit gap	BIS
BIS Business Cycle	Country-specific output gap	BIS

Notes: "Form (BT/AL)" refers to the relevant Bank of England reporting form. See http://www.bankofengland.co.uk/statistics/Pages/reporters/defs/default.aspx for full definitions.

Table 11. Including All Instruments Jointly

	P = ExpP Inward A1 (1)	**P = HomeP Inward B1 (2)**
Log Total Assets$_{t-1}$	1.057	−2.397***
	(1.306)	(0.633)
Tier 1 Ratio$_{t-1}$	0.0145	0.106**
	(0.0652)	(0.0540)
Illiquid Assets Ratio$_{t-1}$	0.0971***	0.0939***
	(0.0366)	(0.0213)
International Activity$_{t-1}$	0.0884	
	(0.0694)	
Core Deposits Ratio$_{t-1}$	0.124***	−0.0282
	(0.0469)	(0.0383)
BIS Financial Cycle		0.0404
		(0.0308)
BIS Business Cycle		0.387
		(0.295)
P = Capital Requirements	−0.139	4.019
	1.203	0.681
	0.273	0.409
P = Sector-Specific Capital Buffer	0.872	0.160
	0.597	0.00222
	0.440	0.962
P = Loan-to-Value Ratio	0.0625	−0.458
	0.242	0.0232
	0.623	0.879
P = Reserve Requirements: Foreign	0.345	2.509
	0.443	0.223
	0.506	0.637
P = Reserve Requirements: Local	0.159	−1.121
	1.083	0.229
	0.298	0.632
P = Interbank Exposure Limits	−0.0206	−1.735
	0.00337	0.0955
	0.954	0.757
P = Concentration Ratios	−0.466*	−11.14*
	3.159	3.195
	0.0758	0.0739

(*continued*)

Table 11. (Continued)

	P = ExpP Inward A1 (1)	**P = HomeP Inward B1 (2)**
Observations	1,360	8,613
R^2	0.117	0.022
Adjusted R^2	0.0195	0.000
No. of Banks	53	312
Time Period	2000:Q1–2013:Q4	2000:Q1–2013:Q4
Destination-Country Fixed Effects	No	No
Time Fixed Effects	No	Yes
Bank Fixed Effects	Yes	Yes
LHS Variable: Loans	1	1
LHS Variable: Other	Total Loans	Total Loans
Sample of Banks: Domestic Owned	1	0
Sample of Banks: Foreign Owned	0	1
Sample of Banks: Domestic and Foreign	0	0

Notes: This table reports the effects of changes in regulation and firm characteristics on log changes in total loans by destination country. The columns report results on the different specifications Inward A1 and Inward B1. For each prudential measure P, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding F-statistics for joint significance in parentheses.

References

Aiyar, S., C. Calomiris, J. Hooley, Y. Korniyenko, and T. Wieladek. 2014. "The International Transmission of Bank Capital Requirements: Evidence from the UK." *Journal of Financial Economics* 113 (3): 368–82.

Buch, C., and L. Goldberg. 2017. "Cross-Border Regulatory Spillovers: How Much? How Important? Evidence from the International Banking Research Network." *International Journal of Central Banking* 13 (S1).

Cerutti, E., R. Correa, E. Fiorentino, and E. Segalla. 2017. "Changes in Prudential Policy Instruments—A New Cross-Country Database." *International Journal of Central Banking* 13 (S1).

Danisewicz, P., D. Reinhardt, and R. Sowerbutts. 2015. "On a Tight Leash: Does Bank Organisational Structure Matter for Macroprudential Spillovers?" Staff Working Paper No. 524, Bank of England.

Hoggarth, G., J. Hooley, and Y. Korniyenko. 2013. "Which Way Do Foreign Branches Sway? Evidence from the Recent UK Domestic Credit Cycle." Financial Stability Paper No. 22, Bank of England.

Houston, J., C. Lin, and Y. Ma. 2012. "Regulatory Arbitrage and International Bank Flows." *Journal of Finance* 67 (5): 1845–95.

Kuttner, K., and I. Shim. 2013. "Can Non-Interest Rate Policies Stabilize Housing Markets? Evidence from a Panel of 57 Economies." NBER Working Paper No. 19723.

Lim, C., F. Columba, A. Costa, P. Kongsamut, A. Otani, M. Saiyid, T. Wezel, and X. Wu. 2011. "Macroprudential Policy: What Instruments and How to Use Them? Lessons from Country Experiences." IMF Working Paper No. 11/238.

Ongena, S., A. Popov, and G. Udell. 2013. "'When the Cat's Away the Mice Will Play': Does Regulation at Home Affect Bank Risk-Taking Abroad?" *Journal of Financial Economics* 108 (3): 727–50.

Reinhardt, D., and R. Sowerbutts. 2015. "Regulatory Arbitrage in Action: Evidence from Banking Flows and Macroprudential Policy." Staff Working Paper No. 546, Bank of England.

International Banking and Cross-Border Effects of Regulation: Lessons from the United States*

Jose M. Berrospide,[a] Ricardo Correa,[a] Linda S. Goldberg,[b] and Friederike Niepmann[a]
[a]Federal Reserve Board
[b]Federal Reserve Bank of New York

Domestic prudential regulation can have unintended effects across borders and may be less effective in an environment where banks operate globally. Using U.S. micro-banking data for the first quarter of 2000 through the third quarter of 2013, this study shows that some regulatory changes indeed spill over. First, a foreign country's tightening of limits on loan-to-value ratios and local-currency reserve requirements increases lending growth in the United States through the U.S. branches and subsidiaries of foreign banks. Second, a foreign tightening of capital requirements shifts lending by U.S. global banks away from the country where the tightening occurs to the United States and to other countries. Third, tighter U.S. capital regulation reduces lending by large U.S. global banks to foreign residents.

JEL Codes: F42, F44, G15, G21.

1. Introduction

In the period since the global financial crisis, policy discussions have highlighted the potential need for the active use of macroprudential instruments to support financial stability goals. But some

*The authors thank Jacob Conway and Eric Parolin for excellent research assistance. We also thank anonymous referees, Sirio Aramonte, Stijn Claessens, Valeriya Dinger, Kebin Ma, Marcus Pramor, Jana Ohls, Tim Schmidt-Eisenlohr, Judith Temesvary, and participants at the 2016 IBEFA summer meeting and the Norges Bank's Financial Stability and Macroprudential Policy workshop for very useful feedback. The views expressed in this paper are solely those of the authors and should not be interpreted as reflecting the view of the Board of Governors, the Federal Reserve Bank of New York, or the staff of the Federal Reserve System.

macroprudential instruments might not work as intended and have effects that propagate across borders through the global linkages of international financial institutions. In the presence of cross-border banking, domestic policies might not be effective, as they do not apply to the same degree to banks headquartered in foreign countries. Changes in domestic prudential instruments might also spill over into foreign markets, because domestic banks affected by the policies adjust their operations globally.[1]

This paper analyzes these issues focusing on the United States and attempts to answer three questions. First, do changes in foreign prudential instruments affect lending growth in the United States? Second, do U.S. global banks adjust their foreign operations when foreign prudential instruments change? Third, do U.S. regulatory changes spill over into foreign countries via U.S. global banks? We find evidence of both spillovers of foreign regulatory changes into the United States and cross-border effects of U.S. prudential instrument changes.

The United States is an interesting case, as its banking sector is markedly interconnected with the rest of the world. Foreign global banks expanded their operations in the United States in the 2000s through local branches and through separately chartered banks (Tarullo 2012). U.S. global banks have substantial exposures to advanced economies and to emerging market countries through cross-border lending, funding, and affiliates located abroad (Cetorelli and Goldberg 2006).

Our analysis uses regulatory reports filed by U.S. global banks and by the U.S. subsidiaries and branches of foreign banks. These bank-level data for 2000:Q1 through 2013:Q3 are combined with a database of prudential instruments newly constructed by the International Banking Research Network (IBRN) (see Cerutti et al. 2017 for a description of the IBRN Prudential Instruments Database). The database has information on the use of seven different prudential instruments by sixty-four countries. Our methodology largely

[1]Lim et al. (2011), Akinci and Olmstead-Rumsey (2015), Cerutti, Claessens, and Laeven (2015), and Vandenbussche, Vogel, and Detragiache (2015) analyze the effectiveness of macroprudential policies in curtailing credit growth and house price inflation using cross-country data. Cross-border spillovers of prudential policies are explored in Aiyar, Calomiris, and Wieladek (2014), Aiyar et al. (2014), and Danisewicz, Reinhardt, and Sowerbutts (2015).

follows that described in Buch and Goldberg (2017) and is part of the joint research effort of the IBRN on cross-border prudential policy spillovers.[2]

Our first specifications test whether U.S. global banks and U.S. branches and subsidiaries of foreign banks adjust their lending in response to foreign prudential instrument changes. We find statistically significant effects for three instruments: capital requirements, local-currency reserve requirements, and limits on loan-to-value (LTV) ratios. The tightening of prudential instruments abroad *increases* loan growth in the United States. Higher foreign-country capital requirements abroad mainly affect U.S. loan growth through U.S. global banks, while higher local-currency reserve requirements and limits on LTV ratios mainly transmit through the lending of the U.S. branches and subsidiaries of foreign banks.

Our second set of tests investigates whether U.S. global banks' exposures in foreign countries react to prudential instrument changes there. The evidence is weaker in this case. Foreign changes in prudential instruments have a weak and mostly insignificant effect on U.S. banks' claims on residents in the country where the change occurs.

Lastly, we explore whether changes in U.S. prudential instruments have effects across borders. While foreign economies have used a combination of both cyclical and structural instruments, U.S. policymakers have favored structural regulations that are less correlated with the financial cycle and are not changed frequently (Elliott, Feldberg, and Lehnert 2013). As a result, the only U.S. instrument change recorded in the IBRN Prudential Instruments Database is related to the introduction of the Basel II.5 capital regulations in 2013:Q1. Our results indicate that after this change the largest U.S. banks, those that are required to participate on annual stress tests

[2]The following studies are part of the IBRN study on the impact of prudential instrument changes on the activities of global banks: Auer, Ganarin, and Towbin (2017); Avdjiev et al. (2017); Başkaya et al. (2017); Bonfim and Costa (2017); Bussière, Schmidt, and Vinas (2017); Caccavaio, Carpinelli, and Marinelli (2017); Damar and Mordel (2017); Frost, de Haan, and van Horen (2017); Gajewski and Krzesicki (2017); Hills et al. (2017); Ho and Wong (2017); Jara and Cabeza (2017); Levin-Konigsberg et al. (2017); Nocciola, Żochowski, and Franch (2016); Ohls, Pramor, and Tonzer (2017); Park and Lee (2017).

or follow the Advanced Approaches capital framework, *reduced* their foreign lending growth relative to the smaller banks.[3]

Taken together, and focusing on the response of U.S. global banks, our results indicate that U.S. prudential regulation reduces foreign lending, whereas tighter foreign prudential regulation increases total lending and shifts this lending away from the host countries undertaking regulatory changes. In general, the magnitudes of the identified spillovers across all the exercises appear to be small. Changes in foreign capital requirements probably had the most significant economic effect: we calculate that stricter capital requirements abroad added a total of $249 billion in lending of U.S. global banks over the period from 2000:Q1 to 2013:Q3.

While our results are broadly consistent with the existing evidence on cross-border spillovers, there are some important differences that we have identified. The effect of higher U.S. capital requirements are consistent with Aiyar et al. (2014), who document that tighter capital requirements for U.K. banks decreased these banks' cross-border lending. In the U.S. data, cross-border spillovers of higher capital requirements work in both directions. Tighter capital standards abroad *increased* lending growth in the United States, mainly through U.S. global banks. While banks may cut lending at home and abroad to comply with higher capital standards, the change of capital requirements in one country affects the relative profitability of lending in different parts of the global banking organization. When capital requirements are higher abroad, domestic lending might become relatively more profitable compared with foreign lending through foreign subsidiaries subject to the higher capital requirements. The fact that higher local-currency reserve requirements and limits on LTV ratios abroad have positive effects on U.S. lending growth follows a similar logic.

The weak response of U.S. global banks' lending to foreign policy changes in the countries where the policy changes occur is somewhat consistent with the evidence on leakages presented by

[3]More information about the Advanced Approaches capital framework can be found at this link: https://www.federalreserve.gov/bankinforeg/basel/advanced-approaches-capital-framework-implementation.htm. Information about the U.S. stress tests conducted by U.S. bank supervisors can be found at this location: https://www.federalreserve.gov/bankinforeg/stress-tests-capital-planning.htm.

Aiyar, Calomiris, and Wieladek (2014) and Reinhardt and Sowerbutts (2015), who show that foreign bank lending expands when the regulation of domestic banks tightens. While we do not find that U.S. banks expand their lending growth, we do not find them contracting their lending growth either, suggesting that foreign policy changes might not be able to impact these banks' local operations. This result contrasts with those in Temesvary (2015), who finds significant responses of U.S. banks' foreign activities to stricter bank regulation in host countries. Part of the divergence in these results may be explained by the use of different cross-country regulatory data and different methodologies for measuring the effect of changes in prudential instruments.

A related literature with contributions by Houston, Lin, and Ma (2012) and Bremus and Fratzscher (2014) exploits a database developed by Barth, Caprio, and Levine (2013), which captures differences in bank regulation and supervision across countries, to analyze changes in global banking activities. Using information on cross-border bank flows, they find evidence for regulatory arbitrage through cross-border lending. As opposed to our paper, their tests rely on aggregate bank flows instead of bank-specific claims. In another cross-country study, Ongena, Popov, and Udell (2013) find effects of tighter home-country regulation on banks' risk taking abroad.

The next section describes the data used in the various exercises testing the transmission of prudential policies through foreign banks operating in the United States, and through U.S. global banks. Section 3 presents the empirical methodology and key empirical results. Section 4 concludes, emphasizing that despite limited real consequences for the U.S. economy over the past decade, prudential instruments applied abroad have the potential to more significantly influence U.S. loan growth in the future.

2. Data and Stylized Facts for the United States

Our analysis examines prudential policy spillovers internationally using four distinct bank panels. The first panel covers U.S.-headquartered global banks' total lending and varies by bank and quarter. The second data set adds a country dimension to the bank and time dimension, capturing U.S. global banks' claims in

different locations through cross-border flows or through branches or subsidiaries established in foreign markets. The two other micro-banking data sets cover foreign bank lending in the United States. One contains data on foreign-owned bank subsidiaries operating in the United States, while the other consists of data on U.S. branches of foreign banks. The data for U.S. global banks and for subsidiaries of foreign banks within the United States span the first quarter of 2000 through the third quarter of 2013, while the U.S. branches of foreign banks data set spans the fourth quarter of 2002 through the third quarter of 2013.[4]

2.1 Bank-Level Data

2.1.1 Data Sources

U.S. commercial bank data cover both U.S. global banks and the U.S. subsidiaries of foreign banks. Balance sheet, income statement, and select off-balance-sheet data for them are drawn from the Federal Financial Institutions Examinations Council (FFIEC) 031 form, better known as the Call Report. Income statement, balance sheet, and selected off-balance-sheet data on U.S. bank holding companies are drawn from the FR Y-9C form. The FFIEC 009 form on the international exposures of U.S. reporting banks is the source of detailed information on the geographic distribution of U.S. bank claims on foreign residents. A bank is defined as a U.S. global bank if it reports the FFIEC 009 and is headquartered in the United States. Capital and asset data for foreign bank holding companies in our aggregated branch data set are drawn from the FR Y-7Q form. Balance sheet and off-balance-sheet data pertaining to U.S. branches and agencies of foreign banking organizations are drawn from FFIEC 002 filings, aggregated across U.S. branches to the level of the "top bank" within the global banking organization.[5] National Information Center (NIC) data are used to connect commercial banks to their high holders. All of these data filings are

[4] We end the analysis in 2013:Q3 since the FFIEC 009 reporting form changed the next quarter. The FR Y-7Q form used in branch regressions was not introduced until 2002:Q4.

[5] "Bank" in this context includes bank holding companies and commercial banks.

quarterly, with the exception of the FR Y-7Q.[6] Although much of the bank-level data are publicly available, bank-level data from the FFIEC 009 report are confidential.[7] Further details on data sources and variable construction are in table 7 in the appendix.[8]

2.1.2 Definition of Dependent Variables

Most of the dependent variables have bank and time dimensions, with $\Delta Y_{b,t}$ defined as the change in log loans by bank b at time t. For some specifications, these loans are divided by their location (U.S. versus foreign addressees).

For a more detailed analysis of the response of U.S. global banks' foreign lending to policy changes (outward analysis), a country j dimension is added, with $\Delta Y_{b,j,t}$ defined as the change in log claims extended by bank b to counterparties in country j at time t.[9] These claims can be cross-border, in which case they are extended from a particular location to a counterparty external to that location, or local, in which case the global bank affiliate in a location extends claims to borrowers in that location.

2.1.3 Bank-Level Variables

As the composition of bank balance sheets may influence the effects of prudential instruments, the data set also includes bank size as

[6]The FR Y7-Q is filed quarterly by foreign banking organizations (FBOs) whose activities are deemed to be effectively that of a financial holding company, and is filed annually by all other FBOs. Data from the FR Y-7Q are then linearly interpolated in order to construct quarterly data for foreign bank holding companies (BHCs).

[7]Most of the data collected on the FR Y-9C, FFIEC 031, FFIEC 002, and FR Y-7Q are available to the public, but there are a small number of series that are confidential.

[8]The data are trimmed to exclude or correct for potential reporting errors and noise. First, we identify outliers and exclude these observations from all descriptive tables and analysis. Observations are identified as outliers if they satisfy at least one of the following four criteria where applicable: (i) a change in log claims or loans > 1 or < -1 (precluding most major mergers and acquisitions), (ii) a tier 1, illiquid assets, core deposits, or international ratio which is > 100 percent or < 0 percent, (iii) not part of a consecutive string of bank-time observations at least eight quarters in length, or (iv) their home country changes between our contemporaneous and lagged periods.

[9]The term "claims" includes loans and securities holdings of banks.

captured by log of total real assets ($LogTotalAssets_{b,t-1}$), percentage of a bank's portfolio of assets that is illiquid ($IlliquidAsset-Ratio_{b,t-1}$), percentage of the banking organization's balance sheet financed with core deposits ($CoreDeposits_{b,t-1}$), percentage of the banking organization's regulatory tier 1 risk-based capital-to-asset ratio ($Tier1Ratio_{b,t-1}$), percentage of the banking organization's net due to minus net due from head office relative to total assets ($Net-DueTF_{b,t-1}$), and percentage of international activity as proxied by the ratio of the banking organization's foreign deposits plus total claims relative to total assets ($InternationalRatio_{b,t-1}$).[10] The analysis also utilizes information on the nationality of the foreign parent of branches and subsidiaries hosted in the United States.

2.1.4 Summary Statistics and Features of the U.S. Banking System

The sample of reporting banks and characteristics of balance sheet data are summarized in table 1. The number of distinct reporting entities for each data set is provided in the first data row. The second row reports the number of observations used in the empirical analysis, combining information on the number of entities and the number of quarters for each entity. For the outward transmission through global banks, the number of observations reflects a combination of the number of global banks active throughout our sample period and the number of countries in which each of these banks reports claims or local funding activity at each quarter.

These summary statistics provide a broad overview of the credit activities of the financial institutions captured in our empirical analysis. In general, the United States is a financial center, both hosting the offices of several foreign financial institutions and serving as the headquarters location for a group of large global banks. The U.S. offices of foreign banks, branches, and subsidiaries account for 18 to 23 percent of U.S. bank assets in our sample period, with their loans representing between 12 and 17 percent of total loans in the United States. The largest foreign participants in the U.S. banking sector are headquartered in advanced economies, particularly in Europe.

[10]Total assets are converted to 2012:Q1 dollars using GDP deflator data from the U.S. Bureau of Economic Analysis.

Table 1. Summary Statistics on Bank Lending and Characteristics

	Outward—U.S. Global Banks			Inward—U.S. Global Banks			Inward—U.S. Subsidiaries of Foreign Banks			Inward—U.S. Branches of Foreign Banks		
Entity Count	**59**			**59**			**102**			**137**		
Observation Count	**35,483**			**1,873**			**2,801**			**4,262**		
Variable	**Mean**	**Median**	**SD**	**Mean**	**Median**	**SD**	**Mean**	**Median**	**SD**	**Mean**	**Median**	**SD**
	Balance Sheet Data (for Each Bank b and Quarter t [and Destination Country j for Outward Claims])											
Dependent Variables:												
ΔLog Loans (Claims)[a]	0.010	0	0.311	0.008	0.008	0.095	0.023	0.016	0.098	0.019	0.005	0.208
ΔLog Cross-Border Claims	0.007	0	0.335									
ΔLog Local Claims	0.011	0	0.411									
Balance Sheet Composition:												
Total Assets (Billions)	633.2	197.8	763.3	269.8	66.1	519.8	14.5	1.3	30.9	15.8	3.6	26.4
Tier 1 Ratio (%)	11.2	10.5	3.4	11.8	10.9	4.1	16.8	12.6	12.5	10.4	9.5	4.8
Illiquid Assets Ratio (%)	57.3	60.7	21.9	64.0	72.9	21.9	70.3	74.9	17.7	34.6	36.2	28.1
International Activity	11.5	5.0	13.8	18.6	8.6	21.5						
Net Due To (Head Office) (%)/Assets	0.1	0.0	0.7	−0.5	0.0	6.4	2.8	0.0	8.2	8.0	11.0	46.8
Core Deposits Ratio (%)	39.7	40.0	23.0	50.5	55.4	21.2	6.08	66.1	24.6	6.0	0.9	12.2
Cycle Variables:												
BIS Financial Cycle	3.0	3.0	16.0	1.8	0.9	5.4	1.4	0.6	15.2	3.6	3.5	15.3
BIS Business Cycle	−0.1	−0.1	2.1	−0.1	0.0	1.3	0.0	−0.1	1.5	0.0	0.0	1.8

Notes: This table provides summary statistics for bank balance sheet and lending data, summarizing those observations included in our baseline regressions. Data are observed quarterly from 2000:Q1–2013:Q3 for U.S. global banks and U.S. subsidiaries of foreign banks, and from 2002:Q4 to 2013:Q3 for U.S. branches of foreign banks. Banking data sources by subset can be found in table 7 and are reported at the level of the top bank within the global banking organization for U.S. global banks and for the U.S. branches of foreign banks (aggregated across U.S. branches in this case), and at the subsidiary level for the U.S. subsidiaries of foreign banks. The tier 1 asset ratio reported for branches is that of this associated parent. The Net Due To (or Due From) variable measures from the perspective of a bank's head office total net internal lending (or borrowing) vis-à-vis all its related domestic and international offices. Cycle variables in the "Inward U.S. Global Bank" sample are constructed as exposure-weighted averages.

[a]Due to data availability, loans are used in all inward regressions, while claims are utilized in all outward regressions. Claims, cross-border claims, and local claims have a country dimension in the outward regression sample.

Similarly, U.S. global banks have a notable presence in foreign markets. Foreign claims, which are composed of cross-border claims and claims originated at foreign offices, for the U.S. global banks in our sample average about 9 percent of total assets. Total claims increased from 8 to 10 percent of total assets, on average, between 2002 and 2012. Most of this increase is accounted for by growth in affiliate local claims, which rose from 2 to 5 percent of total assets during that period (cross-border claims dropped slightly from 6 to 5 percent). By country of destination, between 2002 and 2012 total claims to advanced foreign economies went up from 4 to 7 percent and those to emerging market economies decreased from 4 to 3 percent. The U.S. branches and subsidiaries of foreign banks have higher U.S. lending growth rates, on average, compared with U.S. global banks. Variability in lending is highest for the U.S. branches of foreign banks. For U.S. global banks, the growth in foreign claims by bank and by location is more volatile than lending domestically.

2.2 Data on Prudential Instruments

The prudential instruments included in the IBRN Prudential Instruments Database (Cerutti et al. 2017) are capital requirements, sector-specific capital buffers, limits on LTV ratios, concentration ratios, reserve requirements (local currency and foreign currency), and interbank exposure limits. Although the full database covers sixty-four countries, the only policies that enter into our regression analysis are from those countries with banking entities in the United States or spanned by the claims of U.S. global banks. For inward analysis through global banks, the prudential instruments are weighted aggregates across countries, with weights constructed on the basis of bank-specific information on country exposures in each period.

For regression analysis of policy spillovers to yield convincing findings, the specific prudential instruments used in each regression must have a sufficient level of variation. We screen for sufficient variation by examining the counts of changes in each prudential instrument as relevant for the particular banking entities in each data subset, the number of countries associated with those changes,

and the number of tightening and loosening observations. The panels of table 2 show this information for the four data sets. While there is not a well-defined rule available for determining a sufficient degree of variation for regressors in an econometric specification, we apply a judgmental approach to capture a sufficient number of episodes and number of countries. As a result of this screening we exclude concentration ratios in our outward and inward transmission analysis for U.S. global banks, and exclude foreign reserve requirements, interbank exposure limits, and concentration ratios from our inward transmission analysis for U.S. branches of foreign banks.

2.3 Data on Country Business and Financial Cycles

The analysis introduces controls for country business cycles and credit cycles. These controls are not only important to account for credit demand conditions but also for assessment of whether the effects of the prudential instruments vary over the cycle. Details on the construction of the business cycle control (output gap) and the financial cycle control (credit-to-GDP gap) are described in Bank for International Settlements (2014) and Drehmann, Borio, and Tsatsaronis (2011), respectively.

3. Empirical Method and Regression Results

This section provides conceptual observations on how changes in prudential instruments might spill over internationally into lending activity, presents the main empirical specifications, and reports results for the analysis on the impact of prudential regulations on bank claims both in the United States and abroad. Section 3.1 focuses on the spillovers of foreign regulatory changes to U.S. lending. Section 3.2 explores the effect of changes in foreign regulations on the activities of U.S. global banks in foreign locations. It also analyzes the response of U.S. global banks' foreign activities when U.S. capital requirements change.

While more extensively discussed in Buch and Goldberg (2017), changes in capital requirements, reserve requirements, and loan-to-value ratios could spill over to bank lending through various channels

Table 2. Summary Statistics on Changes in Prudential Instruments

Instrument	Base Data (Before Aggregating to Exposure-Weighted Measures)					Exposure-Weighted Observations
	No. of Country-Time Changes	No. of Country-Time Changes (Tightening)	No. of Country-Time Changes (Loosening)	No. of Bank-Time Changes	Proportion Base-MPP Non-zero	Proportion $ExpP_t$ Non-zero
Outward—U.S. Banks						
Prudential Index	502	329	173	1,400	0.17	0.89
General Capital Requirements	64	64	0	258	0.03	0.24
Sector-Specific Capital Buffer	69	51	18	545	0.02	0.39
Loan-to-Value Ratio Limits	88	64	24	689	0.04	0.16
Reserve Requirements: Foreign	133	83	50	809	0.04	0.19
Reserve Requirements: Local	269	124	145	1,112	0.08	0.48
Interbank Exposure Limit	22	21	1	209	0.01	0.21
Concentration Ratio	32	30	2	356	0.01	0.32
Inward—U.S. Global Banks						
Prudential Index	506	333	173	1,469	0.16	0.69
General Capital Requirements	64	64	0	307	0.03	0.15
Sector-Specific Capital Buffer	68	51	17	622	0.02	0.28
Loan-to-Value Ratio Limits	88	64	24	833	0.03	0.37
Reserve Requirements: Foreign	136	86	50	932	0.04	0.43
Reserve Requirements: Local	270	125	145	1,224	0.07	0.55
Interbank Exposure Limit	22	21	1	260	0.01	0.11
Concentration Ratio	32	30	2	404	0.01	0.18

(*continued*)

Table 2. (Continued)

Instrument	Base Data (Before Aggregating to Exposure-Weighted Measures)					Exposure-Weighted Observations
	No. of Country-Time Changes	No. of Country-Time Changes (Tightening)	No. of Country-Time Changes (Loosening)	No. of Bank-Time Changes	Proportion Base-MPP Non-zero	Proportion $ExpP_t$ Non-zero
Inward—U.S. Subsidiaries of Foreign Banks						
Prudential Index	95	74	21	213	0.08	
General Capital Requirements	22	22	0	55	0.02	
Sector-Specific Capital Buffer	17	14	3	28	0.01	
Loan-to-Value Ratio Limits	31	23	8	93	0.03	
Reserve Requirements: Foreign	1	1	0	1	0.00	
Reserve Requirements: Local	31	14	17	39	0.01	
Interbank Exposure Limit	10	10	0	18	0.01	
Concentration Ratio	6	6	0	10	0.00	
Inward—U.S. Branches of Foreign Banks						
Prudential Index	227	176	51	653	0.15	
General Capital Requirements	37	37	0	128	0.03	
Sector-Specific Capital Buffer	36	28	8	89	0.02	
Loan-to-Value Ratio Limits	58	47	11	219	0.05	
Reserve Requirements: Foreign	48	35	13	79	0.02	
Reserve Requirements: Local	99	56	43	237	0.06	
Interbank Exposure Limit	14	14	0	48	0.01	
Concentration Ratio	17	17	0	41	0.01	

Source: IBRN.
Notes: This table shows summary statistics on changes in the prudential instruments in home and/or destination countries of banks located in the United States. The sample period for U.S. global banks and for subsidiaries of foreign banks is 2000:Q1 to 2013:Q3. The U.S. branches of foreign banks data set goes from 2002:Q4 to 2013:Q3. Data on the instruments come from the IBRN Prudential Instruments Database described in Cerutti et al. (2017) and are on the quarter level. The table is based on the estimation sample. The table shows the total number of changes, i.e., tightening or loosening, for each instrument as well as the proportion of non-zero entries. All home and/or destination countries of banks located in the United States are included.

that depend on the institutions examined. Consider first a change in capital requirements abroad. U.S. global banks that operate foreign subsidiaries need to finance their foreign assets with subsidiary-specific capital. When foreign capital requirements are tightened, U.S. parent banks may cut lending in these markets and employ the available funding for lending in a different location. In contrast, the direction of effects of tighter capital requirements in foreign banks' home countries on their U.S. subsidiaries is less clear. On the one hand, tighter capital requirements in the foreign bank's home country imply that the bank must finance its balance sheet with more capital on a consolidated basis. To achieve this, the parent bank may reduce lending both at home and abroad. However, tighter capital requirements at home also mean that the relative costs of lending at home and abroad change, with lending abroad becoming relatively less expensive.

As opposed to the stand-alone structure of subsidiaries, the assets in branches of foreign banks are directly linked to parent banks' balance sheets. A reduction of lending in the U.S. branches should thus have the same effect on the parent bank's tier 1 ratio as a reduction of lending in its home offices. One would therefore expect that higher capital requirements at home lead to a reduction in lending by U.S. branches of foreign banks, as the parent bank seeks to comply with higher capital standards.

Local-currency reserve requirements used as prudential tools are put in place by national monetary authorities to control the growth in domestic credit. Higher reserve requirements imply that banks need to hold a larger fraction of funds as reserves with the central bank and can lend out only a smaller fraction to local borrowers. Reserve requirements in local currency, however, do not constrain the bank's activities in other countries. Since local funding becomes more expensive, banks have an incentive to raise funding abroad and could move operations to other locations. They could do this by increasing lending of their foreign branches or their foreign subsidiaries.

Limits on LTV ratios are aimed at reducing credit in the economy and often are specifically targeted at counteracting a potential real estate bubble. Such limits apply to all banks that engage in mortgage lending in a given country by decreasing the pool of eligible borrowers. A tightening of LTV limits should thus decrease the

local lending opportunities for all banks and might induce a shift in lending to other markets.

Within regression specifications, the exact mechanisms through which adjustments occur are not constrained by instrument and type of entities considered. Some policy instruments affect all banks that operate in a given market, as is the case of loan-to-value ratios. Other instruments may differentially affect banks in relation to their mode of servicing a location, as could be the case with capital requirements, or the structure of their balance sheets in the case of reserve requirements.

3.1 Inward Analysis: Spillovers into the United States from Foreign Prudential Policies

The inward transmission analysis investigates the consequences for lending in the United States of foreign prudential policies through two channels. First, U.S. banks with large foreign activities might respond to changes in regulation abroad by reallocating activity across foreign and domestic locations. Second, foreign banks that have to comply with home-country regulation might adjust lending by their U.S. subsidiaries or U.S. branches.[11]

3.1.1 Specifications

We run regressions separately for (i) U.S. global banks, (ii) U.S. subsidiaries of foreign banks, and (iii) U.S. branches of foreign banks. In each specification, we regress the log change in lending $\Delta Y_{b,t}$ by entity b in quarter t on a relevant measure of foreign prudential policy changes, including several lagged bank characteristics $X_{b,t-1}$ (see section 2.1 for details) as well as bank and quarter fixed effects. We also control for financial and business cycle variables. Effectively, these regressions show whether policy changes abroad had an effect on lending growth by entity b, after controlling for a bank-specific time-invariant component in entity b's lending growth and a quarter-specific shift in lending growth common to all entities in the sample.

[11] U.S. credit could also be affected through foreign banks that do not have U.S. affiliates but lend cross-border to U.S. firms.

We estimate the following equation on the sample of fifty-nine U.S.-headquartered banks with sizable exposures in foreign countries (global banks):

$$\Delta Y_{b,t} = \alpha_0 + \sum_{k=0}^{2} \alpha_{k+1} ExpP_{b,t-k} + \alpha_4 X_{b,t-1} + \alpha_5 Z_{b,t} + f_b + f_t + \epsilon_{b,t}, \quad (1)$$

where $ExpP_{b,t-k}$ stands for the foreign-exposure-weighted index and captures the extent to which policies are tightened or loosened in countries where entity b has exposures in quarter $t-k$.[12] To control for foreign-country financial and economic developments, the regression also controls for exposure-weighted credit-to-GDP and output gap variables $Z_{b,t}$.[13] Different prudential policies are explored using this specification and for this bank panel. Prudential policy effects can be immediate ($k = 0$) or appear over the next two quarters ($k = 1, 2$). Standard errors are robust.

The regression equation for the 102 U.S. subsidiaries of foreign banks and 137 U.S. branches of foreign banks is given by

$$\Delta Y_{b,j,t} = \alpha_0 + \sum_{k=0}^{2} \alpha_{k+1} HomeP_{j,t-k} + \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + f_b + f_t + \epsilon_{b,j,t}, \quad (2)$$

where $HomeP_{j,t-k}$ indicates whether regulation tightened or loosened in home country j of entity b in quarter $t-k$. $Z_{j,t}$ includes

[12]The exposure-weighted prudential index for bank b at time t is calculated using this formula:

$$ExpP_{b,t} = \sum_{j \neq USA} PP_{jt} \cdot \varphi_{jb,t-1}, \text{ where } \cdot \varphi_{jb,t-1} = \frac{\sum_{t=t-4}^{t-1} claims_{bjt}}{\sum_{j \neq USA} \sum_{t=t-4}^{t-1} claims_{bjt}}.$$

The term PP_{jt} in the formula above stands for any of the indexes that measure the change in one of the prudential instruments (e.g., limits on LTV ratios, capital requirements, etc.) by regulators across all countries spanned by j. The term $claims_{bjt}$ represents bank b's claims on country j at time t through the FFIEC 009 reports.

[13]The exposure-weighted cycle variables are constructed in parallel to the exposure-weighted prudential index. For details, see footnote 12.

country-specific measures of the home country's credit-to-GDP gap and output gap. Standard errors are clustered at the country level.

3.1.2 Spillovers into the United States

Table 3 presents the results of the inward transmission through U.S. global banks, U.S. subsidiaries of foreign banks, and U.S. branches of foreign banks. We only display results for those prudential instruments for which we find significant effects for at least one of these three types of entities. The table presents estimates of contemporaneous effects and two periods of lagged effects. It also displays tests of the sum of effects, with the presentation columns organized both by instrument and entity type. Three instruments show significant inward spillovers: capital requirements, local-currency reserve requirements, and LTV limits. Tighter foreign capital requirements increase the lending of U.S. global banks and of U.S. subsidiaries of foreign banks (the evidence for subsidiaries is weaker though), but do not significantly affect lending by the U.S. branches of foreign banks. In contrast, tighter foreign limits on LTV ratios and local-currency reserve requirements cause U.S. subsidiaries and branches of foreign banks to increase their lending. We do not find significant effects on lending of foreign changes in sector-specific capital buffers. The *PruC* index, which aggregates prudential policy changes over all instruments, has largely insignificant effects, probably because the consequences for lending growth vary substantially by prudential instrument and are more appropriately evaluated in isolation.[14]

Interestingly, both bank-specific characteristics and country conditions drive quarterly lending growth rates. Lending growth by U.S. affiliates of foreign banks follows home-country financial and economic conditions. In particular, lending growth by U.S. subsidiaries is relatively strong when the home country has slower growth, while lending growth by U.S. branches is stronger when the credit-to-GDP gap is higher in the home country (implying a larger gap between the credit-to-GDP ratio and its long-term trend). In contrast, the

[14]The effects of changes in concentration ratios were not analyzed because of limited variation in foreign policies in all three samples. For the same reason, the effects of changes in exposure limits and foreign reserve requirements were not explored for U.S. affiliates of foreign banks.

Table 3. Inward Specification

	Capital Requirements			Reserve Requirements: Local			Loan-to-Value Ratio		
	Global Banks (1)	**Subs (2)**	**Branches (3)**	**Global Banks (4)**	**Subs (5)**	**Branches (6)**	**Global Banks (7)**	**Subs (8)**	**Branches (9)**
P_t	0.036**	0.016	−0.013	−0.003	0.016**	0.024	0.043	−0.013	0.018**
	(0.018)	(0.009)	(0.023)	(0.008)	(0.007)	(0.014)	(0.031)	(0.009)	(0.009)
P_{t-1}				0.009	0.008	−0.009	−0.001	0.014	0.002
				(0.008)	(0.007)	(0.019)	(0.011)	(0.014)	(0.011)
P_{t-2}				−0.005	0.026***	0.008	−0.010	0.021**	0.007
				(0.007)	(0.004)	(0.010)	(0.010)	(0.010)	(0.014)
Log Total Assets_{t-1}	−0.066***	−0.039***	−0.018	−0.067***	−0.040***	−0.018	−0.067***	−0.040***	−0.018
	(0.015)	(0.009)	(0.013)	(0.015)	(0.009)	(0.013)	(0.015)	(0.009)	(0.013)
Tier 1 Ratio_{t-1}	0.002**	0.000	−0.000	0.002**	0.000	−0.000	0.002**	0.000	−0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Illiquid Assets Ratio_{t-1}	−0.000	−0.001***	−0.002***	−0.000	−0.001***	−0.002***	−0.000	−0.001***	−0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Net Due To_{t-1}	−0.003	0.000	−0.000	−0.003	0.000	−0.000	−0.003	0.000	−0.000
	(0.003)	(0.001)	(0.000)	(0.003)	(0.001)	(0.000)	(0.003)	(0.001)	(0.000)
Core Deposits Ratio_{t-1}	0.001	−0.000	0.000	0.001	−0.000	0.000	0.001	−0.000	0.000
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)
BIS Financial Cycle_t	−0.001***	0.001*	0.001***	−0.001**	0.001*	0.001***	−0.001**	0.001*	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

(*continued*)

Table 3. (Continued)

	Capital Requirements			Reserve Requirements: Local			Loan-to-Value Ratio		
	Global Banks (1)	**Subs (2)**	**Branches (3)**	**Global Banks (4)**	**Subs (5)**	**Branches (6)**	**Global Banks (7)**	**Subs (8)**	**Branches (9)**
BIS Business Cycle$_t$	0.000	0.005***	0.002	0.000	0.005***	0.002	0.000	0.005***	0.001
	(0.003)	(0.002)	(0.004)	(0.003)	(0.002)	(0.003)	(0.003)	(0.002)	(0.004)
International Activity$_{t-1}$	0.001*			0.001*			0.001*		
	(0.001)			(0.001)			(0.001)		
Observations	1,873	2,801	4,262	1,873	2,801	4,262	1,873	2,801	4,262
R^2	0.196	0.191	0.100	0.195	0.193	0.100	0.197	0.193	0.100
Adjusted R^2	0.141	0.142	0.059	0.140	0.143	0.059	0.141	0.143	0.059
No. of Banks	59	102	137	59	102	137	59	102	137
Proportion of P_t Non-zero	0.145	0.020	0.030	0.549	0.014	0.056	0.370	0.033	0.051
P_t Coefficient Sum				0.001	0.050***	0.023	0.031	0.022	0.027*
p-value				[0.914]	[0.000]	[0.246]	[0.270]	[0.263]	[0.067]

Notes: This table reports the effects of changes in capital requirements, local-currency reserve requirements, and LTV limits. The sample period for U.S. global banks and for subsidiaries of foreign banks is 2000:Q1 to 2013:Q3. The U.S. branches of foreign banks data set goes from 2002:Q4 to 2013:Q3. Columns 1, 4, and 7 show the results based on the sample of U.S. global banks. Columns 2, 5, and 8 are for U.S. subsidiaries of foreign banks, and columns 3, 6, and 9 are for U.S. branches of foreign banks. In specifications (1) to (3), the variable P_t stands for $ExpP_{b,t}$, the exposure-weighted index. In specifications (4) to (9), P_t stands for $HomeP_{j,t}$, the prudential index that captures prudential policy changes in entity b's home country j. For more details on the variables, see table 7 in the appendix. BIS cycle variables are similarly constructed as exposure-weighted averages in specifications (1) to (3). All specifications include time and bank fixed effects as specified in the lower part of the table. Standard errors are robust for global banks, and clustered by country for affiliate regressions. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

negative and significant coefficients on the exposure-weighted credit-to-GDP gap indicate that the lending growth of U.S. global banks is lower when the credit-to-GDP gap in the countries where these banks operate is higher. This is likely because these banks refocus their lending toward foreign countries and away from domestic lending when foreign demand for credit is strong, a hypothesis that is supported by the positive coefficient on the credit-to-GDP gap in the outward exercise.

Bank-level characteristics also help explain lending growth. After controlling for bank fixed effects on lending growth, U.S. global banks with higher tier 1 ratios (in the previous quarter) have stronger lending growth. This also holds for their foreign activities, as shown later in the outward exercise, and is consistent with previous results in the literature.[15] Tier 1 capital ratios do not appear as drivers of foreign-owned bank lending growth in the United States. Instead, lending growth is stronger when illiquid asset ratios are lower.

Below we discuss the regression results of table 3 in more detail and evaluate the economic impact on loan growth in the U.S. from changes in capital requirements, local-currency reserve requirements, and limits on LTV ratios abroad.

3.1.3 Capital Requirements

The conjecture that foreign capital requirements could shift global bank activity away from the host country is supported by the regression results. We find a significant positive effect of tighter capital requirements abroad on total lending by U.S. global banks (see column 1 of table 3).[16] We also used as the dependent variable total lending minus loans to foreign banks, commercial and industrial loans to foreign addressees, and loans to foreign governments and official institutions. Results based on these alternative dependent variables show that the effects on lending growth are not limited to U.S. lending. U.S. banks increase domestic and

[15]See, e.g., Bernanke and Lown (1991) and Berrospide and Edge (2010).

[16]Lagged values of the capital requirement index are dropped in the regressions displayed in columns 1–3, since these were never significant.

third-country lending growth in response to higher foreign capital requirements.[17]

With regards to the lending of foreign-owned subsidiaries, the regression results indicate that our substitution effect from tighter home capital requirements (lending abroad becomes relatively less expensive than home lending) can dominate the effect associated with the consolidated entity's increased capital needs and give parent banks a net incentive to expand subsidiary operations in the United States. However, overall the support for this effect is relatively weak: the estimated coefficient shown in column 2 is significant only at the 11 percent level. The point estimate related to branch lending is not significant at conventional levels (see column 3).

How large is the positive effect on loan growth from tighter capital requirements abroad? If there were a change in capital requirements in all countries in which a U.S. bank holds claims, then that bank's lending growth would be 3.6 percentage points higher according to the estimated coefficient in column 1. This corresponds to around 38 percent of one standard deviation of the dependent variable. The average value of the exposure-weighted index is 0.028 in the sample, implying an average positive effect on a bank's lending growth rate of 0.1 percentage point.

We conduct a basic experiment to illustrate the magnitudes of potential spillovers from past capital requirement changes: (i) we calculate the effect on a bank's lending growth in each quarter, multiplying the capital requirement index in each period with the estimated coefficient; (ii) we convert the effect on the bank's lending growth rate to a U.S. dollar value, taking into account the lending volume of the bank in the previous period; and (iii) we aggregate the calculated U.S. dollar value over all banks. It is important to note that the estimated coefficients often have large confidence intervals, so the resulting dollar amounts are rough estimates of potential spillover effects.

Most of the regulatory changes in the sample occurred in the first quarter of 2012 and 2013 when several industrialized countries introduced Basel II.5 and Basel III, respectively. In some of

[17]Detailed estimates are shown in table 8 in the appendix. As noted later, the outward analysis shows that U.S. banks do not increase lending growth in the countries where capital requirements are changed.

these countries, U.S. banks have large operations—for example, in Canada, Hong Kong, and Switzerland. Accordingly, the effect on aggregate lending of U.S. global banks is notable. Based on our calculations, the introduction of Basel II.5 or Basel III in 2012:Q1 in twenty-eight countries led U.S. global banks to increase lending by around 2.4 percentage points ($119 billion). Summed over all quarters, additional lending due to changes in capital requirements abroad totaled $249 billion.

3.1.4 Local-Currency Reserve Requirements

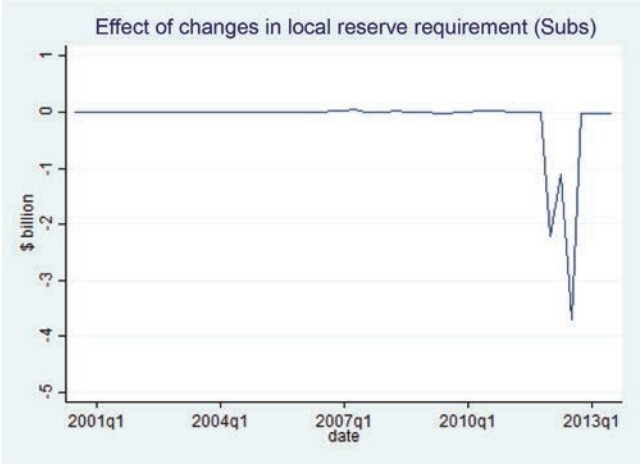
The conjecture that higher local reserve requirements in the home country will make operations by foreign-owned affiliates in the United States relatively more attractive is supported by the regression results, as can be seen in column 5 of table 3. Higher local reserve requirements in the home country increase a U.S. subsidiary's lending growth rate by a total of 5 percentage points over half a year (beta coefficient of 0.07). The contemporaneous and lagged coefficients in the branch regression (column 6 of table 3) are not jointly significant at standard levels, but there is some weak evidence that branch lending responds as well since the coefficient on the contemporaneous prudential variable is significant at the 11 percent level. Banks should not prefer to move activity to subsidiaries or to branches in particular, since the impact of local reserve requirements is not related to the bank's organizational structure as discussed earlier.

U.S. global banks do not seem to respond at all to local reserve requirement changes abroad. In principle, changes in local reserve requirements in a market could also affect U.S. global banks that operate there. However, U.S. global banks do not fund themselves to a significant extent in foreign/local currencies and are probably little affected by these types of regulatory changes.

We investigated whether banks respond symmetrically to tightening versus loosening reserve requirements. In terms of magnitudes, the effects appear to be similar but the timing of responses differs. The effect of a tightening unfolds immediately, while responses to a loosening of reserve requirements occur with a lag of half a year.

Figure 1 illustrates the aggregate effects of reserve requirement changes abroad on lending by U.S. subsidiaries of foreign

Figure 1. Home-Country Local-Currency Reserve Requirements and Lending by U.S. Subsidiaries of Foreign Banks



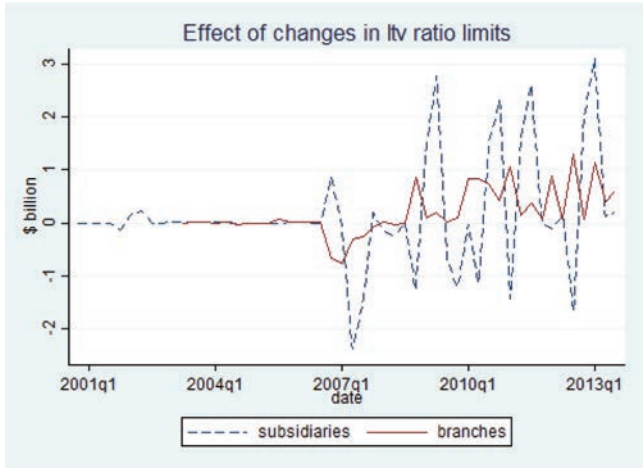
Notes: The chart shows the effect of changes in home-country local-currency reserve requirements on lending by U.S. subsidiaries of foreign banks. Calculations follow the methodology described in the text and are based on the estimated coefficients shown in column 5 of table 3. The figure plots by date the additional lending by subsidiaries in U.S. dollar values due to observed changes in local-currency reserve requirements in these entities' home countries.

banks following the methodology described earlier. The largest effect occurred in 2012. On January18, 2012, the European Central Bank lowered the reserve requirement ratio from 2 percent to 1 percent. India and China, which were parent countries for U.S. subsidiaries in 2012, also lowered their local reserve requirements in this year. Summing the U.S. dollar changes in lending from 2012:Q1 to 2012:Q3 over subsidiaries suggests that the reduction in local reserve requirements in this period led to roughly $7 billion lower lending by these entities, a bit less than half a percent of their total lending over the same period.

3.1.5 Limits on Loan-to-Value Ratios

The regression results in columns 8 and 9 of table 3 support the conjecture that banks headquartered abroad redirect activity to the

Figure 2. Home-Country Limits on LTV Ratios and Lending by U.S. Subsidiaries and Branches of Foreign Banks



Notes: The chart shows the effect of changes in home-country limits on LTV ratios on lending by U.S. subsidiaries (dashed line) and branches (solid line) of foreign banks. Calculations follow the methodology described in the text and are based on the estimated coefficients shown in columns 8 and 9 of table 3. The figure plots by date the additional lending by subsidiaries and branches in U.S. dollar values due to observed changes in limits on LTV ratios in these entities' home countries.

United States in response to tightened LTV limits in their home counties. Lending by both U.S. branches and subsidiaries of foreign banks expands in response to these changes.[18]

If tightening occurs in the parent country, lending growth by U.S. subsidiaries and U.S. branches of foreign banks increases by 2.2 and 2.7 percentage points, respectively, based on estimates in columns 8 and 9 (sum of contemporaneous and lagged coefficients). Figure 2 shows the aggregate effects of past changes in LTV limits by quarter. The volatility of aggregate effects over time is mainly a reflection of tightening and loosening in foreign countries. For subsidiaries, the switching signs on the contemporaneous versus lagged

[18]We did not find evidence for differential effects of tightening versus loosening LTV limits.

effects of policy changes (see column 8) also play a role. Most changes in LTV limits occurred after the 2007–08 financial crisis in advanced economies like Sweden, Canada, Norway, and the Netherlands but also in developing countries like China and Brazil. Summing the effects of past LTV changes over the sample period and over both types of entities suggests that U.S. branches and subsidiaries lent out an additional $15 billion from 2003:Q3 to 2013:Q3 due to policy changes in their home countries. Subsidiaries contributed around 45 percent, and branches around 55 percent, to the increase.[19] Overall the additional lending over the sample period is small, reflecting a tiny fraction of these entities' total lending (0.04 percent).[20]

3.2 Outward Analysis: International Response of U.S. Global Banks to U.S. and Foreign Prudential Policies

The outward transmission exercise assesses the effects of foreign prudential policies on the growth of U.S. banks' claims to foreign countries, including on the reallocation of U.S. banks' external claims across foreign markets. The analysis also explores the impact of U.S regulation on U.S. banks' claims abroad.

3.2.1 Impact of Foreign Prudential Instruments on U.S. Banks' Foreign Claims

First, we consider the impact of different prudential instruments used by the destination country on U.S. bank claims abroad. Each of the prudential instrument measures enters the regression specification with its contemporaneous value and two lags. Formally, we estimate the regression equation:

$$\Delta Y_{b,j,t} = \alpha_0 + (\alpha_1 DestP_{j,t} + \alpha_2 DestP_{j,t-1} + \alpha_3 DestP_{j,t-2}) + \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + f_j + f_t + f_b + \epsilon_{b,j,t}, \quad (3)$$

[19]The larger contribution of branches to this expansion stems from a larger impact of an LTV ratio change on branch lending, compared with subsidiary lending, and the fact that more local reserve requirement changes occurred in the home countries of U.S. branches.

[20]In 2013:Q3, total lending of branches in our data set was $518 billion versus $595 billion of subsidiaries.

where the prudential instrument changes are captured by $DestP_{j,t}$, which records the changes in the prudential instruments of country j in which U.S. bank b has exposures at time t. The dependent variable is the change in logs of U.S. bank b's claims on country$j$ at time t evaluated on an ultimate risk basis.

Table 4 summarizes the main results for individual prudential instruments on the foreign claim growth of U.S. banks. Only two prudential instruments have some statistically significant coefficients: LTV ratio limits and interbank exposure limits. However, the sum of coefficients on these two measures for all lags is not significant, suggesting only a weak effect of prudential regulation in the destination countries on U.S. bank foreign claims. The weak results have two interpretations. First, while some of these policies have been actively used across U.S. counterparty countries, especially in emerging markets, exposures of U.S. global banks to emerging markets are smaller than exposures to advanced economies; it may be that global banks just choose to absorb the costs of the extra regulation. Alternatively, it may be that these policies are ineffective in changing the growth of foreign claims at U.S. banks.

Among other drivers of total claim growth of U.S. global banks, the financial cycle variable has the expected signs in most cases, though the effects seem to be economically small. The negative and significant coefficient on the international ratio suggests that the foreign claim growth is smaller for more diversified banks (banks with more international activities). Core deposits are negatively related to total claims growth, reflecting the fact that U.S. banks with smaller shares of core deposits on their balance sheets (and thus more dependent on wholesale funding) lend more to foreign residents. The positive and significant coefficient on both the illiquid assets ratio and the net due to ratio suggest that less liquid banks and banks with more net internal borrowing from their parents exhibit a higher growth rate in their foreign claims.

3.2.2 Impact of U.S. Prudential Instruments on U.S. Banks' Foreign Claims

Second, we test for the impact of changes in U.S. prudential instruments on U.S. banks' foreign claims. The use of prudential instruments in the United States between 2000 and 2013 is essentially

Table 4. Outward Transmission of Destination-Country Prudential Policy

	Prudential IndexC (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	Loan-to-Value Ratio (4)	Reserve Requirements: Foreign (5)	Reserve Requirements: Local (6)	Interbank Exposure Limits (7)
P_t	0.005	−0.008	−0.002	0.012	−0.005	0.006	−0.002
	(0.006)	(0.014)	(0.010)	(0.010)	(0.005)	(0.009)	(0.018)
P_{t-1}	0.007	−0.009	−0.003	−0.015*	0.001	0.011	−0.037**
	(0.005)	(0.013)	(0.009)	(0.009)	(0.011)	(0.008)	(0.018)
P_{t-2}	0.009*	−0.014	0.013	0.016*	0.002	0.007	0.013
	(0.005)	(0.011)	(0.014)	(0.010)	(0.005)	(0.006)	(0.012)
Log Total Assets_{t-1}	−0.006	−0.006	−0.006	−0.006	−0.006	−0.006	−0.006
	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)	(0.008)
Tier 1 Ratio_{t-1}	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Illiquid Assets Ratio_{t-1}	0.001**	0.001**	0.001**	0.001**	0.001**	0.001**	0.001**
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
International Activity_{t-1}	−0.002***	−0.002***	−0.002***	−0.002***	−0.002***	−0.002***	−0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Net Due To_{t-1}	0.002*	0.002*	0.002*	0.002*	0.002*	0.002*	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

(*continued*)

Table 4. (Continued)

	Prudential IndexC (1)	Capital Requirements (2)	Sector-Specific Capital Buffer (3)	Loan-to-Value Ratio (4)	Reserve Requirements: Foreign (5)	Reserve Requirements: Local (6)	Interbank Exposure Limits (7)
Core Deposits Ratio$_{t-1}$	−0.001***	−0.001***	−0.001***	−0.001***	−0.001***	−0.001***	−0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
BIS Financial Cycle$_t$	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
BIS Business Cycle$_t$	0.003	0.004	0.004	0.004	0.004	0.004	0.004
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)
Observations	25,986	25,986	25,986	25,986	25,986	25,986	25,986
R^2	0.023	0.022	0.023	0.023	0.022	0.023	0.023
Adjusted R^2	0.016	0.016	0.016	0.016	0.016	0.016	0.016
DestP$_{(t)}$ Coefficient Sum	0.021*	−0.030	0.008	0.013	−0.002	0.023	−0.026
p-value	[0.091]	[0.266]	[0.669]	[0.243]	[0.917]	[0.150]	[0.427]

Notes: This table reports the effects of changes in destination-country regulation and firm characteristics on log changes in total loans by destination country. The data are quarterly from 2000:Q1 to 2013:Q3 for a panel of bank holding companies. DestP refers to the changes in regulation in the destination country of the loan. For more details on the variables, see table 7 in the appendix. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the table. Standard errors are clustered by country. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

related to the stricter regulation mandated by the Dodd-Frank Act and the Basel standards on capital regulation, in particular the Basel II.5 standards implemented in January 2013 and the Basel III standards that became effective in January 2014. These regulatory changes are captured in the IBRN Prudential Instruments Database in the capital requirements index. Since our sample ends in 2013:Q3, only the implementation of Basel II.5 can be captured in our empirical analysis. Given this setting, we use the cumulative change in the capital requirement index for the United States as the variable of interest. This indicator is equal to one from the first quarter in 2013 until the end of the sample, and zero otherwise. This approach makes the empirical test a de facto difference-in-difference estimation. More formally, we use the following regression specification:

$$\begin{aligned}\Delta Y_{b,j,t} = {} & \alpha_0 + \alpha_1 \mathit{US}_{cum}\ \mathit{CapReq}_t + \alpha_2 X_{b,t-1} \\ & + \alpha_3 \mathit{US}_{cum}\ \mathit{CapReq}_t * X_{b,t-1} + \alpha_4 Z_{j,t} \\ & + f_j + f_b + \epsilon_{b,j,t}, \end{aligned} \tag{4}$$

where the prudential instrument is captured by $\mathit{US}_{cum}\ \mathit{CapReq}_t$, which records the cumulative changes in U.S. capital requirements. We also include interaction terms between this instrument and some bank characteristics in vector $X_{b,t-1}$ to complete the difference-in-difference analysis. As before, the dependent variable is the change in logs of U.S. bank b's claims on country j at time t evaluated on an ultimate risk basis. In this specification, the U.S. prudential instrument varies only by time and thus we only include bank and country fixed effects. We also use specifications that include country-time fixed effects to account for loan demand at the country level. In these cases, $\mathit{US}_{cum}\ \mathit{CapReq}_t$ is absorbed by the country-time fixed effect and thus we focus our attention only on the interaction of $\mathit{US}_{cum}\ \mathit{CapReq}_t$ and bank-specific characteristics.

Most of the recent regulatory changes in the United States have focused on the systemic global banks which are subject to the Federal Reserve's stress tests, known as the Comprehensive Capital Analysis and Review (CCAR) and, among these banks, those that follow the so-called Advanced Approach capital rules.[21] Therefore, we test for

[21] CCAR BHCs are generally global U.S. BHCs with total consolidated assets above $50 billion. As of 2013:Q3, there were thirty CCAR BHCs, twenty-three

a differential impact of the stricter U.S. regulation on the growth in total and cross-border claims for CCAR/non-CCAR and Advanced Approach/non-Advanced Approach banks. To this end, we include interactions between US_{cum} $CapReq_t$ and dummy variables that take the value of one for CCAR or Advanced Approach banks and zero otherwise. We expect that if there is any negative effect of the new capital regulations on the growth in foreign bank claims, it should be significant for the group of large global banks.[22]

This expectation is supported by the results presented in table 5. The first four columns of the table examine the changes in total claims and cross-border claims to all countries. Columns 5–8 examine the changes in cross-border claims to advanced foreign and emerging economies. In almost all cases, the interaction of US_{cum} $CapReq_t$ and indicator variables for CCAR and Advanced Approach banks is negative and significant. This finding confirms that the new Basel capital regulations reduced the growth in foreign claims at the largest U.S. banks subject to the Federal Reserve's stress tests compared with smaller institutions not subject to these stress tests. For example, taking into account that the difference in growth rates between CCAR and non-CCAR banks before 2013 was on average 0.4 percentage points (the growth rate was 1 percent for CCAR banks and 0.6 percent for non-CCAR banks), our estimates indicate that the difference in growth rates between the two groups of banks and across the two periods should have been –5.5 percentage points (the difference-in-difference estimate). The growth rate differential observed in the data is –5.2 percentage points. Thus, most of the reduction in the growth rate of CCAR banks relative to non-CCAR banks could be attributable to the change in U.S. capital regulation following the implementation of Basel II.5.

We explore further whether the negative impact of the stricter capital regulation is influenced by bank-specific characteristics. To that end, we include interaction terms between the cumulative capital requirements index and three bank-specific characteristics:

of which had foreign claims in the fifty-nine countries in our sample. Advanced Approach BHCs are CCAR BHCs with total assets above $250 billion and foreign exposures larger than $10 billion.

[22]Our estimates likely provide a lower bound to the total effects of regulatory changes, as the banks may have adapted their portfolios as early as 2011.

Table 5. Impact of Changes in U.S. Capital Regulation on Foreign Claim Growth by Type of Claim and Destination Country

	All Countries				Advanced Foreign Countries		Emerging Markets	
	Total Claims		Cross-Border Claims		Cross-Border Claims		Cross-Border Claims	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
US_{cum} $CapReq_t$*$CCAR_t$	−0.055***		−0.074***		−0.078**		−0.072***	
	(0.012)		(0.018)		(0.033)		(0.019)	
US_{cum} $CapReq_t$*		−0.048***		−0.046**		−0.042		−0.053**
Advanced $Approach_t$		(0.014)		(0.019)		(0.028)		(0.020)
Log Total $Assets_{t-1}$	−0.006	−0.003	−0.007	−0.004	−0.014	−0.012	0.003	0.005
	(0.011)	(0.011)	(0.011)	(0.011)	(0.015)	(0.015)	(0.016)	(0.016)
Tier 1 $Ratio_{t-1}$	0.003**	0.003**	0.003**	0.003**	0.005***	0.005***	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Illiquid Assets $Ratio_{t-1}$	0.001*	0.001*	0.001	0.001	0.002**	0.002**	.0001	.0001
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
International $Activity_{t-1}$	−0.002***	−0.002***	−0.002***	−0.002***	−0.003***	−0.003***	−0.001*	−0.001*
	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Net Due To_{t-1}	0.002	0.002	0.002	0.002	0.003	0.003	0.005	0.005
	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)	(0.019)	(0.019)
Core Deposits $Ratio_{t-1}$	−0.003	−0.004	−0.001	−0.001	−0.001*	−0.002*	−0.004	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	35,483	35,483	31,114	31,114	14,809	14,809	16,305	16,305
R^2	0.12	0.12	0.13	0.13	0.1	0.1	0.15	0.15
Adjusted R^2	0.03	0.03	0.03	0.03	0.02	0.02	0.04	0.04
Country-Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports the effects of changes in the interaction of changes in U.S. prudential policy with indicator variables for CCAR or Advanced Approach banks and firm characteristics on log changes in total loans by destination country. CCAR banks are bank holding companies (BHCs) included in the yearly stress-test exercise conducted by the Federal Reserve. Advanced Approach banks are CCAR BHCs with total assets above $250 billion and foreign exposures larger than $10 billion. The data are quarterly from 2000:Q1 to 2013:Q3 for a panel of BHCs. For more details on the variables, see table 7 in the appendix. Each column gives the result for the country and claim type specified in the column header. Specifications in all columns include bank and country-time fixed effects. Standard errors are clustered by bank. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

size, the tier 1 capital ratio, and the core-deposits-to-total-liabilities ratio.[23] Table 6 shows the regression results. The estimations in the first two columns include US_{cum} $CapReq_t$ as a stand-alone variable and separate country, time, and bank fixed effects. The change in U.S. capital regulation seems to reduce the growth in foreign claim of U.S. global banks, as suggested by the negative coefficient on US_{cum} $CapReq_t$, but this effect is not statistically significant. However, balance sheet characteristics appear important to explain bank reactions to the change in capital requirements, as indicated by the three significant interaction terms between US_{cum} $CapReq_t$ and size, tier 1 capital ratio, and the core-deposit-to-total-liabilities ratio in column 2. For example, the negative impact of the stricter regulation is stronger for larger banks; in contrast, banks with more capital (tier 1 capital ratio) and core deposits are able to increase their claims after the new regulations are implemented. Column 3 shows that the significance of the interaction terms between US_{cum} $CapReq_t$ and size and core deposits is robust to accounting for the foreign demand for credit through country-time fixed effects.

To better control for the effect of bank size, and to verify that the impact of the new regulations on foreign claims occurs mainly through the largest global banks, we estimate the same specifications, splitting our sample by CCAR and non-CCAR banks and by Advanced Approach and non-Advanced Approach banks. These results are shown in columns 4–7. As expected, the coefficients on the interaction terms are mostly significant for CCAR and Advanced Approach banks. The interaction terms with core deposits for Advanced Approach banks, and with both tier 1 capital and the core deposits ratio for CCAR banks, are positive and significant, indicating that large banks with more regulatory capital and core deposits are able to offset the impact of the stricter capital regulation. Recent evidence shows that large U.S. banks subject to the stress tests have been increasing their regulatory capital and their deposits base (International Monetary Fund 2015). Our

[23]These three interaction terms have the only significant coefficients in the specifications that include interactions between the cumulative changes in the U.S. capital requirements and all bank characteristics.

Table 6. Impact of Changes in U.S. Capital Regulation on Total Foreign Claim Growth

	All Banks			CCAR Banks	Non-CCAR Banks	Adv. Approach Banks	Non-Adv. Approach Banks
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
US_{cum} $CapReq_t$	−0.005	0.057					
	(0.009)	(0.082)					
US_{cum} $CapReq_t$ *Log Total $Assets_{t-1}$		−0.006**	−0.008**	−0.006	0.008	−0.011	−0.003
		(0.003)	(0.003)	(0.006)	(0.007)	(0.008)	(0.004)
US_{cum} $CapReq_t$ *Tier 1 $Ratio_{t-1}$		0.005**	0.003	0.007*	−0.004	0.007	.0002
		(0.002)	(0.002)	(0.003)	(0.003)	(0.004)	(0.003)
US_{cum} $CapReq_t$ *Core Deposits $Ratio_{t-1}$		0.001***	0.001**	0.001**	.0001	0.001**	.0001
		(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
Log Total $Assets_{t-1}$	−0.014	−0.016	−0.008	−0.012	0.02	−0.035	0.008
	(0.013)	(0.014)	(0.011)	(0.012)	(0.024)	(0.024)	(0.017)
Tier 1 $Ratio_{t-1}$	0.003*	0.002	0.002	0.001	0.003*	0.005	0.001
	(0.002)	(0.002)	(0.001)	(0.003)	(0.002)	(0.004)	(0.002)
Illiquid Assets $Ratio_{t-1}$	0.001**	0.001**	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
International $Activity_{t-1}$	−0.002***	−0.002***	−0.002***	−0.002***	−0.002***	−0.003**	−0.002*
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Net Due To_{t-1}	0.001	0.001	0.002	0.002	0.004	0.001	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Core Deposits $Ratio_{t-1}$	−.0004	−0.001	−0.001	−0.001	.0002	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
BIS Financial $Cycle_t$	0.003***	0.004***					
	(0.001)	(0.001)					
BIS Business $Cycle_t$	.0002	.0001					
	(0.000)	(0.000)					
Observations	31,733	28,464	31,857	21,981	9,876	17,071	14,786
R^2	0.01	0.01	0.13	0.18	0.3	0.22	0.22
Adjusted R^2	0.005	0.01	0.04	0.05	0.03	0.05	0.03
Country-Time Fixed Effects	No	No	Yes	Yes	Yes	Yes	Yes

Notes: This table reports the effects of changes in U.S. prudential policy, the interaction of changes in U.S. prudential policy with changes in destination-country regulation, and firm characteristics on log changes in total loans by destination country. The data are quarterly from 2000:Q1 to 2013:Q3 for a panel of bank holding companies. For more details on the variables, see table 7 in the appendix. Each column gives the result for the subset of banks specified in the column header. CCAR banks are BHCs included in the yearly stress-test exercise conducted by the Federal Reserve. Advanced Approach banks are CCAR BHCs with total assets above $250 billion and foreign exposures larger than $10 billion. Specifications in all columns include bank fixed effects, with the first two columns including country fixed effects. Country-time fixed effects are used as indicated in the lower part of the table. Standard errors are clustered by bank. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

results indicate that this trend may help them withstand the tougher regulations.

These results are consistent with previous findings in the literature suggesting a reduction in cross-border activities caused by stricter prudential policies (e.g., Aiyar et al. 2014). This is especially the case for the largest global banks subject to higher capital requirements that apply to the consolidated entity.

4. Concluding Remarks

The 2007–08 financial crisis has led many countries around the world to review their use of microprudential and macroprudential policy instruments. In a financially integrated world in which banks are global and run large cross-border operations, two questions naturally arise. First, have prudential policies taken by national regulators affected risk taking and credit growth beyond national borders? Second, can domestic prudential policies be effective in containing rapid domestic credit growth and addressing excessive risk taking? The U.S. experience is useful since the country is home to a number of globally active banks, many of which are systemically important, and simultaneously hosts many foreign banks engaged in lending in the United States through both subsidiaries and branches. We focus primarily on the response of credit growth through these banking entities.

We find clear evidence that lending in the United States is affected by foreign policy changes. A tightening of foreign prudential instruments leads to an increase in U.S. lending by both domestically owned global banks with significant foreign operations and by the U.S. affiliates of foreign banks. Specifically, lending growth rises with tighter foreign capital requirements, limits on LTV ratios, and local-currency reserve requirements enacted in foreign economies. The capacity of foreign and U.S. global banks to lend appears to shift, at least in part, from the foreign countries, where it is being constrained, to the United States.

We also find that the largest U.S. global banks, those that are deemed systemic and thus have been required to finance a larger proportion of their balance sheets with capital, appear to cut credit abroad relatively more than the smaller banks in response to tighter capital requirements in the United States. Although the intent of

these capital requirements was not to reduce the supply of credit, the short-term effect points to lower foreign claims growth as a result of the stricter requirements. In contrast, we find that the use of prudential instruments by foreign authorities does not have a significant impact on the activities of U.S. banks in those foreign countries.

While the international spillovers from past prudential policy tightening were moderate, our results highlight the challenges that policymakers face today. Effective control of domestic credit can be complicated by the prudential policies implemented in foreign jurisdictions. At the same time, calibration of domestic policies will need to take into account the spillovers of prudential policy changes in foreign countries and their cross-border effects. Despite limited real consequences for the U.S. economy over the past decade, prudential instruments applied abroad have the potential to more significantly influence loan growth in the future through a variety of banking channels.

Appendix

Table 7. Constructon of Balance Sheet Variables

Variable Name	Report Form Description	Outward/Inward—U.S. Global Banks: Source	U.S Subsidiaries of Foreign Banks: Source	U.S. Branches of Foreign Banks: Source	Notes
ΔY	Outward: log(Total Claims$_t$) − log(Total Claims$_{t-1}$) Inward: log(Total Loans$_t$) − log(Total Loans$_{t-1}$)	**FFIEC 009** FCEX C918, C919, C920, C922, 8593, 8577, 8578, 8579, C915, C916, C917	**FR Y-9C, FFIEC 031** BHCK and RCFD 2122	**FFIEC 002** RCFD 2122	
Illiquid Assets Ratio	{(Loans held for sale + Loans net of unearned income and allowances for loan and lease losses (A.L.L.) + Held-to-maturity MBS, ABS, and structured financial products (amortized cost) + Available-for-sale MBS, ABS, and structured financial products (fair value))/Assets} * 100	**FR Y9-C, FFIEC 031** BHCK and RCFD 5369, B529, B838, B841, B842, B845, B846, B849, B850, B853, B854, B857, B858, B861, G300, G303, G304, G307, G308, G311, G312, G315, G316, G319, G320, G323, G324, G327, G328, G331, K142, K145, K146, K149, K150, K153, K154, K157, 1698, 1703, 1709, 1714, 1718, 1733, 1702, 1707, 1713, 1717, 1732, 1736	**FR Y9-C, FFIEC 031** BHCK and RCFD 5369, B529, B838, B841, B842, B845, B846, B849, B850, B853, B854, B857, B858, B861, G300, G303, G304, G307, G308, G311, G312, G315, G316, G319, G320, G323, G324, G327, G328, G331, K142, K145, K146, K149, K150, K153, K154, K157, 1698, 1703, 1709, 1714, 1718, 1733, 1702, 1707, 1713, 1717, 1732, 1736	**FFIEC 002** RCFD G483, 1754, 1773, 2122, 2170, 3195	Structured financial products available on the FR Y9-C report form starting 2009:Q2.
Log Total Assets	Log (Total assets * (GDP Deflator$_{2012}$/ GDP Deflator))	**FR Y9-C, FFIEC 031, BEA** BHCK 2170, RCFD 2170	**FR Y9-C, FFIEC 031, BEA** BHCK 2170, RCFD 2170	**FFIEC 002, BEA** RCFD 2170	Nominal assets are converted to 2012 dollars using the GDP implicit price deflator series from the BEA.

(*continued*)

Table 7. (Continued)

Variable Name	Report Form Description	Outward/Inward—U.S. Global Banks: Source	U.S Subsidiaries of Foreign Banks: Source	U.S. Branches of Foreign Banks: Source	Notes
Core Deposits Ratio	{(Total transaction accounts + Savings deposits (MMDAs, etc.) + Total time deposit accounts with balances less than $100,000)/Liabilities} * 100	**FR Y9-C, FFIEC 031** BHCB 2210, 2389, 3187, 6648, BHOD 3187, 3189, 2389, 6648, RCON 2215, 2385, 2604, BHCK and RCFD 2948	**FFIEC 031** RCON 2215, 2385, 2604	**FFIEC 002** RCON 1653, 2385, 2604, RCFD 2950	
Tier 1 Ratio	(Tier 1 risk-based capital/Risk-weighted assets (net of allowances and other deductions)) * 100	**FR Y9-C, FFIEC 031** BHCA and RCFD 8274 , A223	**FR Y9-C, FFIEC 031** BHCA and RCFD 8274, A223	**FR Y-7Q** FBOQ 8274, A223	Linear interpolation is used for FR Y-7Q data.
Net Due To	((Net due to own foreign offices, edge and agreement subsidiaries, and IBFs – Net due from own foreign offices, edge and agreement subsidiaries, and IBFs)/Assets) * 100	**FFIEC 009, FR Y-9C, FFIEC 031** FCEX 8595, BHCK and RCFD 2170	**FFIEC 031** RCON 2941, 2163, RCFD 2170	**FFIEC 002** RCFD 2170, 2154, 2944	From the perspective of the commercial bank head office vis-à-vis own foreign offices, edge and agreement subsidiaries, and IBFs.
International Activity	((Foreign Assets + Deposits in foreign offices, edge and agreement subsidiaries, and IBFs)/Assets) * 100	**FFIEC 009, FR Y-9C, FFIEC 031** FCEX C918, C919, C920, C922, 8577, 8578, 8579, BHDM 6631, 6636, RCFN 2200, BHCK and RCFD 2170	**FR Y-9C, FFIEC 031** BHDM and RCFN 6631, 6636		

Notes: Bank-level data collected on the FFIEC 009 are confidential. Although most of the data collected on the FR Y-9C, FFIEC 031, FFIEC 002, and FR Y-7Q are available to the public, there are a small number of series that are confidential. In the case of the FR Y-7Q, a reporting foreign banking organization may request confidential treatment for its bank-level information.

Table 8. Additional Results on the Effect of Capital Requirements: Split between Domestic and Foreign Lending

	Capital Requirements		
	All Loans (1)	**Domestic (2)**	**Foreign (3)**
P_t	0.036**	0.030	0.202*
	(0.018)	(0.020	(0.115)
Log Total $Assets_{t-1}$	−0.066***	−0.077***	−0.092
	(0.015)	(0.019)	(0.060)
Tier 1 $Ratio_{t-1}$	0.002**	0.001	−0.003
	(0.001)	(0.002)	(0.005)
Illiquid Assets $Ratio_{t-1}$	−0.000	−0.000	0.001
	(0.000)	(0.001)	(0.001)
Net Due To_{t-1}	−0.003	0.012	−0.008**
	(0.003)	(0.017)	(0.004)
Core Deposits $Ratio_{t-1}$	0.001	−0.000	0.000
	(0.000)	(0.001)	(0.003)
BIS Financial $Cycle_t$	−0.001**	−0.001*	0.001
	(0.000)	(0.001)	(0.003)
BIS Business $Cycle_t$	0.000	0.002	−0.003
	(0.003)	(0.009)	(0.018)
International $Activity_{t-1}$	0.001*	0.000	−0.001
	(0.001)	(0.001)	(0.002)
Observations	1,873	1,871	1,778
R^2	0.196	0.126	0.101
Adjusted R^2	0.141	0.067	0.037
No. of Banks	59	59	58
Proportion of P_t Non-zero	0.145	0.145	0.151

Notes: This table reports the effects of changes in capital requirements, splitting total loans into loans to U.S. (column 2) and foreign (column 3) residents. The sample period is 2000:Q1 to 2013:Q3. All specifications include time and bank fixed effects. Standard errors are robust for global banks. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

References

Aiyar, S., C. W. Calomiris, J. Hooley, Y. Korniyenko, and T. Wieladek. 2014. "The International Transmission of Bank Capital Requirements: Evidence from the UK." *Journal of Financial Economics* 113 (3): 368–82.

Aiyar, S., C. W. Calomiris, and T. Wieladek. 2014. "Does Macro-Prudential Regulation Leak? Evidence from a UK Policy Experiment." *Journal of Money, Credit and Banking* 46 (s1): 181–214.

Akinci, O., and J. Olmstead-Rumsey. 2015. "How Effective are Macroprudential Policies? An Empirical Investigation." International Finance Discussion Paper No. 1136 (May), Board of Governors of the Federal Reserve System

Auer, S., M. Ganarin, and P. Towbin. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Switzerland." *International Journal of Central Banking* 13 (S1).

Avdjiev, S., C. Koch, P. McGuire, and G. von Peter. 2017. "International Prudential Policy Spillovers: A Global Perspective." *International Journal of Central Banking* 13 (S1).

Bank for International Settlements. 2014. "Debt and the Financial Cycle: Domestic and Global." In *84th Annual Report*, 65–84 (chapter IV) Basel, Switzerland: Bank for International Settlements.

Barth, J. R., G. Caprio Jr., and R. Levine. 2013. "Bank Regulation and Supervision in 180 Countries from 1999 to 2011." *Journal of Financial Economic Policy* 5 (2): 111–219.

Başkaya, Y., M. Binici, Ş. Kalemli-Özcan, and T. Kenç. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Turkey." *International Journal of Central Banking* 13 (S1).

Bernanke, B., and C. S. Lown. 1991. "The Credit Crunch." *Brookings Papers on Economic Activity* 22 (2): 205–48.

Berrospide, J. M., and R. M. Edge. 2010. "The Effects of Bank Capital on Lending: What Do We Know, and What Does It Mean?" *International Journal of Central Banking* 6 (4): 5–54.

Bonfim, D., and S. Costa. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Portugal." *International Journal of Central Banking* 13 (S1).

Bremus, F., and M. Fratzscher. 2014. "Drivers of Structural Change in Cross-Border Banking Since the Global Financial Crisis." Discussion Paper No. 1411, Deutsches Institut fur Wirtschaftsforschung.

Buch, C., and L. S. Goldberg. 2017. "Cross-Border Prudential Policy Spillovers: How Much? How Important? Evidence from the International Banking Research Network." *International Journal of Central Banking* 13 (S1).

Bussière, M., J. Schmidt, and F. Vinas. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from France." *International Journal of Central Banking* 13 (S1).

Caccavaio, M., L. Carpinelli, and G. Marinelli. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Italy." *International Journal of Central Banking* 13 (S1).

Cerutti, E., S. Claessens, and L. Laeven. 2015. "The Use and Effectiveness of Macroprudential Policies: New Evidence." *Journal of Financial Stability* (November).

Cerutti, E., R. Correa, E. Fiorentino, and E. Segalla. 2017. "Changes in Prudential Policy Instruments—A New Cross Country Database." *International Journal of Central Banking* 13 (S1).

Cetorelli, N., and L. Goldberg. 2006. "Risks in U.S. Bank International Exposure" Staff Report No. 240, Federal Reserve Bank of New York.

Damar, H. E., and A. Mordel. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Canada." *International Journal of Central Banking* 13 (S1).

Danisewicz, P., D. Reinhardt, and R. Sowerbutts. 2015. "On a Tight Leash: Does Bank Organizational Structure Matter for Macroprudential Spillovers?" Working Paper No. 524, Bank of England.

Drehmann, M., C. Borio, and K. Tsatsaronis. 2011. "Anchoring Countercyclical Capital Buffers: The Role of Credit Aggregates." *International Journal of Central Banking* 7 (4): 189–240.

Elliott, D. J., G. Feldberg, and A. Lehnert. 2013. "The History of Cyclical Macroprudential Policy in the United States." Finance and Economics Discussion Series Paper No. 2013-29, Board of Governors of the Federal Reserve System.

Frost, J., J. de Haan, and N. van Horen. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from the Netherlands." *International Journal of Central Banking* 13 (S1).

Gajewski, K., and O. Krzesicki. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Poland." *International Journal of Central Banking* 13 (S1).

Hills, R., D. Reinhardt, R. Sowerbutts, and T. Wieladek. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from the United Kingdom." *International Journal of Central Banking* 13 (S1).

Ho, K., and E. Wong. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Hong Kong." *International Journal of Central Banking* 13 (S1).

Houston, J. F., C. Lin, and Y. Ma. 2012. "Regulatory Arbitrage and International Bank Flows." *Journal of Finance* 67 (5): 1845–95.

International Monetary Fund. 2015. "United States—Financial Sector Assessment Program: Stress Testing—Technical Note." IMF Country Report No. 15/173 (July).

Jara, A., and L. Cabeza. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Chile." *International Journal of Central Banking* 13 (S1).

Levin-Konigsberg, G., C. Lopez, F. Lopez-Gallo, and S. Martinez. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Mexico." *International Journal of Central Banking* 13 (S1).

Lim, C. H., F. Columba, A. Costa, P. Kongsamut, A. Otani, M. Saiyid, T. Wezel, and X. Wu. 2011. "Macroprudential Policy: What Instruments and How Are They Used? Lessons from Country Experiences." IMF Working Paper No. 11/238.

Nocciola, L., D. Żochowski, and F. Franch. 2016. "International Banking and Cross-border Effects of Prudential Regulation: Lessons from the Euro Area." Manuscript.

Ohls, J., M. Pramor, and L. Tonzer. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Germany." *International Journal of Central Banking* 13 (S1).

Ongena, S., A. Popov, and G. F. Udell. 2013. "'When the Cat's Away the Mice Will Play': Does Regulation at Home Affect Bank Risk-Taking Abroad?" *Journal of Financial Economics* 108 (3): 727–50.

Park, H., and J. Lee. 2017. "International Banking and Cross-Border Effects of Regulation: Lessons from Korea." *International Journal of Central Banking* 13 (S1).

Reinhardt, D., and R. Sowerbutts. 2015. "Regulatory Arbitrage in Action: Evidence from Banking Flows and Macroprudential Policy." Staff Working Paper No. 546, Bank of England.

Tarullo, D. K. 2012. "Regulation of Foreign Banking Organizations." Speech delivered at the Yale School of Management Leaders Forum, New Haven, Connecticut, November 28.

Temesvary, J. 2015. "The Role of Regulatory Arbitrage in U.S. Banks' International Lending Flows: Bank-Level Evidence." Working Paper, Hamilton College.

Vandenbussche, J., U. Vogel, and E. Detragiache. 2015. "Macroprudential Policies and Housing Prices: A New Database and Empirical Evidence for Central, Eastern, and Southeastern Europe." *Journal of Money, Credit and Banking* 47 (S1): 343–77.

Changes in Prudential Policy Instruments—A New Cross-Country Database*

Eugenio Cerutti,[a] Ricardo Correa,[b] Elisabetta Fiorentino,[c] and Esther Segalla[d]

[a]International Monetary Fund
[b]Federal Reserve Board
[c]Deutsche Bundesbank
[d]Oesterreichische Nationalbank

This paper documents a new database that focuses on changes in the intensity in the usage of several widely used prudential tools, taking into account both macroprudential and microprudential objectives. The database coverage is broad, spanning sixty-four countries, and with quarterly data for the period 2000:Q1 through 2014:Q4. The five types of prudential instruments in the database are capital buffers, interbank exposure limits, concentration limits, loan-to-value (LTV) ratio limits, and reserve requirements. A total of nine prudential tools are constructed since some useful further

*This paper is part of the 2015 IBRN initiative on the domestic effects and international spillovers of prudential instruments. We would like to thank Claudia Buch, Stijn Claessens, Linda Goldberg, Claudia Jadrijevic, Steven Ongena, an anonymous referee, IBRN participants, IMF economists, and central banks and supervisory authorities for their extremely valuable feedback on the construction of the database. We also greatly appreciate the help provided by Calebe De Roure, Jacob Miller, and Marcus Pramor in the construction of the database. The views in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System, the Deutsche Bundesbank, the International Monetary Fund, and the Oesterreichische Nationalbank. The database on prudential instruments used in the paper is available at http://www.newyorkfed.org/IBRN/index.html. Author contact: Cerutti: International Monetary Fund, 700 19th Street NW, Washington, DC 20431, USA, ecerutti@imf.org. Correa: Board of Governors of the Federal Reserve System, 20th Street & C Street, NW, Washington, DC, 20551, USA, ricardo.correa@frb.gov. Fiorentino: Deutsche Bundesbank, Wilhelm-Epstein-Str. 14, 60431, Frankfurt am Main, Germany, elisabetta.fiorentino@bundesbank.de. Segalla: Oesterreichische Nationalbank, Otto-Wagner-Platz 3, A-1090 Vienna, Austria, esther.segalla@oenb.at.

decompositions are presented, with capital buffers divided into four sub-indexes: general capital requirements, specific capital buffers related to real estate credit, specific capital buffers related to consumer credit, and other specific capital buffers; and with reserve requirements divided into two sub-indexes: domestic-currency capital requirements and foreign-currency capital requirements. While general capital requirements have the most changes from the cross-country perspective, LTV ratio limits and reserve requirements have the largest number of tightening and loosening episodes. We also analyze the instruments' usage in relation to the evolution of key variables such as credit, policy rates, and house prices, finding substantial differences in the patterns of loosening or tightening of instruments in relation to business and financial cycles.

JEL Codes: E43, E58, G18, G28.

1. Introduction

Prudential instruments involving the banking system are essential in the policymaking toolkit to promote financial stability. They constitute the tools most often used to implement both microprudential and macroprudential policies.[1] A full distinction between these two types of policies is blurry, and their differences are mostly based on the particular perspective used (Crockett 2000; Borio 2003; Claessens 2015). Microprudential policy seeks to ensure the soundness of individual financial institutions, while macroprudential policy aims to contain systemic risks in the financial system as a whole. Independent of these objectives, which often intersect, there is a consensus that having a systemwide perspective is a fundamental attribute of a well-specified prudential regulatory framework (International Monetary Fund 2013). Such a prudential framework often seeks to increase the resilience of both individual firms and the financial system to shocks (e.g., by building capital buffers); to contain the buildup of vulnerabilities over time (e.g., by reducing procyclical

[1]There are other instruments in the macroprudential toolkit, such as taxes, levies, and capital flow measurements. Nevertheless, most macroprudential tools considered to date apply to the banking system, mainly given the presence of microprudential regulatory tools that are easily adaptable and the more extensive theoretical knowledge on these instruments.

feedback between asset prices and credit); and to control structural vulnerabilities arising through interlinkages and the critical role of individual intermediaries in key markets that can render individual institutions "too big to fail."

Prudential instruments have been used by a large number of countries with either microprudential or macroprudential objectives, but analyzing the effectiveness of these tools and their potential unintended consequences (e.g., domestic and cross-border spillovers) is an undeveloped area at the international level, partly due to the lack of detailed and consistent cross-country information on changes—either loosening or tightening—in the use of prudential instruments. As part of the 2015 International Banking Research Network (IBRN) initiative, which examines domestic effects and international spillovers of changes in prudential instruments (see Buch and Goldberg 2017), the main aim of this paper and its associated database is to consistently document information on the cross-country usage of key prudential instruments during the 2000–14 period, independently of the final microprudential or macroprudential objectives that authorities might have implicitly or explicitly had.[2]

In this context, our contribution to the literature is twofold. First, we compile a detailed and unique data set of widely used prudential instruments covering the intensity in their usage over time in sixty-four countries at a quarterly frequency. The five types of prudential instruments at the center of the database are capital buffers, interbank exposure limits, concentration limits, loan-to-value (LTV) ratio limits, and reserve requirements. A total of nine prudential tools are constructed since we consider some useful breakdowns of the five types of prudential instruments analyzed (capital buffers into four sub-indexes: general capital requirements, specific capital buffers related to real estate credit, specific capital buffers related to consumer credit, and other specific capital buffers; and with reserve requirements divided into two sub-indexes: domestic-currency

[2]The 2015 initiative of the IBRN is a multi-study project on the domestic effects and international spillovers of prudential instruments, where teams of researchers from fifteen central banks and two international organizations used confidential micro-banking data and more precise measures of prudential regulation to test their hypotheses.

capital requirements and foreign-currency capital requirements). Second, we take advantage of these quarterly series and provide a cross-country view of their usage, taking also into account their correlation with key variables such as credit, policy rates, and house prices. These statistics provide a valuable perspective on how countries are effectively using prudential instruments through business and financial cycles.

The selection of these five types of prudential instruments was based on the need to focus on the most widely used prudential instruments across countries. Following Cerutti, Claessens, and Laeven (2015), which offers the largest coverage on the introduction of macroprudential tools within 119 countries during the 2000–13 period, we selected concentration limits, reserve requirements, LTV ratio limits, and interbank exposure limits, since they are the top four instruments in terms of usage.[3] In addition, since our objective is to cover prudential instruments independent of their microprudential or macroprudential objective, we added capital buffers, a key instrument of modern bank regulation and also widely used (especially from a microprudential perspective).

The prudential database aggregates information from primary sources (e.g., central bank reports) and secondary sources (e.g., the Global Macroprudential Policy Instruments [GMPI] survey conducted by the International Monetary Fund [IMF] during 2013). The sources used for each regulatory change are documented in section 2 and in an online appendix available at http://www.newyorkfed.org/IBRN/index.html. The resulting database provides a comprehensive, multi-country, longitudinal overview of prudential policies at a quarterly frequency. Efforts to ensure the consistency of the data set were the result of feedback received directly from country regulators on the accuracy of the policy changes recorded in the database.

[3]In Cerutti, Claessens, and Laeven (2015), an instrument is being used if it is written into a law or into regulatory rules. Their analysis shows that concentration limits were used (in at least one year) in 64 percent of the 119 countries in their sample, reserve requirements in 37 percent of the countries, and LTV ratio limits and interbank exposure limits in 29 percent of the countries. The same top four instruments are selected following their paper's definition of use frequency (the ratio of country-years using a given instrument to the total number of country-years using a macroprudential policy over the 2000–13 sample period).

Our database represents further progress in recent efforts to measure the use of prudential tools across a large number of countries (e.g., Lim et al. 2011; Zhang and Zoli 2014; Aysan et al. 2015; Cerutti, Claessens, and Laeven 2015). The closest to our data set is Akinci and Olmstead-Rumsey (2015), which analyzes macroprudential policies in fifty-seven advanced and emerging economies covering the period from 2000:Q1 to 2013:Q4, with tightening and easing recorded separately for seven macroprudential tools, and with a primary focus on tools applied to address housing-sector developments. Compared with Akinci and Olmstead-Rumsey (2015), our database captures a broader set of instruments that impact the balance sheets of banks, such as capital and reserve requirements, which makes it more appropriate for studying the effects of prudential regulations on banking activities. In contrast, Akinci and Olmstead-Rumsey (2015) is better suited for analyzing imbalances in the domestic housing sector.

More generally, beyond a larger coverage of countries or instruments compared with other data sets capturing regulatory changes, our data set includes instruments that are used to achieve microprudential objectives, in addition to some of the macroprudential instruments covered by other databases. This is not a minor detail, because surveys of macroprudential instruments rely on the authorities' formal intentions and interpretations of the use of these instruments (i.e., whether the instrument is strictly used to comply with a macroprudential objective), which could trigger important omissions in the reporting of instruments that have been used in the past. Moreover, we also cover omissions that are triggered by implicit classifications under other objectives (e.g., monetary objectives for reserve requirements). For example, the usage of reserve requirements in China was not captured in several surveys on macroprudential instruments (e.g., GMPI) despite the fact that some specific studies such as Ma, Xiandong, and Xi (2013) highlighted their broad usage and multiple objectives, including prudential.

We find several interesting patterns when analyzing the changes in prudential indexes as documented in our database. First, even though concentration limits and interbank limits are two widely used prudential instruments, their intensities (in terms of loosening or tightening) are not often adjusted. Second, LTV ratio limits and reserve requirements (on foreign and local currency) have the

largest numbers of tightening and loosening episodes. Third, instruments linked to capital buffers, concentration limits, and interbank exposures have been used to achieve structural objectives, such as creating capital buffers and lowering risks either with a microprudential or macroprudential perspective. Conditional on usage, this observation is supported by the low correlation between the changes in instrument intensity and key financial variables like credit, policy rates, and house prices. Fourth, the correlations for LTV ratio limits, and foreign- and local-currency reserve requirements, with credit growth signals a countercyclical usage by authorities in most cases. The correlations with respect to house prices are mostly not statistically significant across most countries with available data, except for a few Asian countries. Last, the correlations of LTV ratio limits and reserve requirements with countries' policy interest rates reveal heterogeneous policy actions across countries: many statistically significant correlations indicate both complementarities and non-complementarities between these prudential instruments and policy rates.

The rest of the paper is organized as follows. Section 2 documents the construction of the prudential instruments and the sources used to code the changes in these indexes. Section 3 documents the variation in the different prudential instruments over time and across countries. Section 4 analyzes the usage of these prudential instruments in relation to the evolution of key variables such as credit, policy rates, and house prices. Section 5 concludes.

2. Description of the Database

The IBRN Prudential Instruments Database includes quarterly changes for nine prudential policy indexes that have been used by policymakers with some frequency across a sample of sixty-four countries during the period between 2000 and 2014.[4] This section provides a general description of the construction of the indexes, as well as detailed information about each specific instrument.

[4] A list of the sixty-four countries included in the database is reported in table 3 in the appendix. Out of these sixty-four countries, we have limited coverage for seven countries, which are highlighted in bold in table 3.

2.1 Construction of the Prudential Instrument Indexes

To construct the prudential policy indexes reported in the database, we use a method to map policy changes into simple indexes that has recently been used in studies focusing on the intensity of capital controls (Ahmed and Zlate 2014; Pasricha et al. 2015) and macroprudential policies (Akinci and Olmstead-Rumsey 2015). Nine indexes are constructed for the five types of prudential instruments covered, and the indexes are presented in two ways. The first presentation of index data records the changes in a policy instrument with a 1 or –1 entry, depending on whether the prudential tool was tightened or loosened in a given quarter. The index equals 0 in those quarters when no change occurs. The entries in the database for a given instrument are coded as missing if policymakers cannot use that policy tool.[5] An example of such a case is a country that has not enacted a rule to set LTV ratio limits; the index for this instrument is coded as missing until such a rule is passed.

An advantage of this type of coding is that it can capture the intensity of a policy change while incorporating qualitative traits from the policy that cannot be measured by a unique numerical statistic. For example, in certain circumstances, policymakers may decide to change LTV ratio limits on specific types of real estate transactions while maintaining others unchanged. To fully measure the intensity of such a change in the instrument as a single numerical statistic would require a weighted index of all LTV ratio limits applied to the different transactions. For this purpose, one would need to have specific information on all types of real estate transactions. By recording the change with the discrete index described above, a policy change can simply be captured by entries of 1 and –1 in the index. The intensity of the change, although captured imperfectly by this index, measures the direction of the policy change.

For some policy instruments, we are able to record the intensity of the changes more precisely. This is the case for those instruments

[5]Observations are also coded as missing for a few countries without any information for the concentration and interbank exposure limits. We also record the entries for the general capital requirements index of seven countries, listed in bold in the appendix (table 3), as missing. This type of missing value is coded differently in the database from those that reflect the lack of availability of the policy instrument.

that can be summarized by a single numerical indicator. An example of these instruments is reserve requirements on local- or foreign-currency deposits. Although there is some variation across countries, changes in reserve requirements can be captured by a single statistic (Cordella et al 2014; Federico, Vegh, and Vuletin 2014). Using that statistic, we use positive and negative integers to capture the intensity of the instrument's change relative to the starting date, which in the database is the first quarter of 2000.

Recording the intensity of the change in the policy instrument allows us to produce a second class of index, which we call the "cumulative" index. In each quarter, the cumulative index is the sum, since the first quarter of 2000, of all changes in the policy index recorded prior to, and during, the quarter of interest. The purpose of this cumulative index is to capture the level of "tightness" ("looseness") of an instrument at a given point in time.

Although the properties of this index are appropriate for capturing the intensity of policy changes in a given country over time, they are not ideal for assessing differences in the policy stance across countries. For example, the level of an instrument may be different at the starting point in 2000 or the changes in the instruments may have different qualitative implications across countries, which may not be captured by the index. Thus, the instrument indexes should be used with caution when making cross-sectional comparisons with regards to the tightness (or looseness) of a particular instrument.

2.2 Sources of Information

We use a combination of primary and secondary sources to record the changes in the nine policy instruments included in the database. The starting point to determine these instruments' changes is the GMPI survey (see Cerutti, Claessens, and Laeven 2015 for a description). This survey provides a comprehensive view of the set of macroprudential policies that have been used across a large sample of 125 countries.[6] We also use primary information provided directly by national authorities either through the IBRN or the IMF

[6]Even though the GMPI survey included a question asking about the changes in the covered instruments from 2000 to 2013, the responses to these questions are to a large degree missing or incomplete, constituting one of the main challenges in our documentation not only on usage but also on the intensity of usage.

or our searches in national authorities' web pages. We complement these data with other secondary sources like the earlier IMF data set compiled by Lim et al. (2011) and with information drawn from other general databases that have been compiled in recent years by Akinci and Olmstead-Rumsey (2015), Kuttner and Shim (2013), and Reinhardt and Sowerbutts (2015). Additionally, we also complement this information with specific secondary sources of information that apply to the different prudential instruments, as described in the online appendix.

Lastly, one of the main contributions of the database is the participation of IBRN members in the process of constructing the database. All versions of the database were reviewed by staff from central banks participating in the IBRN to ensure its accuracy and completeness. For instance, they provided information on instrument changes that were not recorded in the aforementioned databases, or noted inaccuracies that were corrected. We also received valuable feedback from country representatives who filled the GMPI survey through staff at the IMF.

2.3 Details on Specific Prudential Instruments

2.3.1 General Capital Requirements

The general capital requirements index is based on the regulatory changes introduced in the Basel Accords through the four revisions: I, II, II.5, and III. The index takes a value of 1 when a capital regulation is implemented or tightened and 0 when no changes in capital regulations take place. We assume that the implementation of the Basel Accords never loosens the existing regulation. Therefore, the index never takes the value of –1. The main sources of information for the implementation of the Basel II, II.5, and III agreements are the Basel Committee on Banking Supervision progress reports on members' implementation and country supervision authorities' websites.[7] For those countries not covered by these publicly available sources,

[7]The Bank for International Settlements (BIS) sources are the "Progress Report on Implementation of the Basel Regulatory Framework" (http://www.bis.org/bcbs/implementation.htm) and the "FSI Survey — Basel II, 2.5 and III Implementation" (http://www.bis.org/fsi/fsiop2015.htm).

we directly submitted inquiries to the country authorities through the IBRN or IMF.

The capital requirements index records policy changes at the point in time when the law is implemented and not when it is passed. More importantly, we code the Basel I, II.5, and III agreements as a tightening (an entry equaling 1) of capital requirements, whereas Basel II is coded as neutral (an entry of 0). The decision to record Basel II as not changing the intensity of capital requirements is based on evidence that suggests that the introduction of this agreement did not lead to a tightening nor a loosening of overall capital requirement regulations.[8] As stated by the Basel Committee, the objective of Basel II regarding the overall level of minimum capital requirements was "to broadly maintain the aggregate level of minimum capital requirements, while also providing incentives to adopt the more advanced risk-sensitive approaches of the revised framework" (Basel Committee on Banking Supervision 2006).

2.3.2 Sector-Specific Capital Buffers

The sector-specific capital buffer index is another bank-capital-based indicator that captures regulatory changes that are aimed at curtailing the growth in bank claims to specific sectors of the economy. Changes in this type of prudential instrument usually take the form of adjustments to the risk weights of specific bank exposures, which are tightened or loosened with the financial cycle.

We separately record changes for three categories of credit depending on the borrower's type, namely real estate credit, consumer credit, and other credit. The aggregate sector-specific capital buffer index is equal to the sum of prudential instrument changes across the different types of credit. As such, the index can take on values greater or lower than 1 or –1 in a given quarter, which would signal changes in the capital buffers for more than one sector at the same time.

[8]For a detailed analysis of the quantitative impact of Basel II, see the Financial Stability Institute's report titled "Results of the Fifth Quantitative Impact Study (QIS 5)," which can be found at http://www.bis.org/bcbs/qis/qis5results.pdf.

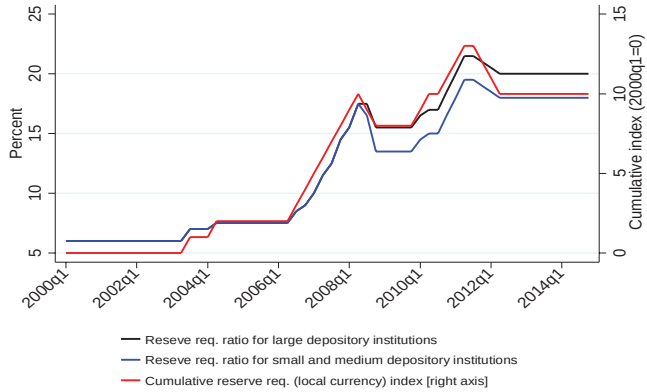
2.3.3 Reserve Requirements

Reserve requirements have typically been used as instruments to conduct monetary policy. However, as noted by Cordella et al. (2014), these requirements have also been used as countercyclical macroprudential tools by emerging economies. The GMPI survey explicitly asked respondents whether they use this tool as a macroprudential or monetary policy tool. We rely on this information to determine whether changes in the instrument should be included in the database, which we complement with other sources if the GMPI does not report whether the country uses reserve requirements to achieve macroprudential objectives.

After we determine that reserve requirements are used in a country to satisfy prudential objectives, we proceed to collect information on the changes in these requirements over time. We separately collect information on changes in reserve requirements for deposit accounts denominated in domestic and foreign currency. The principal sources of information to determine these policy changes are central banks' websites, the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER), and the database by Federico, Vegh, and Vuletin (2014).

Although reserve requirement ratios are typically reported as a number, these requirements can apply to different types of accounts. For example, within deposit accounts, there may be several subcategories, such as demand and savings accounts. Similarly, reserve requirement ratios may apply to deposits of different maturities. We use the numeric index defined earlier to capture the overall level of reserve requirements within a broad category. Given the mostly quantitative nature of this instrument, we also use numbers above or below 1 and –1 to record the intensity in the changes. As shown in figure 1, the cumulative index that records changes in reserve requirement ratios in China tracks the contour of the level of this instrument well. This is one of the strengths of the index, as it is able to capture changes in these policies while at the same time implicitly taking into account qualitative changes like the differentiated treatment of large, and small and medium depository institutions in mid-2008.

Figure 1. Reserve Requirement Ratios and Cumulative Index for China



2.3.4 Concentration Limits and Interbank Exposure Limits

Limits on concentrated exposures and on exposures to other banks are multifaceted policies that affect claims between banks and their borrowers. As opposed to reserve requirement ratios, these limits can be changed by modifying at least five elements that characterize these exposures:

(i) The definition of large exposures: As defined by the Basel Committee on Banking Supervision (2014), an exposure should be classified as large if "the sum of all exposure values of a bank to a counterparty or to a group of connected counterparties ... is equal to or above 10% of the bank's eligible capital base." However, there are some differences in the specific definitions across countries. For example, France characterizes large exposures as those representing 10 percent of eligible capital of a bank or those with a value of more than 300 million euros.

(ii) The level of the limit: The limit on these exposures may be defined as a share of a bank's capital or in monetary terms. These exposures are weighted by the appropriate risk weights.

(iii) Differentiation across counterparties: Weights on exposures may depend on the "riskiness" of the counterparty and the duration of the claims.

(iv) Aggregate limits: Banks may also face aggregate concentration limits, totaled across all large exposures, which should not exceed a threshold expressed as a share of eligible capital.
(v) Sectors and assets that are covered by the regulation: The regulation may cover the exposures of depository institutions, or it may apply to a larger group, incorporating those of nonbank financial institutions. On the counterparty side, some sectors may be exempted from banks' concentration limits. In other cases, the definition of qualified assets that are counted toward exposures limits may also change over time (e.g., interbank exposures).

These layers that encompass the concentration and interbank exposure limits require a careful assessment of the changes in the characteristics of these regulatory requirements over time. We use our index to record these changes using information from the GMPI survey. In the process, we rely on three assumptions to code the changes. First, if multiple changes to the characteristics defined above are implemented, we determine whether, on net, the policy tightened or loosened these exposures limits. Second, if the rules determining the concentration limits, including interbank exposures, are changed in a given quarter, we only code the change for concentration limits and not for interbank exposures. If the changes mostly apply to interbank exposures, we only code a change for this index. Last, in cases when the authorities do not specify the exact quarter, within a year, when the policy changes were implemented, we use the first quarter of that year as the date of implementation.

2.3.5 Loan-to-Value Ratio Limits

LTV ratio limits, or caps, are restrictions on the maximum amount that an individual or firm can borrow against their collateral. The most common form of LTV cap is applied to real estate transactions. In this particular case, authorities may limit the amount that an individual can borrow against the value of the property. The instrument is said to affect the demand for credit, as it applies to any transactions covered by the policy regardless of the type of lender.

In our index, we record changes in LTV ratio limits that affect real estate transactions. Changes in banks' risk weights associated

with LTV ratios are not considered since they do not necessarily constrain the maximum borrowing capacity for borrowers. Nevertheless, two additional types of changes in maximum LTV ratio limits are taken into account: (i) changes related to the maximum amount insured in real estate transactions in Canada and Hong Kong; and (ii) changes in LTV regulations related to the maximum LTV allowed in covered bonds (Denmark and Finland). In those cases, although the regulation does not directly target the characteristics of all the loans, the impact is broadly similar (e.g., covered bonds are the main source of mortgage funding in Nordic countries).

As is the case with reserve requirements, changes in LTV caps can be broadly tracked over time by following the evolution of this numeric variable. However, those changes can also affect subsamples of the universe of mortgages, such as first residential purchases or mortgages on properties that fall in specific price ranges. For cases in which LTVs are tightened for specific types of transactions and loosened for others, we assess whether, on net, the policy change falls in one category or the other and code it accordingly.

3. Usage of Prudential Policies

This section presents information on the changes recorded in the indexes for the policy instruments described before, and for their subcomponents. The database contains information for five types of prudential instruments and sixty-four countries. For two of the instruments, we also calculate subcomponents. For the sector-specific capital buffers, we calculate indexes for buffers that apply separately to real estate loans, consumer loans, and other loans. Similarly, for reserve requirements, we calculate separate indexes for policy changes that apply to accounts denominated in foreign currency and domestic currency. Adding these subcomponents, the total number of prudential indexes increases to nine.

Table 1 presents information on the number of quarterly episodes recorded in each of the nine indexes. As expected, in any given quarter most indexes do not change, which explains the large mass of observations at the value zero. LTV ratio limits and reserve requirements (on foreign and local currency) have the largest numbers of tightening and loosening episodes. The index on general capital requirements differs from all the others because it only encompasses

Table 1. Changes in the Prudential Instrument Indexes

Value	SSCB Real Estate Loans	SSCB Consumer Loans	SSCB Other Loans	Concent. Limits	Interbank Exposures	RR: Foreign Currency	RR: Local Currency	Loan-to-Value Ratio Limits	General Capital Reqs.
–3	0	0	0	0	0	2	1	0	0
–2	0	0	1	0	0	8	8	0	0
–1	15	3	4	2	1	41	157	25	0
0	3,787	3,828	3,819	2,023	1,100	3,699	3,543	1,201	3,320
1	38	9	14	32	24	85	126	72	100
2	0	0	2	0	0	3	2	0	0
3	0	0	0	0	0	1	0	0	0
4	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	1	1	0	0
Total	3,840	3,840	3,840	2,057	1,125	3,840	3,838	1,298	3,420

Notes: This table presents the frequencies of non-missing observations in the prudential database tabulated by instrument and the value of the index in any given quarter. SSCB stands for sector-specific capital buffer and RR stands for reserve requirements. We use all subcomponents of the indexes, including the SSCBs for real estate, consumer, and other loans, and RRs split between those applied to local- and foreign-currency deposit accounts. The value 0 is coded when a given policy instrument is not changed in a quarter. Tightening episodes are recorded with positive values in the index, and loosening episodes are recorded with negative values.

tightenings. These one-sided changes are explained by the way the index is coded, which only incorporates information on the implementation of the Basel Accords (these regulatory changes are coded as neutral or tightenings).

Note that the total number of episodes varies across instruments. As explained in the previous section, instruments that are not available to policymakers due to the absence of legislation that authorizes their use are coded as missing in the database. For some countries, instruments that are introduced during the sample period are coded as of the date the legislation to authorize them is passed. In these cases, if the introduction of the instrument is considered a tightening of the policy stance, it is coded as 1 in the index. There are other instances when the introduction of the instrument does not affect the policy stance, such as introducing reserve requirements and setting them at 0, which are coded as 0 in the index.

The information in table 2 reports the number of countries with policy changes in the sample period, as opposed to the number of total episodes. As expected, most countries made changes to the general capital requirements, as they adopted different versions of the Basel Accords in the past fifteen years. Similarly, reserve requirements on local-currency accounts and LTV ratio limits are instruments broadly used by countries in the sample, but in contrast to capital requirements, these policy tools are both tightened and loosened by many countries in the sample. On the other side of the spectrum, we find that interbank exposures are only modified by one-fifth of the sample, and most of these changes involve a tightening.

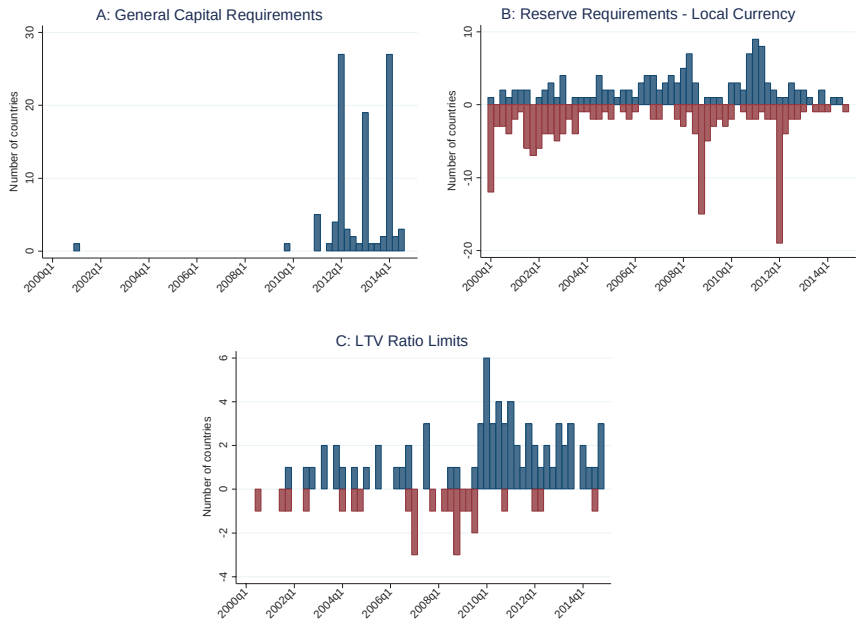
As shown in these tables, the usage of prudential instruments varies notably across the different types, both in the frequency of changes and in the direction of these changes. The use of prudential instruments also changes markedly across the sample period. Figure 2 presents information on the number of countries tightening or loosening three selected prudential policies in every quarter over the sample period. We focus on capital requirements, reserve requirements on local-currency deposits, and LTV ratio limits, some of the indexes with more variation or wider usage across countries. As noted previously, capital requirements are only shown to be tightened during the sample period (graph A), which is explained by the definition of the index. More importantly, those tightenings

Table 2. Use of the Prudential Instruments across Countries

	Distinct Countries with Instrument Changes	Countries with Tightening Episodes	Countries with Loosening Episodes	Countries with Instrument
SSCB Real Estate Loans	22	20	9	64
SSCB Consumer Loans	9	7	3	64
SSCB Other Loans	12	11	3	64
Concentration Limits	22	21	2	36
Interbank Exposures	14	13	1	22
RR: Foreign Currency	21	20	17	64
RR: Local Currency	46	29	44	64
Loan-to-Value Ratio Limits	36	33	14	38
General Capital Requirements	55	55	0	57

Notes: This table reports information on the number of countries with policy changes for each instrument. The database contains a total of sixty-four countries. SSCB stands for sector-specific capital buffer and RR stands for reserve requirements. We use all subcomponents of the indexes, including the SSCBs for real estate, consumer, and other loans, and RRs split between those applied to local- and foreign-currency deposit accounts. The last column shows the number of countries with access to a given instrument at any point in time during the sample period or those countries for which we have any information.

Figure 2. Changes in Prudential Instruments across Time



are clustered after the global financial crisis, as regulators implemented the new requirements embedded in the Basel II.5 and III Accords. In contrast, reserve requirements (graph B) and LTV ratio limits (graph C) exhibit changes throughout the sample period, with both tightenings and loosenings. In the case of reserve requirements, there are two important loosening periods that coincided with the global financial crisis and the European sovereign debt crisis. LTV ratio limits were largely tightened after the global financial crisis, perhaps as a result of loose monetary policies in several countries.

These patterns prompt several questions, especially about the reaction functions of regulators and supervisors to financial stability vulnerabilities and the use of prudential policies. Some instruments appear to be used more frequently and co-move with the financial cycle, while others are changed less often and perhaps as a reaction to financial crises. We explore these issues in the next section.

4. Cyclical or Countercyclical Usage?

This section analyzes whether changes in the usage of prudential instruments in each country are correlated with the evolution of credit growth, house prices, and policy rates. These correlations cannot fully reveal the underlying microprudential or macroprudential emphasis used by the authorities (which could change over time), but they offer an overview of the cyclicality of prudential instruments with respect to, for example, bank credit or house prices.

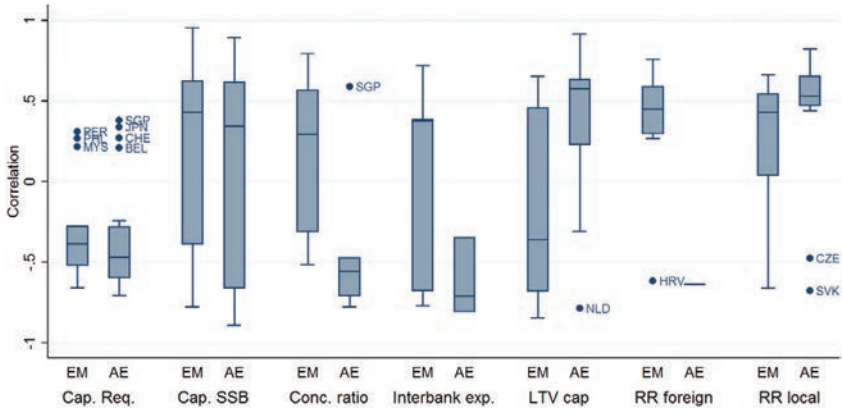
In principle, if a prudential instrument is used with a macroprudential intent, then, to some degree, we would expect a positive correlation between the intensity of this instrument and credit growth, indicating a countercyclical usage (e.g., tightening during high credit growth periods and loosening during low credit growth periods). In addition, the correlation of prudential instruments with respect to the policy rate of each country offers some clues as to whether the usage of these financial stability tools has been complementary to the monetary policy objectives, as captured by the evolution of the policy rate.

Figure 3 shows the distribution of the statistically significant correlations between the usage of prudential instruments and real credit growth in each country.[9] These correlations are calculated based on the cumulative index of seven prudential indexes presented in the previous sections (with the three sector-specific capital buffers presented as an aggregate) and real credit growth (annualized, using the most recent four quarters, and deflated using CPI inflation) from series produced by the Bank for International Settlements (BIS) and the IMF International Financial Statistics (IFS).[10] Countries that register some fluctuation in the usage of prudential instruments over time are the only ones with correlations, so the number of correlations plotted varies across instruments. In the case of capital requirements (Cap. Req.), it is possible to calculate correlations with credit

[9] Correlations are similar if we use nominal credit growth instead of real credit growth.

[10] Results are broken down into emerging markets (EM) and advanced economies (AE), following the IMF October 2015 World Economic Outlook (WEO) classification.

Figure 3. Distribution of Correlations between Intensity Changes in Prudential Instruments and Real Credit Growth



Note: Only statistically significant correlations at the 10 percent level or less are plotted.

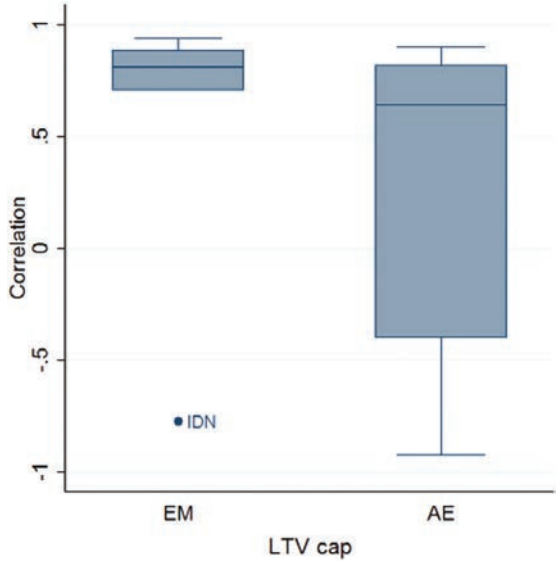
growth for fifty-one countries, of which thirty-three are statistically significant. Most of the distribution of these statistically significant correlations is clearly on the negative side (especially the distribution within the 25th and 75th percentiles that is captured by the boxes in the standard box plot figure). This is driven by the fact that capital requirements are not frequently changed, and the timing of changes is linked with the implementation of Basel reforms that often happen after crises or financial turmoil, coinciding with slowdowns in credit growth. The distribution of the correlations is more broadly distributed in the case of the sector-specific capital buffer (Cap. SSB) than the general capital requirements (sixteen statistically significant correlations out of twenty-five available correlations), with the median being slightly above zero for the EM and AE groupings. Despite being among the most widely used instruments (Cerutti, Claessens, and Laeven 2015), changes in the intensity of usage in the concentration ratio (Conc. ratio) and interbank exposure (Interbank exp.) limits do not show many significant correlations with the evolution of credit growth. This result is not explained by the correlations being insignificant, but by the fact that the intensity in the

usage of these two instruments does not change for most countries (fourteen statistically significant correlations out of eighteen calculated for concentration limits, and eight statistically significant out of eleven calculated for interbank exposure limits). Moreover, most of these statistically significant correlations are for EMs, and the distribution of correlations is broadly across positive and negative values. Therefore, this evidence suggests that instruments linked to capital buffers, concentration limits, and interbank exposure limits are used with more structural objectives in mind (e.g., creating capital buffers, and lowering risks either with a microprudential or macroprudential perspective), instead of business or credit cycle considerations.

In contrast, the correlations for the LTV ratio limits (LTV cap) and foreign-currency (RR foreign) and local-currency (RR local) reserve requirements with credit growth signal a countercyclical usage in most cases. The correlations of the local-currency reserve requirement index (twenty-six statistically significant correlations out of thirty-nine calculated) are positive for both emerging markets and advanced economies. With the exception of Argentina, there are nine emerging markets (Hungary, Croatia, Ukraine, Romania, Philippines, Lithuania, Peru, Brazil, and Turkey) with significant positive correlations. The results are similar for the index of foreign-currency reserve requirements in emerging markets (eight statistically significant correlations out of fourteen calculated; these countries are Romania, Argentina, Peru, Chile, Russia, Colombia, Brazil, and Croatia, which is an outlier on the negative side). These results are in line with those presented in the related literature. For example, Federico, Vegh, and Vuletin (2014) find a positive correlation between the evolution of reserve requirements and countries' real GDP growth. Although not expected, there are fourteen advanced economies with local-currency reserve requirements that exhibit positive and significant correlations (such as Italy, Spain, Portugal, Greece, Singapore, Netherlands, Slovenia, France, etc.).[11] Foreign-currency reserve requirements appear to be irrelevant in advanced economies, with only three calculated correlations, of which only one (Slovakia) is statistically significant.

[11]For euro-area countries, reserve requirements ratios are determined by the European Central Bank.

Figure 4. Distribution of Correlations between Intensity Changes in LTV Ratio Limits and House Prices

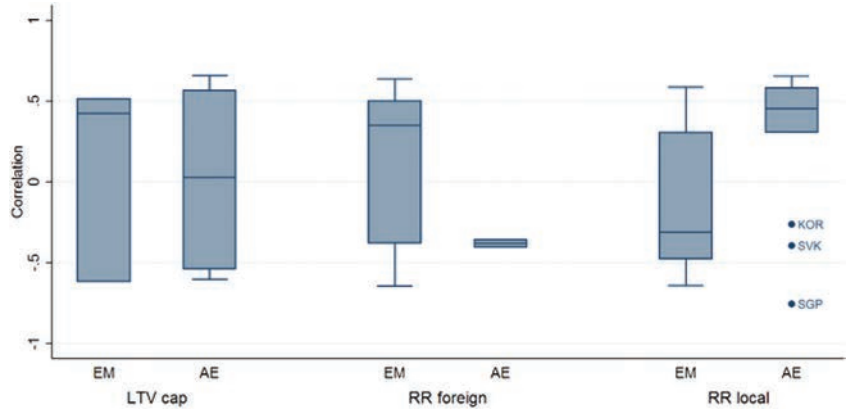


Note: Only statistically significant correlations at the 10 percent level or less are plotted.

The correlations between LTV ratio limits and credit growth (there are seventeen statistically significant correlations out of twenty-one calculated) suggest that some advanced economies have used this instrument more countercyclically. Several countries have positive correlations with respect to credit growth (Spain, Norway, Denmark, Singapore, Iceland, Luxembourg, Hong Kong, and Canada), with the only exceptions being Korea and the Netherlands. As highlighted in the literature (Cerutti, Claessens, and Laeven 2015), the effect of LTV ratio limits on house prices is not clearly specified on average across countries. This is also visible in figure 4 for AEs, where the statistically significant correlations between LTV ratio limits and house prices are above and below zero.[12]

[12]The positive significant correlations between LTV ratio limits and house prices are mostly from Asia (e.g., Hong Kong, South Korea, Malaysia, and India). This correlation captures the effect of lending standards on house prices, and is

Figure 5. Distribution of Correlations between Intensity Changes in Prudential Instruments and Policy Rates



Note: Only statistically significant correlations at 10 percent or less are plotted.

The correlations of both LTV ratio limits and reserve requirements with countries' policy interest rates are also revealing and are shown in figure 5.[13] In the case of LTV caps, unlike the correlations with credit growth, there are advanced economies with statistically significant positive correlations (Denmark, Luxembourg, and Iceland), as well as another group with statistically significant negative correlations (Singapore, Hong Kong, and Canada). The median is around zero. We find a similar result for three emerging economies. These findings suggest that LTV caps are used in several countries together with higher policy rates to achieve, perhaps, complementary objectives. But this pattern does not apply in all countries, as shown by some statistically significant negative correlations.

supported by some studies (e.g., Igan and Kang 2011; International Monetary Fund 2011; Akinci and Olmstead-Rumsey 2015; Cerutti, Dagher, and Dell'Ariccia 2015) that have found a positive relationship between LTV limits and house price increases over time. Other studies like Vandenbussche, Vogel, and Detragiache (2015), which focuses on Eastern Europe, find that other instruments, such as capital and non-standard liquidity measures, had a larger impact on house prices.

[13]The correlations (not reported) between policy rates and the intensity of usage of capital buffers, concentration limits, and interbank exposures limits are in line with the correlations with credit growth. The changes in the usage intensity of these instruments is not related to the monetary policy stance.

In the case of reserve requirements, many EMs appear to use this instrument, especially for local-currency accounts, as a way to (at least partially) offset the effects of changes in the policy rate (for example, India, Argentina, the Philippines, China, and Bulgaria have negative and significant correlations between reserve requirements and policy rates). However, we find the opposite pattern in a smaller group of countries, since Romania, Poland, and Lithuania display statistically significant positive correlations. Among advanced economies, changes in local-currency reserve requirements are positively correlated with policy rates in ten countries (all members of the euro area), showing that in most cases, changes in local-currency reserve requirements and policy rates were used as complementary policies.

5. Conclusions

We have compiled and documented a unique data set measuring changes in the intensity of use for nine widely used prudential tools, covering a large sample of sixty-four countries over the period between 2000:Q1 and 2014:Q4. We find that LTV caps and reserve requirements (on foreign and local currency) have the largest number of tightening and loosening episodes. We also provide evidence related to the correlations between changes in prudential instruments and key financial variables such as credit, policy rates, and house prices. Changes in capital buffers, concentration limits, and interbank exposures are aimed at achieving more structural objectives, such as enhancing the resilience of the banking sector, and lowering risks either with a microprudential or macroprudential perspective. In contrast, we show that the use of LTV ratio limits and foreign and local-currency reserve requirements appear more consistent with countercyclical policy objectives in most cases, but with some important heterogeneity across countries. Lastly, some of our tests indicate complementary and non-complementary interactions between a few of the prudential policy instruments and monetary policy rates.

As part of the initiative of the IBRN on cross-border prudential policy spillovers, which consisted of a research project involving multiple countries and international organizations, the data set documented in this paper makes a clear contribution. While this

database is used across all of the studies of that initiative, and helps inform the analysis of the effectiveness of prudential instruments and their potential unintended consequences at the international level, the database has much broader relevance. Given the unique nature of the data set, it will further provide a service to future analyses in the research and policy communities on the use and the effectiveness of microprudential and macroprudential policies toward either controlling credit growth or increasing the resilience of the financial sector.

Appendix

Table 3. List of Countries

Argentina	Germany	Malaysia	Singapore
Australia	Greece	Malta	Slovak Republic
Austria	Hong Kong	Mexico	Slovenia
Belgium	Hungary	**Mongolia**	South Africa
Brazil	Iceland	Netherlands	South Korea
Bulgaria	India	New Zealand	Spain
Canada	Indonesia	**Nigeria**	Sweden
Chile	Ireland	Norway	Switzerland
China	Israel	Peru	Taiwan
Colombia	Italy	Philippines	Thailand
Croatia	Japan	Poland	Turkey
Czech Republic	**Kuwait**	Portugal	Ukraine
Denmark	Latvia	Romania	United Kingdom
Estonia	**Lebanon**	Russian Federation	United States
Finland	Lithuania	**Saudi Arabia**	**Uruguay**
France	Luxembourg	Serbia	**Vietnam**

Note: Countries with limited information are in bold font.

References

Ahmed, S., and A. Zlate. 2014. "Capital Flows to Emerging Market Economies: A Brave New World?" *Journal of International Money and Finance* 48 (Part B): 221–48.

Akinci, O., and J. Olmstead-Rumsey. 2015. "How Effective are Macroprudential Policies? An Empirical Investigation."

International Finance Discussion Paper No. 1136 (May), Board of Governors of the Federal Reserve System.

Aysan, A. F., S. Fendolu, M. Kılınç, and S. Yıldız. 2015. "Credit Cycles and Capital Flows: Effectiveness of Macroprudential Policy Framework in Emerging Countries." Mimeo, Central Bank of Turkey.

Basel Committee on Banking Supervision. 2006. "International Convergence of Capital Measurement and Capital Standards: A Revised Framework Comprehensive Version." June. Available at http://www.bis.org/publ/bcbs128.pdf.

———. 2014. "Supervisory Framework for Measuring and Controlling Large Exposures." April. Available at http://www.bis.org/publ/bcbs283.pdf.

Borio, C. 2003. "Towards a Macroprudential Framework for Financial Supervision and Regulation?" BIS Working Paper No. 128 (February).

Buch, C., and L. Goldberg. 2017. "Cross-Border Prudential Policy Spillovers: How Much? How Important? Evidence from the International Banking Research Network." *International Journal of Central Banking* 13 (S1).

Cerutti, E., S. Claessens, and L. Laeven. 2015. "The Use and Effectiveness of Macroprudential Policies: New Evidence." Forthcoming in *Journal of Financial Stability.*

Cerutti, E., J. Dagher, and G. Dell'Ariccia. 2015. "Housing Finance and Real-Estate Booms: A Cross-Country Perspective." IMF Staff Discussion Note No. 15/12.

Claessens, S. 2015. "An Overview of Macroprudential Policy Tools." *Annual Review of Financial Economics* 7: 397–422.

Cordella, T., P. Federico, C. Vegh, and G. Vuletin. 2014. "Reserve Requirements in the Brave Macroprudential World." Policy Research Working Paper No. 6793 (February), World Bank.

Crockett, A. 2000. "Marrying the Micro- and Macro-prudential Dimensions of Financial Stability." Speech given at the Eleventh International Conference of Banking Supervisors, Basel, Switzerland, September 21.

Federico, P., C. Vegh, and G. Vuletin. 2014. "Reserve Requirement Policy over the Business Cycle." NBER Working Paper No. 20612.

Igan, D., and H. Kang. 2011. "Do Loan-to-Value and Debt-to-Income Limits Work? Evidence from Korea." IMF Working Paper No. 11/297.

International Monetary Fund. 2011. "Housing Finance and Financial Stability—Back to Basics?" In *Global Financial Stability Report: Durable Financial Stability: Getting There from Here*, April, 111–57 (chapter 3). Washington, DC: International Monetary Fund.

———. 2013. "Key Aspects of Macroprudential Policy." IMF Policy Paper (June 10).

Kuttner, K. N., and I. Shim. 2013. "Can Non-interest Rate Policies Stabilise Housing Markets? Evidence from a Panel of 57 Economies." BIS Working Paper No. 433.

Lim, C. H., F. Columba, A. Costa, P. Kongsamut, A. Otani, M. Saiyid, T. Wezel, and X. Wu. 2011. "Macroprudential Policy: What Instruments and How to Use Them? Lessons from Country Experiences." IMF Working Paper No. 11/238.

Ma, G., Y. Xiandong, and L. Xi. 2013. "China's Evolving Reserve Requirements." *Journal of Chinese Economic and Business Studies* 11 (2): 117–37.

Pasricha, G., M. Falagiarda, M. Bijsterbosch, and J. Aizenman. 2015. "Domestic and Multilateral Effects of Capital Controls in Emerging Markets." NBER Working Paper No. 20822.

Reinhardt, D., and R. Sowerbutts. 2015. "Regulatory Arbitrage in Action: Evidence from Banking Flows and Macroprudential Policy." Staff Working Paper No. 546, Bank of England (September).

Vandenbussche, J., U. Vogel, and E. Detragiache. 2015. "Macroprudential Policies and Housing Prices: A New Database and Empirical Evidence for Central, Eastern, and Southeastern Europe." *Journal of Money, Credit and Banking* 47 (1): 343–77.

Zhang, L., and E. Zoli. 2014. "Leaning Against the Wind: Macroprudential Policy in Asia." IMF Working Paper No. 14/22.

International Prudential Policy Spillovers: A Global Perspective*

Stefan Avdjiev, Cathérine Koch, Patrick McGuire, and Goetz von Peter
Bank for International Settlements

We combine the BIS international banking statistics with the IBRN Prudential Instruments Database in a global study analyzing the effect of prudential measures on international lending. Our bilateral setting, which features multiple home and destination countries, allows us to simultaneously estimate both the international transmission and the local effects of such measures. We find that changes in macroprudential policy via loan-to-value limits and local-currency reserve requirements have a significant impact on international bank lending. Balance sheet characteristics play an important role in determining the strength of these effects, with better-capitalized banking systems and those with more liquid assets and less core deposit funding reacting more. Overall, our results suggest that the tightening of these macroprudential measures can be associated with international spillovers.

JEL Codes: F42, G15, G21.

*This paper is part of a multi-study research initiative of the International Banking Research Network (IBRN) on cross-border prudential policy spillovers. We thank Jose Berrospide, Claudia Buch, Matthieu Bussière, Ricardo Correa, Dietrich Domanski, Mathias Drehmann, Ingo Fender, Linda Goldberg, Friederike Niepmann, Christian Schmieder, and Tsvetana Spasova for valuable comments and suggestions, and Michael Brei and Leonardo Gambacorta for sharing their data on bank characteristics, as well as Jakub Demski for excellent research assistance. The views expressed in this paper are those of the authors and do not necessarily reflect the views of the Bank for International Settlements. Any remaining errors are solely our responsibility. Author contact: Bank for International Settlements, Centralbahnplatz 2, 4002 Basel, Switzerland. E-mails: stefan.avdjiev@bis.org, catherine.koch@bis.org, patrick.mcguire@bis.org, goetz.vonpeter@bis.org.

1. Introduction

Increased recourse to prudential and, in particular, macroprudential policy measures in the wake of the financial crisis has fueled a debate about the transmission mechanisms and impact of these instruments. An elusive, but important, aspect of this debate is the extent to which prudential measures generate spillovers in international banking that affect credit conditions faced by borrowers abroad.

This paper provides a global perspective on the international transmission of prudential measures that complements the country-specific studies using bank-level data in the context of the International Banking Research Network (IBRN). The Bank for International Settlements (BIS) international banking statistics are aggregated, but they are available for multiple national banking systems and destination markets.[1] By painting a comprehensive picture of the main banking systems' foreign positions, these statistics provide a perspective lacking in other banking data sets. We use these data in a bilateral panel regression, where indicators of prudential policy changes taken in home and destination countries enter jointly.

When a country enacts prudential policy, three types of effects may occur. The first, purely domestic, effect relates to domestically owned banks altering their local positions vis-à-vis borrowers in the same country. The other two effects are international in nature and are the focus of our study on spillovers. First, banks headquartered abroad may change their foreign lending to the country that enacted the policy; we use the term *local effect* to denote that it affects borrowers in the very country that changed the policy, the "destination" of credit flows. At the same time, banks headquartered in the country that enacted the measure may alter their foreign lending to the rest of the world; here, the term *international transmission* captures the fact that the effect of "home-country" regulation is felt by borrowers in other destinations (see International Monetary Fund, Financial Stability Board, and Bank for International Settlements 2016 for an overview).

[1] In this paper, "national banking system" refers to the set of large internationally active banks that are headquartered in each respective BIS reporting country, and "destination" refers to the country where these banks' counterparties (borrowers) reside.

To measure these effects, we use a panel of sixteen banking systems and fifty-three counterparty countries, covering nearly 90 percent of global foreign claims from 2000 to 2014. Our focus is on two components of banks' consolidated foreign claims: (i) international claims, which consist of banks' cross-border claims and local claims in foreign currencies, and (ii) foreign affiliates' local claims denominated in local currency. Claims include both loans and banks' holdings of debt securities.

Amongst the policy measures contained in the IBRN database, loan-to-value (LTV) limits and local-currency reserve requirements are the macroprudential instruments that have the most significant effects on international bank lending. In the majority of cases we consider, the estimated international effects of a macroprudential tightening turn out to be expansionary.

We find that a tightening of LTV limits in a *destination* country leads to an increase in international bank lending to the residents of that country (local effect). Banks' international claims also respond to LTV changes in their home country (international transmission), whereby their balance sheet characteristics modulate the strength of this effect. Better-capitalized banking systems and those with more liquid assets and less core deposit funding tend to increase their international claims by more in the face of tighter LTV requirements at home. This is consistent with the idea that stronger bank balance sheets are generally associated with more lending (see Gambacorta and Shin 2016)—in our case, international lending.

Similar effects are evident for a tightening of local-currency reserve requirements. When implemented by a *destination* country, such a tightening is associated with an increase in international bank lending to borrowers in that country. When enacted by a *home* country, such a tightening is transmitted abroad by international banks in the form of higher growth in lending to borrowers in other destinations. Again, this effect is stronger for better-capitalized banking systems and those less reliant on deposit funding.

2. Data and Stylized Facts

This section describes the data used in our analysis, drawing on the BIS consolidated banking statistics (CBS),[2] Bankscope, the IBRN

[2]For more detail on the BIS international banking statistics, see BIS (2015).

Prudential Instruments Database, and various indicators of business and financial cycles. In contrast to the single-country studies in the IBRN research initiative, we examine the transmission of prudential measures via bilateral international lending between multiple home countries and destination markets, as elaborated in section 3. In this setting, the country where banks are headquartered is the *home country*, which is synonymous with those banks' nationality, whereas the *destination country* is the location of the borrowers receiving credit.

2.1 International Bank Lending

We draw on the BIS CBS on an immediate counterparty basis to construct a quarterly panel of sixteen bank nationalities (home countries) and fifty-three destination markets for the period 2000:Q1 to 2014:Q4.[3] These sixteen nationalities include the major internationally active banks, and account for almost 90 percent of the aggregate stock of global foreign claims reported in the CBS at end-2014:Q4. Note that, while we use the term "lending" throughout the paper, reported claims include not only bank loans but also holdings of securities on banks' balance sheets.

The first dependent variable we consider is *international claims* (IC), which is the sum of two components: *cross-border claims* (XBC), i.e., claims booked by banks headquartered in a given country ("home") vis-à-vis residents of another country ("destination"), and *local claims in foreign currencies* (LCFC) booked by those banks' affiliates in that destination country (IC = XBC + LCFC).[4] Our second dependent variable is *local claims in local currency* (LCLC), i.e., claims booked by banks' affiliates in the destination country and denominated in that country's local currency.[5] Both

[3]The sixteen creditor bank nationalities and fifty-three borrower (destination) countries are listed in appendix 3. The panel is unbalanced in that not all banking systems have outstanding claims on all fifty-three destination countries.

[4]The BIS CBS do not distinguish between the positions of branches and subsidiaries.

[5]Cross-border claims account for the bulk of international claims for most lender-borrower (nationality-destination) pairs in our sample. As of end-2014, global cross-border claims totaled $19.2 trillion, or 86 percent of global international claims. At the same time, most local claims tend to be denominated in local currency. At the end of 2014, 71 percent of all local-currency claims were denominated in local currency.

dependent variables enter the specification in quarterly log changes (denoted as $\Delta Y_{i,j,t}$).

We adjust both dependent variables for exchange rate fluctuations and breaks in series. The currency of LCLC is known by construction, so adjusting for exchange rate movements is straightforward. By contrast, the currency composition of international claims is not reported in the CBS. We still adjust international claims for currency valuation effects using the methodology described in appendix 1.

Table 1 (panel A) provides summary statistics for our bilateral dependent variables for the full sample and for the main subsamples that we examine in the empirical part.

2.2 Changes in Prudential Instruments

Our data on the use of prudential instruments are taken from the IBRN Prudential Instruments Database, which is described in Cerutti et al. (2017). After tailoring these data to our global setting, table 2 summarizes the policy changes in each prudential instrument from the perspectives of home countries (panel A) and destination markets (panel B). With an eye on the variation needed for identification, we consider two levels of aggregation. Column 1 shows the total number of measures taken, while columns 2 and 3 distinguish between tightening and loosening of measures at the country-time level.

Our estimation is performed at the level of home-destination pairs observed at the quarterly frequency. Columns 4–6 provide the number of changes in prudential measures from this perspective. For each type of instrument, a typical tightening episode is coded as "+1", and a loosening as "–1" in the quarter the prudential measure takes effect, and "0" otherwise (Buch and Goldberg 2017 and Cerutti et al. 2017). In most of the analysis below, we ignore sector-specific capital buffers, interbank exposure limits, and concentration ratios, as these measures exhibit too little variation for obtaining robust results. We ultimately steer our main focus to macroprudential policies implemented via LTV limits, and local-currency reserve requirements, since these measures have the largest estimated impact on international bank lending.

Table 1. Summary Statistics

	N = All, D = All			N = Advanced, D = Advanced			N = All, D = Emerging			N = EU, D = EU		
	Obs: 26,326			Obs: 15,431			Obs: 10,691			Obs: 10,201		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
A. Dependent Variables												
Δ International Claims	1.08	0.81	18.09	0.57	0.57	18.52	1.80	1.10	17.46	0.66	0.48	17.21
Δ Local Claims in Local Currency	1.54	0.00	18.97	0.73	0.00	19.04	1.54	0.00	18.97	1.11	0.00	17.45
B. Balance Sheet Composition of Home-Country Banking Systems												
Log Total Assets	8.02	8.08	0.87	7.93	8.00	0.87	8.19	8.23	0.81	7.83	7.91	0.92
Tier 1 Ratio (%)	3.80	4.01	1.65	3.82	4.04	1.59	3.72	3.92	1.71	3.43	3.52	1.52
Illiquid Assets Ratio (%)	53.14	52.48	13.46	54.32	54.12	13.45	50.79	50.09	12.46	54.32	57.34	14.88
International Activity (%)	39.22	35.15	16.76	39.44	34.84	16.45	39.51	36.03	16.77	42.15	39.70	17.12
Net Intragroup Liabilities (%)	−0.78	−0.43	2.40	−0.93	−0.50	2.45	−0.57	−0.27	2.34	−1.35	−0.86	2.39
Deposits Ratio (%)	42.52	39.81	12.35	41.99	39.67	12.04	42.69	39.84	12.13	36.79	37.34	9.10

(*continued*)

Table 1. (Continued)

	N = All, D = All			N = Advanced, D = Advanced			N = All, D = Emerging			N = EU, D = EU		
	Obs: 26,326			Obs: 15,431			Obs: 10,691			Obs: 10,201		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
C. BIS Cycle Variables												
BIS Financial Cycle (Destination)	1.77	3.70	13.18	2.52	3.88	13.69	0.63	3.37	12.43	4.05	4.27	12.99
BIS Financial Cycle (Home)	3.23	3.36	16.32	4.54	4.52	18.38	1.44	1.77	12.64	5.32	4.41	18.55
BIS Business Cycle (Destination)	−0.01	−0.09	1.46	0.00	−0.09	1.46	−0.01	−0.07	1.44	0.01	−0.13	1.51
BIS Business Cycle (Home)	0.00	−0.05	2.04	−0.02	−0.12	1.85	0.04	0.06	2.29	−0.03	−0.21	2.06

Notes: This table provides summary statistics for our bilateral dependent variable on lending, balance sheet characteristics of our included home-country banking systems, and the included BIS cycle variables for home and destination countries. Data are observed quarterly from 2000:Q1 to 2014:Q4. International claims and local claims in local currency are from the BIS CBS on an immediate borrower basis (panel A). For panel B, banking systems' balance sheet characteristics on total assets, tier 1 capital, illiquid assets, and core deposits are from Bankscope. Banking system data on international activity draw on foreign claims from the BIS CBS, while the net intragroup liabilities are based on the BIS locational banking statistics. The net intragroup liabilities are measured from the perspective of a bank's head office total net internal borrowing vis-à-vis all its related international offices. As for panel C, the BIS business cycle indicator draws on the output gap estimates presented in BIS (2014), and the financial cycle indicator is based on estimates of credit-to-GDP gaps using the methodology of Drehmann, Borio, and Tsatsaronis (2011).

Table 2. Summary Statistics on Changes in Prudential Instruments

	No. of Country-Time Changes			No. of Destination-Nationality-Time Changes			
	All (1)	Of Which Tightenings (2)	Of Which Loosenings (3)	All (4)	Of Which Tightenings (5)	Of Which Loosenings (6)	As % Share of Obs. (7)
A. Changes in the Home Country of Nationality (HomeP)							
Prudential Index	94	70	24	4,888	3,640	1,248	19.69%
General Capital Requirements	31	31	0	1,612	1,612	0	6.49%
Sector-Specific Capital Buffer	13	10	3	676	520	156	2.72%
Loan-to-Value Ratio Limits	19	13	6	988	676	312	3.98%
Reserve Requirements: Local	37	13	24	1,924	676	1,248	7.75%
Interbank Exposure Limit	10	10	0	520	520	0	2.10%
Concentration Ratio	8	8	0	416	416	0	1.68%
B. Changes in the Destination Country (DestP)							
Prudential Index	486	325	161	7,158	4,928	2,230	28.84%
General Capital Requirements	94	94	0	1,473	1,473	0	5.93%
Sector-Specific Capital Buffer	65	48	17	989	734	255	3.98%
Loan-to-Value Ratio Limits	89	65	24	1,346	991	355	5.42%
Reserve Requirements: Local	241	99	142	3,410	1,474	1,936	13.74%
Interbank Exposure Limit	24	23	1	347	331	16	1.40%
Concentration Ratio	31	29	2	449	420	29	1.81%

Notes: This table shows summary statistics on changes in prudential instruments over the period 2000:Q1–2014:Q4. The reported data are based on the regression sample.

2.3 Balance Sheet Characteristics and Cycle Variables

Balance sheet characteristics for the sixteen bank nationalities are constructed using Bankscope data and the BIS international banking statistics. Using Bankscope, we compute the log of total assets, the total customer deposit ratio, the capital ratio, and a measure of illiquidity for the set of internationally active banks headquartered in each CBS-reporting jurisdiction. These data are adjusted for mergers and acquisitions (see Brei, Gambacorta, and von Peter 2013) to eliminate jumps in balance sheet positions that are unrelated to lending. Since international banking activity is highly concentrated, we select a set of internationally active banks in each jurisdiction that also contributes to the BIS CBS. To aggregate bank-level characteristics to system-wide variables, we use weighted averages across the individual banks of a given nationality.

We construct the net intragroup funding ratio and the measure of international activity for each banking system from various parts of the BIS international banking statistics. The variable definitions are provided in table 5 in appendix 1, in line with the common approach laid out by Buch and Goldberg (2017). Table 1 (panel B) presents summary statistics for the balance sheet characteristics used in the empirical analysis.

Finally, in our regression analysis we also control for business and financial cycles[6] using the output gap estimates in BIS (2014) and the financial cycle indicator based on the methodology in Drehmann, Borio, and Tsatsaronis (2011). While the credit-to-GDP gap is not the only relevant financial cycle indicator, it has been demonstrated to be the single most reliable measure of countries' position in the financial cycle. As such, it has been proposed by the Basel Committee on Banking Supervision (BCBS) as an internationally consistent guide for making decisions on the countercyclical capital buffer (BCBS 2010). An additional advantage of the credit-to-GDP gap is that it is available for a broader set of countries and time periods than the main alternatives. Table 1 (panel C) provides some descriptive statistics for the financial and business cycle variables of home and destination countries as used in our regressions.

[6]The financial cycle is defined as the self-reinforcing interactions between perceptions of value and risk, attitudes toward risk, and financing constraints, which translate into booms followed by busts (Borio 2014).

3. Empirical Methodology

The BIS international banking statistics lack the bank-level data available to the IBRN country teams. But they open an additional dimension by combining data from many reporting countries. To complement the country-level analyses, we use the aggregate BIS CBS in a global specification to investigate the effects of prudential measures on international banking activity. This specification amounts to a bilateral panel regression in which such measures in both home and destination countries enter jointly. In this setting, inward and outward transmission are two sides of the same coin, and the effect of prudential policy changes on international credit can be estimated separately from their effect on local credit.

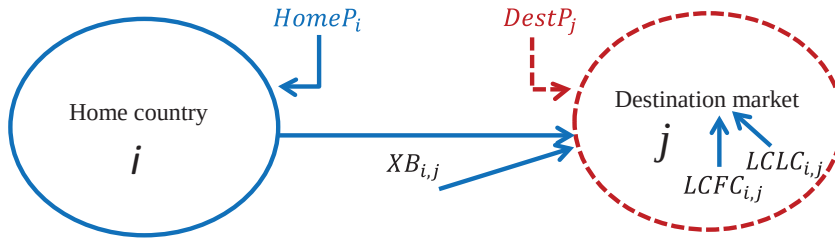
3.1 The Global Specification

An empirical specification appropriate for the bilateral nature of the BIS international banking statistics must include multiple home countries and destination markets simultaneously. Appendix 2 shows that our global specification can be derived from the inward as well as from the outward transmission channels presented in figure 1 of Buch and Goldberg (2017). The index i denotes a bank's home country (i.e., its nationality), j represents the destination market, and bold font is short-hand for vectors consisting of the contemporaneous and lagged values of the respective variables.[7] Our specification relates the log change in international claims of banks headquartered in country i on residents of destination country j at time t, in response to prudential measures in home and destination countries (while controlling for the variables described above),

$$\Delta Y_{i,j,t} = \alpha_0 + \boldsymbol{\gamma'} \boldsymbol{HomeP_{i,t}} + \boldsymbol{\alpha'} \boldsymbol{DestP_{j,t}} + \alpha_4 X_{i,t-1} + \alpha_5 Z_{i,t} + \alpha_6 Z_{j,t} + f_i + f_j + f_t + \varepsilon_{i,j,t}. \quad (1)$$

[7]The empirical exercise in this paper is set up to examine the short-term impact of prudential measures on international bank lending. As a consequence, it has a different focus from the literature that studies the long-term relationship between bank capital and loan volume (e.g., Buch and Prieto 2014; Gambacorta and Shin 2016).

Figure 1. Illustration of the Global Specification



Notes: Foreign claims of banks headquartered in a given country i ("home") on residents in another country j ("destination") can take several forms. One is cross-border claims, which can be booked either in the home country or in a third country; both are denoted here by $XB_{i,j}$. Another is local claims, which are booked in the destination market j and can be denominated in foreign currencies ($LCFC_{i,j}$) or in the local currency of the destination ($LCLC_{i,j}$). The sum of cross-border claims and local claims in foreign currencies is international claims, and the growth rate of this variable between all ij-pairs (home countries and destination markets) is one of the two dependent variables, $\Delta Y_{i,j}$, that we examine. The other dependent variable that we consider is based on the growth rate of local claims in local currency. The extent to which these aggregates react to prudential measures in the home country, $HomeP_i$, while controlling for other factors, measures the *international transmission* of prudential actions via banks from i (solid lines). Any concurrent prudential action in the destination, $DestP_j$, represents a *local effect* of prudential action that is felt by borrowers in the country that enacts the measure (dashed lines).

The global specification based on bilateral country-level data brings two advantages. First, it provides a single baseline for both inward and outward transmission. The coefficients on $HomeP_{i,t}$ and its lags measure the *international transmission* of prudential measures from i to the rest of the world, whereby the flow of credit "outward from i" and "inward to j" are two sides of the same coin. Meanwhile, $DestP_{j,t}$ captures the *local effect* of prudential measures taken by the destination country j on its own borrowers, via international banks from other home countries. Hence, the second advantage of the global specification is that it contains multiple home countries *and* destination markets, so the additional dimension helps to identify the local effect separately from the international transmission channel. In principle, our estimates of $\boldsymbol{\alpha}$ and $\boldsymbol{\gamma}$ should be weighted averages of those found in single-country studies. Figure 1 helps to illustrate the logic of our bilateral setting.

3.2 Controlling for Balance Sheet Characteristics

The strength of transmission of prudential measures may well depend on the state of banks' balance sheets. Hence, in our second empirical specification, we extend (1) by interacting balance sheet characteristics with *home*-country prudential action,

$$\Delta Y_{i,j,t} = \alpha_0 + \boldsymbol{\gamma'}\boldsymbol{HomeP_{i,t}} + \boldsymbol{\alpha'}\boldsymbol{DestP_{j,t}} + \boldsymbol{\beta'}\boldsymbol{HomeP_{i,t}}X_{i,t-1} + \alpha_4 X_{i,t-1} + \alpha_5 Z_{i,t} + \alpha_6 Z_{j,t} + f_i + f_j + f_t + \varepsilon_{i,j,t}. \quad (2)$$

The effects of prudential measures are evaluated by joint F-tests. The estimate of $\boldsymbol{\alpha}$ captures the *local effect* of a measure, i.e., the sensitivity of foreign bank claims on borrowers in the same destination country that takes the measure. By contrast, significant estimates of $\boldsymbol{\gamma}$ and $\boldsymbol{\beta}$ are evidence of *international transmission* of prudential measures, where $\boldsymbol{\gamma}$ measures the baseline effect and $\boldsymbol{\beta}$ indicates how the balance sheet composition of banks from the regulating country shapes the strength of the response. It is plausible that geographical focus, internal capital markets, or different business models and the associated funding structures make a difference in this regard. International transmission overall is thus the sum of the estimated effects, $\sum_n \gamma_n + \sum_n \beta_n X_{in}$, or the partial derivative of (2) with respect to a unit impulse $HomeP_i$, evaluated at the median X_{in}.

In order to examine the robustness of our benchmark results and to investigate their main drivers, we estimate several alternative regression specifications for three subsamples: (i) lending by advanced economy (AE) banking systems to AE borrowers; (ii) lending by all banking systems to emerging market economy (EME) borrowers; and (iii) lending by European Union (EU) banking systems to EU borrowers. All regressions use robust standard errors to accommodate heteroskedasticity of any type.[8] Further estimation details are provided in the table notes.[9]

[8]When clustering by nationality and destination (our cross-sectional dimension), standard errors exhibit only minor changes without affecting overall significance.

[9]We do not report additional results from the specifications with cumulative effects of prudential measures and their interactions with the business and financial cycle variables, as these yield no substantive additional insights.

4. Main Results

Our empirical analysis draws on the regression specifications in equations (1) and (2). We estimate these specifications for each of the prudential instruments listed in section 2.2, as well as for a composite prudential policy index which aggregates all prudential instruments into a single variable (Buch and Goldberg 2017). As discussed above, we examine two types of bank claims for our dependent variable—international claims and (foreign affiliates') local claims denominated in local currency. The results we obtain for international claims are much more significant (from an econometric point of view) and more interesting (from an economic point of view) than the respective results for local claims. Thus, in the rest of this section we focus exclusively on our results for international claims.[10]

The estimated coefficients on the composite prudential policy index are statistically significant (for the home country, the destination country, or both) in several of the empirical specifications that we examine. This suggests that both home- and destination-country prudential actions have a significant impact on international bank lending. Nevertheless, since the composite prudential policy index aggregates information over a very diverse set of prudential tools, its estimated coefficients are difficult to interpret. The remainder of this section thus focuses on the results from the individual prudential instrument specifications.

Examining these results reveals that the prudential policy measures that tend to have the most significant impact on international bank lending are (i) limits on loan-to-value ratios and (ii) local-currency reserve requirements. This is in line with the findings of the majority of the national studies in the IBRN research initiative (Buch and Goldberg 2017). In the remainder of this section, we discuss the estimated impact of each of the two macroprudential measures above in more detail and provide economic intuition for the main results.

[10]Due to space constraints, we only report the results for the prudential measures and specifications that have the most significant impact on international bank lending. All other results are available upon request.

4.1 Limits on Loan-to-Value Ratios

From the perspective of a country as a *destination* of credit flows, we find that a tightening of its LTV limits leads to a statistically significant increase in international bank lending to the residents of that country (table 3, panel A). Intuitively, since LTV limits are usually tightened during upswings in the credit cycle, banks located abroad have an incentive to lend into the booming destination market. While internationally active banks are not typically engaged in direct cross-border mortgage lending, it is quite likely that they extend cross-border loans to other borrowers in the destination country that benefit from the real estate boom (e.g., construction companies, real estate developers, etc.).

Our subsample estimates reveal that this relationship is statistically significant for all lender-borrower regional combinations that we examine (table 3, panel A, columns 2–4). That said, the estimated impact is largest for the intra-EU subsample. This could be due to the higher degree of harmonization in legal frameworks within the EU, which tends to lower the costs associated with intra-EU international lending.

In terms of economic magnitude, our results suggest that a one-time tightening of LTV limits in the *destination* country is associated with a 4.4 percentage point (three-quarter) cumulative increase in the growth rate of international claims. As with any global regression, the above estimated impact should be interpreted with caution: since the estimated coefficients are obtained from a regression that contains multiple home countries *and* destination markets, they represent merely weighted averages across lenders and borrowers. The respective impacts for individual banking systems and destinations markets may vary considerably.

Next, we turn to the international transmission of LTV requirements from a *home* country to the rest of the world. LTV limits usually apply to local mortgage lending in order to curtail excessive credit growth and counteract a potential real estate bubble (Bruno, Shim, and Shin 2015). Such limits narrow the pool of eligible borrowers for all banks that engage in mortgage lending in a given country.[11] As a consequence, a tightening of LTV ratios in

[11]There is empirical evidence that the effectiveness of measures such as LTV caps is considerably enhanced if they are implemented in tandem with monetary policy moves in the same direction (Bruno, Shim, and Shin 2015).

Table 3. Impact of Changes in Loan-to-Value Limits on International Claims

	N = All D = All (1)	N = Advanced D = Advanced (2)	N = All D = Emerging (3)	N = EU D = EU (4)
A. Prudential Measures, Equation (1)				
DestP	4.39***	3.30*	3.35***	4.15**
	(0.00)	(0.06)	(0.01)	(0.05)
HomeP	−0.45	2.58	−4.58**	−0.90
	(0.78)	(0.24)	(0.05)	(0.76)
Observations	26,326	15,431	10,691	10,201
R^2	0.05	0.05	0.06	0.07
Adjusted R^2	0.04	0.04	0.05	0.06
No. of Destination Countries	53	28	25	27
No. of Home Countries	16	15	16	11
B. Prudential Measures and Their Interactions with Balance Sheet Characteristics, Equation (2)				
DestP	4.38***	3.27*	3.35***	4.17**
	(0.00)	(0.06)	(0.01)	(0.04)
HomeP	143.10***	151.30*	−27.97	651.60***
	(0.01)	(0.07)	(0.76)	(0.00)
Log Total Assets*HomeP	−15.56***	−15.43*	−5.40	−58.00***
	(0.01)	(0.06)	(0.56)	(0.01)
Capital Ratio*HomeP	7.20***	3.55	11.91***	1.88
	(0.00)	(0.22)	(0.00)	(0.75)
Illiquid Assets Ratio*HomeP	−0.67***	−0.55	−0.50*	−2.47***
	(0.00)	(0.28)	(0.07)	(0.01)
International Activity*HomeP	0.07	−0.02	0.79**	−1.38
	(0.77)	(0.96)	(0.03)	(0.37)
Net Intragroup Liabilities*HomeP	−1.06	−1.34	−0.64	1.74
	(0.41)	(0.49)	(0.75)	(0.80)
Core Deposits Ratio*HomeP	−0.37*	−0.30	0.31	0.12
	(0.06)	(0.61)	(0.41)	(0.97)
Observations	26,326	15,431	10,691	10,201
R^2	0.05	0.05	0.07	0.08
Adjusted R^2	0.04	0.04	0.06	0.06
No. of Destination Countries	53	28	25	27
No. of Home Countries	16	15	16	11

Notes: This table estimates equations (1) and (2) and reports the effects of changes in destination-country (DestP) and home-country (HomeP) prudential policy measures on log changes in international claims. The quarterly data for home-destination country pairs range from 2000:Q1 to 2014:Q4. All regressions control for home-country bank balance sheet characteristics (lagged by one quarter) as well as business and financial cycles, as described in section 3 and appendix 1. Panel A shows the sum of coefficient estimates (including the contemporaneous effect and two lags) of DestP (vector α) and of HomeP (vector γ) with p-values of F-tests in parentheses. Panel B adds the sums of interaction effects (contemporaneous effects and two lags) of HomeP with individual lagged home bank characteristics (vector β). For details on the variables, see appendix 1. Column 1 features all countries, column 2 only advanced economies, column 3 emerging market economies as destinations, and column 4 focuses on EU member countries. Appendix 3 lists the countries used as home (N) and destination (D). All specifications include N, D, and T fixed effects. Standard errors are robust. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

the home jurisdiction should limit domestic lending opportunities in the affected sector, inducing banks to direct more lending to other sectors (including abroad).

We find that the stand-alone impact of a tightening of home-country LTV requirements on international bank lending is not statistically significant (table 3, panel A). Nevertheless, the results from the regressions which include the interaction terms indicate that certain balance sheet characteristics significantly affect the response of national banking systems to changes in home-country LTV limits (table 3, panel B).

Better-capitalized banking systems tend to increase their international claims by more in the face of tighter LTV requirements in their home country. Accordingly, the sums of the estimated coefficients on the interaction terms between the capital ratio and the home LTV limits variable are positive and significant. One possible explanation is that, as intended in a macroprudential context, banks interpret a tightening of LTV ratios in their home country as a signal of elevated credit risk in a booming housing market. Well-capitalized banks are in a better position to expand internationally in spite of the state of the housing market at home. Our regional subsample results reveal that the estimates above are mainly driven by international claims on EME borrowers (table 3, column 3). Since EME claims tend to have higher risk weights, banking systems with thicker capital cushions would be more likely to rebalance their lending portfolios toward EMEs in response to a tightening of LTV requirements in their home jurisdiction.

Banks' liquidity and funding positions also modulate the strength of the international transmission. The estimated coefficients on the home-country LTV interactions with the illiquid assets ratio and the core deposits ratio are both negative and statistically significant. Intuitively, the more illiquid a bank's assets are, the less flexibility that bank has to shift out of domestic into international lending. At the same time, higher shares of core deposits in the funding mix could be taken to mean that this banking system has a local business focus and mostly operates the traditional business model of collecting deposits and making mortgage loans. Such a banking system would not only be more exposed to the housing market in its home country, but would also find it more difficult to expand

internationally in response to a tightening of home-country LTV limits since it may lack the expertise and sophistication to do so.

Results on the size variable suggest that larger banking systems tend to increase their international claims by less than smaller banking systems in response to a tightening of home-country LTV limits. Intuitively, larger banking systems tend to have bigger home markets. As a result, when faced with tighter LTV limits, they have more opportunities to switch out of domestic mortgage lending into other forms of domestic lending, which dampens their incentives to increase their international claims.

4.2 Local-Currency Reserve Requirements

Historically, reserve requirements have often been applied as monetary policy instruments. More recently, however, Ma, Xiandong, and Xi (2013) and Cordella et al. (2014) document that they are increasingly used as countercyclical macroprudential tools. The IBRN Prudential Instruments Database includes only changes in reserve requirements, which the respondents to the IMF Global Macroprudential Policy Instruments survey have explicitly identified as macroprudential tools (as opposed to monetary policy instruments) (Cerutti et al. 2017).

From the perspective of a country as a *destination* of credit flows, we find that a tightening of its local-currency reserve requirements is associated with an increase in international bank lending to the country (table 4, panel A). The estimated coefficient is positive and statistically significant (at the 10 percent level). It implies that a one-time increase in local-currency reserve requirements in the destination country is associated with a 1.1 percentage point (three-quarter) cumulative rise in the growth rate of international claims.[12] Intuitively, higher reserve requirements imply that banks located in the destination country need to hold a larger share of funding as reserves. This would typically lead to a reduction in local lending by local banks (Buch and Goldberg 2017). The resulting market gap is likely to be filled by increased international lending from foreign banks.

[12]The caveats about the interpretation of the estimated size of the cumulative impact discussed in the preceding subsection apply here as well.

Table 4. Impact of Changes in Local Reserve Requirements on International Claims

	N = All D = All (1)	N = Advanced D = Advanced (2)	N = All D = Emerging (3)	N = EU D = EU (4)
A. Prudential Measures, Equation (1)				
DestP	1.13*	1.86	0.36	−0.14
	(0.07)	(0.45)	(0.59)	(0.93)
HomeP	3.10**	9.84***	−1.43	4.07
	(0.03)	(0.01)	(0.53)	(0.49)
Observations	26,326	15,431	10,691	10,201
R^2	0.05	0.05	0.06	0.07
Adjusted R^2	0.04	0.04	0.05	0.06
No. of Destination Countries	53	28	25	27
No. of Home Countries	16	15	16	11
B. Prudential Measures and Their Interactions with Balance Sheet Characteristics, Equation (2)				
DestP	1.10*	1.72	0.35	−0.04
	(0.08)	(0.48)	(0.60)	(0.98)
HomeP	24.17	73.86	−50.56	22.69
	(0.58)	(0.38)	(0.37)	(0.79)
Log Total Assets*HomeP	−0.91	−3.36	3.72	−0.17
	(0.78)	(0.60)	(0.37)	(0.98)
Capital Ratio*HomeP	3.56***	3.93*	4.15***	3.61
	(0.00)	(0.07)	(0.00)	(0.11)
Illiquid Assets Ratio*HomeP	0.00	0.18	0.50	0.19
	(1.00)	(0.83)	(0.16)	(0.81)
International Activity*HomeP	−0.03	0.15	0.16	0.09
	(0.81)	(0.64)	(0.31)	(0.77)
Net Intragroup Liabilities*HomeP	1.45	2.04	0.91	−0.57
	(0.34)	(0.43)	(0.64)	(0.82)
Core Deposits Ratio*HomeP	−0.52**	−1.82*	−0.62**	−1.24
	(0.03)	(0.07)	(0.05)	(0.21)
Observations	26,326	15,431	10,691	10,201
R^2	0.05	0.05	0.06	0.07
Adjusted R^2	0.04	0.04	0.05	0.06
No. of Destination Countries	53	28	25	27
No. of Home Countries	16	15	16	11

Notes: This table estimates equations (1) and (2) and reports the effects of changes in destination-country (DestP) and home-country (HomeP) prudential policy measures on log changes in international claims. The quarterly data for home-destination country pairs range from 2000:Q1 to 2014:Q4. All regressions control for home-country bank balance sheet characteristics (lagged by one quarter) as well as business and financial cycles, as described in section 3 and appendix 1. Panel A shows the sum of coefficient estimates (including the contemporaneous effect and two lags) of DestP (vector α) and of HomeP (vector γ) with p-values of F-tests in parentheses. Panel B adds the sums of interaction effects (contemporaneous effects and two lags) of HomeP with individual lagged home bank characteristics (vector β). For details on the variables, see appendix 1. Column 1 features all countries, column 2 only advanced economies, column 3 emerging market economies as destinations, and column 4 focuses on EU member countries. Appendix 3 lists the countries used as home (N) and destination (D). All specifications include N, D, and T fixed effects. Standard errors are robust. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Our results also indicate that a tightening of local-currency reserve requirements in the *home* country is associated with a statistically significant increase in international bank lending to the rest of the world (table 4, panel A). The estimated coefficient suggests that, on average, a one-time increase in local-currency reserve requirements in the home country is associated with a 3.1 percentage point (three-quarter) cumulative increase in the growth rate of international claims of banks headquartered there to the individual destination countries to which they are lending.

Intuitively, higher reserve requirements imply that the return offered to depositors would have to be lower, which would most likely lead to a decline in local deposit funding (Buch and Goldberg 2017). As a consequence, internationally active banks that are affected by the increase in local-currency reserve requirements would be more likely to rebalance their funding mix away from deposit funding and toward wholesale funding. The former funding source is typically used to finance local lending, while the latter often funds international lending (McGuire and von Peter 2016). Thus, the shift in banks' funding structure triggered by a tightening of local-currency reserve requirements may ultimately result in a rebalancing away from domestic and toward international lending.

The subsample estimates reveal that the above result is mostly driven by international lending from AE banks to AE borrowers (table 4, panel B, column 2). This is not surprising. AE banks which have just shifted their funding mix in response to a tightening of home reserve requirements would be more likely to reallocate their lending to other AEs rather than to EMEs, since (foreign) AE borrowers would tend to have more similar characteristics to AE banks' domestic borrowers.

Furthermore, we find evidence that banks' business models affect the international transmission of changes in home-country local-currency reserve requirements (table 4, panel B). The estimated coefficients on the interaction terms between the capital ratio and the local-currency reserve requirements are positive and strongly statistically significant (table 4, column 1). This implies that banking systems that are better capitalized tend to respond to a tightening of local-currency reserve requirements in their home country with a greater expansion in their international claims than thinly capitalized banking systems. A possible explanation for this result is

related to the fact that, all else equal, domestic assets are likely to carry lower risk weights than foreign assets, especially if the latter are vis-à-vis borrowers in EMEs. Indeed, our regional results reveal that the relationship estimated above is strongest in the case of international claims on EME borrowers (table 4, column 3). Furthermore, although the estimated interaction coefficient for international claims on AE borrowers (table 4, column 2) is also statistically significant—albeit less so than its counterpart for EME borrowers—the respective coefficient for the intra-EU subsample (table 4, column 4) is insignificant. This combination of results could be a manifestation of the fact that the risk-weight differential between domestic and foreign assets tends to be smaller for intra-EU (lender-borrower) pairs than for other AE-to-AE (lender-borrower) pairs.

Our results also suggest that banking systems which are more reliant on core deposits tend to increase their lending by less in response to a tightening of home-country reserve requirements (table 4, column 1). As discussed in the previous subsection, banking systems with higher shares of core deposits tend to be locally oriented and focus on the traditional business model of collecting deposits and making mortgage loans. The ability of such banking systems to expand internationally in response to a tightening of (home-country) local-currency reserve requirements would normally be limited by a lack of expertise and sophistication. This potential explanation is supported by the results from our regional estimates, which reveal that the statistical significance of the estimated coefficients is highest for the subsample of EME borrowers (table 4, column 3). Intuitively, banks with more traditional business models would be less likely to venture into lending to EMEs as a response to a tightening of local reserve requirements due to the greater credit risk and the higher monitoring costs associated with such lending.

4.3 Robustness Checks

In addition to our benchmark regressions, we estimate weighted regressions in which we give larger bilateral positions more weight in the estimation (in proportion to the lagged *level* of the dependent variable). The weighted regression forces the estimation to align with the response of the larger banking systems that account for the bulk of global bank credit (Amiti, McGuire, and Weinstein 2016), and

thereby serves as a robustness check for our benchmark results.[13] The main results from the weighted regressions are very close to their counterparts from the benchmark regressions discussed in the previous two subsections.

In our benchmark specifications, we evaluate the impact of each prudential policy measure on international bank lending without controlling for other types of prudential policy actions. For example, when examining the impact of changes in LTV caps, we do not control for changes in local-currency reserve requirements and vice versa. In order to test the robustness of our results, we reestimate our benchmark specifications (equations (1) and (2)), while simultaneously including the two most relevant prudential policy variables (LTV caps and local-currency reserve requirements). The estimates of the main coefficients from the simultaneous regressions are similar to those obtained in the benchmark regressions, indicating that our results are robust along that dimension as well.[14]

5. Concluding Remarks

In this paper, we provide a global perspective on the international effects of prudential and, in particular, macroprudential policy measures—one that complements the bank-level analyses in the various jurisdiction-specific IBRN companion papers. We investigate the effects of prudential actions on international banking activity in a global specification using the BIS international banking statistics, which lack the bank-level detail available to individual jurisdictions, but which offer an additional dimension by combining data from many reporting countries. Our benchmark specification amounts to a bilateral panel regression in which prudential actions in home and destination countries enter jointly. In this setting, the international transmission can be estimated separately from the local effects of a given change in prudential policy.

[13]For example, a 2 percent growth in claims in a large bilateral link (e.g., U.K. banks' claims on the United States) contributes far more to the aggregate growth in claims worldwide than a 90 percent growth in numerous small bilateral positions (e.g., Austrian banks' claims on Chile).

[14]Space constraints prevent us from publishing the tables associated with the above robustness checks. All sets of results are available upon request.

Our results from a panel of sixteen banking systems and fifty-three counterparty countries suggest that changes to macroprudential policy via loan-to-value limits and local-currency reserve requirements are the measures from the IBRN database that are most likely to have a significant impact on banks' international lending.

Specifically, tighter loan-to-value limits in the *destination* country have a positive impact on international claims extended to that country. Banks' international claims also respond to LTV changes in their *home* country, with balance sheet characteristics affecting the strength of the international transmission. In particular, better-capitalized banking systems and those with more liquid assets and less core deposit funding tend to increase their international claims by more in the face of tighter LTV requirements in their home country.

A tightening of local-currency reserve requirements in either the home or the destination country is also associated with an increase in international bank lending. The latter effect is stronger for banking systems that are better capitalized and those that are less reliant on deposit funding.

Overall, the results suggest that the tightening of macroprudential policy measures, often intended to constrain domestic credit, can give rise to potentially sizable expansionary international spillovers.

Appendix 1. Data Description and Definitions

Selection of Banking Systems

The BIS consolidated banking statistics contain data covering the foreign positions of banks from (headquartered in) more than thirty home reporting countries. Some banking systems were excluded because (i) there were large jumps due to breaks in series for which no pre-break data are available; (ii) the underlying breakdowns by claim type (local vs. international) or by sector (bank, non-bank financial, and official sector) were incomplete or missing; or (iii) consolidated foreign claims outstanding were always less than $100 billion. The sample of sixteen national banking systems used in this

paper (see appendix 3) account for almost 90 percent of the reported global total at end-2014.

Selection of Bilateral Nationality-Destination Pairs

International claims are highly concentrated between major pairs of bank nationalities and counterparty countries, leaving many other bilateral pairs with small reported positions. To ensure that growth rates (our dependent variables) are economically meaningful, we restrict the sample of nationality-destination pairs to those that exceed $1 billion. Individual international loans tend to be large, often exceeding $100 million on any one counterparty. As a result, a single claim on a counterparty located in a country attracting a small stock of claims otherwise can induce excessive swings in the growth rates.

Adjustments for Exchange Rate Movements

International claims on a particular counterparty country tend to be denominated in a mixture of currencies. Changes in the relative value of these currencies induce changes in the outstanding stock of claims when expressed in any single currency, here in U.S. dollars. Our interest in this paper is to understand how changes in policy measures affect the growth in credit, net of any valuation changes induced by exchange rate movements.

To adjust the quarterly growth rate of international claims, we use the BIS locational banking statistics (LBS) to derive estimates of the currency composition of the bilateral positions. We first split international claims into cross-border claims in all currencies (XBC) and local claims in foreign currencies (LCFC) (i.e., INTL = XBC + LCFC). For LCFC, a partial currency breakdown (USD, EUR, JPY, other) is available in the BIS LBS by nationality, at least for the key banking systems' bilateral claims on countries that themselves report in the LBS.

For these and any other banking systems' LCFC on countries that do not report in the LBS, and for all banking systems' XBC on all countries, we base estimates of the currency shares (USD, EUR, JPY, CHF, GBP, other) on the LBS by residency. Here, we assume that the currency distribution of international claims on a particular

Table 5. Construction of Variables Used in the Empirical Analysis

Variable Name	Description	Data Source
Dependent Variables		
International Claims[a]	Cross-Border Claims + Local Claims in Foreign Currencies (Growth Rate)	BIS International Banking Statistics[b]
Local Claims in Local Currency[a]	Claims Booked by Banks' Affiliates in the Destination Country and Denominated in that Country's Local Currency (Growth Rate)	BIS International Banking Statistics[b]
Independent Variables		
Illiquid Assets Ratio	(Loans and Advances to Banks + Loans and Advances to Non-banks, including Received Bills)/Assets (in %)	Bankscope[c]
Log Assets	Log (Balance Sheet Total)	Bankscope[c]
Core Deposits Ratio	Savings Deposits/Assets (in %)	Bankscope[c]
Capital Ratio	Tier 1 Capital Ratio/Total Assets	Bankscope[c]
Net Intragroup Funding/Liabilities	(Liabilities Minus Claims of the Parent Bank vis-à-vis Foreign Affiliates/Total Liabilities (in %)	BIS Locational Banking Statistics,[b] Bankscope[c]
International Activity	Ratio of Foreign Claims to Total Assets (in %)	BIS Consolidated Banking Statistics,[b] Bankscope[c]

[a]Claims include both reporting banks' loans and holdings of debt securities.
[b]Certain portions of the data are publicly available; others are marked as confidential by the respective reporting national authorities. The publicly available parts of the data can be accessed at http://www.bis.org/statistics/consstats.htm?m=6%7C31%7C70.
[c]Commercial data set.

counterparty country is identical across banking systems—that is, that the currency shares of U.S. banks' cross-border claims on Hungary are assumed to be the same as the shares of German, Swiss, and other banks' claims on Hungary. For those counterparty countries that themselves report the LBS to the BIS, we make an additional correction to exclude interoffice positions from each currency total.

With the currency shares for the two components—LCFC and XBC—in hand, we are able to estimate the overall currency shares for each consolidated banking system's total international claims on each counterparty country. The second step in our adjustment is to feed these series, along with exchange rates, into a calculation of the quarterly growth rate in international claims that excludes the effect of exchange rate movements in the key currencies.

Appendix 2. Derivation of the Global Specification

This appendix derives a global specification, appropriate for the structure of the BIS CBS, building on Buch and Goldberg's (2017) regression devised for individual IBRN country teams. We show that this extension gives rise to a single bilateral panel regression in which prudential actions in both home and destination countries enter jointly, regardless of whether we start from the inward or outward specification.

Consider *inward* transmission with respect to the domestic market of a given country. Throughout, we use i to denote a bank's home country (i.e., nationality) and j for the destination country (i.e., counterparty). In Buch and Goldberg (2017), the destination index is omitted since the regression relates to a single destination market j. Reproducing the baseline inward specification with lags and interaction terms omitted for simplicity,

$$\Delta Y_{b,t} = \alpha_0 + \alpha_1 HomeP_{i,t} + \alpha_4 X_{b,t-1} + \alpha_5 Z_{i,t} + f_b + f_t + \varepsilon_{b,t}, \quad (3)$$

where $\Delta Y_{b,t}$ is the log change in lending of bank b from country i to the domestic market, $X_{b,t-1}$ is a vector of control variables of foreign bank balance sheets, and $Z_{i,t}$ represents the cycle variables for country i. Specifically, individual banks b from different foreign countries i operate in a given domestic market. Credit thus flows via foreign banks to the domestic market, possibly affected by prudential policies in their respective home countries, captured by $HomeP_{i,t}$. The fixed effect f_t controls for any concurrent prudential action in the domestic market. The term *inward transmission* thus consistently refers to the direction of credit flows, as well as to the effects of policy abroad, imported to the domestic market.

The global version is a straightforward extension, based on the fact that the BIS CBS contain not one, but many, domestic markets: there are now multiple destinations j,[15]

$$\Delta Y_{i,j,t} = \alpha_0 + \alpha_1 HomeP_{i,t} + \alpha_4 X_{i,t-1} + \alpha_5 Z_{i,t} + f_i + f_t + \beta_1 DestP_{j,t} + f_j + \alpha_6 Z_{j,t} + \varepsilon_{i,j,t}. \quad (3')$$

The estimate of α_1 measures inward transmission, while $\beta_1 DestP_{j,t}$ measures the effect of concurrent prudential actions in the various destination markets j.

Extending the IBRN equation for *outward* transmission demonstrates the virtue of the symmetry afforded by our global setting. The outward specification bank level starts with

$$\Delta Y_{b,j,t} = \alpha_0 + \alpha_1 DestP_{j,t} + \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + f_j + f_t + f_b + \varepsilon_{b,j,t}. \quad (4)$$

In that setting, the banks observed in a given country lend to various foreign destinations j, through cross-border claims and local claims booked abroad. These banks are all from the same home country i (not indexed), with any prudential action at home subsumed in f_t. A limitation of that setting is that *outward transmission* refers to the flow of credit, not to the transmission of prudential actions to foreign markets.[16]

Expanding the baseline to a global specification leads to a more natural measure of outward transmission, since the equation will contain prudential actions in various *home* countries too. Expanding

[15] All banks b headquartered in the same country i are combined, so the bank-specific index b is replaced by the home-country index i, where bank-specific features X_b are replaced by aggregate characteristics of banking system i. Variables distinguishing the different destinations j now enter symmetrically with those for different home countries i.

[16] Prudential actions at home most likely affect all home banks. It thus takes meaningful variation in actions taken abroad (in destinations j) to identify any effect of such actions. Hence outward transmission no longer refers to the direction of regulatory transmission as before (as equation (4) associates prudential action with *destination* countries). Instead, "outward" refers to the flow of lending, which runs "outward" from the home country to destinations j.

equation (2) for multiple home countries i allows to see the variation in prudential action across home countries, $HomeP_{i,t}$,

$$\Delta Y_{i,j,t} = \alpha_0 + \alpha_1 DestP_{j,t} + \alpha_4 X_{i,t-1} + \alpha_5 Z_{j,t} + f_j + f_t + f_i + \beta_1 HomeP_{i,t} + \alpha_6 Z_{i,t} + \varepsilon_{i,j,t}. \quad (4')$$

Importantly, outward transmission of prudential actions from home to destination countries is measured by β_1, analogous to the way that α_1 captured inward transmission from abroad in (3′). Indeed, the global specifications (3′) and (4′) are symmetric, up to the coefficient labels. The directions of credit flows and policy transmission are now aligned. This symmetry is natural, since one bank's home is another's destination market.

It follows that the global specification provides a *single baseline* for both inward and outward transmission which, including two lags in vector form (bold), reads

$$\Delta Y_{i,j,t} = \alpha_0 + \boldsymbol{\gamma' HomeP_{i,t}} + \boldsymbol{\alpha' DestP_{j,t}} + \alpha_4 X_{i,t-1} + \alpha_5 Z_{i,t} + \alpha_6 Z_{j,t} + f_i + f_j + f_t + \varepsilon_{i,j,t}. \quad (5)$$

This is equation (1) in the main text. The coefficients on $HomeP_{i,t}$ and its lags measure the international transmission of policy, whereas those on $DestP_{j,t}$ capture the local effect of prudential policy changes.

Appendix 3. Sets of Home and Destination Countries

Home Countries (Bank Nationalities)

- All (N = 16):
  Australia, Austria, Belgium, Canada, Denmark, France, Germany, India, Italy, Japan, Netherlands, Portugal, Spain, Sweden, United Kingdom, United States.
- Advanced (N = 15):
  Australia, Austria, Belgium, Canada, Denmark, France, Germany, Italy, Japan, Netherlands, Portugal, Spain, Sweden, United Kingdom, United States.
- EU Member Countries (N = 11):
  Austria, Belgium, Denmark, France, Germany, Italy, Netherlands, Portugal, Spain, Sweden, United Kingdom.

Destination Countries

- All (D = 53):
  Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, China, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Malta, Malaysia, Mexico, Netherlands, New Zealand, Norway, Peru, Poland, Portugal, Romania, Russia, Singapore, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, Ukraine, United Kingdom, United States.
- Advanced (D = 28):
  Australia, Austria, Belgium, Canada, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States.
- Emerging (D = 25):
  Argentina, Brazil, Bulgaria, Chile, China, Croatia, Czech Republic, Hong Kong, Hungary, Iceland, India, Indonesia, Israel, Korea, Malaysia, Mexico, Peru, Poland, Romania, Russia, Singapore, South Africa, Thailand, Turkey, Ukraine.
- EU Member Countries (D = 27):
  Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

References

Amiti, M., P. McGuire, and D. Weinstein. 2016. "The Determinants of Global Bank Credit: Separating Push and Pull Factors." Mimeo.

Bank for International Settlements. 2014. "Debt and the Financial Cycle: Domestic and Global." In *84th Annual Report*, 65–84 (chapter IV). Basel, Switzerland: Bank for International Settlements.

———. 2015. "Introduction to BIS Statistics." *BIS Quarterly Review* (September): 35–51.

Basel Committee on Banking Supervision. 2010. "Guidance for National Authorities Operating the Countercyclical Capital Buffer." December.

Borio, C. 2014. "The Financial Cycle and Macroeconomics: What Have We Learnt?" *Journal of Banking and Finance* 45 (2): 182–98.

Brei, M., L. Gambacorta, and G. von Peter. 2013. "Rescue Packages and Bank Lending." *Journal of Banking and Finance* 37 (2): 490–505.

Bruno, V., I. Shim, and H. S. Shin. 2015. "Comparative Assessment of Macroprudential Policies." BIS Working Paper No. 502 (June).

Buch, C., and L. Goldberg. 2017. "Cross-Border Regulatory Spillovers: How Much? How Important? Evidence from the International Banking Research Network." *International Journal of Central Banking* 13 (S1).

Buch, C., and E. Prieto. 2014. "Do Better Capitalized Banks Lend Less? Long-Run Panel Evidence from Germany." *International Finance* 17 (1): 1–23.

Cerutti, E., R. Correa, E. Fiorentino, and E. Segalla. 2017. "Changes in Prudential Policy Instruments—A New Cross-Country Database." *International Journal of Central Banking* 13 (S1).

Cordella, T., P. Federico, C. Vegh, and G. Vuletin. 2014. "Reserve Requirements in the Brave Macroprudential World." Policy Research Working Paper No. 6793, World Bank (February).

Drehmann, M., C. Borio, and K. Tsatsaronis. 2011. "Anchoring Countercyclical Capital Buffers: The Role of Credit Aggregates." *International Journal of Central Banking* 7 (4): 189–240.

Gambacorta, L., and H. S. Shin. 2016. "Why Bank Capital Matters for Monetary Policy." BIS Working Paper No. 558 (April).

International Monetary Fund, Financial Stability Board, and Bank for International Settlements. 2016. "IMF-FSB-BIS Elements of Effective Macroprudential Policies" August.

Ma, G., Y. Xiandong, and L. Xi. 2013. "China's Evolving Reserve Requirements." *Journal of Chinese Economic and Business Studies* 11 (2): 117–37.

McGuire, P., and G. von Peter. 2016. "The Resilience of Banks' International Operations." *BIS Quarterly Review* (March): 65–78.