

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

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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.

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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

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turn, the Mexican financial system hosts many foreign affiliates¹ 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

¹Foreign 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 Loan-to-Value Ratios Reserve Requirements	Sector-Specific Capital Buffers Interbank Exposure Limits 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,

²It 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

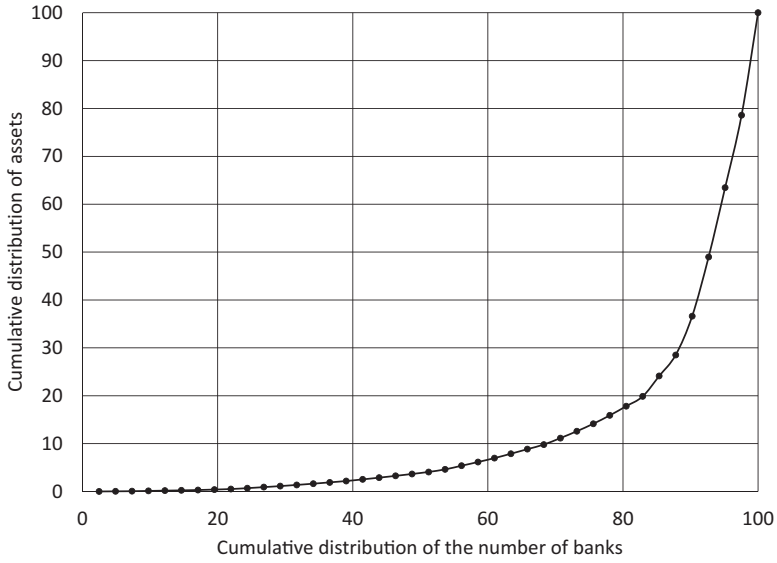


Figure 2. Banking System Capital Ratio

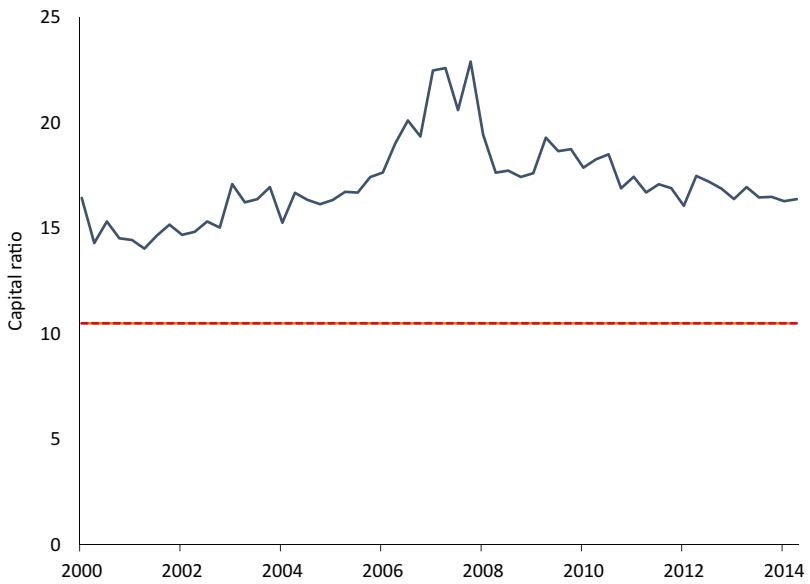
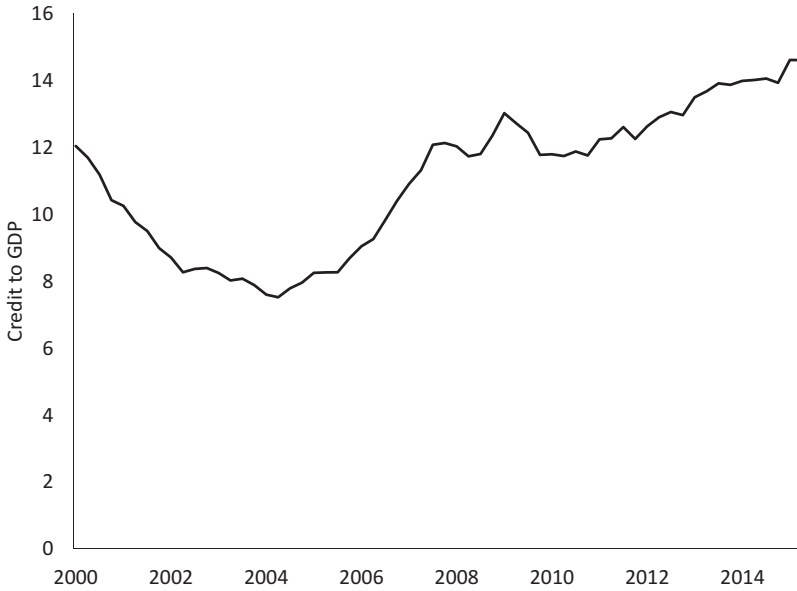


Figure 3. Bank Credit-to-GDP Ratio

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.

³During 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.

⁴For 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.

⁵From 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 (4.81)	10.120 (13.39)	30.910 (16.59)	-8.273 (7.67)	-44.670* (19.31)	-18.100 (10.52)	-24.490** (8.50)	-24.550** (7.13)
ExpP _{t-1}	-8.250 (6.38)	0.383 (14.46)	-8.086 (16.51)	-22.660 (13.91)	8.988 (12.52)	6.359 (10.53)	-6.406 (4.03)	-7.117** (2.40)
ExpP _{t-2}	-5.268 (6.33)	-5.510 (11.34)	10.990 (16.40)	-18.470 (13.93)	-39.070* (19.26)	29.290 (25.08)	-3.566 (2.61)	-13.100 (14.00)
ΣExpP _{t-s}	-15.915 [0.28]	4.989 [0.89]	33.817 [0.46]	-49.403* [0.07]	-74.745** [0.02]	17.542 [0.64]	-34.467 [0.01]	-44.765 [0.03]
L. Log Total Assets	-4.040** (1.67)	-4.029** (1.57)	-3.904* (1.65)	-3.924** (1.59)	-3.967** (1.67)	-4.150** (1.56)	-4.199** (1.73)	-4.199** (1.74)
Capital Ratio _t	0.018 (0.05)	0.019 (0.06)	0.018 (0.05)	0.023 (0.06)	0.018 (0.05)	0.019 (0.05)	0.017 (0.05)	0.017 (0.06)
Illiquidity Ratio _t	-0.178*** (0.01)	-0.178*** (0.01)	-0.180*** (0.01)	-0.173*** (0.01)	-0.180*** (0.01)	-0.176*** (0.01)	-0.180*** (0.01)	-0.182*** (0.01)
International Activity _t	-0.037 (0.02)	-0.037 (0.02)	-0.035 (0.02)	-0.036 (0.02)	-0.037 (0.02)	-0.037 (0.02)	-0.037 (0.02)	-0.037 (0.02)
Core Deposits _t	-0.023 (0.12)	-0.030 (0.11)	-0.027 (0.12)	-0.007 (0.14)	-0.024 (0.12)	-0.032 (0.12)	-0.026 (0.12)	-0.028 (0.12)
Constant	53.930** (17.28)	53.840** (16.37)	52.640** (17.08)	52.250** (16.68)	53.340** (17.29)	54.990** (16.06)	55.590** (17.87)	55.690** (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 (21.19)	28.98 (28.96)	2.54 (35.94)	46.97 (144.80)	5385.00 (63165.80)	9.79 (22.69)	9.77 (33.07)	18.67 (38.57)
ExpP _{t-1}	-43.41 (29.69)	-44.41 (26.17)	-18.98 (74.24)	152.50* (78.09)	74248.20** (30125.20)	56.58** (18.37)	-29.90* (13.41)	-28.57 (16.92)
ExpP _{t-2}	-9.83 (8.31)	-17.53 (13.57)	67.32 (50.99)	-52.07 (35.75)	159355.00** (65647.20)	29.39 (64.75)	16.96 (29.75)	150.20** (44.69)
ΣExpP _{t-s}	-52.67 [0.27]	-32.96 [0.23]	50.88 [0.74]	147.42 [0.52]	238988.20*** [0.01]	95.75 [0.32]	-3.18 [0.96]	140.33 [0.15]
Log Total Assets _{t-1}	-3.99 (2.22)	-4.56** (1.72)	-3.89* (1.72)	-3.06 (2.10)	-3.99** (1.66)	4.04** (1.60)	-4.11** (1.73)	-3.77* (1.86)
Capital Ratio _{t-1}	0.01 (0.07)	-0.02 (0.06)	0.01 (0.05)	0.01 (0.07)	0.02 (0.05)	0.02 (0.06)	0.02 (0.05)	0.02 (0.06)
Illiquidity Ratio _{t-1}	-0.17*** (0.02)	-0.17*** (0.02)	-0.18*** (0.02)	-0.18*** (0.01)	-0.18*** (0.01)	-0.17*** (0.02)	-0.18*** (0.01)	-0.18*** (0.01)
International Activity _{t-1}	-0.04* (0.02)	-0.05 (0.02)	-0.03 (0.02)	-0.03 (0.02)	-0.04 (0.02)	-0.04 (0.02)	-0.04 (0.02)	-0.03* (0.01)
Core Deposits _{t-1}	-0.050 (0.16)	-0.10 (0.16)	-0.03 (0.12)	0.004 (0.14)	-0.03 (0.12)	-0.04 (0.13)	-0.04 (0.11)	-0.08 (0.08)
ΣExpP*Log Total Assets	3.89 [0.36]	3.85 [0.41]	-7.93 [0.59]	-9.53 [0.57]	-16289.41*** [0.02]	-4.87 [0.56]	-3.44 [0.65]	-15.18 [0.10]
ΣExpP*Capital Ratio	0.18 [0.76]	-0.36 [0.24]	1.32 [0.38]	-3.47 [0.10]	-3432.19*** [0.01]	-0.40 [0.79]	0.016 [0.99]	-2.37* [0.09]
ΣExpP*Illiquidity Ratio	-0.10 [0.78]	-0.18 [0.34]	0.49 [0.64]	-0.98 [0.30]	-198.22 [0.48]	0.028 [0.97]	0.002 [0.99]	-0.09 [0.69]
ΣExpP*International Activity	0.028 [0.93]	0.56* [0.05]	-0.46 [0.46]	-0.14 [0.74]	648.31** [0.05]	-0.18 [0.83]	0.11 [0.93]	-1.14 [0.15]
ΣExpP*Core Deposits	0.05 [0.85]	0.22 [0.36]	-0.27 [0.89]	1.37 [0.12]	-216.30 [0.35]	-0.98 [0.24]	-0.04 [0.95]	1.84** [0.045]
Constant	53.70* (22.99)	60.35** (18.04)	52.55** (17.73)	43.89* (22.12)	53.54** (17.14)	53.87** (16.69)	54.92** (17.88)	51.29** (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:

⁶Capital 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 (0.02)	0.134 (0.38)	-0.055 (0.05)	0.003 (0.02)	-0.418** (0.14)	0.050 (0.04)	-0.008 (0.03)	-0.079 (0.05)
Log Total Assets _{t-1}	-0.043** (0.01)	-0.042*** (0.01)	-0.044** (0.01)	-0.045*** (0.01)	-0.042** (0.01)	-0.045** (0.01)	-0.043*** (0.01)	-0.042** (0.01)
Capital Ratio _{t-1}	0.0004 (0.0004)	0.0003 (0.0004)	0.0003 (0.0005)	0.0004 (0.0005)	0.0003 (0.0004)	0.0002 (0.0005)	0.0003 (0.0004)	0.0004 (0.0004)
Illiquidity Ratio _{t-1}	-0.002*** (0.0001)	-0.002*** (0.00006)	-0.002*** (0.0001)	-0.002*** (0.0001)	-0.002*** (0.0001)	-0.002*** (0.0001)	-0.002*** (0.0001)	-0.002*** (0.0001)
International Activity _{t-1}	-0.0004* (0.0001)	-0.0004* (0.0001)	-0.0003* (0.0001)	-0.0004 (0.0001)	-0.0003* (0.0001)	-0.0004* (0.0001)	-0.0003* (0.0001)	-0.0004* (0.0001)
Core Deposits _{t-1}	0.0002 (0.001)	0.0003 (0.001)	0.0004 (0.001)	0.0003 (0.001)	0.0004 (0.001)	0.0006 (0.001)	0.0003 (0.001)	0.0002 (0.001)
ExpP _t *Output Gap _t	0.001 (0.01)	-0.040 (0.13)	-0.006 (0.02)	0.003 (0.01)	0.050 (0.01)	-0.004 (0.01)	0.009 (0.02)	0.002 (0.02)
ExpP _t *Credit Gap _t	0.0005 (0.001)	-0.0556 (0.072)	0.0167 (0.043)	-0.0265 (0.020)	0.1840** (0.072)	0.0110* (0.005)	0.008 (0.003)	-0.024 (0.001)
Constant	0.526** (0.17)	0.520** (0.15)	0.536** (0.18)	0.551*** (0.16)	0.525** (0.17)	0.532** (0.19)	0.534*** (0.15)	0.532** (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 (3.83)	3.682 (6.06)	0.717 (2.37)	0.312 (0.78)		-0.957 (3.17)	-8.632 (6.37)	-8.762 (6.37)
ExpP _{t-1}	-2.085 (4.06)	-2.172 (7.41)	-0.770 (3.08)	-1.137 (1.17)		-0.535 (4.08)	-3.180 (3.16)	-4.372 (2.96)
ExpP _{t-2}	-1.913 (2.80)	-4.991 (4.83)	-1.142 (1.29)	-3.025 (6.61)		17.28 (14.72)	0.314 (4.76)	-3.308 (2.62)
ΣExpP _{t-s}	-3.410 [0.72]	-3.692 [0.82]	-1.318 [0.83]	-4.124 [0.61]		16.481 [0.45]	-11.717 [0.40]	-16.761 [0.21]
Log Total Assets _{t-1}	-2.418 (1.76)	-2.396 (1.64)	-2.416 (1.75)	-2.470 (1.69)	-2.414 (1.75)	-2.633 (1.65)	-2.487 (1.82)	-2.545 (1.80)
Capital Ratio _{t-1}	0.032 (0.05)	0.031 (0.05)	0.032 (0.06)	0.031 (0.06)	0.032 (0.06)	0.029 (0.06)	0.031 (0.06)	0.030 (0.06)
Illiquidity Ratio _{t-1}	-1.377*** (0.37)	-1.375*** (0.37)	-1.383*** (0.38)	-1.380*** (0.38)	-1.383*** (0.37)	-1.367*** (0.39)	-1.382*** (0.37)	-1.382*** (0.37)
Core Deposits _{t-1}	-0.008 (0.12)	-0.006 (0.12)	-0.013 (0.12)	-0.011 (0.13)	-0.012 (0.13)	-0.016 (0.12)	-0.015 (0.13)	-0.019 (0.13)
Credit Gap _t	-0.067 (0.24)	-0.066 (0.24)	-0.069 (0.25)	-0.067 (0.25)	-0.069 (0.25)	-0.066 (0.25)	-0.071 (0.25)	-0.071 (0.25)
Output Gap _t	-0.451 (1.31)	-0.492 (1.23)	-0.489 (1.41)	-0.476 (1.42)	-0.485 (1.40)	-0.568 (1.44)	-0.536 (1.45)	-0.588 (1.48)
Constant	36.950* (19.09)	36.720* (18.06)	37.000* (19.11)	37.500* (18.49)	36.980* (19.06)	39.170* (17.98)	37.850* (19.77)	38.490* (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 (23.07)	31.95 (25.86)		-17.79 (45.38)			-7.39 (7.70)	-6.28 (7.77)
ExpP _{t-1}	-16.41 (16.83)	-23.62 (17.77)		-46.81 (55.49)			1.21 (8.60)	38.96*** (18.52)**
ExpP _{t-2}	-16.50 (11.79)	-39.15 (21.59)		-222.90 (169.70)			-4.61 (18.16)	18.52** (7.04)
ΣExpP _{t-s}	-20.24 [0.58]	-30.82 [0.34]		-287.55 [0.17]			-10.79 [0.75]	51.21 [0.06]
Log Total Assets	-3.23 (2.08)	-2.95 (1.95)	-3.28 (1.89)	-3.90** (1.64)	-3.27 (1.88)	-3.99** (1.60)	-3.46 (1.96)	-3.38 (1.97)
Capital Ratio _{t-1}	0.016 (0.07)	0.025 (0.07)	0.023 (0.06)	0.016 (0.056)	0.023 (0.056)	0.016 (0.06)	0.019 (0.06)	0.022 (0.06)
Illiquidity Ratio _{t-1}	-0.20*** (0.01)	-0.20*** (0.01)	-0.20*** (0.01)	-0.20*** (0.01)	-0.20*** (0.01)	-0.20*** (0.01)	-0.20*** (0.01)	-0.20*** (0.01)
Core Deposits _{t-1}	-0.02 (0.11)	-0.02 (0.12)	-0.01 (0.12)	-0.03 (0.11)	-0.01 (0.12)	-0.04 (0.11)	-0.02 (0.12)	-0.03 (0.12)
ΣExpP _{t-s} *Log Total Assets	1.50 [0.50]	2.63 [0.12]		17.08 [0.16]			-22.49 [0.16]	-14.68 [0.00]
ΣExpP _{t-s} *Capital Ratio	-0.05 [0.85]	-0.04 [0.84]		0.41 [0.90]			1.63 [0.05]	1.15 [0.07]
ΣExpP _{t-s} *Illiquidity Ratio	-0.13 [0.20]	-0.14 [0.20]	-0.19 [0.69]	2.94 [0.05]			0.14 [0.39]	0.64 [0.00]
ΣExpP _{t-s} *Core Deposits	0.31 [0.13]	0.23 [0.19]	0.35 [0.65]	-3.07 [0.11]			0.88 [0.00]	4.07 [0.00]
Output Gap _t	-0.71 (1.14)	-0.74 (1.07)	-0.62 (1.32)	-0.95 (1.40)	-0.62 (1.3)	-0.97 (1.4)	-0.85 (1.4)	-0.77 (1.42)
Credit Gap _t	-0.06 (0.25)	-0.06 (0.25)	-0.06 (0.24)	-0.05 (0.24)	-0.06 (0.24)	-0.04 (0.23)	-0.059 (0.24)	-0.059 (0.25)
Constant	44.33* (22.10)	41.31* (20.91)	44.66* (20.16)	51.03** (17.45)	44.65* (20.09)	51.93** (17.01)	46.65* (20.87)	46.15* (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 (1.05)	-6.170 (5.52)	0.888 (1.68)	-1.016 (1.39)	0 (.)	4.702 (2.97)	4.184 (2.97)	-1.165 (2.16)
Log Total Assets _{t-1}	-3.371* (1.49)	-3.378** (1.33)	-3.463* (1.63)	-3.528* (1.53)	-3.525* (1.54)	-3.649** (1.50)	-3.576** (1.09)	-3.287* (1.40)
Capital Ratio _{t-1}	0.037 (0.05)	0.034 (0.05)	0.036 (0.05)	0.035 (0.05)	0.036 (0.05)	0.034 (0.05)	0.038 (0.05)	0.037 (0.05)
Illiquidity Ratio _{t-1}	-0.192*** (0.02)	-0.190*** (0.02)	-0.198*** (0.01)	-0.199*** (0.01)	-0.198*** (0.01)	-0.198*** (0.01)	-0.198*** (0.01)	-0.182*** (0.02)
Core Deposits _{t-1}	0.062 (0.12)	0.037 (0.12)	0.061 (0.12)	0.056 (0.12)	0.063 (0.11)	0.060 (0.11)	0.048 (0.12)	0.054 (0.12)
Credit Gap _t	-0.087 (0.21)	-0.003 (0.18)	-0.066 (0.20)	-0.065 (0.21)	-0.065 (0.20)	-0.038 (0.23)	-0.094 (0.25)	-0.129 (0.24)
Output Gap _t	-0.094 (1.32)	-1.230 (1.38)	-0.193 (1.30)	-0.167 (1.30)	-0.209 (1.31)	-0.377 (1.25)	0.045 (1.36)	0.397 (1.32)
ΣExpP _{t-s} *Credit Gap _t	0.0664 (0.067)	-0.367*** (0.084)	-0.132 (0.25)	0.191 (0.18)	0 (.)	0.127 (0.25)	0.132 (0.27)	0.375 (0.28)
ΣExpP _{t-s} *Output Gap _t	-0.134 (0.15)	5.395** (1.67)	-0.0445 (0.25)	0.536 (0.37)	0 (.)	-0.182 (0.55)	-0.496 (0.45)	-0.964** (0.29)
Constant	42.04* (18.53)	42.90** (17.16)	43.30* (20.45)	44.01* (19.45)	43.88* (19.62)	45.75** (19.05)	43.97** (15.43)	40.71* (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	-0.042		-0.005			
	ExpP _{t-1}	-0.017*		0.023**			
	ExpP _{t-2}	0.006		0.020**			
	ΣExpP _{t-s}	-0.052 [0.46]		0.037** [0.03]			
Spain	ExpP _t	-0.022	-0.002	0.028**	-0.024		
	ExpP _{t-1}	-0.005	-0.017	0.024	0.008		
	ExpP _{t-2}	0.019	-0.075	0.017	0.208*		
	ΣExpP _{t-s}	-0.008 [0.81]	-0.094 [0.34]	0.069 [0.22]	0.012 [0.80]		
Great Britain	ExpP _t	0.011					
	ExpP _{t-1}	0.018					
	ExpP _{t-2}	-0.057					
	ΣExpP _{t-s}	-0.045 [0.51]	-0.028 [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***				
	ΣExpP _{t-s}	-0.060 [0.28]	-0.042 [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
	ΣExpP _{t-s}	-0.022 [0.64]	-0.011 [0.90]			-0.085* [0.08]	-0.085* [0.08]
United States	ExpP _t	-0.096	-0.108				
	ExpP _{t-1}	-0.059**	-0.075*				
	ExpP _{t-2}	-0.037***	-0.038**				
	ΣExpP _{t-s}	-0.192* [0.05]	-0.221 [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).