Supranational Supervision: How Much and for Whom?*

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We argue that the extent to which supervision of banks takes place on the supranational level should be guided by two factors: cross-border externalities from bank failure and heterogeneity in bank failure costs. Based on a simple model, we show that supranational supervision is more likely to be welfare enhancing when externalities are high and country heterogeneity is low. This suggests that different sets of countries (or regions) should differ in the extent to which their regulators cooperate across borders. We apply the insights of our model to discuss optimal supervisory arrangements for different regions of the world and contrast them with existing arrangements and current policy initiatives. We also offer a political economy discussion on the likelihood with which countries delegate supervisory authority to supranational authorities.

JEL Codes: G21, G28.

1. Introduction

The question of how to regulate and supervise large international banks has taken center stage in the debate on the reform of the banking sector. The failure of internationally active financial institutions, such as Lehman Brothers, and cross-border banks, such as Fortis, Dexia, or the Icelandic banks, played a prominent role during the Global Financial Crisis. As a consequence, there is a growing

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recognition that memoranda of understanding and supervisory colleges are not sufficient to deal with large and systemically important cross-border financial institutions. In the euro zone, a banking union with a single supervisory mechanism at the European Central Bank and a single resolution board is being implemented, both as a crisis-resolution tool and as a necessary condition for making the euro zone a sustainable currency union (Beck 2012).

The discussion on the optimal international financial architecture is a complex one and often gets mired in details. In this paper, we argue that this discussion should be guided by a basic trade-off. This trade-off can serve as a general framework for gauging the need and feasibility of different forms of cross-border integration of bank supervision. In particular, based on a simple model, we derive circumstances under which a supranational supervisor is preferable to a national supervisor. Our model also permits us to analyze intermediate forms of cooperation, such as minimum standards across countries. We then apply the insights from the model to the discussion on the optimality of different forms of cross-border cooperation that are currently being considered in the global regulatory reform debate, as well as a political economy discussion on what circumstances make it more likely that countries will delegate part or all of their supervisory authority to supranational authorities.

In the wake of the Global Financial Crisis, several initiatives have aimed at closer international cooperation to regulate banks (for example, principles and standards, peer reviews, and progress reports by the Financial Stability Board). One key insight from the crisis, however, has been that such cooperation is most important at the stage of intervention and resolution of failing banks, i.e., at the point where supervisors have to decide if and how to intervene in a failing bank. There have been efforts to force bail-ins of creditors to reduce the costs of bank failure to taxpayers. In this context, there are also reforms under discussion to lessen the impact of bank failures on the rest of the financial system and the economy at large. Recovery and resolution plans, also known as living wills, for the largest financial institutions, are an important part of these reforms.

The different initiatives to intensify cooperation among supervisors have seen different degrees of success. Initial cooperation in the context of the living wills for G-SIFIS (global systemically important financial institutions) has been replaced by increased

suspicion, especially between U.S. and European supervisors.[1] On the other hand, in several smaller regions, there has been progress. In the Nordic-Baltic region, a memorandum of understanding has been signed that includes ex ante burden-sharing agreements. Moreover, a college of resolution authorities has been formed that includes ministries of finance. Supervisors in Africa have taken first steps towards closer cooperation with the establishment of the Community of African Banking Supervisors. Cooperation in certain subregions, as for example in the East African Community, has advanced even further. In the euro zone there have been attempts to move toward a fully fledged banking union, with a supranational supervisor and resolution authority. In spring 2014, political negotiations resulted in a partial banking union, with a single supervisory mechanism, a coordinated resolution mechanism based on national schemes, but no single deposit insurance fund.

The variety of experiences and approaches that are taken raises the question of what kind of cooperation is optimal for which set of countries. Our paper aims to inform the debate by focusing on the supervisory decision to intervene and resolve failing banks. Specifically, we propose that there are two dimensions that should determine the degree of supervisory integration—cross-border externalities from financial instability and heterogeneity of countries in the costs of failing banks. We model the supervisory decision to intervene in a failing bank under national and supranational supervision regimes and derive conditions under which either of the two results in higher welfare. The analysis shows that higher externalities and lower heterogeneity between countries in failure costs result in a higher likelihood that supranational supervision is welfare improving over national supervision. We also show that there is an intermediate form of cooperation between national supervisors that can reduce (but not eliminate) externalities from national supervision of cross-border banks while at the same time avoiding most of the inefficiencies related to heterogeneity in failure costs. Based on the analysis, we propose solutions for cross-border regulatory coordination or integration for different countries and regions in the world, and contrast them with current arrangements and policy initiatives.

[1] See, for instance, *Financial Times* (2013a).

However, we also analyze under which circumstances countries are likely to agree to different forms of regulatory coordination or supervisory integration, thus providing a political economy analysis of the different degrees of progress made in cross-border regulatory cooperation around the globe. We show that incentive compatibility can seriously limit the implementation of a supranational solution. We also show that small countries—even if their preferences only have little effect on supranational decision making—can benefit more from delegation than large countries. Finally, we show that biases arising from national supervision of cross-border banks can also result in too lenient licensing of banks.

Our paper is linked to a small—but growing—literature on cross-border bank regulation. Loranth and Morrison (2007) discuss the implications of capital requirements and deposit insurance for cross-border banks and show that capital requirements set at a level to offset the safety-net subsidy of deposit insurance result in too little risk taking in the case of multi-national banks. Dell'Arricia and Marquez (2006) show that competition between national regulators can lead to lower capital adequacy standards, since national regulators do not take into account the external benefits of higher capital adequacy standards in terms of higher stability in other countries. Acharya (2003) argues that coordinating capital adequacy ratios across countries without coordinating other dimensions of the regulatory framework, such as resolution policies, can have detrimental effects. Freixas (2003) and Goodhart and Schoenmaker (2009) show that ex post negotiations on recapitalization of failing cross-border banks can lead to underprovision of the necessary resources and identify an advantage of ex ante burden-sharing agreements in helping overcome coordination problems between regulators. Holthausen and Ronde (2002) consider cooperation between home- and host-country supervisor on the intervention decision for a multi-national bank. Given that national regulators represent national interests, a misalignment of interests leads to sub-optimal exchange of information and distorted intervention decisions. Niepmann and Schmidt-Eisenlohr (2013) show that decisions of national governments on recapitalization of failing banks are inefficient if national banking systems are linked through the interbank markets.

More closely related to our paper, Calzolari and Loranth (2011) analyze how the organizational structure of multi-national banks can

influence regulatory behavior. Specifically, organization of foreign presence through branches leads to higher incentives to intervene, as the home-country regulator can draw on all assets. At the same time, it can reduce intervention incentives if the regulator is responsible for repaying all deposits, including in foreign branches. However, there is no heterogeneity that induces costs for supranational regulation and hence no tension between the optimality of domestic and supranational regulation, which is the focus of our analysis. Beck, Todorov, and Wagner (2013) show that different dimensions of cross-border banking (deposit collection, investment and ownership) distort regulatory interventions in different directions. Similar to Calzolari and Loranth (2011), the analysis focuses on distortions arising from national solutions and there is no trade-off with supranational regulation. The paper also provides evidence on intervened banks from the recent crisis, supporting the theoretical analysis in that intervention decisions in foreign banks are distorted. Unlike the previous literature, our paper focuses on the intervention decision into failing banks and compares different national and supranational regulatory arrangements. Unlike previous papers, we also focus on incentive compatibility and political economy considerations.

There is also a more institutionally oriented literature on legal differences across countries in the treatment of domestic and foreign creditors (e.g., Krimminger 2007). Osterloo and Schoenmaker (2005) and Schoenmaker (2010) discuss the importance of regulation of cross-border banks within Europe. Allen et al. (2011) discuss policy options for the regulation of cross-border banks in the European Union. Schoenmaker and Siegmann (2013) compare the efficiency of different burden-sharing agreements to a supranational supervisor, using data on the largest thirty European banks.

The externality-heterogeneity trade-off discussed in this paper mirrors a similar discussion in the literature on fiscal decentralization (see, for example, Oates 1972). This literature argues that the comparative advantage of centralization increases with the size of interjurisdictional externalities but decreases with preference heterogeneity. The trade-off is also related to the literature on optimal currency areas and trade blocs. Following Mundell (1961), the cost of having a common currency is that countries are subject to different shocks (Mundell 1961), hence their "optimal" exchange rate differs (Maloney and Macmillen 1999, and Mundell 1961). A currency

area imposes a common exchange rate and thus creates costs similar to the one from imposing a common intervention threshold in our paper. The externalities in that literature are different, though; common currencies can be motivated without resorting to externalities between the members of the union (e.g., elimination of frictions from currency exchange is a key motive), but externalities arise vis-à-vis countries that are not in the union. Heterogeneity and externalities also play a role in the trade literature. In standard models of international trade, heterogeneity is not a cost to trade agreements (as the optimal tariff is zero and hence independent of country characteristics) but can threaten incentive compatibility, as it will lead to an asymmetric distribution of gains (see, e.g., Bond and Park 2002 for an analysis of asymmetries in country size). Externalities in this literature arise from trade connections among countries, similar to cross-border banking in the present paper.

The remainder of the paper is structured as follows. The next section discusses the key trade-off faced by supranational supervision, based on externalities and country heterogeneity. Section 3 offers a formal model and derives the levels of externalities and heterogeneity for which supranational supervision is preferable to national supervision. Section 4 applies the insights of the theoretical model and derives political economy implications of our analysis. Section 5 extends our theoretical model along several dimensions and provides a broader discussion on the optimality of different forms of cross-border cooperation in bank regulation and supervision. Section 6 uses the theoretical analysis to discuss the current status of cross-border cooperation between supervisors, while section 7 concludes.

2. The Trade-Off Arising from Cross-Border Bank Supervision

Since the onset of the Global Financial Crisis, there has been an increasing realization that the regulatory perimeter of banks has to match their geographic footprint. Many analysts and observers, however, also agree that a one-size-fits-all approach to supranational regulation is neither desirable nor realistic, as benefits and costs from moving from national to supranational regulatory frameworks differ greatly across different regions.

We argue that there are two factors that determine whether the regulatory architecture should become supranational.

2.1 Cross-Border Externalities

The raison d'être for financial regulation is externalities from bank failure. After all, in the absence of such externalities, bank governance can be left in the hands of shareholders and other stakeholders—as is the case for non-financial corporations. Externalities from bank failures partly materialize at the domestic level, for example, by causing a credit crunch in the domestic economy. Such externalities do not create a rationale for international regulation, since a domestic supervisor will be best equipped to deal with them. However, the failure of banks in a country also causes substantial externalities for other countries—and increasingly so, due to the fact that the financial systems of countries have become more interconnected in recent decades, along several dimensions.

First, externalities arise from cross-border activities of specific financial institutions. For example, the failure of a bank that has foreign assets will incur costs abroad—among others, by leading to lower credit availability to foreign firms. Such costs will not be taken into account by a domestic supervisor, leading to inefficient decisions. A point in case is Iceland (which from the perspective of the Icelandic supervisor had substantial foreign assets and deposits), where it can be argued that supervisors had insufficient incentives to control bank risk. Beck, Todorov, and Wagner (2013) show that banks' cross-border activities distorted supervisory incentives during the crisis of 2007–9. The implications for international regulation are straightforward: in order to avoid these distortions, the perimeter of the supervisor should match that of banks. Or, put differently, the benefits from moving to supranational supervision are higher for regions with significant cross-border banking activities.

This first source of externalities is a problem for developing and developed countries alike. As documented by Claessens and van Horen (2014), there are close ownership links in banking across the world, which have been increasing over the past two decades. These links have led countries to sign (legally non-binding) memoranda of understanding between supervisory authorities and have led to

the establishment of supervisory colleges. The resolution experience with several multi-national banks over recent years has made clear that such arrangements might not be enough.

Second, in a financially integrated world, there are plenty of other channels through which a shock arising from failure of one bank can spill over to other countries. This includes fire-sale externalities and common asset exposures, informational contagion among investors, direct interbank exposures, or counterparty risk. For such externalities and contagion effects to materialize, no direct cross-border links have to exist between two banking systems. It is more likely to find such externalities and sources of contagion in more developed financial systems where banks focus increasingly on non-interest sources of income and market-based funding and investment strategies (Demirgüç-Kunt and Huizinga 2010).

Third, specific externalities arise within a monetary union because a country cannot simply devalue its currency to regain competitiveness following a shock and hence may need to tap—in some form or other—the resources of other countries. The costs from asymmetric shocks are thus much higher in monetary unions. Further, relying on a common lender of last resort might result in a tragedy-of-the-commons problem, as it is in the interest of every member government with fragile banks to "share the burden" with the other members. It is important to note that this externality applies on the systemic level rather than just for individual institutions. The Spanish cajas did not have any specific cross-border exposures, but their failure is at the core of the Spanish crisis, with repercussions for the whole euro zone. Similarly, Cypriot banks have not had particularly close links with the rest of the euro zone (though links with other European countries, especially Russia, have been close), but their failure has imposed stress on the euro zone as a whole.

Fourth, externalities also arise from regulatory arbitrage. Banks have incentives to move to jurisdictions with lighter regulation—such jurisdictions benefit from an "inflow" of banking business—but this will cause negative externalities for other countries if and when lighter regulation leads to bank failure. Related to this, a cross-border financial institution operating in different jurisdictions might be subject to a "regulatory run," leading to an inefficient resolution process. Again the externalities are higher among financially

more integrated countries since the hurdles to moving business across borders are lower.

Not all cross-border externalities are of equal importance. A crucial distinction arises between externalities related to specific financial institutions and systemic externalities. It is mainly the systemic externalities that deserve regulation and supervision. For example, the failure of international banks in a country may not affect other countries much if the banks in these countries are in good financial health at the same time. This suggests that the extent to which cross-border externalities are systemic is much higher in financially and economically integrated areas because in those areas the likelihood that banks will face stress simultaneously is greater.

2.2 Heterogeneity in Resolution Costs across Countries

If all countries were identical ex ante, it would be easy to agree on the right structure for international regulation, and implementation would be straightforward. However, countries differ in practice along various dimensions, which increases the cost of closer cooperation and convergence.

First, countries differ in their legal and regulatory systems. This makes it hard to specify a common set of rules and standards, forcing adaptation of general principles to local circumstances. For example, while some countries are moving towards a universality approach where international insolvency is treated as a single case, many countries adopt a territorial approach where each country looks out for its own creditors before contributing assets to pay creditors in other countries. These differences not only lead to higher costs of bank failure in the case of internationally exposed banks but also lead to a higher difference in such costs.[2]

A second source of heterogeneity arises from preferences. Countries may differ, for example, in how they view the role of the government in the economy (one consequence being differences in state ownership), in how they focus on fiscal independence, or with respect to their risk tolerance. For example, a basic trade-off in banking

[2]See Claessens, Herring, and Schoenmaker (2010) for a more detailed discussion.

(and finance more generally) is between risk and return; e.g., lightly regulated institutions may perform better under normal conditions but may be more prone to fragility, while heavy-handed regulation reduces the risk but may also depress banks' profitability and their contribution to economic growth. Differences in risk tolerance can also lead to differences in the costs of bank failure.

Third, heterogeneity can result from informational asymmetries. Such asymmetries arise with respect to the health of another country's banking system but also regarding the most suitable approach to resolving problems under local conditions. Informational asymmetries tend to be compounded in the presence of cultural differences or a lack of geographical proximity. A somewhat different case is that of asymmetric interests and resources between home- and host-country supervisors, such as in the case of market-dominating subsidiaries that form only a small part of the overall banking group. While the subsidiary is considered systemically important for the host country, it is not for the overall banking group and for the home-country supervisor.

There are thus multiple sources of heterogeneity that decrease both the optimality and the desirability of supranational supervision. The next section models heterogeneity as arising from differences in the costs that bank failure imposes on countries.

3. A Model of Optimal Allocation of Supervisory Power

In this section we introduce a simple model to analyze the circumstances under which supervision should be delegated to the supranational level and when it should remain national. The trade-off will be determined by two factors: cross-border externalities arising from cross-border exposure of domestic banks and country heterogeneity arising from differences in the cost of bank failures. In our analysis we will focus on the supervisory task of intervening and closing a troubled bank.

There are two countries, A and B, each inhabited by a representative bank. Both countries are of the same size—an assumption which we will relax later. There are three periods— 0, 1, and 2— and there is no discounting. In period 0, each bank raises one unit of funds from depositors and invests it into a project. The deposit

interest rate is to be taken as zero.[3] The return on the project is random. More specifically, the project succeeds with probability λ and yields a return of $R > 1$ at date 2, while with probability $1 - \lambda$, the project fails and yields a zero return in period 2. The ex ante probability of success is uniformly distributed on $[0, 1]$.

Both banks have a cross-border exposure of β ($0 \leq \beta \leq 1$), meaning that a share β of each project is carried out in the other country. Note that while cross-border externalities arise here from cross-border investments, they could alternatively also arise in the presence of indirect foreign depositors or foreign bank ownership (Beck, Todorov, and Wagner 2013). Besides direct cross-border exposures, β can also be thought of as resulting from other, indirect, cross-border externalities, such as those due to common asset exposures and contagion effects. While we assume here cross-border activities that are symmetric (the source of heterogeneity in our analysis comes from differences in bank failure costs), this need not be the case. We will return to the issue of asymmetric externalities in section 5.2.

At date 1, each bank's project probability of success, λ_i ($i \in \{A, B\}$), becomes known. Based on this information, a supervisor can decide whether to intervene in a bank or to allow it to continue. If the supervisor decides to intervene in a bank, she can recover the initial investment of one. This intervention can be interpreted in different ways: it could be a liquidation or a purchase and assumption operation involving another bank. If the supervisor decides not to intervene and allows a bank to continue to period 2, with probability λ_i, the project will be successful and the bank will be able to repay its debt and pay out the surplus to equity. With probability $1 - \lambda_i$, the bank will fail. Bank failure causes external costs c_i. These costs include losses for borrowers losing access to their financing, cost of disruption for savers and creditors of the banks, and costs external to the bank's stakeholders, such as contagion and spillover effects for the rest of the financial system and the real economy.

These costs of bank failure may vary across banks or countries, and without loss of generality we assume $c_A \leq c_B$. Heterogenous failure costs may, for example, arise because the cost of bank failure

[3]This may be the consequence of deposit insurance with a risk-insensitive premium.

is expected to be significantly higher in more bank-based economies where there is greater reliance by enterprises, households, and governments on bank financing. Countries may also differ in their marginal cost of public funds (needed to stabilize the economy after bank failure)—more indebted countries may find it difficult to cope with bank failures (Demirgüç-Kunt and Huizinga 2013).[4] There might also be differences in terms of risk-return trade-offs where country A is more willing to accept the costs of bank failure. Failure costs may also depend on bank types, with smaller, more regional banks imposing fewer costs on the national economy than large, too-big-to-fail banks.

3.1 Efficient Supervision

We first consider the benchmark of efficient intervention decisions. Efficiency requires the supervisor to maximize world (utilitarian) welfare, consisting of the returns to domestic debt, and equity minus external costs in both countries. For bank i, the efficient intervention threshold is given by λ_i, at which the expected returns from continuation equal the return from immediate liquidation.

The return for the world economy if the project of bank i succeeds is R (occurring with probability λ_i), while the return in the case the bank fails is $-c_i$ (occurring with probability $1 - \lambda_i$). The return in the case of date 1 liquidation is 1. We hence obtain for the threshold λ_i that creates indifference to liquidation:

$$\lambda_i R - (1 - \lambda_i)c_i = 1. \tag{1}$$

Solving for λ gives

$$\lambda_i^* = \frac{1 + c_i}{R + c_i}. \tag{2}$$

Efficiency thus dictates intervention when $\lambda < \lambda_i^*$ and continuation when $\lambda \geq \lambda_i^*$. Note that λ_i^*, given the assumption of uniformly

[4]For a discussion on the external costs that bank failure can impose on the financial system and the real economy, see Beck (2011). In principle, intervention at date 1 may also incur some costs; however, we would think that such costs are of lower order than those arising from bank failure at date 2.

distributed shocks, is also the likelihood of intervention (from (2) we also have that $\lambda_i^* \in (0,1)$). Equation (2) thus shows that (efficient) intervention becomes more likely when the failure costs, c_i, increase (since $\lambda_i^{*\prime}(c_i) > 0$). The implication is that supervisors should be stricter in countries with higher failure costs. Note also that cross-border activities do not affect the efficient intervention point, as they are internalized in the efficient solution.

3.2 Decentralized Supervision

We now consider outcomes when each bank is supervised domestically. National supervisors will only care about domestic payoffs. This may modify the intervention threshold and drive a wedge between the socially efficient and the domestic intervention point.

The intervention point for bank i can be derived as follows. If the domestic supervisor intervenes at the intermediate date, the bank will be liquidated, in which case domestic payoffs are 1 and identical to world payoffs. Where there is no intervention, the bank succeeds with probability λ. In this case the payoff is R, which again is the same as before. With probability $1-\lambda$, the bank fails. In this case there is no return for the bank, and the country in addition suffers the domestic share of the bank failure cost, $(1-\beta)c_i$. Total expected domestic payoff is hence $\lambda R - (1-\lambda)(1-\beta)c_i$. It follows that the domestic supervisor is indifferent to intervention when

$$\lambda_i^D R - (1-\lambda)(1-\beta)c_i = 1. \tag{3}$$

Rearranging for λ_i^D, we obtain the intervention threshold

$$\lambda_i^D = \frac{1+(1-\beta)c_i}{R+(1-\beta)c_i}. \tag{4}$$

For $\beta > 0$ the intervention threshold differs from that derived in the previous section and is hence inefficient from the perspective of world welfare. The reason is that a domestic supervisor does not internalize the cost of bank failure accruing abroad. In fact, we can see from equation (4) that the domestic supervisor is more

lenient compared with the efficient solution (for $\beta > 0$ we have that $\lambda_i^D < \lambda_i^*$).[5]

Proposition 1. *Domestic and efficient interventions do not coincide ($\lambda_i^D \neq \lambda_i^*$) whenever there are cross-border activities ($\beta > 0$). In particular, there exists a range of λ's for which the domestic supervisor lets the bank continue, even though this is inefficient (that is, the domestic supervisor is too lenient).*

Proof. The proof follows directly from comparing equations (2) and (4), observing that $\lambda_i^D = \lambda_i^*$ for $\beta = 0$ and $\lambda_i^{D\prime}(\beta) < 0$ and $\lambda_i^{*\prime}(\beta) = 0$.

3.3 Supranational Supervision

We next consider the case of a supranational supervisor. Compared with a domestic supervisor, the supranational supervisor has the potential to improve welfare because he takes into account the cost of bank failure in both countries. The disadvantage of supranational supervision is that the supranational supervisor is assumed to follow a uniform policy across countries, that is, he cannot set a different intervention threshold in country A than in country B. Thus, his intervention decision cannot reflect country-specific bank failure costs.

The supervisor sets his policy λ^S at $t = 0$, maximizing expected welfare in the world economy. This welfare consists of the expected world payoffs from the activities of both banks:

$$W(\lambda^S) = \int_0^{\lambda^S} d\lambda + \int_{\lambda^S}^1 (\lambda R - (1-\lambda)c_A)d\lambda + \int_0^{\lambda^S} d\lambda + \int_{\lambda^S}^1 (\lambda R - (1-\lambda)c_B)d\lambda. \quad (5)$$

[5]The counterpart to lenient interventions in domestic banks with foreign operations is excessive intervention in foreign-owned banks (in which case the regulator will not internalize the benefit of continuation accruing to foreign shareholders). More generally, overall intervention distortions in international banks will depend on foreign assets, deposits, and equity shares. In particular, Beck, Todorov, and Wagner (2013) show that the presence of foreign deposits makes a national regulator more lenient, while foreign ownership of the bank makes the domestic regulator stricter. In our model, we abstract from foreign deposits and foreign ownership.

In equation (5), the first expression is expected welfare arising when the λ of bank A is below the intervention threshold λ^S (and the supervisor intervenes) and the second expression is expected welfare when the health of bank A is above the threshold, in which case the supervisor does not intervene. The third and fourth expressions are the respective terms arising for bank B.

The first-order condition for the supranational supervisor is given by

$$2 - (\lambda^S R - (1 - \lambda^S)c_A) - (\lambda^S R - (1 - \lambda^S)c_B) = 0. \tag{6}$$

We hence obtain the following for the intervention threshold of the supranational supervisor:

$$\lambda^S = \frac{1 + \frac{c_A + c_B}{2}}{R + \frac{c_A + c_B}{2}}. \tag{7}$$

Two points are worthy of note. First, and as expected, the supranational supervisor's decision does not depend on cross-border exposures. Second, it depends on the average failure costs in both countries, $\frac{c_A + c_B}{2}$, rather than the cost specific to the bank in question. This introduces an inefficiency ex post (equation (2) tells us that optimal intervention should depend on the country-specific costs).

PROPOSITION 2. *Supranational and efficient interventions do not coincide ($\lambda^S \neq \lambda_i^*$) whenever there is country heterogeneity ($c_A < c_B$). In particular, there exists a range of λ's for which the supranational supervisor inefficiently intervenes in the country with the low failure costs but inefficiently allows continuation in the country with high failure costs.*

Proof. The proof follows directly from comparing equations (2) and (7).

Note that without our assumption of the supervisor being constrained to a uniform policy across countries, supranational regulation would obviously be always welfare enhancing, as it would then coincide with the efficient solution. There are various reasons why this assumption is sensible. The first one is practical. Fairness in international regulation dictates that countries cannot be treated

differently. For example, suppose that a pan-European supervisor closes down banks in Southern Europe (because he perceives a high c there) but lets banks of the same health in Northern Europe continue. This would cause obvious political problems. Second, country-specific failure costs are not contractible in reality. To see the impact of this, consider a slight modification in the model. Suppose that instead of ex ante heterogeneity in failure costs (that is, we already know at $t = 0$ which country has high and low failure costs at $t = 1$), failure costs materialize at $t = 1$ (only at date 1 the identity of the country that has high failure costs is learned, and each country has the same probability of being the high-cost country). So, at date $t = 0$ only the aggregate realization of failure costs is known but not which country has the high cost). This modification does not change anything in the efficiency properties of the analysis (since there is still one high- and one low-cost country). And since at $t = 0$ (when the supranational agency is formed and countries have to decide on the threshold) the identity of the high- and low-cost country is not known yet, countries will have to implement a supranational solution that does not vary across countries. A third justification for uniform policies is information asymmetry: while the domestic supervisor may be able to observe the failure cost of its bank at date 1, a supranational supervisor may not. The best the supranational supervisor can hence do is to base his intervention decisions on the ex ante distribution of failure costs, which may be symmetric. Finally, actual regulation is almost always symmetric. For example, Basel Accords impose identical capital requirement rules across countries, even though failure costs of banks in different countries are very likely to differ.

Domestic intervention decisions are inefficient in our model because a domestic supervisor does not internalize the cost of failure of the domestic bank for foreign stakeholders in the bank. A similar externality arises when intervention decisions in the domestic bank affect risk taking at the foreign bank. In particular, Shapiro and Skeie (2013) analyze a setting where banks are intervened sequentially. Intervention (or lack thereof) in the first bank can provide a signal to the second bank about the likelihood of supervisory intervention and affect the risk taking of this bank. Efficiency may then require shutting down the first bank for certain realizations of the failure probability in which it would otherwise remain open. This is

in order to contain risk taking at the second bank. Such a channel would provide an alternative rationale for supranational regulation: domestic supervisors would ignore the beneficial signaling effect of bank closure on foreigners and create an externality similar to the one arising from cross-border bank activities.

3.4 When Is Supranational Supervision Efficient?

We are now in a position to analyze whether supervision should take place at the domestic or the supranational level. For this we examine whether supranational supervision leads to higher world welfare. Expected world welfare under domestic regulation is

$$W(\lambda_A^D, \lambda_B^D) = \int_0^{\lambda_A^D} d\lambda + \int_{\lambda_A^D}^1 (\lambda R - (1-\lambda)c_A)d\lambda + \int_0^{\lambda_B^D} d\lambda + \int_{\lambda_B^D}^1 (\lambda R - (1-\lambda)c_B)d\lambda. \quad (8)$$

The welfare impact of supranational supervision can be written as

$$\begin{aligned}\Delta W &= W(\lambda^S) - W(\lambda_A^D, \lambda_B^D) \\ &= \int_{\lambda_A^D}^{\lambda^S} (1 - \lambda R + (1-\lambda)c_A)d\lambda \\ &\quad - \int_{\lambda^S}^{\lambda_B^D} (1 - \lambda R + (1-\lambda)c_B)d\lambda. \end{aligned} \quad (9)$$

We denote with $\Delta c := c_B - c_A$ the difference in costs across countries.

Proposition 3. *The benefits from supranational supervision, ΔW,*

(i) increase in cross-border externalities β;
(ii) decrease in country heterogeneity $\Delta c (= c_B - c_A)$.

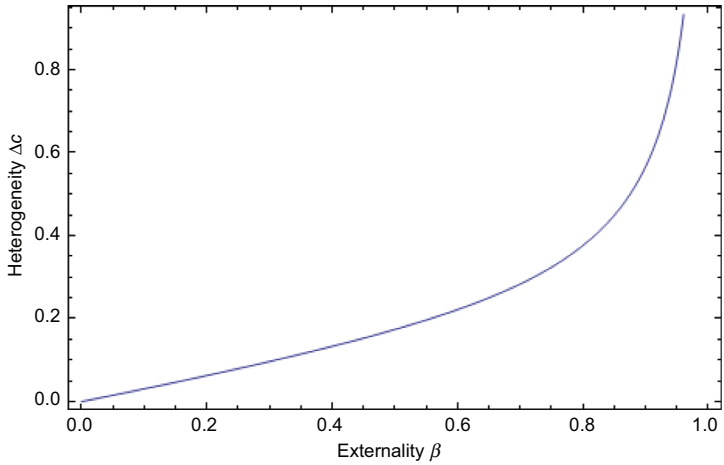
In addition, there exists a function $\widehat{\Delta c}(\beta)$ with $\frac{d\widehat{\Delta c}}{d\beta} > 0$ such that for $\Delta c < \widehat{\Delta c}(\beta)$ supranational supervision is efficient, while for $\Delta c > \widehat{\Delta c}(\beta)$ domestic supervision is efficient.

Proof. Using (4) and (7) to substitute λ_A^D, λ_B^D, and λ^S in (9), we obtain ΔW as a function of β and Δc: $\Delta W = \Delta W(\beta, \Delta c)$. From this we can derive that $\frac{\partial \Delta W}{\partial \beta} > 0$ and $\frac{\partial \Delta W}{\partial \Delta c} < 0$. Thus, β increases the benefits from supranational supervision, while Δc decreases it. Since in addition we have that $\Delta W(0,0) = 0$, there exists hence a function $\widehat{\Delta c}(\beta)$ (with $\frac{d\widehat{\Delta c}}{d\beta} > 0$) for which $\Delta W(\beta, \widehat{\Delta c}(\beta)) = 0$. For this function we then have that $\Delta W(\beta, \Delta c) < 0$ if $\Delta c > \widehat{\Delta c}(\beta)$ and $\Delta W(\beta, \Delta c) > 0$ if $\Delta c < \widehat{\Delta c}(\beta)$.

How can we interpret this finding in the context of the discussion in section 2? High externalities in the form of large global banks being active across several countries or in the form of banks across countries being exposed to the same capital markets increase the likelihood that supranational supervision is welfare improving. Similarly, high externalities stemming from being part of a currency union increases the optimality of supranational supervision. On the other hand, a high difference in failure costs reduces this likelihood, as it increases the range of λ where the supranational supervisor makes an inefficient decision from the viewpoint of either country. As discussed above, such differences can arise from different financial structures or fiscal policy stances but also political preferences.

Figure 1 illustrates the trade-off between externalities and heterogeneity. This figure depicts $\widehat{\Delta c}(\beta)$ for a (gross) return in the case of success of $R = 1.1$ and failure costs of $c = 0.3$ (note that this restricts Δc to be less than or equal to 0.6). The area above $\widehat{\Delta c}(\beta)$ gives the region where domestic supervision is optimal, while the area below this critical line indicates efficiency of supranational supervision. We can see that the critical line passes the origin of the coordinate system—which is to be expected since for $\beta = 0$ and $\Delta c = 0$ there are neither benefits nor cost to supranational supervision. We can also see that the critical line is upward sloping, that is, higher externalities have to be offset by higher heterogeneity in order to preserve the neutrality of both types of supervision. In addition, the figure shows that when the externalities are only modest ($\beta < 0.5$), the relationship between β and Δc is fairly linear. However, when the externalities are high (in particular, for $\beta > 0.7$), the costs needed to offset them become very high. This suggests that for sets of countries that display a high degree of externalities,

Figure 1. Externalities vs. Heterogeneity: The Case of Supranational Supervision



supranational supervision is desirable no matter how heterogenous the countries are.

In our two-country world, the natural bound for β is 0.5. However, our model can also be interpreted as pertaining to a world of $2n$ ($n \geq 1$) countries, where half of the countries are identical to country A in the baseline model and the other half are identical to country B. In this world, a complete diversification allocation implies $\beta = \frac{n-1}{n}$, which is only bounded by one. We also note that banks that have more than half of their activities outside their country of domicile are not uncommon, as for example the case of Swiss banks shows; hence the analysis of the trade-off for $\beta > 0.5$ has relevance.

It should be pointed out that the decision to delegate supervision to the supranational level is in principle orthogonal to whether supervision is carried out in a rule-based or discretionary way.[6] Both supranational and national supervision can be carried out in the form of a rule (set at date 0) or as discretionary (at date 1). For national supervision there is absolutely no difference between setting the intervention threshold at date 0 and date 1. For supranational regulation, consider the following modification of the model. Instead

[6]Since risk is exogenous in our model, there is no time-inconsistency problem here.

of each country being inhabited by one bank, let there be a continuum of banks operating whose realizations of λ are drawn independently. At date 1, a supervisor will thus face the whole specter of ranges of λ (by the law of large numbers, there will be realizations of λ in each non-empty interval on $[0, 1]$) in each country). The supervisor then has to decide on a marginal bank to intervene, which by the symmetry assumption has to be the same across countries. He thus faces exactly the same problem as from an ex ante perspective.

4. The Political Economy of Supranational Supervision

So far, we have considered the optimality of supranational supervision from the viewpoint of global welfare. But is agreeing to supranational supervision also incentive compatible from the individual country's viewpoint? This section discusses the political economy of delegating supervisory authority to a supranational institution. We first discuss the general case of incentive compatibility before gauging the role of relative country size.

4.1 Incentive Compatibility

As countries are asymmetric in their failure costs, their incentives to join a supranational solution are not identical. This creates situations where even though a supranational solution is optimal for overall welfare, one of the two countries would suffer under supranational regulation. In this case, delegation to the supranational level may not be politically feasible.

The following proposition analyzes this problem.

Proposition 4. *Whenever $c_A < c_B$, efficient supranational supervision may not be incentive compatible. In particular, one can define a $\widehat{\beta}_0$ such that*

(i) for $\beta < \widehat{\beta}_0$, there are parameter values for which the welfare of country A is lower under supranational supervision ($W_A(\lambda^S) < W_A(\lambda_A^D, \lambda_B^D)$) even if such supervision is efficient ($W_A(\lambda^S) + W_B(\lambda^S) > W_A(\lambda_A^D, \lambda_B^D) + W_B(\lambda_A^D, \lambda_B^D)$);

(ii) for $\beta > \widehat{\beta}_0$, there are parameter values for which the welfare of country B is lower under supranational supervision

($W_B(\lambda^S) < W_B(\lambda_A^D, \lambda_B^D)$) even if such supervision is efficient from the perspective of world welfare ($W_A(\lambda^S) + W_B(\lambda^S) > W_A(\lambda_A^*) + W_B(\lambda_B^*)$).

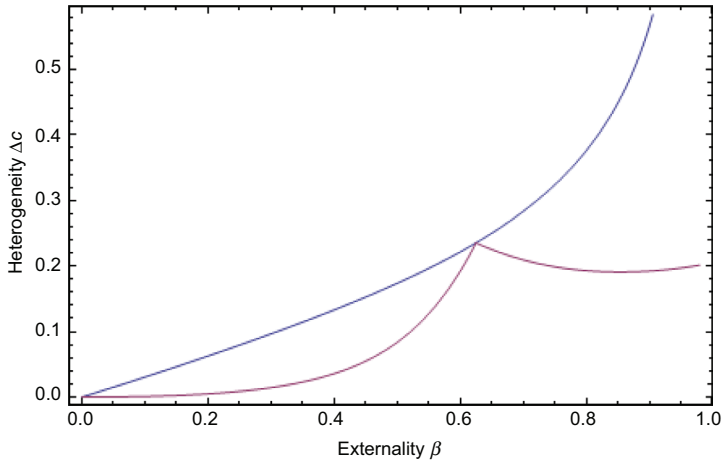
Proof. The welfare impact of moving from domestic to supranational regulation is for country A and country B, respectively,

$$\begin{aligned}
\Delta W_A &= W_A(\lambda^S) - W_A(\lambda_A^D, \lambda_B^D) \\
&= \int_{\lambda_A^D}^{\lambda^S} (1 - \lambda R + (1-\beta)(1-\lambda)c_A)d\lambda \\
&\quad - \int_{\lambda^S}^{\lambda_B^D} \beta(1-\lambda)c_B d\lambda, \qquad (10) \\
\Delta W_B &= W_B(\lambda^S) - W_B(\lambda_A^D, \lambda_B^D) \\
&= \int_{\lambda_A^D}^{\lambda^S} \beta(1-\lambda)c_A)d\lambda \\
&\quad - \int_{\lambda^S}^{\lambda_B^D} (1 - \lambda R + (1-\beta)(1-\lambda)c_B)d\lambda. \qquad (11)
\end{aligned}$$

Analogous to the proof of proposition 3, one can define $\widehat{\Delta c}_A(\beta)$ and $\widehat{\Delta c}_B(\beta)$ (with $\frac{d\widehat{\Delta c}_A}{d\beta}, \frac{d\widehat{\Delta c}_B}{d\beta} > 0$) for which $\Delta W_A(\beta, \widehat{\Delta c}(\beta)) = 0$ and $\Delta W_B(\beta, \widehat{\Delta c}(\beta)) = 0$. These functions give combinations of Δc and β for which a country is indifferent to supranational regulation. Next it can be shown that $\widehat{\Delta c}_A(\beta) - \widehat{\Delta c}_B(\beta)$ is increasing in β (that is, country A's incentives to join relative to country B are increasing in β). In addition, we have that $\widehat{\Delta c}_A(\beta) - \widehat{\Delta c}_B(\beta) < 0$ for $\beta = 0$ and $\widehat{\Delta c}_A(\beta) - \widehat{\Delta c}_B(\beta) > 0$ for sufficiently large β. Since $\widehat{\Delta c}_A(\beta) - \widehat{\Delta c}_B(\beta)$ is continuous and increasing in β, it follows by the intermediate value theorem that there exists a $\widehat{\beta}_0$ such that $\widehat{\Delta c}_A(\beta) - \widehat{\Delta c}_B(\beta) < 0$ for $\beta < \widehat{\beta}$ and $\widehat{\Delta c}_A(\beta) > \widehat{\Delta c}_B(\beta)$ for $\beta > \widehat{\beta}$.

The intuition behind this result is the following. Since supranational regulation is based on average costs, interventions will become

Figure 2. Incentive Compatibility of the Supranational Solution



relatively tighter in the low-cost country under the supranational outcome: from (4) and (7) we have that $\lambda^S - \lambda_A^D > \lambda^S - \lambda_B^D$ (for the high-cost country, interventions may even become less stringent). Because of this, country A will prefer supranational regulation less than country B. There is, however, also a second effect. Since costs are higher in country B, the externality from bank failures in this country are also higher. Thus, correcting this externality (by moving to supranational regulation) is relatively more beneficial for country A. The importance of the second effect depends on β, the measure of externality. For small β the first effect will thus dominate, while for large β the second will be larger.

Figure 2 illustrates this point. The upper line replicates the externality-heterogeneity trade-off of figure 1 (supranational supervision is hence efficient below this line). The lower line defines the incentive compatibility of the supranational solution: all points below the lower line refer to parameters constellations where both countries benefit from supranational regulation, while above the lower line supranational is not desirable for at least one country. In the area between the upper and the lower line are hence the outcomes where supranational regulation is desirable but not incentive compatible. To the left of the peak in the lower line this is because

the incentive constraint of country A is binding, while to the right it is the constraint of country B that binds. We can see that incentive compatibility is a serious problem, as it significantly reduces the area where efficient supranational regulation can be implemented without violating the interest of individual countries. We can also see that incentive compatibility is most "problematic" (as judged by the vertical distance between the upper and the lower line) when externalities are either very low or very high. For modestly high externalities (β around 0.65), there are few incentive problems. The variation of incentive problems across different degrees of externalities underlines the need for context-specific analysis of cross-border regulatory cooperation.

4.2 Asymmetric Country Size

Another source of incentive constraints can arise when the sizes of countries differ. Supranational regulation may then to a larger extent reflect the characteristics of the larger country, which may negatively effect the incentives of the smaller country to join.

To analyze the impact of country size, consider the following extension to the model. While in the baseline the size of each bank (size of the initial investment) was 1, let us assume that the size of the bank in country A and B is w_A and w_B, respectively. The bank in country i now needs w_i funds at date 0, returns w_i if liquidated at date 1, returns $w_i R$ at date 2 in case of success, and causes costs of $w_i c_i$ in case of failure (equivalently to modifying bank size, one may also change the number of banks operating in each country). This simple scaling of operations will neither affect the efficient nor the decentralized intervention points (equations (2) and (4) still apply). However, it will affect the supranational solution, as the latter applies to both countries at the same time. Welfare is now given by the weighted average of the payoffs from each bank:

$$W(\lambda^S) = w_A \left(\int_0^{\lambda^S} d\lambda + \int_{\lambda^S}^1 (\lambda R - (1-\lambda)c_A) d\lambda \right) + w_B \left(\int_0^{\lambda^S} d\lambda + \int_{\lambda^S}^1 (\lambda R - (1-\lambda)c_B) d\lambda \right). \qquad (12)$$

Note that for $w_A = w_B$, this collapses to welfare in the baseline model, equation (5). The first-order condition for λ^S is

$$w_A + w_B - w_A(\lambda^S R - (1-\lambda^S)c_A) - w_B(\lambda^S R - (1-\lambda^S)c_B) = 0. \tag{13}$$

Solving for λ^S leads to the new intervention threshold of the supranational supervisor:

$$\lambda^S = \frac{1 + \frac{w_A c_A + w_B c_B}{w_A + w_B}}{R + \frac{w_A c_A + w_B c_B}{w_A + w_B}}. \tag{14}$$

The supranational outcome is hence determined by the *weighted* average of the failure costs in the two countries, $\frac{w_A c_A + w_B c_B}{w_A + w_B}$. The failure costs of the smaller country are hence taken into account less for supranational decision making.

Proposition 5. *A country's gain from moving from domestic to supranational supervision may increase or decrease as the size of the other country changes (that is,* $\frac{\partial(W_i(\lambda^S) - W_i(\lambda_A^D, \lambda_B^D))}{\partial w_j}$ *may be either positive or negative for* $i \neq j$*).*

Proof. See the appendix.

The intuition for why the impact of higher size of the other country can go either way is that there are three effects on the country's benefit from joining a supranational approach. First, when the other country is larger, externalities from bank failures in the other country are higher. This will either increase or decrease the benefits from supranational regulation, depending on whether under the supranational solution supervision in the other country become tighter or not. Second, a larger size of the other country will mean that the supranational solution depends less on the characteristics of the domestic bank, in accordance with equation (14). This lowers the country's utility from operation of its own bank, as interventions are then less tailored to the characteristics of the domestic bank. Third, the change in the supranational regulation arising from a larger foreign bank will affect domestic utility by changing the likelihood of failure of the other bank. This leads to an improvement in domestic

utility if the other country is the high-cost country since then supranational regulation will become tighter and the foreign bank will fail less (if the foreign bank is the low-cost bank, this effect is reversed).

The result of proposition 5 is interesting, as it goes against the often-voiced argument that smaller countries tend to lose under supranational solutions if under such solutions their characteristics are less taken into account. The reason is that a small country can be subject to significant externalities from the failure of foreign banks (simply, because there are many foreign banks from the perspective of a small country). It hence has a high interest in international regulation that addresses the cross-border externalities from bank failures.

While in this section we considered asymmetries in country size as the source of incentive constraints, incentive problems also arise when the externalities are asymmetric (that is, β differs across countries). For instance, suppose that country B is a financial center. Most of the costs of bank failure will then fall outside its borders, while the country itself may be relatively little affected by bank failures in other countries. For such a country there are limited gains from supranational supervision (arising because it allows internalizing of externalities). It may hence object to supranational supervision even if it is of benefit to countries overall. We will discuss this in more detail below.

5. Extensions

This section discusses several extensions of our model. First, we will analyze an intermediate solution between decentralized and supranational supervision. Second, we will discuss the case of asymmetric externalities. Finally, we discuss how cross-border externalities of bank failure results in biased decisions to allow banks to operate in the first place.

5.1 An Intermediate Solution

Domestic and supranational supervision are two extreme solutions on a continuum of possible forms of cooperation on cross-border banking. In the following, we will discuss an intermediate solution where countries commit to a *minimum threshold* for intervention.

Such solutions are commonly observed in international agreements, which define minimum standards but leave it up to countries to implement higher standards. They also retain the requirement of symmetry in that the same threshold applies to each country.

Suppose that countries agree on a threshold $\lambda^*_{\min}$, such that a country has to intervene whenever $\lambda \leq \lambda^*_{\min}$ but is free to decide about intervention when $\lambda > \lambda^*_{\min}$. Such a minimum threshold helps to internalize externalities that tend to make countries more lenient in their intervention policies. At the same time, by giving countries discretion about interventions, it allows them to cater intervention policies to their own failure costs.

The next proposition shows that such an approach has appeal relative to the two solutions considered previously.

PROPOSITION 6. *When $\beta > 0$ and $c_A < c_B$, an optimally chosen minimum threshold $\lambda^*_{\min}$*

(i) results in strictly higher welfare than under the decentralized solution ($W(\lambda^*_{\min}) > W^A(\lambda^D_A, \lambda^D_B) + W^B(\lambda^D_A, \lambda^D_B)$ for $\lambda^*_{\min} = \arg\max W(\lambda_{\min})$);

(ii) results in (weakly) higher welfare than under the supranational solution ($W(\lambda^*_{\min}) \geq W^A(\lambda^S) + W^B(\lambda^S)$ for $\lambda^*_{\min} = \arg\max W(\lambda_{\min})$).

Proof. See the appendix.

The reason why an (optimally) set minimum intervention point dominates the domestic solution is that it allows to implement efficient supervision in country A (by setting $\lambda_{\min} = \lambda^*_A$) without imposing any inefficiencies in the high-cost country B, as this country is still free to deviate to a higher level of stringency. It also dominates supranational regulation whenever $\lambda^S < \lambda^D_B$. In this case, when setting $\lambda_{\min} = \lambda^S$, country B again has the possibility to deviate by setting a higher stringency, which would benefit welfare. However, when $\lambda^S \geq \lambda^D_B$, no country deviates from a minimum threshold λ^S. In this case, a welfare improvement may not be attainable under the intermediate solution.

Since an optimally set intermediate solution is never dominated by the two other solutions, it is not instructive to analyze how the heterogeneity-externality trade-off affects the desirability of the

intermediate solution. In the following we will thus focus on a "naive" intermediate approach where the minimum threshold is set equal to the efficient level of country A: $\lambda_{\min} = \lambda_A^*$. This can be thought of as the natural outcome in a world where supranational regulators are reluctant to enforce regulation that is stricter than the one required for the low-cost country (i.e., it avoids that regulation is ever excessive for a country).

Since $\lambda_{\min} = \lambda_A^*$, intervention decisions will then be efficient whenever they are done in country A:

$$\lambda_A^I = \lambda_{\min}. \tag{15}$$

Country B may decide to be even stricter and hence to intervene sometimes when $\lambda > \lambda_{\min}$. This is desirable (and also optimal for the country itself) since the country has higher failure costs and hence also a higher optimal intervention threshold. However, whenever $\beta > 0$, the country will not be strict enough from a world perspective and supervision may still be subject to some inefficiency. Formally, intervention by country B will be the maximum of the domestically optimal intervention for the country, λ_B^D, and the minimum threshold:

$$\lambda_B^I = \max[\lambda_B^D, \lambda_{\min}]. \tag{16}$$

How does the intermediate solution compare with the domestic and the supranational approach? Compared with the domestic solution, we have that intervention will always be more efficient in country A under the intermediate approach (as λ_A^I is fully efficient). For interventions in country B, two situations arise. The first case is when the minimum threshold is not binding. In this case country B will set the same threshold as in the domestic solution. Where the threshold is binding, the country will set a higher threshold than under the domestic solution. Interventions will then be more efficient, as the threshold partially forces the country to internalize the externalities. Overall, we thus have that intervention is always more efficient in country A under the intermediate solution, while it is at least as efficient in country B. The minimum threshold λ_A^* thus still dominates decentralized supervision.

However, the intermediate solution does not necessarily dominate the supranational approach. Interventions are more efficient in

country A, but they may be more or less efficient in country B. In fact, a similar trade-off as in section 3.4 arises. On the one hand, the intermediate solution allows country B to carry out interventions depending on the country's own cost. On the other hand, the country will not fully internalize the externality, as the country will determine its own intervention level whenever the threshold is not binding.

PROPOSITION 7. *The benefits from supranational supervision relative to the intermediate solution*

(i) increase in cross-border externalities β*;*
(ii) decrease in country heterogeneity $\Delta c := c_B - c_A$*.*

In addition, there is a function $\widehat{\Delta c}(\beta)$ *with* $\frac{\widehat{\Delta c}^I}{d\beta} > 0$ *such that for* $\Delta c < \widehat{\Delta c}^I$ *supranational supervision is optimal, while for* $\Delta c > \widehat{\Delta c}^I(\beta)$ *the intermediate solution is optimal.*

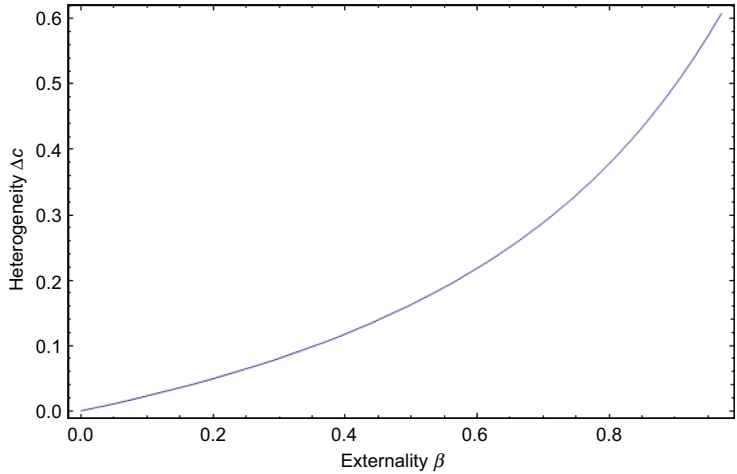
Proof. Welfare under the intermediate solution is given by

$$W(\lambda_A^D, \lambda_B^D) = \int_0^{\lambda_{\min}} d\lambda + \int_{\lambda_{\min}}^1 (\lambda R - (1-\lambda)c_A)d\lambda + \int_0^{\min[\lambda_B^D, \lambda_{\min}]} d\lambda + \int_{\min[\lambda_B^D, \lambda_{\min}]}^1 (\lambda R - (1-\lambda)c_B)d\lambda. \tag{17}$$

The remaining part of the proof is analogous to proposition 3.

Figure 3 depicts the trade-off for the same parameters as in figure 1 ($R = 1.1$ and $c = 0.3$). The region where supranational supervision remains optimal is below the critical threshold $\widehat{\Delta c}^I$. We can see that $\widehat{\Delta c}^I(\beta)$ still goes to the origin of the coordinate system—which is, of course, because whenever there is neither an externality nor a cost difference, intermediate solution and supranational supervision coincide. It can also be seen that the figure shows a positive relationship between β and $\widehat{\Delta c}^I$. However, compared with figure 1,

Figure 3. Externalities vs. Heterogeneity: The Case of the Intermediate Solution



the relationship is now less sensitive to β in regions where externalities are high. It should be pointed out that $\widehat{\Delta c}^{I}$ is always below $\widehat{\Delta c}$ in figure 1, indicating that there are now fewer situations where supranational supervision is desirable. This is because the alternative (intermediate solution) is now more attractive than in section 3 (where we considered the domestic solution).

5.2 Asymmetries in Externalities

For the baseline model we have assumed that the sole source of heterogeneity is country differences in the failure costs c. Two questions arise. First, does heterogeneity in β create a similar trade-off with externalities as cost heterogeneity does? Second, is the heterogeneity-externality trade-off robust to introducing asymmetries in β?

Consider first the question of whether β-heterogeneity creates its own trade-off. For this we modify the baseline model such that we now have $\beta_A \geq \beta_B$ (beta heterogeneity) but $c_A = c_B = c$ (no cost heterogeneity). The intervention thresholds for the efficient, the decentralized, and the supranational solution are then (similar to equations (2), (4), and (7))

$$\lambda^* = \frac{1+c}{R+c}, \tag{18}$$

$$\lambda_i^D = \frac{1+(1-\beta_i)c}{R+(1-\beta_i)c}, \tag{19}$$

$$\lambda^S = \frac{1+c}{R+c}. \tag{20}$$

We can see that as long as $\beta_i > 0$, domestic interventions are still inefficient ($\lambda_i^D < \lambda^*$), as they ignore the cross-border externalities. However, the supranational solution is now identical to the efficient one ($\lambda^S = \lambda^*$). Intuitively, this is because an asymmetric distribution of the failure costs among countries (differences in β's) does not affect the efficient intervention point (λ^* is now the same across countries). There is thus no longer a cost to supranational regulation, which previously arose because it imposed a symmetric threshold across countries that actually required different interventions. The lesson is thus that a trade-off is created by heterogeneity in the efficient intervention points but not by heterogeneity in the decentralized solutions. A corollary of this is that the supranational solution is always optimal among countries with the same failure costs, even if externalities from cross-border banking vary across the countries.

The next question is, what happens to the trade-off of the baseline model if we allow β to vary across countries? We now permit $\beta_A \neq \beta_B$ and $c_A \neq c_B$. As before, introducing β-heterogeneity affects neither the efficient intervention points λ_i^* nor the supranational intervention point, λ^S, which are still given by equation (2) and (7), respectively. Replacing β with β_i in equation (4), we obtain for the new decentralized intervention point of country i

$$\lambda_i^D = \frac{1+(1-\beta_i)c_i}{R+(1-\beta_i)c_i}. \tag{21}$$

The welfare impact of moving from domestic to supranational regulation is still given by equation (9), but now with λ_i^D as given above. We denote with $\beta := \frac{\beta_A+\beta_B}{2}$ the average cross-border externality in the economy and with $\triangle\beta = \beta_B - \beta_A$ the beta heterogeneity.

Proposition 8. *When there is asymmetry in externalities ($\beta_A \neq \beta_B$), the benefits from supranational regulation* ΔW

(i) increase in average cross-border externalities β;
(i) can decrease or increase in country heterogeneity $\triangle c$.

Proof. See the appendix.

The reason why cost heterogeneity may now also increase the benefits from supranational regulation is the following. When β_A is smaller than β_B, an increase in cost asymmetry may also increase externalities. The total cross-border externality that would arise from the failure of both banks is $\beta_A c_A + \beta_B c_B = \beta_A(c - \triangle c) + \beta_B(c + \triangle c)$, which is increasing in $\triangle c$ whenever $\beta_B > \beta_A$. Cost asymmetries and externalities cannot be separated in this case and hence the trade-off cannot be analyzed.

5.3 Biases in the Decision to Let Banks Operate

Our analysis has focused on intervention decisions at $t = 1$. However, the fact that a bank operates across borders also has implications for the incentives for letting banks operate at $t = 0$. To see this, let us modify the model and assume that liquidation of the bank at date 1 only returns $l \leq 1$. Hence, it is no longer clear that letting the bank operate is optimal.

We first analyze the decision to allow the bank to invest at $t = 0$ for an (exogenously) given intervention decision, denoted $\widehat{\lambda}$. This decision can be interpreted in a strict sense as whether to grant a license to a bank, but also more generally as an action by regulators or supervisors that affects the incentives of a bank to invest in a project. For instance, tighter capital regulation may make certain investments uneconomical.

World welfare (net of cost of investment at $t = 0$) from letting a bank operate is $l - 1$ when the bank is liquidated (occurring when $\lambda \leq \widehat{\lambda}$) and $\lambda R - (1 - \lambda)c_A - 1$ otherwise (same as in the baseline model). In expected terms we thus have

$$W_i^n(\widehat{\lambda}) = \int_0^{\widehat{\lambda}} l d\lambda + \int_{\widehat{\lambda}}^1 (\lambda R - (1 - \lambda)c_A) d\lambda - 1. \qquad (22)$$

By contrast, the domestic supervisor only perceives costs of $(1 - \beta)c_A$ when a bank fails. Domestic welfare is thus

$$W_i^{n,D}(\widehat{\lambda}) = \int_0^{\widehat{\lambda}} l d\lambda + \int_{\widehat{\lambda}}^1 (\lambda R - (1 - \beta)(1 - \lambda)c_A) d\lambda - 1. \qquad (23)$$

For $\beta > 0$ we have that $W_i^{n,D}(\lambda) > W_i^n(\lambda)$, that is, the domestic benefits from operating the bank are higher than the benefits for world welfare. From this we can conclude the following proposition.

Proposition 9. *For given intervention threshold $\widehat{\lambda}$ ($0 < \widehat{\lambda} < 1$), the domestic decision to let a bank operate may be inefficient. In particular, whenever $\beta > 0$ there are parameter values for which it is not efficient to let the bank operate, but a domestic supervisor nevertheless would let it operate.*

Proof. We have that $W_i^n(\widehat{\lambda}) < 0$ for $R = 0$ and $W_i^n(\widehat{\lambda}) > 0$ for sufficiently large R. Since W_i^n is monotonically and continuously increasing in R, there exists an $\widehat{R}$ at which $W_i^n(\widehat{\lambda}) = 0$ (intermediate value theorem). Consider a very small ε ($\varepsilon > 0$). For $\widehat{R} - \varepsilon$ we then have $W_i^n(\widehat{\lambda}) < 0$ but $W_i^{n,D}(\widehat{\lambda}) > 0$ (since $W_i^{n,D}(\widehat{\lambda}) > W_i^n(\widehat{\lambda})$). There exist thus parameter values for which it is not optimal to let the bank operate, but a domestic supervisor would nevertheless choose to let it operate.

The intuition for this result is straightforward. The domestic supervisor does not internalize the foreign costs of bank failures. She hence perceives higher benefits from operating the bank than warranted from the perspective of world welfare.

Another question is whether there is any bias in letting banks operate at $t = 0$ when intervention thresholds are endogenous. That is, we can compare the decision of the domestic supervisor to let the bank operate at $t = 0$ given that she will also set $\lambda = \lambda_i^D$, with the decision whether the bank should be operated in a first-best world (that is, is it efficient to run the bank at $t = 0$ given that liquidations are set efficiently at λ_i^*).

The domestic benefit from letting the bank operate is now given by (replacing $\widehat{\lambda}$ with λ_i^D in equation (23))

$$W_i^{n,D}(\lambda_i^D) = \int_0^{\lambda_i^D} l d\lambda + \int_{\lambda_i^D}^1 (\lambda R - (1-\lambda)(1-\beta)c_A) d\lambda - 1. \quad (24)$$

We have $W_i^{n,D}(\lambda_i^D) \geq W_i^{n,D}(\lambda_i^*)$ (that is, domestic benefits are at least as high under the decentralized solution than under any other intervention threshold). Otherwise λ_i^D would not maximize

the benefits of the domestic supervisor. From this it follows that $W_i^{n,D}(\lambda_i^D) > W_i^n(\lambda^*)$ since we have $W_i^{n,D}(\widehat{\lambda}) > W_i^n(\widehat{\lambda})$ for arbitrary $\overline{\lambda}$ as shown above. Thus, the domestic benefits from operating the bank are still higher. This leads to the following proposition.

PROPOSITION 10. *Whenever $\beta > 0$, the domestic supervisor's decision to let a bank operate at $t = 0$ with an intervention threshold of $\lambda = \lambda_i^D$ is biased relative to the first best with an intervention threshold λ_i^*. In particular, there are parameter values for which it is not efficient to let the bank operate, but the domestic supervisor nevertheless lets it operate.*

Proof. Since $\lambda_i^D = \arg\max_\lambda W_i^{n,D}(\lambda)$, we have that $W_i^{n,D}(\lambda_i^D) \geq W_i^{n,D}(\widehat{\lambda})$ for arbitrary $\widehat{\lambda}$. The rest of the proof is analogous to proposition 9.

There are now two reasons for this bias. First, as in proposition 9, there is the bias arising from the fact that for a given intervention threshold, the domestic costs of letting the bank operate are lower then the social costs (due to the externality). Second, the domestic supervisor will choose an intervention threshold that is more lenient than the efficient one. This further increases the domestic benefits from operating the bank.[7]

A corollary of the last point is that the ex ante decision whether to let a bank operate will be less subject to inefficiencies if the ex post intervention decision is on the supranational level. In the context of the European Banking Union, this would mean that the decision to delegate intervention powers for large banks to the European Central Bank has alleviated the need for having also supranational control over the operation of banks.

Propositions 9 and 10 suggest that in a world where banks are domestically licensed and supervised, we have too many banks operating. This argument is independent of the normal reasoning relying on subsidies for banks arising from bailouts and deposit insurance, and is solely due to cross-border activities of banks. Our model thus

[7]Note that there is no straightforward way to analyze the bias for a supranational regulator to let a bank operate, because her intervention decision depends on the characteristics of the other bank as well.

suggests that cross-border banking without appropriate cross-border regulatory cooperation can result in "overbanking."

It should be noted that the decision of whether to delegate the $t = 0$ decision to the supranational level is subject to the same trade-off as the one for the decision at $t = 1$. In particular, when a supranational decision maker determines whether to let both banks operate or not, there will be costs in the presence of heterogeneity (when $c_A < c_B$, it might be optimal to let bank A operate but not bank B). On the upside, a supranational regulator can eliminate the bias that domestic decisions are subject to, as analyzed above. The last section of the appendix shows this formally.

6. Implications for the Debate on Supranational Supervision

In this section we will apply the insights from the theoretical analysis to the policy discussion on cross-border bank regulation and supervision. The baseline model has discriminated between two possible solutions (national and supranational supervision). In reality, there is a continuum of solutions, reflecting different degrees of cooperation (such as through minimum intervention thresholds). We can use the insights of our model to discuss these different forms of cooperation. The key challenge for an appropriate approach is to overcome externalities while at the same time being adequate for different degrees of heterogeneity.

Regions and countries differ markedly regarding the extent to which their banks pose externalities to other banks but also how heterogeneous their economies and banking systems are. This leads to the straightforward but important conclusion that the optimal degree of cross-border regulatory convergence also differs across regions. In particular, applying our trade-off, homogenous regions with strong externalities should implement a large degree of common supervision. On the other end of the spectrum, the gains from supranational supervision are the lowest for heterogeneous regions in which cross-border externalities are limited.

6.1 Solutions in the Case of Low Externalities

Low externalities do not call for heavy institutional solutions. Nevertheless, the exact arrangements should depend on the heterogeneity

of the countries involved. In the case of high heterogeneity, simple solutions, such as supervisory colleges and memoranda of understanding (MoUs) for information exchange and cooperation between home- and host-country supervisors suffice. In addition, countries can carry out joint crisis-simulation exercises or even develop joint crisis-management plans. This is the case for countries that have very low shares of cross-border banks and have limited integration with international financial markets, such as, e.g., India, a country with limited foreign bank participation and still some capital account restrictions. In the context of our model, such cooperation will imply domestic solutions but with potentially lower external costs c.

Countries that are more homogenous in their legal and regulatory structure (or because they pursue the joint goal of financial integration), and whose bank failure costs are therefore more similar, can go a step further and establish colleges of bank resolution authorities, which include not only supervisors but also other stakeholders involved in the resolution of banks, including deposit insurers and, critically, ministry of finance officials representing taxpayers. Such countries can also try to achieve convergence in cross-border regulatory frameworks. An example of a relatively homogenous but not yet financially well-integrated region is the East African community.[8] Such a solution might be similar to the intermediate solution we discussed above, with a common intervention threshold.

6.2 Solutions in the Case of High Externalities

High externalities call for institutional and regulatory solutions that go beyond those described above. In most cases, this also means surpassing the arrangements that were in place before the 2007 crisis. We argue that one can broadly distinguish between four different cases, which reflect different degrees of heterogeneity across the countries involved.

A first case arises between financially well-integrated regions that are nevertheless relatively heterogeneous, such as the United States

[8]While most of the East African countries (Burundi, Kenya, Rwanda, Tanzania, and Uganda) have had historically a high share of non-African banks, there has been a recent trend for Kenyan banks to expand across the other four countries, with several banks from these countries also planning to expand across East Africa.

and Europe or continental Europe and the United Kingdom. In such a situation, moving supervision completely to the supranational level is too costly and politically infeasible. Our model suggests this would not be welfare improving, not only on the aggregate level but also most likely not for individual countries. This suggests that efforts should therefore rather focus on removing the largest externalities and distortions in the regulatory process and achieving a certain degree of convergence. Given the political constraints and legal differences, such arrangements have to be partly on an institution-specific basis (e.g., SIFIs) or joint support structures for specific financial markets, such as standing foreign exchange swap facilities (Allen et al. 2011). The current trend towards resolution and recovery plans ("living wills") can be exploited in this context. We can also learn here from the experience with Lehman Brothers, where resolution over the weekend was not possible due to, among many other factors, legal differences between UK and U.S. regulatory and corporate governance frameworks. This emphasizes that living wills for cross-border SIFIs should be developed under the joint supervision of all relevant supervisory and resolution authorities. In the context of our model, these efforts would lead to a lowering of the bank failure costs in both countries, while staying with the domestic solution.

A second case arises when externalities among heterogeneous regions are very asymmetric. While externalities between the United States and Europe are probably fairly balanced in that European banks suffer from U.S. bank failures similarly as U.S. banks from European failures, this is not the case among countries that are predominantly either home or host to cross-border banks. For small host countries, where subsidiaries of large multi-national banks are market dominant but constitute only a small part of the overall banking group, there is little chance for an influential voice in the supervisory process, while at the same time, these countries face high external costs from the failure of such banks. In the context of our model, this would imply a small weight in the decision of a supranational supervisor, while at the same time a high c, so that any supranational decision process would be too lenient. While our analysis in section 4.2 suggests that small countries may also benefit from supranational solutions, this might not be the case for the large home countries. Insisting on stand-alone subsidiaries that can be

relatively easily fire-walled in times of crises might therefore be the preferred option for host-country regulators, such as in many African and Latin American countries. While this entails a certain efficiency cost, as subsidiaries cannot as easily exploit scale economies, this disadvantage might be more than outweighed by the benefits that arise because host countries have better incentives to appropriately supervise these institutions. For the small host country, this might involve lower external costs c, but possibly also lower externalities β from bank failure, as the stand-alone subsidiary would be treated as a domestic bank.

A third case arises among financially well-integrated countries that display somewhat lower heterogeneity. This applies especially for countries that have close economic and political links, but that are neither connected through a currency union nor coordinate their macroeconomic policies. For such countries, a complete supranational approach may still be too costly an option. However, the optimal level of supranational supervision in this case goes beyond the previous cases, as these countries can implement strong ex ante burden-sharing and resolution agreements. The MoU for burden sharing among the Nordic-Baltic countries is an example of such an arrangement. In the context of our model, this could be the intermediate option of ex ante agreed intervention thresholds. The adoption of such an agreement is also facilitated by the fact that externalities seem relatively evenly distributed and there is no dominating member, so that there are fewer political economy obstacles than in more asymmetric country groupings. Members of the EU that are currently not part of the euro-zone could benefit from similar arrangements.

Finally, there is the case of currency unions, possibly coupled with joint macroeconomic policies. For such regions externalities are very high because of the high degree of interdependence but also because asymmetric shocks are more costly within currency unions, as previously discussed. At the same time, such countries will display limited (ex ante) heterogeneity in the failure costs of banks. Thus, our analysis calls for a high degree of supranational delegation in this case. Such delegation should result in a joint bank supervision and resolution framework, with a central resolution authority that has both powers and resources to intervene in failing banks. However, our model can also explain the existence of political economy

obstacles to such an agreement if heterogeneity in bank failure costs is correlated with country size.[9] Our model can also explain why the adoption of an ex post banking union will not be politically feasible, as ex post heterogeneity will always be higher than ex ante heterogeneity. This underlines the importance of differentiating between the resolution of legacy problems and forward-looking institutional solutions in the context of the current euro-zone crisis (Beck 2012).

6.3 The Role for International Bodies

Our "tailored approach" to international supervision does not deal well with the problem of regulatory arbitrage across jurisdictions and, related to this, the incentives for supervisors to engage in a race to the bottom. In particular, countries that are not strongly integrated with the regulatory system of other countries may develop very different standards and requirements, creating space and incentives for financial institutions to arbitrage across jurisdictions. By doing so, they might impose high external costs on other countries and—in the context of our model—face a low intervention threshold. In addition, these countries may find it optimal to refrain from closer integration with the expressed aim of becoming a "regulation haven." The presence of jurisdictions with insufficiently regulated institutions can pose significant negative externalities for other countries.

This is where international bodies such as the Basel Committee come in. These bodies typically limit themselves to issuing minimum standards and regulation, but this is essential for containing regulatory arbitrage. For example, Basel-style capital requirements put a floor on how far individual jurisdictions can go in loosening regulation.

Another issue is that of coordinating across heterogeneous countries with different economic interests and political weights. During the 2007–9 crisis, a consortium of international bodies under the leadership of the European Bank for Reconstruction and Development (EBRD) convened regulators and banks from home and host countries in Europe to avoid aggressive capital repatriation and a

[9]See, for example, the recent discussions on rules setting the extent of bail-in and thus distribution of bank losses within the euro zone (*Financial Times* 2103b).

credit crunch in Central and Eastern Europe, with some success.[10] Similar arrangements might be necessary to prevent regulatory runs across heterogeneous but well-integrated countries. In addition, a champion of the interests of small host countries of large cross-border banks in Africa and Latin American might be needed, given the limited influence with home-country supervisors in Europe or the United States.

7. Conclusions

We have argued that there is no universally applicable optimal degree of supervisory integration. We suggest that two factors should be used to judge whether a set of countries should delegate supervision to the supranational level at a given point in time: the degree to which there are externalities of bank failures across countries and the extent of country heterogeneity. Countries that face low externalities and are fairly heterogeneous should only display a modest level of coordination, such as through supervisory colleges and common stress tests. Moving to the other end of the spectrum, financially well-integrated countries that are not particularly heterogeneous should have a strong supranational approach to supervision and resolution. The clearest case for a full supranational solution is within currency unions—where externalities are very high and heterogeneity should be low or can most easily be reduced. Currency unions should use an integrated approach to the design of their regulatory architecture by moving both supervision and resolution to a supranational body.

It is important to note that the optimal supervisory structure is expected to change over time. Countries may converge in their institutional arrangements or overcome political constraints for closer cross-border cooperation, effectively lowering heterogeneity. Long-term trends towards more financial integration (even though partly reversed during the ongoing crisis) suggest that cross-border externalities will increase. This makes it likely that supranational supervision will become attractive for an increasingly larger set of countries in the future.

[10]See De Haas et al. (2015). In a broader sense, one could argue that international financial institutions, such as the EBRD, can thus play an important role by internalizing externalities from cross-border banking under national supervision.

One important dimension we have stressed is that of the political economy of supranational supervisory arrangements. Even if supranational supervision improves aggregate welfare, it might not be adopted if individual countries do not benefit from it. The recent discussions in the euro zone on establishing a banking union are a good example of this.

Appendix

Proof of Proposition 5

Consider first country A. The country's gain (or loss, if negative) from moving to a supranational solution is given by

$$\begin{aligned}\Delta W_A &= W_A(\lambda^S) - W_A(\lambda_A^D, \lambda_B^D)\\ &= w_A \int_{\lambda_A^D}^{\lambda^S} (1 - \lambda R + (1-\beta)(1-\lambda)c_A)d\lambda\\ &\quad - w_B \int_{\lambda^S}^{\lambda_B^D} \beta(1-\lambda)c_B d\lambda. \end{aligned} \tag{25}$$

Taking derivative with respect to w_B gives

$$\begin{aligned}\frac{\partial \Delta W_A}{\partial w_B} &= -\int_{\lambda^S}^{\lambda_B^D} \beta(1-\lambda)c_B d\lambda\\ &\quad + w_A(1 - \lambda^S R + (1-\beta)(1-\lambda^S)c_A)\frac{\partial \lambda^S}{\partial w_B}\\ &\quad + w_B \beta(1-\lambda^S)c_B \frac{\partial \lambda^S}{\partial w_B}. \end{aligned} \tag{26}$$

The first term, $-\int_{\lambda^S}^{\lambda_B^D} \beta(1-\lambda)c_B d\lambda$, arises because a larger country B means that externalities from bank failures in this country are larger. Supranational regulation will hence benefit country A more whenever it leads to a more stringent regulation in country B ($\lambda^S > \lambda_B^D$); otherwise, country A's gains from supranational regulation will decline ($\lambda^S < \lambda_B^D$). The second and third terms arise because a larger country B means that supranational regulation will become tighter, as country B is the country with the higher cost of failure (from equation (14)) we have that $\frac{\partial \lambda^S}{\partial w_B} > 0$ for $c_A < c_B$). This

lowers utility for country A arising from operations of its own bank since for this bank a lower threshold is optimal from the domestic perspective (we have $w_A(1-\lambda^S R+(1-\beta)(1-\lambda^S)c_A) < 0$) but lowers the expected externalities from failure of the bank in the other country, as this bank is intervened more often, which then benefits country A ($w_B\beta(1-\lambda^S)c_B > 0$).

Proof of Proposition 1

The net effect is ambiguous. Suppose that $\beta = 0$. In this case we have that

$$\frac{\partial \Delta W_A}{\partial w_B} = w_A(1-\lambda^S R + (1-\lambda^S)c_A)\frac{\partial \lambda^S}{\partial w_B} < 0, \tag{27}$$

and the incentives to join are hence lowered following an increase in w_B. Consider next $\beta = 1$ and $1 - \frac{w_A c_A + w_B c_B}{c_B(w_A+w_B)} < \beta$. From $\beta = 1$ we have

$$\frac{\partial \Delta W_A}{\partial w_B} = -\int_{\lambda^S}^{\lambda_B^D}(1-\lambda)c_B d\lambda + w_B(1-\lambda^S)c_B\frac{\partial \lambda^S}{\partial w_B}. \tag{28}$$

This expression is larger than zero because $1 - \frac{w_A c_A + w_B c_B}{c_B(w_A+w_B)} < \beta$ implies that $\lambda^S > \lambda_B^D$ (follows from (4) and (7)) and the first term is hence positive (the second term is positive anyway, as shown above).

Consider now country B. Country B's gain from moving to a supranational solution is given by

$$\Delta W_B = W_B(\lambda^S) - W_B(\lambda_A^D, \lambda_B^D) = w_A\int_{\lambda_A^D}^{\lambda^S}\beta(1-\lambda)c_A d\lambda$$
$$- w_B\int_{\lambda^S}^{\lambda_B^D}(1-\lambda R + (1-\beta)(1-\lambda)c_B)d\lambda. \tag{29}$$

Taking derivative with respect to w_B gives

$$\frac{\partial \Delta W_B}{\partial w_A} = \int_{\lambda_A^D}^{\lambda^S}\beta(1-\lambda)c_A d\lambda + w_B(1-\lambda^S R$$
$$+ (1-\beta)(1-\lambda^S)c_B)\frac{\partial \lambda^S}{\partial w_A} + w_A\beta(1-\lambda^S)c_A\frac{\partial \lambda^S}{\partial w_A}. \tag{30}$$

The net effect is again ambiguous. Consider first $\beta = 0$. In this case we have that

$$\frac{\partial \Delta W_B}{\partial w_A} = w_B(1 - \lambda^S R + (1 - \lambda^S)c_B)\frac{\partial \lambda^S}{\partial w_A} < 0, \tag{31}$$

since $1 - \lambda^S R + (1 - \lambda^S)c_B > 0$ and $\frac{\partial \lambda^S}{\partial w_A} < 0$ (a higher weight of the other country means interventions in the domestic bank will be less efficient for the country). Consider next $\beta = 1$. We have for the utility gain of country B

$$\frac{\partial \Delta W_B}{\partial w_A} = \int_{\lambda_A^D}^{\lambda^S} (1 - \lambda)c_A d\lambda + w_A(1 - \lambda^S)c_A \frac{\partial \lambda^S}{\partial w_A}. \tag{32}$$

The first term is positive (since $\lambda_A^D < \lambda^S$) but the second term is negative (since $\frac{\partial \lambda^S}{\partial w_A} < 0$). Let now $w_A \to 0$. We then have from equation (14) that $\lambda^S = \lambda^B$ and $\frac{\partial \Delta W_B}{\partial w_A}$ simplifies to

$$\frac{\partial \Delta W_B}{\partial w_A} = \int_{\lambda_A^D}^{\lambda^S} (1 - \lambda)c_A d\lambda, \tag{33}$$

which is strictly larger than zero since $\lambda^S > \lambda_A^D$.

Proof of Proposition 6

Part 1

Consider a minimum threshold of $\lambda_{\min} = \lambda_A^*$. Since country A's desired threshold is less than λ_A^* ($\lambda_A^D < \lambda_A^*$, from comparing (2) and (4)), country A will choose the lowest permitted intervention threshold, which is λ_A^*. Interventions in country A will hence lead to higher welfare (compared with the domestic solution), as they are now efficiently chosen. For country B we may either have $\lambda_B^D < \lambda_{\min}$ ($= \lambda_A^*$) or $\lambda_B^D \geq \lambda_{\min}$. In the first case ($\lambda_B^D < \lambda_{\min}$), country B's desired intervention point is also lower than the minimum one and it will hence choose the minimum one (λ_A^*). Welfare in this case is higher (compared with the domestic solution), as supervision is more efficient in both country A and country B. In the second case ($\lambda_B^D \geq \lambda_{\min}$), the minimum threshold is not binding and country B

chooses the same intervention point as under the domestic approach (λ_B^D). Overall welfare is still higher since supervision in country A is more efficient. We have thus shown that there exists a minimum threshold under which welfare will be higher than under the domestic solution. The optimal minimum threshold will hence also lead to higher welfare than can be obtained through domestic supervision.

Part 2

Consider a minimum threshold of $\lambda_{\min} = \lambda^S$. Since $\lambda_A^D < \lambda^S$, the threshold is binding for country A, which hence chooses λ^S. Interventions in country A are then identical to the ones obtained under supranational supervision. When $\lambda_B^D < \lambda^S$, the threshold is also binding for country B and it will hence choose λ^S. The outcome is then the same as under supranational supervision and welfare is unchanged. When $\lambda_B^D \geq \lambda^S$, the constraint is not binding and the country will choose λ_B^D. Supervision is hence tighter in country B (relative to the supranational approach) and since λ_B^D is still below the optimal level ($\lambda_B^D < \lambda_B^*$), interventions will be more efficient. Welfare thus increases. Overall, there thus exists a minimum threshold that (weakly) welfare-dominates the supranational solution. To complete the proof we still need to show that there are parameter values for which an intermediate solution cannot improve upon the supranational solution. Consider parameter values for which $\lambda_A^* = \lambda_B^D$ (that is, the efficient solution for country A coincides with the decentralized solution for country B). From (2) and (4) we obtain that this occurs when $c_A = (1-\beta)c_B$. We then only have to consider two cases for the minimum threshold: (i) $\lambda_{\min} \in [\lambda_A^D, \lambda_A^*)$ and (ii) $\lambda_{\min} \in [\lambda_A^*, \infty)$. When $\lambda_{\min} \in [\lambda_A^D, \lambda_A^*)$ we have that $\lambda_{\min} \geq \lambda_A^D$. The constraint is hence binding for country A, which will thus choose λ_A^D. We also have that $\lambda_{\min} < \lambda_A^* = \lambda_B^D$, hence the constraint is not binding for country B. This country will hence choose λ_B^D. The outcome is then identical to the decentralized solution and in cases where the decentralized solution is not optimal, welfare will hence be lower than under supranational supervision. When $\lambda_{\min} \in [\lambda_A^*, \infty)$, the threshold will be binding also for country B (since $\lambda_A^* = \lambda_B^D$). Both countries will hence choose $\lambda_{\min}$. Such an outcome is also attainable under supranational regulation (by setting a mandatory intervention threshold of $\lambda_{\min}$); hence it cannot lead to higher welfare.

Proof of Proposition 8

Part 1

Taking derivative in equation (9) with respect to β gives

$$\frac{\partial \Delta W}{\partial \beta} = -(1 - \lambda_A^D R + (1 - \lambda_A^D)c_A)\frac{\partial \lambda_A^D}{\partial \beta} - (1 - \lambda_B^D R + (1 - \lambda_B^D)c_B)\frac{\partial \lambda_B^D}{\partial \beta}. \tag{34}$$

From (21) we have that $\frac{\partial \lambda_i^D}{\partial \beta} < 0$ (higher externalities make the domestic supervisor more lenient) and that $1-\lambda_i^D R+(1-\lambda_i^D)c_i > 0$ when $\beta_i > 0$ (at the domestic intervention threshold, the welfare gains from liquidation are higher than the gains continuation). It follows that $\frac{\partial \Delta W}{\partial \beta} > 0$. Hence, higher β-heterogeneity increases the benefits from supranational regulation.

Part 2

Taking derivative in equation (9) with respect to $\triangle c$ (keeping constant the mean costs $\frac{c_A+c_B}{2}$) gives

$$\frac{\partial \Delta W}{\partial \Delta c} = -\frac{\lambda_B^D - \lambda_A^D}{2} - (1 - \lambda_A^D R + (1 - \lambda_A^D)c_A)\frac{\partial \lambda_A^D}{\partial dc} - (1 - \lambda_B^D R + (1 - \lambda_B^D)c_B)\frac{\partial \lambda_B^D}{\partial dc}. \tag{35}$$

We have for the derivatives of the cut-off points with respect to $\triangle c$:

$$\frac{\partial \lambda_A^D}{\partial \Delta c} = -\frac{(R-1)(1-\beta_A)}{2(R+(1-\beta_A)c_A)^2} \leq 0 \tag{36}$$

$$\frac{\partial \lambda_B^D}{\partial \Delta c} = \frac{(R-1)(1-\beta_B)}{2(R+(1-\beta_B)c_B)^2} \geq 0. \tag{37}$$

Consider first $\beta_A = 1$ and $\beta_B = 0$. We then have that $\lambda_A^D = \frac{1}{R}$ and $\lambda_B^D = \frac{1+c_B}{R+c_B}$. It follows that $\frac{\partial \lambda_A^D}{\partial \Delta c} = 0$ and $1-\lambda_B^D R+(1-\lambda_B^D)c_B = 0$ (the latter is because when there is no externality, the domestic

intervention decision is efficient). The third and fourth term in $\frac{\partial \Delta W}{\partial \Delta c}$ are hence zero and we have

$$\frac{\partial \Delta W}{\partial \Delta c} = -\frac{\lambda_B^D - \lambda_A^D}{2}, \tag{38}$$

which is smaller than zero because of $\lambda_B^D > \lambda_A^D$. The benefits from supranational regulation thus fall.

Consider next $\beta_A = 0$ and $\beta_B = 1$. We then have that $\lambda_A^D = \frac{1+c_A}{R+c_A}$ and $\lambda_B^D = \frac{1}{R}$. It follows that $\frac{\partial \lambda_B^D}{\partial \Delta c} = 0$ and $1 - \lambda_A^D R + (1 - \lambda_A^D)c_A = 0$. The third and fourth term in $\frac{\partial \Delta W}{\partial c}$ are hence zero and we have again

$$\frac{\partial \Delta W}{\partial \Delta c} = -\frac{\lambda_B^D - \lambda_A^D}{2}. \tag{39}$$

This term is now, however, larger than zero because of $\lambda_B^D < \lambda_A^D$. Thus welfare can either increase or decrease in response to higher cost heterogeneity.

The Heterogeneity-Externality Trade-Off at $t = 0$

We consider in the following the benefits from delegating the decision power about whether banks are allowed to operate at $t = 0$ to the supranational level. For this, let us denote interventions at $t = 1$ in each country by $\widehat{\lambda}_i$ (as special cases, these interventions may be the optimal domestic or supranational ones). Similarly to equation (22), it is (welfare) optimal to let bank i operate if

$$\int_0^{\widehat{\lambda}_i} l d\lambda + \int_{\widehat{\lambda}_i}^1 (\lambda R - (1-\lambda)c_i) d\lambda - 1 \geq 0. \tag{40}$$

The domestic decision maker will find it optimal to let the bank operate if

$$\int_0^{\widehat{\lambda}_i} l d\lambda + \int_{\widehat{\lambda}_i}^1 (\lambda R - (1-\beta)(1-\lambda)c_i) d\lambda - 1 \geq 0, \tag{41}$$

similar to equation (23). A supranational decision maker has to impose uniform decision across countries, as in the baseline analysis. He can thus either let no or both banks operate. He will decide for the second option if

$$\int_0^{\widehat{\lambda}_A} l d\lambda + \int_{\widehat{\lambda}_A}^1 (\lambda R - (1-\lambda)c_A) d\lambda - 1$$
$$+ \int_0^{\widehat{\lambda}_B} l d\lambda + \int_{\widehat{\lambda}_B}^1 (\lambda R - (1-\lambda)c_B) d\lambda - 1 \geq 0.$$

Consider first the case of heterogeneity ($c_A < c_B$) but zero externality ($\beta = 0$). The condition for domestic operation becomes then

$$\int_0^{\widehat{\lambda}_i} l d\lambda + \int_{\widehat{\lambda}_i}^1 (\lambda R - (1-\lambda)c_i) d\lambda - 1 \geq 0, \tag{42}$$

which is identical to the efficiency condition (40). Thus each bank will operate precisely when it is efficient. Under supranational decision making, either zero or two banks will operate. Supranational decision making will hence be inefficient in all cases where it is optimal to have only one bank operating (that is, when condition (40) is fulfilled for bank A but not for bank B). It is thus optimal to leave the decision-making power in the hands of domestic authorities.

Consider next the case of no heterogeneity ($c_A = c_B$) but with externalities ($\beta > 0$). As discussed in the text, the domestic decision then suffers from a bias. In particular, there are cases where it is optimal not to let a bank operate but the domestic decision maker still lets the bank operate. The condition for operation under supranational decision making is now

$$\int_0^{\widehat{\lambda}} l d\lambda + \int_{\widehat{\lambda}}^1 (\lambda R - (1-\lambda)c_i) d\lambda - 1 \geq 0, \tag{43}$$

which is identical to the efficiency condition. Decision making at the supranational level is hence preferable in this case.

Taken together, the analysis thus shows that the optimal allocation of banking policies at $t = 0$ is subject to a trade-off between heterogeneity and externalities as well.

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