Competition among Regulators and Credit Market Integration*

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Abstract

This paper analyzes the incentives for independent domestic bank regulators to coordinate regulatory policies when the jurisdictions under their authority are financially integrated. Because of externalities in bank regulation, competition among regulators reduces regulatory standards relative to a centralized solution, making the independent solution inefficient. Coordinating regulation, however, entails a loss of independence if equal standards must be applied to all countries. Then, a central regulator is more likely to emerge among more homogeneous countries. In that context, a centralized regulator will be unanimously preferred to independence only if it sets regulatory standards higher than those of the country with the highest individual standards. The existence of financial linkages between more than two jurisdictions may prevent the formation of partial regulatory unions, or, if they succeed in forming, may constitute an impediment for the formation of more comprehensive unions. Finally, increases in financial integration across countries have different effects on the incentives for the formation of regulatory unions depending on the form they take.

1 Introduction

In recent years, technological progress and regulatory changes have led to the progressive integration of international financial markets. In that context, banks' cross-border activities have become increasingly important, raising new problems for regulators that have remained nationally bounded. This trend has spurred a debate on the costs and benefits of the international harmonization of bank regulation. As a specific example, in the EU the introduction of the Euro and the single market have raised the question of whether a continental regulatory agency would be necessary or desirable.

In this paper, we compare the costs and benefits of centralized and decentralized banking regulation. The benefit of coordinating regulation is that it allows government agencies to properly internalize any interdependencies that may exist across countries due to the integration of their financial systems. The cost is that it leads to a loss of flexibility in regulators' ability to set their policies, to the extent that a centralized regulator would be forced to treat all the banking systems in countries under its jurisdiction equally. We develop a model that incorporates this tradeoff to address three main issues. First, we examine how competition among regulators affects regulatory standards. Second, we analyze countries' incentives to form bilateral "regulatory unions" and how those incentives are affected by the existence of multiple countries. Finally, we dicuss how increasing international financial integration affects the relationship between regulation and the interdependency of banks' activities.

The model we present is one where national regulators concerned with the stability of their country's banking system as well as the profitability of their domestic banks set their regulatory policies (capital adequacy standards) non-cooperatively. We compare such a setup with one where an international regulator sets equal standards for all the banks. In our model, banks grant loans and can increase the probability of repayment on these loans by monitoring them. However, limited liability and the existence of deposit insurance lead each bank to provide an inefficiently low level of monitoring. Regulators can increase banks' incentives to monitor by requiring them to hold minimum capital adequacy standards, which, however, are costly to the bank.

We start by focusing on a situation where countries are symmetric and show that competition among regulators leads to lower capital adequacy standards than under a unified

regulator. This occurs for two reasons. First, in financially integrated economies, banking regulation introduces an externality: higher capital adequacy standards in one country not only make the domestic banking system more stable, they also benefit foreign economies where the domestic country's banks operate by lowering the probability of bank failure in those markets. Independent regulators do not internalize this positive spillover, so that each regulator will "under-regulate" relative to a unified regulatory agency. Second, to the extent that regulators are concerned about the shareholders of their domestic banks, they may lower their banks' capital adequacy standards in order to provide them with an advantage over foreign banks. In other words, in addition to the externality raised above, there can also be a "competition in laxity" as regulators attempt to promote their domestically chartered banks.[1]

We use this basic result to address the second of the issues raised above, the analysis of the conditions under which a centralized international regulator is likely to emerge, i.e., when would domestic regulators find it preferable to surrender their authority to a supranational regulator in order to reap the benefits from centralization. To this end, we drop the symmetry assumption and allow country-level regulators to have different "tastes" (or needs) for regulation. Here, we find two of the main results in our paper. The first is that, with asymmetric countries, a centralized regulator will be unanimously preferred to independence only if such regulator were to choose capital adequacy standards higher than those of the country with the highest individual standards. The second main result is that independent domestic regulators will endogenously agree to merge into a central regulator only if the countries are not too dissimilar in their individual regulatory standards or objectives.

The intuition for these results is as follows. While there may be large benefits to coordinating regulatory policies and internalizing the externalities generated by regulation, there are also costs associated with forming a regulatory union. These costs are mainly related to a loss of flexibility and are higher for more asymmetric countries, if, as we assume, a central regulator finds it politically difficult, if not impossible, to impose different standards across countries. Hence, more similar countries are more likely to opt for a centralized solution, while asymmetric countries will probably choose to maintain independent regulators, as these countries are significantly different in their regulatory needs. However, even if countries are

[1] This latter effect has been studied in the literature on environmental regulation. See Oates (1996) for a discussion of these and other issues.

similar, we find that, somewhat surprisingly, regulation still has to increase relative to the highest level under independent regulation in order for both countries to be better off. This occurs because increasing the level of regulation hurts domestic banks. If this effect is to be compensated, it must be that regulation also increases for foreign banks.

Extending the analysis beyond the case of two countries raises additional complications and illustrates a series of new tradeoffs. We find that, with multiple financially integrated countries, regulatory unions among a subset of countries may fail to emerge if the number of countries that remain independent is sufficiently large, even when these partial unions would have emerged in the absence of these other countries. This occurs because the tighter standards stemming from coordinating regulation may put the merged banking systems at a significant disadvantage relative to the banks in the countries which have remained outside the union. Related to this, we also show that partial integration may not be a good avenue for achieving full integration, as countries outside the regulatory union may find it more beneficial to free-ride off the increased regulation in other countries rather than to join the union.

Finally, we examine how the degree of international financial integration affects the externality associated with regulation. More cross-border banking means more international competition and more interdependence of financial stability. Hence, increasing financial integration should have an effect not only on the efficacy of regulation imposed on banks at home, but also on the behavior of these banks abroad (the externality in regulation).[2] We consider two measures of financial integration. The first is the extent to which products offered by either domestic or foreign intermediaries are substitutes for borrowers. The second is the percentage of revenues derived from foreign lending activities that banks are able to retain. We find that the impact of increases in the degree of financial integration on the regulatory spillover across countries, as well as the efficacy of domestic regulation, depends on how financial integration takes place. We show that an increase in substitutability between loans by domestic and foreign banks increases the magnitude of the spillover, and increases the benefit associated with centralized regulation. This generally leads to an increase in the incentive to form a regulatory union. However, we find that when an increase in integration

[2]Similar insights have been applied to the analysis of optimum currency areas. Recently, Bencivenga, Huybens, and Smith (2001) have argued that the benefit or cost of a "dollarization" depends greatly on the extent to which credit markets are integrated internationally. Here we offer a similar focus in the context of banking regulation.

comes in the form of a reduction in the cost of serving foreign borrowers relative to domestic borrowers, the effect is ambiguous, suggesting that the exact form of integration is crucial for understanding its effect. Changes in the degree of financial integration are likely to affect the competitive structure of banking markets. From that point of view, the possibility of heterogeneous results for the effect of an increase in financial integration on the incentives to form a regulatory union can be interpreted as a reflection of the unsettled debate on whether bank competition promotes or hinders the stability of banking systems.

Most of the insights and implications of this paper can be applied to the broad issue of bank regulation in a financially integrated international economy or to a single economy with competing regulatory agencies, such as the US. In the US, banks are faced with the choice of chartering at the state versus at the national level, and being regulated by different supervisory agencies. The recent deregulation of interstate branching restrictions, along with the lowering of the legal barrier to entry into other banking activities, raises the question of whether a unified regulatory body would be desirable for the US. For the European case, this analysis is also relevant for a number of reasons. First, the Single Market Act has created an environment where banks chartered in any EU member country are allowed to open branches anywhere in the Union while remaining under the supervisory authority of their country of origin. Second, the introduction of the Euro has intensified the linkages among financial markets. Finally, Euroland is characterized by a unique situation of separation between the geographic domain of monetary and regulatory authorities. Indeed, since the inception of the Euro, the European Central Bank (ECB) has assumed full authority over monetary policy, while bank regulation and supervision has remained in the hands of independent national agencies (often the national central banks), whose job it is to ensure the safety and soundness of the domestic banking system.

The framework just described has allowed regulatory and supervisory practices to vary across countries. Although the Basle Accord has gone a long way towards harmonizing capital standards at an international level, individual countries have maintained large discretion on the determination of which assets can be used to meet capital requirements.[3] Information disclosure, inspection procedures, accounting systems, and limits on the scope of banks' activities are also heterogenous across countries, as well as rescue policies designed to manage

[3]Gorton and Winton (2000) discuss how this issue has led to significant heterogeneity in the definition of tier 1 capital across countries. Also see Prati and Schinasi (1999) for a detailed examination of the differences across European countries.

banking crises. For example, Wagster (1996) finds that despite the Basle Accord's purported intent of "leveling the playing field" for banks across countries, it does not appear that the accords went very far in eliminating the pricing advantage of Japanese banks. In this paper, we work on the basis of the view that even in the presence of international agreements, countries maintain sufficient autonomy to compete over regulatory standards (see White (1993) for a discussion of this issue).

This paper proceeds as follows. Section 2 briefly reviews some related literature. Section 3 describes the model. Section 4 provides a preliminary analysis. Section 5 contains the central issues of the paper, analyzing both the incentives for a regulatory union between two countries to form as well as considering the effects introduced by the existence of multiple countries. Section 6 discusses the issues associated with increased financial integration. Section 7 concludes.

2 Related Literature

Traditionally, regulation has been justified as an attempt to provide protection for depositors from the risk of failure of their bank. Moreover, bank failures also create negative externalities that can adversely affect the economy, hurting their customers, both depositors and borrowers, and possibly spreading to other banks (see Bhattacharya and Thakor, 1993, for a survey of these issues). Therefore, regulation has focused on promoting the safety and soundness of the banking system.

To promote this stability, a number of regulatory instruments have been identified, ranging from portfolio restrictions to capital adequacy standards. Moreover, while some, such as deposit insurance, have been instituted in order to benefit depositors directly, others, such as deposit interest rate ceilings, are believed to benefit depositors only indirectly by increasing bank profits and thus strengthening the system. Much of the recent literature has focused on the optimal assignment of these instruments to address the concerns highlighted above (see Santos (2001) for a recent survey). For example, as a response to increased risk-taking by banks resulting from deposit insurance, regulators have instituted capital requirements to control the risk in banks' portfolios.[4] From this perspective, a closely related paper is

[4]There is considerable debate as to the ultimate effect of many of these instruments. In particular, much of the focus has been placed on the role of capital adequacy ratios in curbing risk-taking behavior. For example, see the discussion in Rochet (1992) or more recently in Besanko and Kanatas (1996), Calem and Rob (1999), and Hellmann, Murdock, and Stiglitz (2000).

that by Acharya (2001), who focuses on how coordinating on only one regulatory dimension, such as capital adequacy ratios, can have detrimental effects when other instruments, such as closure policies, are allowed to differ. He does not, however, consider the incentives from the regulator's perspective to form a regulatory union, an issue that is central to this paper.

There are a number of models from the literature on banking regulation that share many of the features of our model. For example, recent work by John, Saunders, and Senbet (2000) illustrates the classic result that bank capital regulation, or bank portfolio restrictions, may help reduce banks' risk-shifting incentives, but place a constraint on banks' activities. There is also a vast literature on prudential regulation of banks with features similar to those in this paper (for a survey of this literature, see Dewatripont and Tirole, 1994). Hellmann, Murdock, and Stiglitz (2000) and Repullo (2002) show that regulatory instruments (capital requirements coupled with deposit rate controls) can increase efficiency and facilitate prudent investment, but may be costly to the banks. Our contribution is to model the interaction between integration and the objectives of regulators in providing for a sound banking system.

The notion of competition among regulators has been recently analyzed in a context where multiple regulators have authority over the same group of agents. Kane (1984) argues that competition among financial regulators is beneficial as it fosters the production of more efficient regulatory services.[5] Laffont and Martimort (1999) demonstrate that, in the presence of non benevolent regulators, splitting authority among different regulatory bodies limits their discretion in engaging in socially wasteful activities by making collusion between regulators and the regulated firm more difficult. Here, we focus on an alternative situation where multiple regulators have authority over different groups of agents that in turn compete with each other over common markets. From that point of view, our paper is closer to White (1994), who argues that cooperation among independent regulators may not be sustainable by drawing a parallel with the well-known problems of cartel stability. Santos and Scheinkman (2000) also analyze a similar issue by examining whether competing exchanges have incentives to lower their standards and demand fewer contractual guarantees to their traders.[6] They do not, however, endogenize regulators' decisions to coordinate their actions.

[5] Similarly, Dermine (1991) argues that competition among exchanges would improve their quality if participants were able to choose the market in which to operate and investors were able to judge the quality of regulation.

[6] See also Gehrig (1998) for an analysis of competing stock exchanges.

3 Model

We present a simple model of bank regulation and lending competition. There are two countries, each with a banking system in which operates a monopolistic bank with limited liability and a regulator for the bank chartered in that country.[7] The bank in each country can invest in a risky loan portfolio with gross return R when succesful and 0 when not (see below). Each bank can affect the probability of success on its investments by monitoring. The probability of success for bank $i's$ investments is equal to the monitoring effort q_i, which is chosen by each bank independently and carries a cost cq_i^2 per dollar lent.[8] Banks have access to a fixed amount of equity E at a cost of ρ, and to an unlimited amount of insured deposits at a cost of δ. We capture the idea that bank capital is a particularly costly form of financing for a financial intermediary by assuming that $\rho \geq \delta$. (See Gorton and Winton, 2000, for a formalization of this issue; Hellman et al., 2000, and Repullo, 2002, make similar assumptions). The fixed supply of bank equity, E, represents the notion that bank equity is not only costly but also that banks may face difficulties raising it, at least on short notice.[9] This is consistent with Stein (1998) and Almazan (2002), among others, who argue that banks may face a nearly fixed supply of equity capital in the short run.

The per-dollar return to the bank in country i is denoted by R_i, and is decreasing and (weakly) convex in the bank's loan quantity L_i ($\frac{\partial R_i}{\partial L_i} < 0$, $\frac{\partial^2 R_i}{\partial L_i^2} \geq 0$). Since we assume that there is in existence some measure of integration between the two countries, the per loan return to bank i is also decreasing in the total amount lent by the bank in country j, L_j ($\frac{\partial R_i}{\partial L_j} < 0$). These are the only characteristics for the average (per loan) return we require at this point. We defer the development of an explicit model of competition between the banks until Section 6, where we analyze the effect of a change in the degree of integration between the two credit markets.

The model has three stages. In stage one each regulator chooses a capital adequacy standard, k_i, for the banks chartered in her country. This capital standard acts in the usual

[7] This particular market structure simplifies notation. The results in this paper would hold even if there were multiple banks in each country.

[8] The role of bank monitoring in this model is analogous to that in Besanko and Kanatas (1993), in that it increases the return on the project and reduces the probability of failure. See also Dewatripont and Tirole (1994) for a model along these lines.

[9] In order to maintain some degree of symmetry across countries, we assume that the level of capital available to each country's bank is the same, E. While issues related to competition and integration between large and small countries are clearly important in the design of the policy related to integration, they lie somewhat outside the current focus of this paper on the behavior of competing regulators.

way, implying that the bank must hold equity equal to a fraction k_i of the loans it grants. In stage two, each bank chooses how much to lend. In stage three, banks choose how much effort to put into monitoring each investment.

Following the discussion above, we assume that a bank regulator cares about the safety and soundness *(stability)* of the banking sector, which would be the case if the primary motivation for regulation was to protect depositors and to minimize the losses associated with the deposit insurance fund. Stability of the banking system, in this case, is just the probability the bank does not fail, given by the bank's monitoring effort q_i.[10] We also allow for the possibility that the regulator cares about the well-being of other claimants on the banking firm, such as bank shareholders. We do this by allowing the regulator to care about bank profits directly. This is achieved by assuming that the regulator puts a weight α_i on bank profits and a weight $1 - \alpha_i$ on banking system stability. Therefore, the overall utility of the regulator in country i can be expressed as:

$$U^i = \alpha_i \Pi_i + (1 - \alpha_i)\xi q_i,$$

where Π_i represents the profits for the bank in country i, and ξ is a scaling factor to take into account the fact that $q_i \in [0, 1]$.[11]

We consider two separate cases, one of independent national regulators, where each bank is regulated only by its home country, and the other of a central regulator that sets regulatory standards for all banks in the system. We assume that each independent national regulator has the ability to set capital adequacy standards for the banks chartered in that country, and so can only control k_i. In the case of a centralized regulator, we assume that this regulator can set both k_i and k_j, but must treat all banks equally, so it must set both to be the same ($k = k_i = k_j$). Indeed, it seems reasonable to assume that a centralized regulator would find it politically infeasible to impose different regulatory standards for each country.

This setup allows us to analyze situations where regulators from different jurisdictions

[10] It is worth noticing that while banking system stability is captured by the probability of repayment q_i, this measure may not account for the efficiency of the system. For this, one should also include the cost of this monitoring activity directly in the regulator's objective function. This cost is just cq_i^2, making the measure of efficiency and stability $q_i - cq_i^2$. Adding this component to the regulator's objective function strengthens our results, as it makes the regulator's objective function "more concave".

[11] As is often the case, the choice of the regulator's objective function is somewhat arbitrary, in that the only requirement that is needed is that it internalize the benefits of intermediation of all the bank's constituents in some way. For example, focusing on maintaining bank profitability but minimizing the expected deposit insurance payouts would be an equally plausible alternative specification and would share the same features as that in the text.

have different "tastes" or needs for regulation and place greater or less emphasis on bank profits versus financial system safety. Banks in some countries might be more efficient than in others, and the marginal impact of increasing regulations might be more or less deleterious for those banks. Similarly, the banking system in one country might be more stable than in another, necessitating lower regulatory standards, all things equal. This can occur either because financial institutions are more sound, financial markets are older and better developed, or because there is more credibility in the government's role as a prudential regulator.

A further reason why competition among regulators can be asymmetric is that regulators in different countries can have different institutional arrangements with the banks under their control, or may have different concerns over the trade-off between bank profits and systemic stability. In some contexts, this has been referred to as the degree to which regulators are captured by the financial institutions under their control.[12] To the extent that regulators in different countries may exhibit differing degrees of regulatory capture, the competition among these regulators will also be asymmetric. Yet another reason why each country might treat its banks differently is that in some countries there may be greater foreign ownership of domestic banks. If so, we would expect domestic regulators to be relatively less concerned about bank shareholders if a significant fraction of them are foreigners.[13] We therefore model asymmetry between the countries by allowing the weights each regulator places on bank profits and stability, α_i, to differ across countries.

4 Preliminary Analysis

As a preliminary step in the analysis, we briefly illustrate the impact of the lack of coordination on regulators' optimal choices. Then, we turn to the main focus of the paper, and analyze the incentives to form a regulatory union.

We solve the model by backwards induction. In stage 3, banks in each country i choose

[12] Kane (1990) argues that regulatory capture in the Resolution Trust Corporation may have lead to inefficiencies in closure policies for U.S. savings and loans corporations during the 1980's.

[13] Though we do not focus explicitly on this issue, for countries with highly captured regulators, centralizing bank regulation could be a way of decreasing the influence banks yield over their regulators. For countries that exhibit a degree of regulatory capture that is not optimal for the eventual well-being of its constituents, centralizing regulation takes control out of the hands of local regulators and makes it more difficult for local banks to exert influence on the central regulators.

their monitoring effort so as to maximize profits

$$\max_{q_i} q_i \left(R_i \left(L_i, L_j \right) - \left(1 - k_i \right) \delta \right) L_i - k_i \rho L_i - c q^2 L_i.$$

The profit maximizing monitoring effort is given by

$$\widehat{q_i} = \frac{R_i \left(L_i, L_j \right) - \left(1 - k_i \right) \delta}{2c}$$

Note that $\widehat{q_i}$ is decreasing in bank $i's$ loan granting decisions L_i, as well as in those of the bank in country j, L_j.

In order to justify the need for regulation in this framework, we note that a welfare-maximizing social planner would chose

$$q_i^{sp} = \frac{R_i \left(L_i, L_j \right)}{2c} > \widehat{q_i}.$$

In other words, it is clear that a social planner that fully internalizes the losses associated with non-performing loans would choose a higher level of monitoring than what the bank, subject to limited liability, chooses. Therefore, a rationale for regulation is to raise the level of monitoring to a level closer to that which a social planner would choose.

In stage two, banks choose how much to lend. In general that corresponds to equalizing the marginal revenue of their investment to its marginal cost. However, as suggested above, the assumption that the banks' cost of capital, ρ, is greater than the cost of deposits, δ, implies that banks never choose to hold excess capital, i.e., any capital requirement will always be binding. This together with the assumption that capital is in short supply means that banks will choose to lend as much as possible.[14] Given the available capital E and the capital requirement k_i, the total loan amount for bank i will be $\widehat{L_i} = \frac{E}{k_i}$.

We can now solve the first stage of the model, where each regulator chooses the capital adequacy standard k for the bank in its country. Assume for now that both countries are symmetric, so that $\alpha_i = \alpha_j = \alpha$. In this case, the maximization problem for each independent regulator is

$$\max_{k_i} U^i(k_i, k_j) = \max_{k_i} \left\{ \alpha \widehat{\Pi}_i(k_i, k_j) + (1 - \alpha) \widehat{q_i}(k_i, k_j) \right\}, \tag{1}$$

[14] This is a standard result when bank capital is more costly than deposits. See Repullo (2002) for a discussion and formalization of this result.

where $\widehat{\Pi}_i(k_i, k_j) = \Pi_i(\widehat{q}_i, \widehat{L}_i, \widehat{L}_j)$ represents the equilibrium (maximized) profits of the bank in country i. In what follows we restrict our analysis to values of α such that this maximization problem admits an interior solution.[15]

We compare this problem to the case of a centralized regulator, who is able to choose capital adequacy standards for both banks. Assume that the central regulator's objective function is the sum of the objective functions of the national regulators. Since the problem is symmetric for each country, we drop the subscripts i and j from the objective functions. The central regulator would therefore maximize

$$\max_{\mathbf{k}} U(\mathbf{k}) = \max_{\mathbf{k}} \left\{ 2\alpha\widehat{\Pi}(\mathbf{k}) + 2(1-\alpha)\widehat{q}(\mathbf{k}) \right\} \tag{2}$$

where $\mathbf{k} = (k, k)$, so that the central regulator must choose the same level of capital requirement for both countries. For these two maximization problems, we have the following result.

Proposition 1 *Two symmetric regulators, with $\alpha_i = \alpha$ for $i = 1, 2$, will choose a lower level of capital requirement than what would be chosen by a centralized regulator characterized by the same degree of regulatory capture α.*

Proof. See the Appendix. ■

The proposition holds for two reasons. The first is that, as argued above, the independent regulators fail to internalize the spillover to other countries caused by the regulation of their banks. The second is that, to the extent that national regulators care about all of their banks' claimants, including bank shareholders, they will have an incentive to lower capital adequacy standards in order to provide their banks with an advantage over foreign institutions.

It is worth pointing out that some of the literature on both bank and environmental regulation has discussed the possibility that independent regulators would choose a sub-optimal level of regulation. In particular, some authors have focused on the second effect that we identify, the "race to the bottom" effect: the risk that national regulators, in an attempt to favor their own banks vis a vis foreign institutions, will have an incentive to reduce regulatory standards and increase forbearance (see, e.g., White, 1993, and more formally in the literature on environmental regulation as illustrated in Oates, 1996). Our

[15] This restriction rules out equilibria with 0 or 100% capital requirements, which are economically uninteresting.

model formalizes this result in the context of banking regulation, and argues that to the extent that there are international spillovers in banking regulation, national regulators are unlikely to internalize such externalities and, hence, are likely to under-regulate relative to a centralized solution.[16] We note as well that we derive the results in our model under a very weak form for the externality of regulation, since it only acts through banks' choices of monitoring effort. To the extent that banks' activities abroad may directly affect the stability of the foreign economies in which they operate, our results should be strengthened.

From the proposition, it also follows directly that $U^i(k^*, k^*) > U^i(k_i^*, k_j^*)$ for $i, j = 1, 2$. In other words, symmetric national regulators will always have an incentive to surrender their authority to a centralized regulatory agency. As their preferences are identical, there is nothing to be gained from the flexibility associated with the independent solution. In what follows, we consider the more realistic situation where regulators' preferences are not symmetric.

5 Incentives to form a regulatory union

As argued above, there are a number of reasons to believe that competition either among banks or among regulators need not be symmetric. We have reason to expect, therefore, that the regulatory standards set by competing regulators may be different as well. Moreover, a central regulator with the ability to discriminate across countries and apply different standards to each would probably also choose different levels of capital adequacy ratios for each country. However, as we have previously argued, one of the characteristics of a central regulator is that it typically finds it infeasible to apply different standards to each country. The imposition of equal regulatory standards in this case may entail losses to each country that could dominate any gains that would be obtained from internalizing the externality. In this case, coordination might be more harmful than beneficial, as there are strong economic reasons for maintaining separate regulators. Therefore, in what follows, we investigate the conditions under which countries will endogenously choose to form a regulatory union. First, we analyze the simple case where there are only two countries that, because of the absence

[16] It is worth pointing out that this "laxity" in regulation is measured only relative to the optimal regulatory standard that would be imposed if regulation were instead coordinated across countries. We take no stance on whether regulation should optimally be lax or tight, assuming that any incentive to loosen or tighten regulations should be reflected in the regulator's objective function. For example, one reason to want regulation to be lax may be to promote financial innovation.

of significant financial links with others, can be considered in isolation from the rest of the world. Second, we discuss some further issues that arise when more than two countries need to be taken into account.

5.1 The two-country case

In this section, we examine the conditions under which two asymmetric countries find it preferable to form a regulatory union. To this end, we drop the assumption of symmetry and allow the regulator of each country to place a different weight on bank profitability. Without loss of generality, we assume that $\alpha_1 > \alpha_2$, so that we can think of country 1's regulator as either having a more efficient banking system, so that its safety concerns are less important, or as being more captured. Following the notation of the previous section, let the capital adequacy standard chosen by competing (independent) regulators be given by k_1^*, k_2^*. To establish a relationship between the degree of regulatory capture and the equilibrium level of regulation in each country, we assume the following standard regularity conditions:

$$\left| \frac{\frac{\partial^2 U^i}{\partial k_i \partial k_j}}{\frac{\partial^2 U^i}{\partial k_i^2}} \right| < 1 \text{ for } i, j = 1, 2, \; i \neq j \; . \tag{3}$$

This assumption is closely related to conventional stability conditions used in the industrial organization literature, which imply that each each regulator's reaction function is decreasing in the level of regulation of the competitor (see for example Dixit, 1986).[17] We can now state the following proposition**.**

Proposition 2 *Under condition (3),* $\alpha_i > \alpha_j$ *implies* $k_i^* < k_j^*$.

Proof. See the Appendix. ■

The intuition for this result is straightforward. A regulator that places a greater emphasis on bank profits will choose a lower level of capital requirements than one that places a relatively greater emphasis on the safety of the banking system.

[17] This regularity condition represents in our model simply a restriction that the weight each regulator places on bank profitability, α_i, be sufficiently small. Otherwise regulators would choose the lowest level of regulation possible consistent with profit maximization, and ignore safety consideration. We present the assumption in its standard form for consistency with the literature on the stability of equilibrium.

Now consider a centralized regulator that maximizes the joint benefit to both countries but has to impose the same regulatory standards across both countries. Under what conditions will both countries be better off under a centralized regulator? Another way of phrasing this question is whether there exists a common level of required capital, k, such that a central regulator imposing that regulation uniformly on both countries can make both individual regulators better off.

The following proposition demonstrates that the answer to this question is not entirely obvious. This result extends to the asymmetric case our finding that competition among regulators reduces regulatory standards, and constitutes one of our main results.

Proposition 3 *Any common capital adequacy ratio k preferred by both regulators to the outcome under independent regulation will have to be larger than the largest of the two independent levels of regulation: $k > \max\{k_1^*, k_2^*\}$.*

Proof. Assume WLOG that $\alpha_1 > \alpha_2$, or $k_1^* < k_2^*$. Define the reaction function $\widehat{k}_i(k_j)$ as $\widehat{k}_i = \arg\max_k U^i(k, k_j)$, so that $k_i^* = \widehat{k}_i(k_j^*)$. By the envelope theorem, we know that

$$\frac{\partial U^i\left(\widehat{k}_i(k_j), k_j\right)}{\partial k_j} > 0. \tag{4}$$

Now, consider $k = k_2^*$. By (4), we have $U^2\left(k_2^*, k_2^*\right) > U^2\left(k_2^*, k_1^*\right)$. However, by definition $U^1\left(k_2^*, k_2^*\right) < U^1\left(k_1^*, k_2^*\right)$, so that a uniform regulation with $k = k_2^*$ would not be accepted by regulator 1. Furthermore, because of (4), for any $k < k_2^*$, we have $U^1(k, k) < U^1\left(\widehat{k}_1(k), k\right) < U^1\left(k_1^*, k_2^*\right)$. Therefore no $k \in [0, k_2^*]$ will be preferred to the Nash solution by regulator 1. ■

This results says that a minimum requirement for both countries' regulators to be better off under centralized regulation is that the capital adequacy ratio chosen by the central regulator must be greater than the ratio that either regulator would choose independently. In order to renounce its independence, a regulator has to be given compensation that comes in the form of a higher capital requirement for its competitor. Then, the choice of each regulator is between the independent solution where capital adequacy standards are optimal given the opponent's choice, and the unified regime, where capital adequacy standards are individually sub-optimal, but the opponent's level is higher than under independence. It is worth noting that this result holds for any situation where $k_1^* \neq k_2^*$. The asymmetry need not stem from different degrees of regulatory capture. It may result from completely different objective functions, as long as the main properties $\frac{\partial^2 U^i(k_i, k_j)}{\partial k_i^2} < 0$ and $\frac{\partial U^i(k_i, k_j)}{\partial k_j} > 0$ hold.

This result is somewhat surprising and puts into question the possibility, and the ease, of obtaining a centralized solution if national level regulators have to agree to relinquish their control in favor of a centralized regulatory agency. It seems natural to expect that the creation of a centralized regulator would be the outcome of negotiations, which may entail having the centralized regulator choose the average regulatary standards that would be chosen by independent regulators, or having as an objective function a weighted average of the independent regulators' objectives. Either of these two cases is likely to include a tendency to involve an intermediate standard. However, this ignores the result that lack of coordination leads to under-regulation. Forming a regulatory union may in fact push regulatory standards above the level imposed by either independent regulator, which the proposition demonstrates is a necessary condition for a centralized regulator to emerge endogenously (as an agreement between the regulators of both countries).

This result helps explain the current situation with multiple regulators. More precisely, we can prove that only countries with sufficiently similar objective functions will be able to reach an agreement on a regulatory union. In order to do so, we first need the following preliminary result.

Lemma 1 *For any capital adequacy ratio k such that $U^1(k,k) > U^1(k_1^*, k_2^*)$, we have $U^2(k,k) > U^2(k_2^*, k_1^*)$.*

Proof. See the Appendix. ■

This lemma implies that any level of common regulation preferred to the independent solution by regulator 1 would also be preferred by regulator 2. Hence, a necessary and sufficient condition for the emergence of a central regulator to be feasible is

$$\max_k U^1(k,k) \geq U^1(k_1^*, k_2^*).$$

The net benefit to regulator 1 from choosing to renounce independence and merge in a unified regulatory agency can be written as $U^1(\widetilde{k},\widetilde{k}) - U^1(k_1^*, k_2^*)$, where $\widetilde{k} = \arg\max_k U^1(k,k)$. Lemma 1 allows us to abstract from the choice of an objective function for the centralized regulator, and focus directly on this net benefit function in order to determine when centralizing regulation will be a mutually agreeable outcome. By Proposition 3, we can restrict attention to values of $\widetilde{k} > k_2^*$, since otherwise we know that this net benefit to regulator 1 must be negative. To simplify notation, we use the variable s to represent a measure of the

difference between the regulators' objective functions, or the degrees of regulatory capture, as follows: $s = \frac{\alpha_1 - \alpha_2}{2}$. This allows us to write $\alpha_1 = \alpha - s$ and $\alpha_2 = \alpha + s$, where $\alpha = \frac{\alpha_1 + \alpha_2}{2}$. Note that, as $0 < \alpha < 1$, we have $0 \leq s < \frac{1}{2}$.

Proposition 4 *There exists an* $\widehat{s} \in \left(0, \frac{1}{2}\right)$ *such that* $U^1(\widetilde{k}, \widetilde{k}) - U^1\left(k_1^*, k_2^*\right) \geq 0$ *if* $s \leq \widehat{s}$*, and* $U^1(\widetilde{k}, \widetilde{k}) - U^1\left(k_1^*, k_2^*\right) < 0$ *otherwise.*

Proof. See the Appendix. ■

This proposition states that, while similar countries may benefit from having a centralized regulator, countries that are more dissimilar will be unable to find a common level of regulation preferred by both regulators to the independent solution. This result is clear given our earlier discussion. Centralizing regulation eliminates the ability to impose different regulatory standards in each country. However, when countries are very different, optimal regulation may in fact call for unequal standards in regulation. Therefore, as the differences between countries magnify, the cost of this loss of flexibility increases, with the consequence that only relatively symmetric countries are likely to end up forming regulatory unions. As long as the differences between the countries are not too large, regulators in these countries can find mutually agreeable regulatory standards such that the benefits of coordination outweigh the loss of flexibility of imposing equal levels of regulation in each country. Note that we can interpret $\widehat{s}$ as the maximal difference between countries such that coordinated regulation is preferable to maintaining independence. Figure 1 summarizes this result: for high (low) levels of asymmetry the costs from losing regulatory independence are higher (lower) than the benefits from internalizing cross-country externalities in regulation and avoiding regulatory competition.

5.2 The multiple-country case

In the previous section, we have analyzed the conditions under which two countries operating in isolation choose to form a regulatory union. However, countries are likely to have financial links with more than one counterpart and should take into account the effects stemming from those links when considering a regulatory union with a subset of their financial partners. Therefore, here we extend the analysis to consider how the incentives to form a regulatory union between two countries change when a other countries are taken into account.

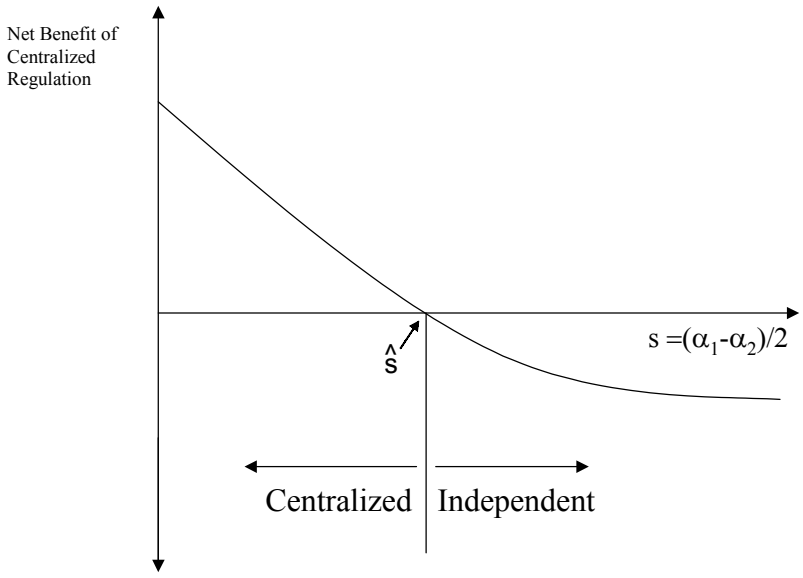

Figure 1: Incentive to form a regulatory union

The study of the multiple-country case is relevant for a number of reasons. Regulatory unions, such as the ones across states in the U.S. or across countries in Europe, typically involve a large number of jurisdictions. The degree of heterogeneity and the associated political problems across countries are likely increasing in the number of participating countries, making the regulatory union less likely to arise. Hence, it is important to determine whether the formation of a regulatory union among a subset of countries makes it more or less likely that countries outside the union will also choose to join. Second, it is important to understand whether a subset of countries that would otherwise like to form a regulatory union may be helped or hindered in this endeavor by the existence of financial links with other countries. In what follows, we discuss both of these issues.

Proposition 5 *Suppose there are N symmetric countries, $N-1$ of which are joined in a regulatory union, with the remaining country not part of the union. Then there is always an $\overline{N} > 0$ such that, if $N \geq \overline{N}$, the country outside the union will prefer to remain outside of the union. Moreover, this country will choose a lower capital adequacy ratio than that chosen by the union of the other $N-1$ countries.*

Proof. See the Appendix. ■

This proposition shows that a regulatory union among a subset of countries will not necessarily constitute a pole of attraction for other countries to join. On the contrary, it

may be the case that countries left out will find their incentives to coordinate with the countries in the union reduced. The intuition behind this result is the following. When a subset of countries form a regulatory union, they increase their, now common, capital adequacy ratio. Countries left out free-ride on this benefit without having to pay the cost in terms of lost independence and tighter regulation themselves. Hence, countries outside the regulatory union that would have found it desirable to coordinate their regulation with some of the countries in the union when they all operated independently, may now find it optimal to remain on the outside once a partial union is formed.

It is important to note that Proposition 5 applies to situations where a full union among all the countries would be feasible if all countries simultaneously agreed to join, since in our model symmetric countries can always reap the benefits of centralizing regulation, without bearing the costs associated with the loss of independence. As such, the proposition points out that following an approach of partial integration may not be the best path towards eventually achieving full integration. For such an approach to work, it seems likely that the linkages between the countries may have to be strengthened as countries are added into the union.

Our second question is addressed in the following proposition.

Proposition 6 *Suppose there are N symmetric countries, $M < N$ of which consider joining into a regulatory union. Then, for any exogenous cost $\varepsilon > 0$ borne by each country of forming a regulatory union, there exists an $\widetilde{N}$ such that for $N > \widetilde{N}$, the M countries will choose not to form the (partial) regulatory union.*

Proof. See the Appendix. ■

The intuition for this result is the following. In the previous section, we showed that, in a two-country world, a condition for a regulatory union to be acceptable for both countries involved is that the capital adequacy ratio chosen under the union is higher than the highest ratio chosen under independence. However, in the presence of multiple countries, things are more complicated. If there are countries that do not participate in the union, an increase in the capital adequacy ratio makes banks in the participating countries less competitive relative to those banks in countries outside the union. Hence, the benefits from forming a union are reduced relative to the case where the countries considering centralization are not financially integrated with the rest. It follows that when centralization involves some positive

costs, there may be situations where this decrease in the net benefit from coordination is enough to make partial unions infeasible. The importance of the result stems again from the fact that, with symmetric countries, a full union should be feasible in this case, pointing out that it is exactly the presence of the other countries outside of the union that makes the partial union infeasible.

In the case of asymmetric countries, it is difficult to do comparative static on the number of countries. However, the intuition from Proposition 6 would still apply. Indeed, since asymmetric regulators find it costly to merge into a regulatory union, the existence of countries that are different enough not to be able to join a regulatory union themselves may also prevent the formation of a union among countries that, although not identical, would find it mutually beneficial to increase regulatory coordination if they were operating in isolation.

6 Financial integration

While up to this point we have merely assumed that there is *some* amount of integration between the markets, the discussion in this paper raises the question of the likely impact of increasing the level of financial integration across countries. If the externality from regulation increases with greater financial integration, countries that are currently too dissimilar to form a regulatory union may choose to do so as their markets become more integrated. However, the trend could be the opposite if greater financial integration also magnifies the costs stemming from the loss of flexibility that comes with uniform standards. The subsequent discussion illustrates that whether coordinating regulation becomes more or less beneficial in more integrated markets depends on how integration affects bank competition and profitability.

To shed some light on these issues we introduce here a simple model of lending market integration that provides a microfoundation for the return function, R_i, employed in our main framework. In broad terms, a defining feature of any model of market integration must be that changes in the aggregate demand and/or supply in one market have repercussions in the other market. Suppose therefore that bank i, $i = 1, 2$, has an amount L_i to lend, and as before this is given by $\frac{E}{k_i}$. Bank i can choose to lend a fraction of this amount at home, γ_i, or abroad, $1 - \gamma_i$. We provide two measures of market integration. The first is the extent to which products offered by either domestic or foreign intermediaries are substitutes for domestic customers, with greater substitutability implying more integration.

We use the variable θ to represent this measure of integration. Our second measure is the proportion of the revenue that banks collect on their foreign market investments. The higher is this proportion, the lower is the cost of operating abroad, and the more integrated are the markets. We denote this measure of integration by t, with an increase in t reflecting a decrease in cross-border barriers to entry. Both measures are inspired by the idea that in fully integrated markets the law of one price should apply (see Chen and Knez, 1995).

Bank i faces the following inverse demand curves[18] at home and abroad (the superscript h refers to its demand at home, and the superscript f its demand in the foreign country).

$$\begin{aligned} P_i^h &= A - \gamma_i L_i - \theta(1-\gamma_j)L_j \\ P_i^f &= A - (1-\gamma_i)L_i - \theta\gamma_j L_j, \end{aligned}$$

where $\gamma_i L_i$ represents the amount bank i lends in its domestic market, and $(1-\gamma_i)L_i$ the amount lent abroad (similar terms hold for the bank in country j). We assume throughout that $A \geq 2\left(L_i + L_j\right)$. Recalling that t represents the proportion of foreign revenue bank i is able to collect, the revenue for the bank in country i can be expressed as

$$\Phi_i = L_i\left(\gamma_i P_i^h + t(1-\gamma_i)P_i^f\right)$$

Analogous demand and revenue functions hold for the bank in country j. The bank's objective is to maximize Φ_i with respect to its choice of loan allocations at home and abroad, γ_i and $1-\gamma_i$, respectively. This model of competition can now be incorporated in our main framework by defining the per-dollar return as $R_i = \frac{\Phi_i(\widehat{\gamma}_i,\widehat{\gamma}_j)}{L_i}$, where $\widehat{\gamma}_i, \widehat{\gamma}_j$ represents the optimal allocations for each bank. Having described the model, we relegate its full development to the appendix.

Case 1: Greater substitutability of domestic and foreign bank services

The marginal benefit of centralizing regulation depends on the extent to which the externality associated with regulation increases or decreases with financial integration. As argued above, one measure of the degree of integration between two credit markets is the extent to which services (e.g., loans) offered by a foreign bank are substitutes for services offered by domestic banks, measured by the parameter θ. To isolate the effect of changes in this measure of integration, we set $t = 1$.

[18] These inverse demand curves are standard for a model of price competition with differentiated products. See the appendix for a derivation.

Lemma 2 *Fix $t = 1$. The size of the externality associated with bank regulation is increasing in θ: $\frac{\partial^2 U^i(k_i,k_j)}{\partial k_j \partial \theta} > 0$.*

This result points out that an increase in the extent to which foreign and domestic banks provide substitute services increases the importance of the spillovers related to regulation. Increases in θ make the domestic market more subject to international competition. This means that increases in regulation abroad will have a larger impact at home, and vice versa, so that an increase in foreign banks' capital requirements leads to a larger increase in the return to lending to domestic banks, and consequently to a larger increase in bank monitoring.

This discussion raises a follow-up question, which is whether an increase in integration also implies that regulators will have a larger incentive to relinquish control and centralize regulation. The answer to this, however, is less straightforward, since in addition to the externality we must factor in how the costs stemming from the loss of flexibility that comes with uniform standards react to changes in the degree of financial integration. Furthermore, if, as is the case for θ, integration leads to greater capital requirements, less-regulated countries may have an incentive to free-ride on competitors' increased requirements, and this may reduce their incentive to join into a regulatory union.

For our model numerical simulations show that, for a given degree of country asymmetry, an increase in integration raises the incentives to form a regulatory union and, hence, leads more diverse countries to choose to surrender their regulatory power to a centralized authority. Whether this is a general result, however, depends on the extent to which $\frac{\partial U^i(k_i,k_j)}{\partial k_i}$ changes with θ, and on bank's ability to free-ride on competitors' more restrictive capital requirements.[19]

Case 2: Reduction in costs of operating abroad

As suggested above, the effects of increasing financial integration on the incentives to centralize regulation may depend on how one measures integration, and may actually *reduce* the externality associated with regulation. We demonstrate this possibility by analyzing the effect of an increase in t, which corresponds to a reduction in the costs of operating abroad. To isolate this effect, we set $\theta = 1$.

Lemma 3 *Fix $\theta = 1$. The size of the externality associated with bank regulation is increasing in t $\left(\frac{\partial^2 U^i(k_i,k_j)}{\partial k_j \partial t} > 0\right)$ for t close to 1, and is decreasing in t $\left(\frac{\partial^2 U^i(k_i,k_j)}{\partial k_j \partial t} < 0\right)$ for t close to 0.*

[19] If $\frac{\partial^2 U^i(k_i,k_j)}{\partial k_i \partial \theta} > 0$, an increase in θ leads to an increase in k_i^*. Since $\frac{\partial U^i(k_i,k_j)}{\partial k_j}$ is positive, country j benefits from this increase in $i's$ capital requirement, and may have a reduced incentive to coordinate regulation.

The result points out that an increase in the proportion of returns that banks collect on their foreign investments increases domestic regulator's sensitivity to foreign regulation in well integrated markets, but reduces it when the costs of doing business abroad are high. Given these results, it is clear that whether the marginal benefit of having centralized regulation is increasing in the level of integration depends on the extent to which the countries are already integrated, and in the kind of integration taking place.

7 Conclusions

This paper has shown that competition among regulators reduces regulatory standards relative to a centralized solution. In addition, it has proven, under some broad regularity conditions, that centralizing regulation is more likely to be beneficial for countries that are homogeneous and financially integrated. The implications of this paper are relevant for regulatory policy in an increasingly integrated world.

A question that has not been analyzed, however, is whether a regulatory union is actually likely to emerge, even if one is feasible. The analysis in the paper focused on a situation where coordinating regulatory policy leads to a Pareto improvement. However, what was ignored is that the formation of a central regulatory agency would probably be the outcome of negotiation between all the relevant parties, particularly the individual regulators. Our analysis shows that this is an important issue, since our model demonstrates that in order for centralized regulation to be Pareto improving it must raise the level of regulation of all banking systems involved. We expect that the inherent tensions of a negotiated outcome may push the centralized institution to choose a level of regulation somewhere between the levels that would be chosen by independent regulators. Even if the outcome could be successfully negotiated, it is still possible that after the centralized regulator is formed there might be strong pressure put on it to choose a moderate level of regulation.[20] The study of this issue is beyond the scope of this paper.

The analysis in this paper can be extended in a number of directions. One natural extension is to allow banks to change the location of their headquarters, and hence, implicitly allow them to choose their regulator. Under those circumstances, the race-to-the-bottom

[20] For example, the negotiated outcome may lead to a centralized regulator that assigns a weight $\overline{\alpha} = \frac{\alpha_1+\alpha_2}{2}$ to bank profits. There may then be situations where the level of regulation chosen by this centralized regulator is below k_2^*, even if a level exists greater than k_2^* that would make both countries better off.

effect of competition described in this paper would be even stronger as regulators would compete to prevent banks from leaving their regulatory domain, and our conclusions would most likely be, if anything, reinforced.

One other extension that raises interesting issues not discussed in this paper is the case of non-benevolent regulators. In that case, the welfare consequences of competition could be different if one took into account beneficial effects like those analyzed by Laffont and Martimort (1999) and Kane (1984). Finally, this paper does not explicitly consider the potential costs involved in the transition from a decentralized to a centralized regulatory system, such as the potential loss of country specific information and expertise. These costs, although likely to be transitory, if large enough would help explain the reluctance of countries with relatively similar characteristics to surrender national authority to a centralized regulator. As pointed out in the analysis of the multiple-country case, the existence of such costs would require the potential for larger gains from coordination for a central regulator to emerge. However, taking into account transition costs would not dramatically change the main conclusions in this paper.

Appendix

A A simple model of loan allocation

In this section we characterize the solution to the model of loan allocation and international competition presented in the section on financial integration. Recall that the goal of the bank in country i is to maximize its revenue with respect to its loan allocation choice γ_i.

$$\max_{\gamma_i} \Phi_i = L_i \left(\gamma_i P_i^h + t(1-\gamma_i) P_i^f \right),$$

where P_i^h and P_i^f are the (inverse) demand functions bank i faces at home and abroad, respectively, as defined in the text.[21]

For completeness, we illustrate the demand functions for the bank in country j:

$$\begin{aligned} P_j^h &= A - \theta(1-\gamma_i)L_i - \gamma_j L_j \\ P_j^f &= A - \theta\gamma_i L_i - (1-\gamma_j)L_j \end{aligned}$$

Bank j's revenue function is

$$\Phi_j = L_j \left(\gamma_j P_j^h + t(1-\gamma_j) P_j^f \right)$$

Maximizing Φ_i and Φ_j with respect to γ_i and γ_j, respectively, we find that the equilibrium allocation of each bank is

$$\begin{aligned} \widehat{\gamma}_i &= \frac{(2+\theta)A(1-t) - 2\theta L_j(1-t) + L_i\left(4t-\theta^2\right)}{L_i(1+t)\left(4-\theta^2\right)} \\ \widehat{\gamma}_j &= \frac{(2+\theta)A(1-t) - 2\theta L_i(1-t) + L_j\left(4t-\theta^2\right)}{L_j(1+t)\left(4-\theta^2\right)} \end{aligned}$$

[21] These (inverse) demand curves are standard demand curves for a model of competition with differentiated products. In the usual case of price competition, the demand curve for bank i at home

$$Q_i^h = a - P_i^h + \lambda P_j^f$$

That faced by bank j abroad is

$$Q_j^f = a - P_j^f + \lambda P_i^h$$

Substituting the second equation into the first and solving for the price obtained by bank i yields

$$P_i^h = \frac{1}{1-\lambda^2}\left((1+\lambda)a - Q_i^h - \lambda Q_j^f\right),$$

which corresponds to the demand function presented in the text.

Analogous results obtain for the price obtained by bank i in country j.

Note that t represents an inverse measure of barriers to entry into foreign markets. For $t = 1$, $\widehat{\gamma}_i = \widehat{\gamma}_j = \frac{1}{2}$. We can now use this to define the per-dollar lent return of bank i as $R_i = \frac{\Phi_i(\widehat{\gamma}_i, \widehat{\gamma}_j)}{L_i}$, which corresponds to the return used in the text. Note that this return function has all the properties assumed in the text: $\frac{\partial R_i}{\partial L_i} < 0$, $\frac{\partial R_i}{\partial L_j} < 0$, and $\frac{\partial^2 R_i}{\partial L_i^2} \geq 0$ (which implies that $\frac{\partial^2 R_i}{\partial k_i^2} \leq 0$).

Recall that the expression for (equilibrium) bank profits is given by

$$\widehat{\Pi}_i = \widehat{q}_i[R_i(L_i, L_j) - (1 - k_i)\,\delta]\frac{E}{k_i} - \rho E - c\widehat{q}_i^2\frac{E}{k_i}$$

Since we are interested in the externality associated with increased integration, we are interested in the sign of the expression $\frac{\partial^2 R_i}{\partial k_j \partial \tau}$, $\tau = t, \theta$.

We start our analysis with the effect of changing the degree of substitutability between each bank's loan offers. We isolate the effect through θ by fixing the other integration variable t to equal 1. In this case, the per loan return for bank i simplifies to

$$R_i = A - \frac{1}{2}L_i - \frac{1}{2}\theta L_j$$

It is now obvious that $\frac{\partial R_i}{\partial L_j} = -\frac{1}{2}\theta < 0$, $\frac{\partial^2 R_i}{\partial L_j \partial \theta} = -\frac{1}{2} < 0$, and $\frac{\partial R_i}{\partial \theta} = -\frac{1}{2}L_j < 0$. Using the definition of $\widehat{\Pi}_i$, we see that

$$\frac{\partial^2 \widehat{\Pi}_i}{\partial k_j \partial t} = -\frac{E}{k_i}\frac{\left(\left(R_i - \delta\,(1 - k_i)\right)\frac{\partial^2 R_i}{\partial L_j \partial t} + \frac{\partial R_i}{\partial t}\frac{\partial R_i}{\partial L_j}\right)\frac{E}{k_j^2}}{2c}$$

Substituting in the values for each of these expressions, we have

$$\frac{\partial^2 \widehat{\Pi}_i}{\partial k_j \partial \theta} = \frac{E}{k_i}\frac{1}{2}\frac{\left(A - \frac{1}{2}L_i - L_j\theta - \delta\,(1 - k_i)\right)\frac{E}{k_j^2}}{2c},$$

which will be positive if either of the two following sufficient conditions is verified: either $\theta < \frac{L_j}{L_i}$ or $A - L_i - L_j > \delta\,(1 - k_i)$. The second condition is likely to be verified, since in order for banks to lend at their capacity we have already assumed that $A \geq 2\,(L_i + L_j)$ and that $\frac{d\Pi_i}{dL_i} > 0$.

For the regulator's concern for stability, we know that

$$\frac{\partial^2 \widehat{q}_i}{\partial k_j \partial \theta} = \frac{-\frac{\partial^2 R_i}{\partial L_j \partial \theta}\frac{E}{k_j^2}}{2c} = \frac{E}{4k_j^2 c} > 0$$

Since the regulator's utility function is $U^i = \alpha_i \Pi_i + (1-\alpha_i)\,\xi \widehat{q}_i$, and the extent of the externality in regulation is captured by $\frac{\partial U^i}{\partial k_j} = \alpha_i \frac{\partial \Pi_i}{\partial k_j} + (1-\alpha_i)\,\xi \frac{\partial \widehat{q}_i}{\partial k_j}$, our results above imply that the externality is increasing in θ.

We next look at changes in the parameter measuring the cost of doing business abroad, t. To abstract from any other effects, we set θ, the substitutability parameter, equal to 1 in what follows.

Again using the definition of $\widehat{\Pi}_i$, we can sign each of the terms of $\frac{\partial^2 \widehat{\Pi}_i}{\partial k_j \partial t}$. Note that

$$\frac{\partial^2 R_i}{\partial L_j \partial t} = \frac{1}{9} \frac{4\left(-t\left(t+2\right)+3\right)\left(3A - L_i - 2L_j\right) - 9L_i}{L_i\left(1+t\right)^2}$$

is negative for $t = 1$ and positive for $t = 0$. It is obvious that

$$\frac{\partial R_i}{\partial L_j} = \frac{1}{9} \frac{-4\left(t\left(t-2\right)+1\right)\left(3A - 2L_j - L_i\right) - 9tL_i}{L_i\left(1+t\right)} < 0$$

At $t = 1$, we have

$$\frac{\partial R_i}{\partial t} = \frac{1}{2}\left(A - \frac{L_i + L_j}{2}\right) > 0,$$

and at $t = 0$,

$$\frac{\partial R_i}{\partial t} = \frac{1}{9} \frac{A9\left(4L_j + 4L_i - 3A\right) - 21L_jL_i - 12L_j^2 - 12L_i^2}{L_i} < 0.$$

We can therefore conclude that

$$\begin{aligned} \frac{\partial_i^2 \widehat{\Pi}}{\partial k_j \partial t} &> 0 \text{ at } t = 1 \\ \frac{\partial_i^2 \widehat{\Pi}}{\partial k_j \partial t} &< 0 \text{ at } t = 0 \end{aligned}$$

In terms of the regulator's stability concerns, notice that $\frac{\partial^2 \widehat{q}_i}{\partial k_j \partial t} = -\frac{1}{2c} \frac{\partial^2 R_i}{\partial L_j \partial t} \frac{E}{k_j^2}$, which means that

$$\begin{aligned} \frac{\partial^2 \widehat{q}_i}{\partial k_j \partial t} &> 0 \text{ at } t = 1 \\ \frac{\partial^2 \widehat{q}_i}{\partial k_j \partial t} &< 0 \text{ at } t = 0 \end{aligned}$$

By the same argument as above, our results above imply that the externality is first decreasing and then increasing in t.

B Proofs

We start by establishing a number of results concerning the bank's (maximized) profit function, as well as the stability function for bank regulation. This will prove useful in deriving the equilibrium, and the relevant comparative statics. First, since $\widehat{q_i} = \frac{R_i(L_i,L_j)-(1-k_i)\delta}{2c}$, its first derivative with respect to k_i is

$$\frac{d\widehat{q_i}}{dk_i} = \frac{\frac{dR_i}{dL_i}\frac{dL_i}{dk_i} + \delta}{2c} = \frac{-\frac{dR_i}{dL_i}\frac{E}{k_i^2} + \delta}{2c} > 0.$$

The second derivative is

$$\frac{d^2\widehat{q}_i}{dk_i^2} = \frac{-\frac{d^2R_i}{dL_i^2}\left(\frac{E}{k_i^2}\right)^2 + \frac{dR_i}{dL_i}\frac{2E}{k_i^3}}{2c}.$$

It follows that if $\frac{d^2R_i}{dL_i^2} \geq 0$, as it is in the model we have presented above, $\widehat{q}_i$ is increasing and concave in k_i, i.e., $\frac{d^2\widehat{q}_i}{dk_i^2} < 0$. (This is a sufficient, but not necessary condition.)

We also have

$$\frac{d\widehat{q_i}}{dk_j} = \frac{\frac{dR_i}{dL_j}\frac{dL_j}{dk_j}}{2c} = \frac{-\frac{dR_i}{dL_j}\frac{E}{k_j^2}}{2c} > 0$$

The fact that capital requirements are a binding constraint on loan quantities means that the first order conditions with respect to L_i are positive, i.e.:

$$\Pi_i = \widehat{q}_i[R_i(L_i,L_j) - (1-k_i)\,\delta] + \widehat{q}_i\frac{dR_i}{dL_i}L_i - \rho k_i - c\widehat{q}_i^2 > 0. \tag{5}$$

Let's look at equilibrium profits

$$\widehat{\Pi}_i = \widehat{q}_i[R_i(L_i,L_j) - (1-k_i)\,\delta]\frac{E}{k_i} - \rho E - c\widehat{q}_i^2\frac{E}{k_i}$$

The derivative of these profits with respect to capital is

$$\frac{d\widehat{\Pi}_i}{dk_i} = \frac{\partial\widehat{\Pi}_i}{\partial k_i} + \frac{\partial\widehat{\Pi}_i}{\partial L_i}\frac{dL_i}{dk_i} + \frac{\partial\widehat{\Pi}_i}{\partial q_i}\frac{dq_i}{dk_i}$$

where the last term is zero because of the envelope theorem, the first term is negative as long as capital is more expensive than deposits, and the middle term is negative by (5).

The derivative of profits with respect to the other countries' capital requirement, k_j, is

$$\frac{d\widehat{\Pi}_i}{dk_j} = -\widehat{q}_i\frac{dR_i}{dL_j}\frac{E}{k_j^2}\frac{E}{k_i} > 0,$$

so that bank i benefits from an increase in the capital requirement for bank j.

Proof of Proposition 1 The set of first order conditions (FOC) for the case of independent national regulators, equation (1), is (note that we ignore the subscripts for each country, since the objective functions are symmetric)

$$\begin{aligned} \alpha \frac{d\Pi(k_i, k_j)}{dk_i} + (1-\alpha) \frac{d\widehat{q}(k_i, k_j)}{dk_i} = 0 \\ \alpha \frac{d\Pi(k_j, k_i)}{dk_j} + (1-\alpha) \frac{d\widehat{q}(k_j, k_i)}{dk_j} = 0 \end{aligned} \tag{6}$$

The solution to this maximization problem defines a Nash equilibrium of the game between competing regulators, and constitutes a pair $\left(k_i^*, k_j^*\right)$ satisfying these two equations simultaneously. Since the countries are symmetric, an equilibrium exists with $k_i^* = k_j^*$. We focus on this case.

The case of the central regulator is given as follows. The FOC for equation (2) is

$$\alpha \left(\frac{d\Pi(k_i, k_j)}{dk_i} + \frac{d\Pi(k_i, k_j)}{dk_j} \right) + (1-\alpha) \left(\frac{d\widehat{q}(k_i, k_j)}{dk_i} + \frac{d\widehat{q}(k_i, k_j)}{dk_j} \right) = 0 \tag{7}$$

Along with the constraint that $k_i = k_j$, the solution to this problem yields a regulatory standard k^*.

Compare now the solutions to the two problems. If we substitute the solution of the Nash game between independent regulators, the pair $\left(k_i^*, k_j^*\right)$, into the first order conditions for the central regulator, equation (7), and rearrange slightly, we obtain

$$\left[\alpha \frac{d\Pi(k_i^*, k_j^*)}{dk_i} + (1-\alpha) \frac{d\widehat{q}(k_i^*, k_j^*)}{dk_i} \right] + \alpha \frac{d\Pi(k_i^*, k_j^*)}{dk_j} + (1-\alpha) \frac{d\widehat{q}(k_i^*, k_j^*)}{dk_j} \tag{8}$$

The first term in expression (8) is zero as it is identical to the first order condition for national regulator i when it chooses regulatory standards independently.

Evaluating all terms of the following expression at $\left(k_i^*, k_j^*\right)$, we have

$$\frac{d\Pi(k_i^*, k_j^*)}{dk_j} = \frac{\partial \Pi}{\partial k_j} + \frac{\partial \Pi}{\partial q} \frac{d\widehat{q}}{dk_j} + \frac{\partial \Pi}{\partial L_i} \frac{dL_i}{dk_j} + \frac{\partial \Pi}{\partial L_j} \frac{dL_j}{dk_j} = \frac{\partial \Pi}{\partial L_j} \frac{dL_j}{dk_j},$$

since $\frac{\partial \Pi}{\partial q} = 0$ from the envelope theorem, $\frac{\partial \Pi}{\partial k_j} = 0$ since k_j does not directly affect bank $i's$ profits, and $\frac{dL_i}{dk_j} = 0$. However, $\frac{\partial \Pi}{\partial L_j} < 0$ since increasing the loan quantity for bank j decreases the profits to bank i. At the same time, $\frac{dL_j}{dk_j} < 0$ since $L_j = \frac{E}{k_j}$. Therefore, $\frac{d\Pi(k_i^*, k_j^*)}{dk_j} > 0$.

Similarly, we have that

$$\frac{d\widehat{q}(k_i^*, k_j^*)}{dk_j} = \frac{\partial \widehat{q}}{\partial L_i}\frac{dL_i}{dk_j} + \frac{\partial \widehat{q}}{\partial L_j}\frac{dL_j}{dk_j} = \frac{\partial \widehat{q}}{\partial L_j}\frac{dL_j}{dk_j} > 0$$

since $\frac{dL_i}{dk_j} = 0$ and $\frac{\partial \widehat{q}}{\partial L_j}, \frac{dL_j}{dk_j} < 0$. Therefore, both terms from expression (7) are positive. This implies that $k^* > k_i^*, k_j^*$, or in other words that we need a higher regulatory standard in order to satisfy expression (7). ■

Proof of Proposition 2: Start from a symmetric equilibrium with $\alpha_1 = \alpha_2$ and $k_1^* = k_2^*$, and consider a mean preserving spread over α, so that $\alpha_1 = \alpha + s$ and $\alpha_2 = \alpha - s$. We need to show that $\frac{d\left(k_1^* - k_2^*\right)}{ds} < 0$. Define

$$a_i = \frac{\partial^2 U^i}{\partial k_i^2}$$
$$b_i = \frac{\partial^2 U^i}{\partial k_i \partial k_j}$$
$$\mu_\alpha^i = \frac{\partial^2 U^i}{\partial k_i \partial \alpha_i}$$

Note that a_i and μ_α^i are both negative, while the sign of b_i can be either positive or negative and determines the slope of the reaction functions. Totally differentiating the first order conditions and rearranging, we have

$$\begin{bmatrix} a_1 & b_1 \\ a_2 & b_2 \end{bmatrix} \begin{bmatrix} dk_1^* \\ dk_2^* \end{bmatrix} = - \begin{bmatrix} \mu_\alpha^1 \frac{\partial \alpha_1}{\partial s} ds \\ \mu_\alpha^2 \frac{\partial \alpha_2}{\partial s} ds \end{bmatrix},$$

that solving gives

$$\begin{bmatrix} dk_1^* \\ dk_2^* \end{bmatrix} = \frac{1}{\Delta} \begin{bmatrix} -a_2 & b_1 \\ b_2 & -a_1 \end{bmatrix} \begin{bmatrix} \mu_\alpha^1 ds \\ -\mu_\alpha^2 ds \end{bmatrix},$$

where Δ is the determinant of the matrix. Now, we can write

$$\frac{d\left(k_1^* - k_2^*\right)}{ds} = -\frac{1}{\Delta}\left[\left(a_2 + b_2\right)\mu_\alpha^1 + \left(a_1 + b_1\right)\mu_\alpha^2\right].$$

Condition (3) implies $\Delta > 0$, and together with $a_1 < 0$, $a_2 < 0$ implies that $a_i + b_i < 0$. Then, as $\mu_\alpha^1 < 0$, $\mu_\alpha^2 < 0$, we have $\frac{d\left(k_1^* - k_2^*\right)}{ds} < 0$. □

Proof of Lemma 1: Assume $U^1(k, k) > U^1(k_1^*, k_2^*)$. As $k_1^* < k_2^*$, by the envelope theorem we know that $U^1(k_1^*, k_2^*) > U^1(\widehat{k}(k_1^*), k_1^*)$, and by definition $U^1(\widehat{k}(k_1^*), k_1^*) > U^1(k_2^*, k_1^*)$. Hence, we can write

$$U^1(k, k) - U^1(k_2^*, k_1^*) = \alpha_1\left[\Pi(k, k) - \Pi(k_2^*, k_1^*)\right] + (1 - \alpha_1)\left[\widehat{q}(k, k) - \widehat{q}(k_2^*, k_1^*)\right] > 0.$$

As $k > k_2^*$ (by Proposition 3), we know that the second term, $\widehat{q}(k,k) - \widehat{q}(k_2^*, k_1^*)$, has to be positive. Given $\alpha_1 > \alpha_2$, the equivalent expression with α_2 instead of α_1 must also be positive, since we are putting more weight on the component we know is positive. Therefore $U^2(k,k) > U^2(k_2^*, k_1^*)$. $\square$

Proof of Proposition 4: We begin by focusing on the benefit to integration for the regulator in country 1, $U^1(\widetilde{k},\widetilde{k}) - U^1(k_1^*, k_2^*)$, and seeing how this changes with s, the measure of the difference between each country. We therefore focus on

$$\frac{d\left[U^1(\widetilde{k},\widetilde{k}) - U^1(k_1^*, k_2^*)\right]}{ds}$$

This can be written as (the subscripts on the utility functions refer to the first derivative with respect to that argument)

$$U_1^1\frac{\partial\widetilde{k}}{\partial s} + U_2^1\frac{\partial\widetilde{k}}{\partial s} + \frac{\partial U^1}{\partial s}|_{\widetilde{k},\widetilde{k}} - U_1^1\frac{dk_1^*}{ds} - U_2^1\frac{dk_2^*}{ds} - \frac{\partial U^1}{\partial s}|_{k_1^*,k_2^*}$$

Applying the envelope theorem, this reduces to

$$\frac{\partial U^1}{\partial s}|_{\widetilde{k},\widetilde{k}} - U_2^1\frac{dk_2^*}{ds} - \frac{\partial U^1}{\partial s}|_{k_1^*,k_2^*} \tag{9}$$

Now, remember that

$$\frac{\partial U^1}{\partial s}|_{\widetilde{k},\widetilde{k}} = \Pi(\widetilde{k},\widetilde{k}) - \widehat{q}(\widetilde{k},\widetilde{k})$$
$$\frac{\partial U^1}{\partial s}|_{k_1^*,k_2^*} = \Pi(k_1^*, k_2^*) - \widehat{q}(k_1^*, k_2^*)$$

So that the difference is

$$\frac{\partial U^1}{\partial s}|_{\widetilde{k},\widetilde{k}} - \frac{\partial U^1}{\partial s}|_{k_1^*,k_2^*} = \left[\Pi(\widetilde{k},\widetilde{k}) - \Pi(k_1^*, k_2^*)\right] + \left[\widehat{q}(k_1^*, k_2^*) - \widehat{q}(\widetilde{k},\widetilde{k})\right]$$

Now, suppose that an s' exists such that at $s = s'$, $U^1(\widetilde{k},\widetilde{k}) - U^1(k_1^*, k_2^*) \leq 0$, and that $\widetilde{k} \geq k_2^*$ (we can restrict attention to this case by Proposition 3). In this case, we have

$$\alpha_1\Pi(\widetilde{k},\widetilde{k}) + (1-\alpha_1)\widehat{q}(\widetilde{k},\widetilde{k}) \leq \alpha_1\Pi(k_1^*, k_2^*) + (1-\alpha_1)\widehat{q}(k_1^*, k_2^*),$$

which is equivalent to

$$\frac{\alpha_1}{(1-\alpha_1)}\left[\Pi(\widetilde{k},\widetilde{k}) - \Pi(k_1^*, k_2^*)\right] \leq \widehat{q}(k_1^*, k_2^*) - \widehat{q}(\widetilde{k},\widetilde{k}),$$

which means $\left[\Pi(\widetilde{k},\widetilde{k})-\Pi\left(k_1^*,k_2^*\right)\right]<0$, since, by assumption, $\widetilde{k}>k_2^*$, the second term must be negative. Since this is true for any s' such that $U^1(\widetilde{k},\widetilde{k})-U^1\left(k_1^*,k_2^*\right)\leq 0$, we therefore have shown that, for $s\geq\widehat{s}$, $\frac{\partial U^1}{\partial s}|_{\widetilde{k},\widetilde{k}}-\frac{\partial U^1}{\partial s}|_{k_1^*,k_2^*}<0$, if such an $\widehat{s}$ exists.

What remains is to show that the second term in equation (9) is non-negative so that once it is subtracted from the rest, the whole expression is negative. First, it is clear that U_2^1 is positive. Second, $\frac{dk_2^*}{ds}$ is non-negative given the regularity condition for the equilibrium, which implies that the regulator should (weakly) increase the level of regulation if the weight placed on banking system stability increases. In other words, this demonstrates that, if $U^1(\widetilde{k},\widetilde{k})-U^1\left(k_1^*,k_2^*\right)=0$ for any difference $\widehat{s}$ between the countries, it will be negative for any larger value of s. $\widehat{s}$ therefore represents the maximal difference between the countries.

To show that such an $\widehat{s}$ exists, note that, for $s=0$, it is always true that $U^1(\widetilde{k},\widetilde{k})-U^1\left(k_1^*,k_2^*\right)>0$ because of the externality in regulation. At the same time, it is also clear that there must be some value of s, $\widetilde{s}$, such that regulator 1 chooses the minimal level of regulation $k_1^*=0$, and regulator 2 chooses the maximal, $k_2^*=1$. There therefore must exist and $\epsilon>0$ such that for any $s=\widetilde{s}-\epsilon$, the regulator in country 1 prefers to remain independent instead of increasing its level of regulation above k_2^*, i.e., $U^1(\widetilde{k},\widetilde{k})-U^1\left(k_1^*,k_2^*\right)<0$. Therefore, by continuity an $\widehat{s}$ such that $U^1(\widetilde{k},\widetilde{k})-U^1\left(k_1^*,k_2^*\right)=0$ must exist. $\square$

Proof of Proposition 5: Suppose where there are N symmetric countries. For each bank the return on loans depends on the loan quantity it grants and on the average loan quantity granted by the banks chartered in other countries,

$$R_i\left(\frac{E}{k_i},\frac{1}{N-1}\sum_{j\neq i}^{N-1}\frac{E}{k_j}\right).$$

This framework serves the purpose of maintaining a constant degree of international financial integration, allowing us to do comparative statics on the number of countries. Suppose that $N-1$ of the N symmetric countries participate in a regulatory union, and one country, country 1, does not. For $i\neq 1$, the regulator of this partial union maximizes the utility of a representative country in the union:

$$\max_k \alpha\left\{\widehat{q}_i\left[R\left(N\right)-\left(1-k\right)\delta\right]\frac{E}{k}-\rho E-c\frac{E}{k}\widehat{q}_i^2\right\}+\left(1-\alpha\right)\xi\widehat{q}_i,$$

where $R(N)=R\left(\frac{E}{k},\frac{1}{N-1}\sum_{j=1}^{N-2}\frac{E}{k}+\frac{1}{N-1}\frac{E}{k_1}\right)$ and $\widehat{q}_i=\frac{R(N)-(1-k)\delta}{2c}$.

Since banks maximize profits with respect to q, we can write

$$\frac{d\Pi_i}{dk} = \frac{\partial \Pi_i}{\partial k} + \frac{\partial \Pi_i}{\partial R}\frac{dR(N)}{dk},$$

since the remaining term, $\frac{\partial \Pi_i}{\partial q_i}\frac{d\widehat{q}_i}{dk}$, is equal to zero because of the envelope theorem. Note that

$$\frac{\partial \Pi_i}{\partial k} = \widehat{q}_i \delta \frac{E}{k} - \frac{E}{k^2}\left\{\widehat{q}_i \left[R(N) - (1-k)\,\delta\right]\frac{E}{k} - c\frac{E}{k}\widehat{q}_i^2\right\}, \tag{10}$$

and $\frac{\partial \Pi_i}{\partial R} = \widehat{q}_i \frac{E}{k}$. Using the definition of $\widehat{q}_i$, we can write

$$\frac{d\widehat{q}_i}{dk} = \frac{\delta}{2c} + \frac{\frac{dR}{dk}}{2c}$$

Define R'_{own} to be the partial derivative of the return function with respect to its first argument (the regulation in the home country), and R'_{other} the partial derivative of the return function with respect to its second argument (the average regulation in countries other than home). Then, for any given N, we have for the regulator of the partial union

$$\frac{dR(N)}{dk} = -\frac{E}{k^2}R'_{own} - \frac{N-2}{N-1}\frac{E}{k^2}R'_{other}.$$

This means that for any pair (k, k_1) we have

$$\lim_{N\to\infty}\frac{dR(N)}{dk} = -\frac{E}{k^2}R'_{own} - \frac{E}{k_i^2}R'_{other}. \tag{11}$$

It is easy now to see that (11) implies that the first order condition for the regulator of the partial union

$$\alpha\left[\frac{\partial \Pi_i}{\partial k} + \frac{\partial \Pi_i}{\partial R}\frac{dR}{dk}\right] + (1-\alpha)\,\xi\left(\frac{\delta}{2c} + \frac{\frac{dR}{dk}}{2c}\right) = 0, \tag{12}$$

which defines $\widehat{k}_{partial}$, converges to that for a centralized regulator for all N countries. It follows that $\lim_{N\to\infty}\widehat{k}_{partial} = \widehat{k}$.

The first order condition for the regulator of the sole country outside the union is

$$\alpha\left[\frac{\partial \Pi_1}{\partial k_1} + \frac{\partial \Pi_1}{\partial R_1}\frac{dR_1}{dk_1}\right] + (1-\alpha)\,\xi\left(\frac{\delta}{2c} + \frac{\frac{dR_1}{dk_1}}{2c}\right) = 0; \tag{13}$$

where

$$\frac{\partial \Pi_1}{\partial k_1} = \widehat{q}_1 \delta \frac{E}{k_1} - \frac{E}{k_1^2}\left\{\widehat{q}_1 \left[R_1(N) - (1-k_1)\,\delta\right]\frac{E}{k_1} - c\frac{E}{k_1}\widehat{q}_1^2\right\}, \tag{14}$$

and

$$R_1(N) = R\left(\frac{E}{k_1}, \frac{1}{N-1}\sum_{j=2}^{N}\frac{E}{k_j}\right).$$

This means that we have

$$\lim_{N\to\infty}\frac{dR_1(N)}{dk_1} = -R'_{own}\frac{E}{k_1^2}.$$

Then, since $R'_{own} < 0$ and $R'_{other} < 0$, we have that at $k_1 = \widehat{k}$,

$$\begin{aligned}
\frac{\partial \Pi_1}{\partial k_1} &= \frac{\partial \Pi_i}{\partial k}, \\
R_1(N) &= R(N), \\
\frac{dR_1(N)}{dk_1} &< \frac{dR(N)}{dk},
\end{aligned}$$

which implies that (13) is negative at $k_i = \widehat{k}$, so that the equilibrium, as $N \to \infty$, is characterized by the pair $\left(\widehat{k}_1, \widehat{k}\right)$, with $\widehat{k}_1 < \widehat{k}$.

Because of the externalities in the game, any $\widetilde{k}$ such that $U^1\left(\widetilde{k}, \widetilde{k}, ...\widetilde{k}\right) > U^1\left(\widehat{k}_1, \widehat{k}, ...\widehat{k}\right)$ would also have to satisfy $\widetilde{k} > \widehat{k}$. However, since $\widehat{k}$ is by definition the level of regulation that maximizes the utility of any given country's regulator conditionally on imposing uniform regulation across all countries, there cannot exist a $\widetilde{k}$ that satisfies this condition. Since we have just shown that $U^1\left(\widehat{k}_1, \widehat{k}, ...\widehat{k}\right) > U^1\left(\widehat{k}, \widehat{k}, ...\widehat{k}\right)$ at the limit, there cannot exist any level of regulation at which the independent country is willing to join the partial regulatory union.

Finally, note that, since $U^1\left(\widehat{k}_1, \widehat{k}, ...\widehat{k}\right) > U^1\left(\widehat{k}, \widehat{k}, ...\widehat{k}\right)$, there must exist some $Z > 0$ such that $U^1\left(\widehat{k}_1, \widehat{k}, ...\widehat{k}\right) - U^1\left(\widehat{k}, \widehat{k}, ...\widehat{k}\right) \geq Z > 0$. Fix $\widehat{k}_1$. Since U^1 is continuous in all its variables (all the levels of capital regulation for all N countries), $\exists$ some $\delta > 0$ such that $U^1\left(\widehat{k}_1, \widehat{k} - \delta, ...\widehat{k} - \delta\right) - U^1\left(\widehat{k}, \widehat{k}, ...\widehat{k}\right) \geq \frac{Z}{2} > 0$. This tells us that there must be some level of regulation for all other countries but the first, given by $\widehat{k} - \delta$, such that country 1 still does not want to join the union if the only increase in regulation will be by the amount δ, in order to get everyone up to $\widehat{k}$. However, since $\lim_{N\to\infty}\widehat{k}_{partial} = \widehat{k}$, $\exists$ some $N' > 0$ such that for all $n > N'$, $\widehat{k}_{partial} \geq \widehat{k} - \delta$. Therefore, this proves that for all $n > N'$, $U^1\left(\widehat{k}_1, \widehat{k}_{partial}, ...\widehat{k}_{partial}\right) - U^1\left(\widehat{k}, \widehat{k}, ...\widehat{k}\right) > 0$, which demonstrates that given country 1 can

do strictly better by staying out of the union and regulating by an amount $\widehat{k}_1$, it a fortiori must be able to do at least as well by regulating optimally. This establishes our result. □

Proof of Proposition 6: Suppose where there are N symmetric countries. Consider the case of a partial regulatory union encompassing M of the N countries (without loss of generality consider these countries to be indexed 1 to M). The regulator of this partial union maximizes the utility of the representative country in the union:

$$\max_k \alpha \left\{ \widehat{q}_i \left[R\left(M,N\right) - \left(1-k\right)\delta \right] \frac{E}{k} - \rho E - c\frac{E}{k}\widehat{q}_i^2 \right\} + \left(1-\alpha\right)\xi\widehat{q}_i,$$

where $R(M,N) = R\left(\frac{E}{k}, \frac{M-1}{N-1}\frac{E}{k} + \frac{1}{N-1}\sum_{j=M+1}^{N}\frac{E}{k_j} \right)$ and $\widehat{q}_i = \frac{R(M,N)-(1-k)\delta}{2c}$. Using the notation from the previous proof, we can write

$$\frac{dR(M,N)}{dk} = -\frac{E}{k^2}R'_{own} - \frac{M-1}{N-1}\frac{E}{k^2}R'_{other}.$$

Then, we have

$$\lim_{N\to\infty} \frac{dR(M,N)}{dk} = -\frac{E}{k^2}R'_{own}. \tag{15}$$

Using an argument similar to that in the previous proof it is easy to show that

$$\lim_{N\to\infty} \widehat{k}_{partial} = k^*,$$

where $\widehat{k}_{partial}$ is the capital adequacy ratio chosen by the regulator of the partial union and k^* is that emerging in the Nash (independent) solution. Letting $U_{partial}(M,N)$ represent the utility of a representative regulator in the partial union or M out of N countries, and $U_{Nash}(N)$ that of a regulator in the independent (Nash) equilibrium, it follows that for the countries in the partial regulatory union

$$\lim_{N\to\infty} U_{partial}(M,N) = U_{Nash}(N).$$

Then, for any $\varepsilon > 0$, there exists an $\widetilde{N}$ such that for $N > \widetilde{N}$ we have $U_{partial}(M,N) - U_{Nash}(N) < \varepsilon$. □

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