Multinational Banks in Regulated Markets: Is Financial Integration Desirable?

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Multinational banks in regulated markets: Is financial integration desirable?[1]

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Abstract

We set up a two-country, regional model of trade in financial services. Competitive firms in each country manufacture non-traded consumer goods in an uncertain productive environment, borrowing funds from a bank in either the home or the foreign market. Duopolistic banks can choose their levels of monitoring of firms and thus the levels of risk-taking, where the risk of bank failure is partly borne by taxpayers in the banks' home countries. Moreover, each bank chooses the allocation of its lending between domestic and foreign firms, while the bank's overall loan volume is fixed by a capital requirement set optimally in its home country. In this setting we consider two types of financial integration. A reduction in the compliance costs of cross-border banking reduces aggregate output and increases risk-taking, thus harming consumers and taxpayers in both countries. In contrast, a reduction in the costs of screening foreign firms is likely to be beneficial for banks, consumers, and taxpayers alike.

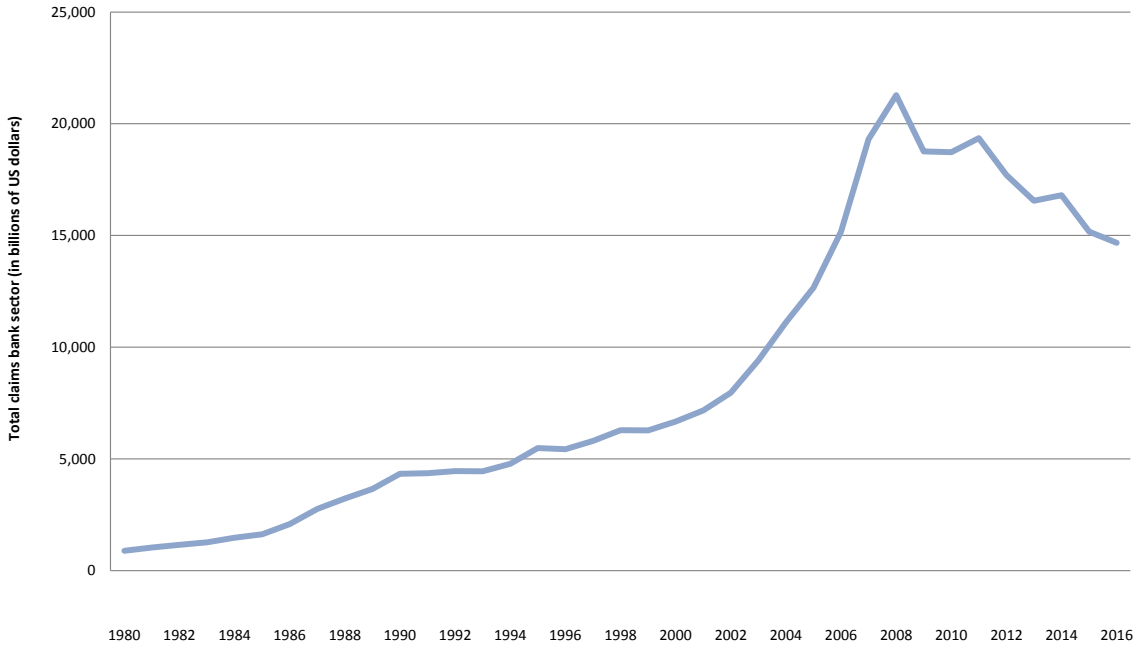
Keywords: multinational banks, foreign direct investment, capital regulation, financial integration

JEL classifications: F36, G18, H81

1 Introduction

The internationalization of the banking sector has increased rapidly over the last few decades, and in particular during the past 15 years. Total international bank lending accelerated sharply after 2000, almost quadrupling between 2000 and 2008, by which point it had reached 40% of world GDP. Since then, cross-border banking has receded noticeably, but the worldwide volume of cross-border claims is still more than twice what it was in 2000 (see Figure 1).[1] More disaggregated evidence comes from a database with more than 5000 banks in 137 countries (Claessens and van Horen, 2014). This documents large increases in the presence of foreign banks in most countries since the mid-1990s, but also a substantial heterogeneity at the country level with respect to the importance of foreign banks in national banking sectors.

Figure 1: Worldwide cross-border claims of banking sectors (1980-2016)



Source: BIS Statistics (2017), Table A4, stats.bis.org/statx/srs/table/a4

The financial crisis of 2008 has shown that this increasing internationalization in the banking sector is not without risk. Many banks worldwide have suffered huge losses

[1]Figure 1 incorporates all cross-border claims that arise from foreign affiliates (branches and subsidiaries) of a parent firm. See Bank for International Settlements (2010) for a discussion of the determinants of international lending before and after the 2007/08 financial crisis.

from subprime financial products that originated in the US housing market (Diamond and Rajan, 2009).[2] Financial integration was thus a key factor in transforming the crisis in the US housing market into a worldwide banking crisis, during which large financial institutions in many countries had to be rescued by taxpayer monies. In several countries, including Ireland and Iceland, the bailouts were so massive as to threaten the entire state of public finances.[3]

The financial crisis has therefore re-invigorated the debate as to whether increasing internationalization in the banking industry is a desirable development that should be fostered by policy measures to reduce the costs of cross-border banking. One important reason as to why the increasing internationalization of the banking sector may increase its exposure to risk is the limited information about foreign loan markets. Empirical evidence shows that "gravity models", in which distance acts as a proxy for information costs or information asymmetries, are able to explain international transactions in financial services at least as well as they can explain goods-trade transactions (Portes, Rey, and Oh, 2001; Portes and Rey, 2005).

Whether financial integration increases or reduces risk-taking in banks is, however, still an open empirical issue. Acharya, Hasan and Sauners (2006) show, for a sample of Italian banks during the 1990s, that geographic and sectoral diversification increased the risk of banks' lending portfolios. Similarly, Berger et al. (2005) find that large banks operate at a greater distance than smaller banks and monitor these distant loans less intensively, implying a higher exposure to asset risk. On the other hand, Goetz, Laeven and Levine (2016) have recently found the opposite result, showing for a US sample of bank holding companies that geographic expansion reduced banks' risks. In this paper, we argue that one reason for these controversies may lie in the fact that international lending faces two different types of extra costs, as compared to making loans in a bank's domestic market. Our analysis shows that reducing the cost differential between domestic and international lending through "financial integration"

[2]Econometric evidence for a sample of large banks across the world confirms that, during this period, the exposure to the US real estate market was a factor that significantly contributed to stock market losses (Beltratti and Stulz, 2012).

[3]The government of Iceland decided to guarantee deposits of domestic investors, but declined to guarantee the deposits of foreigners. Ireland, in contrast, bailed out both domestic and international creditors with taxpayer money. In the fiscal year 2010 alone, this caused an Irish budget deficit equal to 32% of the country's GDP.

can have very different effects on banks' risk-taking, as well as on welfare in the lending countries, depending on which type of extra cost for foreign lending is reduced.

We study these issues in a two-country trade model that incorporates several characteristics of the banking sector. Our model has two banks, each headquartered in a different country, and extending loans to small, competitive firms The banks are multinationals in that each has a domestic affiliate, located in the bank's home country, and a foreign affiliate, located in the other country. International lending by a bank takes place through its foreign affiliate, while domestic lending is undertaken by its home-country affiliate. In deciding upon the conditions of their loans, the bank affiliates make monitoring decisions that determine the riskiness of their operations in the banks' home and foreign markets. Banks face two, very different types of cost. The first is the cost of meeting the general legal and regulatory framework in the country in which the lending is taking place. We label this the "compliance cost". The second is the cost of learning about the affiliate's individual client. We label this the "information cost". The costs of international lending are higher than those for domestic loans. Firstly, bank loans of the foreign affiliate face higher compliance costs, as they have to deal with the tax and regulatory system of a foreign country. This will make a foreign bank affiliate more costly and hence less profitable than a bank unit that operates in its home country. Secondly, information costs for individual bank customers for a foreign-based affiliate are higher than those facing a domestic affiliate. We shall show that these information asymmetries result in the foreign affiliates of banks choosing to monitor their loans less well, resulting in more risky lending in the banks' foreign markets compared to that in their home markets.

Another feature of financial markets is that governments implicitly or explicitly offer guarantees in case of bank failure. Our model incorporates the fact that the riskiness of bank operations has implications for taxpayers, as exemplified by the cases of Ireland and Iceland mentioned above. In our model, these spillovers arise not from discrete bail-out decisions but from government guarantees for the savings deposits that banks use to finance their loans. Such deposit-insurance schemes exist in virtually all developed countries, exposing taxpayers to the risks of national bank failures and creating a fundamental moral hazard problem for banks (see Demirgüç-Kunt and Detriagiache, 2002). In order to address the moral-hazard problem that deposit insurance entails, governments can set minimum capital standards. We consequently model active governments setting optimal capital-adequacy standards as their principal policy

instrument, forcing banks operating within their borders to hold a minimum amount of equity for every loan they provide. This capital regulation reduces the bank's moral hazard and limits its total loan volume. In setting the capital-adequacy standard, the government balances the impact of its regulation on bank profits, the expected costs to taxpayers that arise in the case of bank failure, and the real effects that the availability of credit has for expected output and hence consumer surplus.

While binding capital regulation fixes the total volume of lending, each bank is left to determine the share of its its equity, and hence lending, that goes to firms in its home and foreign markets. Moreover, each bank affiliate chooses the level of its monitoring, and hence the riskiness of its loans, as a function of its (information) costs of monitoring. With higher information costs in the foreign market, monitoring levels will be lower there, as compared to the domestic market. In the presence of the implicit subsidies to risk-taking resulting from the government guarantees, foreign affiliates of banks will choose too little monitoring, such that each bank's lending choice will be distorted towards the more risky lending activity in the foreign market.

In this setting, the focus of our analysis is on the effects that financial integration will have on banks, consumers and taxpayers in each country. We show that these effects differ critically depending on which international friction is reduced. If economic and financial integration lowers the compliance costs for foreign affiliates, while information costs remain unchanged, then the effects of closer integration are predominantly negative. Overall lending and aggregate output would fall in equilibrium, as a result of each bank redirecting more of any given total loan volume towards its foreign market, where its costs are higher. At the same time, the average riskiness of bank lending and hence the expected losses to taxpayers increase, as each bank makes relatively more loans in its foreign market where information is more costly and monitoring levels are therefore lower. In contrast, if information costs in the foreign market fall as a result of financial integration, then the effects of such a policy are most likely positive. A shift towards greater lending in the foreign market is now accompanied by increased monitoring, raising expected consumer surplus, while reducing the risks to taxpayers. The conclusion from our analysis is, therefore, that it is crucial for financial integration to be accompanied by policies that increase transparency and reduce information costs. One important measure in this context have been stress tests for banks, both in the United States and in the European banking union.

1.1 Related literature

Our paper combines elements from international trade theory and the literature on financial regulation. In international trade, there is a small strand of literature that explicitly examines the banking sector.[4] Following the early work by Eaton (1994), de Blas and Russ (2013) and Niepmann (2015) have analyzed banks' choices between foreign direct investment and cross-border lending. Buch, Koch and Koetter (2011) show a close empirical link between size, productivity and international activity in the banking sector that is similar to the well-established patterns for manufacturing firms. Other papers have analyzed the spillover effects of FDI in the banking sector on the host country's banking system (Lehner and Schnitzer, 2008). None of these papers incorporates any policy instruments, however. On the other hand, a sizeable literature has studied the effects of economic integration on policy competition in trade models with imperfect competition (e.g., Kind, Midelfart and Schjelderup, 2005; Ottaviano and van Ypersele, 2005; Haufler and Wooton, 2010). These papers have not been applied to the specific policy issues facing the banking sector, and in particular do not incorporate the risk-taking choices that are fundamental in banking.

To incorporate these effects, we draw on the literature on capital regulation in the banking sector. Several authors have stressed that, in a closed economy, capital regulation increases the risk buffer of banks and curbs risky behaviour (Rochet, 1992; Hellman, Murdock and Stiglitz, 2000). Calzolari and Lorath (2011) study the regulation of multinational banks that operate either through foreign branches or subsidiaries, whereas Sinn (1997) and Acharya (2003) focus on the effects of regulatory competition when banks operate internationally. The present paper is closest to Dell'Ariccia and Marquez (2006), where regulators choose nationally optimal capital requirements by trading off the aggregate level of banks' profits against the benefits of financial stability. We extend their model and link it to the trade literature, incorporating different types of trade frictions. This allows us to study the effects of financial integration on different agents in the economy and on national welfare.

Our analysis of financial integration is related to a further literature strand that examines the effects of changes in market structure on banks' risk-taking decisions. The fundamental argument is that increased competition lowers banks' profit margins and

[4]The general literature on trade in services and public policy is surveyed in Francois and Hoekman (2010).

lowers their charter value. As a consequence, this reduces the loss to banks in the case of default and induces them to take higher risks (Keeley, 1990; Allen and Gale, 2004). Empirical work shows the importance of this effect, finding that intensified bank competition in the U.S. market has induced banks to switch from safer to more risky lending activities (Jiang, Levine and Lin, 2017). One important difference between increased competition and financial integration is that the latter affects the banks in each market asymmetrically, by aligning their information and compliance costs.

A final related literature strand studies issues of risk-taking in connection with the internationalization strategies of banks. The theoretical contributions in this literature are typically based on portfolio-choice models, however, and the microeconomic contributions are primarily empirical (e.g., Beltratti and Stulz, 2012; Buch, Koch, and Koetter, 2013; Ongena, Popov and Udell, 2013).

The remainder of this paper is set up as follows. Section 2 introduces our trade model with goods production and cross-border lending by banks. Section 3 studies the optimal capital regulation by the government. Section 4 analyzes the effects of financial integration, focusing on reductions in compliance costs on the one hand and reductions in information costs on the other. Section 5 studies, by means of numerical simulations, how the different types of financial integration feed back on governments' optimal regulation policy. Section 6 concludes.

2 The model

2.1 General setup

We consider a region composed of two identical countries $i \in \{1, 2\}$. In each country, goods are manufactured by competitive firms that have to borrow in order to be able to produce their output of non-tradeable goods. Loans are provided by two multinational banks, each having its parent company in one of the two countries and a subsidiary in the other.[5] Thus each bank can be viewed as having a domestic affiliate and a foreign

[5]Empirical evidence suggests that cross-border lending occurs mainly through (legally independent) subsidiaries, rather than (legally dependent) branches of a parent bank. Cerutti, Dell'Ariccia and Martinez Peria (2007, Table 1) document, for the investment of the world's 100 largest banks in Latin America and Eastern Europe, that foreign subsidiaries are three times as frequent in these countries

affiliate, each of which is subject to the regulatory environment in the market in which it operates. Consequently, the banking sector is characterized by a duopolistic market structure in each country.

In this respect, our model is closely related to the "reciprocal dumping" model of international trade in identical products, originally developed by Brander and Krugman (1983). In the absence of international lending, each bank would be a monopolist in its domestic market. The opportunity to set up a foreign affiliate results in each bank seeking to acquire a share in its foreign market. This is done by offering loans that are fundamentally identical to those offered by the domestic incumbent but, due to the greater distance between bank and borrower, are more expensive to provide.[6]

Our model departs from that of Brander and Krugman in several further respects. Firstly, the notion of "distance" in our model is not confined to the ("iceberg") trade costs of Brander and Krugman (1983). Such trade costs do exist in our model, and they can be interpreted as the additional compliance costs of dealing with a foreign tax and regulatory system.[7] In addition, however, information about individual bank customers is critical in the banking sector. Therefore, we also consider higher information costs faced by a bank that arise from it being less familiar with potential borrowers in a foreign country. As a consequence, banks may choose to exert different levels of effort in monitoring their domestic and foreign loans.

Secondly, the lending activities of each bank affiliate are regulated by its host government. For any given level of equity held by a bank affiliate, the equity requirements set by local regulators limit the quantity of loans that can be made by the affiliate. Hence, when a multinational bank faces an aggregate restriction on its equity, it can choose how to divide its scarce equity between its two affiliates, and thereby allocate its lending between its domestic and foreign markets. The absence of a binding restriction would permit a bank to "segment" its markets, setting lending in each country independently of conditions in the other market. If, however, overall lending is con-

as branches of the parent firm.

[6]This set-up seems to characterize the conditions in international financial markets quite well. See the article "Global banks. A world of pain" in *The Economist, 5 March 2015*, which focuses on the cost disadvantages of foreign affiliates of multinational banks after the financial crisis.

[7]See Bank for International Settlements (2010) for an account of how deregulation (a reduction in compliance costs) in the 1980s boosted international lending, and how re-regulation after the financial crises caused cross-border lending to contract.

strained through equity requirements, the bank has to decide upon its lending to the two countries simultaneously. Despite having limited funds available to lend, each of the duopolistic banks has an incentive to enter its foreign market, as is the case for the duopolistic firms in Brander and Krugman (1983).

Finally, banks face a fundamental moral hazard incentive in our model, arising from the limited liability of each affiliate. In the event of failure, bank owners are affected only to the extent that the bank's operations are financed by equity, while the losses accruing to local depositors are covered by the host country's deposit insurance scheme and eventually have to be met by local taxpayers. This distorts the banks' choices towards lending in their more risky, foreign markets.

The timing in our model is as follows. In the first stage, each of the two governments simultaneously sets the equity requirement for any bank affiliates operating within its jurisdiction. In the second stage, the banks decide upon the division of their fixed amount of equity between their affiliates. Given the equity requirements, this determines the allocation of their lending to the two markets. When the equity requirements are not binding for a multinational bank, it can treat market each market separately in its lending decision. If, in contrast, the equity requirements are binding, then the bank decides upon the shares of its equity that go to their domestic and foreign affiliates. In the third stage, each affiliate of the multinational bank chooses the level of monitoring of its loans. Finally, in the fourth stage, firms produce output that is sold and consumed domestically. We solve the model using backwards induction.

2.2 Goods production

Homogeneous goods are produced in each country by small, competitive firms. The final consumer good is not traded, being produced exclusively for domestic consumption. The market inverse demand curve for the good is linear, with the price P_i being a function of realized domestic output Q_i:

$$P_i = A - bQ_i. \tag{1}$$

Competitive firms face no fixed costs of production, but each firm requires a bank loan to finance its output activity. Every firm plans to produce one unit of output using a single unit of an input. This input is the numeraire, such that a firm has to borrow a single unit of currency in order to acquire its services. Firms have the choice of

whether to borrow from the local affiliate of either the home or the foreign bank. Each firm in country i with a loan from a bank headquartered in country $h \in \{i, j\}$ succeeds in production with probability q_{ih}.[8] Each firm's output is one, if successful, and zero otherwise. Denoting by L_{ih} the number of loans made by the affiliate of bank $h \in \{i, j\}$ in country i, expected output Q_i in country i is then

$$Q_i = q_{ii}L_{ii} + q_{ij}L_{ij}. \tag{2}$$

Substituting (2) into (1) yields the expected price as a function of the expected success of the loans in the market,

$$P_i = A - b\left(q_{ii}L_{ii} + q_{ij}L_{ij}\right). \tag{3}$$

The expected profit for a firm in country i borrowing from bank h at cost R_{ih} is

$$\pi_{ih} = q_{ih}\left(P_i - R_{ih}\right) + \left(1 - q_{ih}\right)0 \quad \forall\, h \in \{i.j\}. \tag{4}$$

If a firm is successful, it will sell its (unit of) output at the prevailing price P_i and repay the loan at rate R_{ih} to its bank. If the firm fails, however, it earns nothing and defaults on its bank loan. We assume that there is free entry into the goods sector and consequently zero expected profits. This implies, from (4), that each bank will charge a loan rate R_{ih} that is equal to the expected price of the product in market i. Moreover, the loan rate of *both* banks $h \in \{i, j\}$ will equal the expected output price, even if the success probability q_{ih} of loans from the home-based and the foreign-based bank affiliate differs. This is because firms make zero profits regardless of whether they succeed or not, and hence will be indifferent as to the success probability of their loan:

$$R_i = R_{ih} = P_i \quad \forall\, h \in \{i, j\}. \tag{5}$$

All rents that arise from (successful) goods production will therefore be transferred to the two banks in our model. Importantly, this implies that *banks* have an interest in having their loans succeed, as they will only receive the loan rate R_i in this eventuality.

For the remainder of the paper we shall use R_i to represent the price in country i. Demand for loans can be seen as the derived demand for the consumption good that is produced by firms using these bank loans. Thus the expected price of loans made by banks in country i is

$$R_i = A - b\left(q_{ii}L_{ii} + q_{ij}L_{ij}\right) \quad \forall i, j, i \neq j. \tag{6}$$

[8] As we will argue below, this probability of success is a positive function of the level of monitoring offered by the lender.

2.3 Banks

There are two multinational banks, one headquartered in each country and with a subsidiary in the other country. Each bank affiliate can lend locally, but the foreign subsidiary of each bank faces higher costs of lending. If the banks' ability to lend were unlimited, the markets would be segmented, in that lending decisions could be made separately for each market. However, the leading case in our analysis is characterized by the total lending volume of each bank being restricted by capital regulation and a limited equity endowment of the bank. Consequently each bank must determine the volume of its loans to each market, subject to the total amount of loans that it is able to make.

Banks' funds come from two sources: a combination of savings deposits and equity. In line with actual practice in virtually all OECD countries, we assume that savings deposits are insured in the country where the bank unit operates.[9] The main argument for deposit insurance is that it prevents bank runs and thereby stabilizes the banking system (Diamond and Dybvig, 1983). For analytical simplicity, we further assume that the coverage of deposit insurance is complete and that the deposits of a bank affiliate operating in country i come entirely from the residents of that country.[10]

Deposit insurance is well known to cause moral-hazard effects for banks (Demirgüç-Kunt and Detriagiache, 2002). In order to protect its taxpayers, the banking regulator in country i therefore imposes a capital-adequacy standard, k_i, representing the minimum proportion of bank lending that must be backed by the bank's equity, as opposed to consumer deposits. Thus, for bank h's affiliate in country i, the regulator requires the ratio of equity, E_{ih}, to lending, L_{ih}, to be no less than the capital standard k_i:

$$\frac{E_{ih}}{L_{ih}} \geq k_i. \tag{7}$$

The total equity of a bank headquartered in country i is fixed at E_i. Each bank is free, however, to allocate its total equity among its two affiliates. In particular, each bank

[9] See Barth, Lee and Phumiwasana (2006) for an overview of deposit insurance schemes around the world and Huizinga and Nicodème (2006) for an analysis of how the existence and the design of deposit insurance affects the inflow of foreign deposits.

[10] This assumption could be generalized by allowing a share of deposits to come from both the parent and the host country of the multinational affiliate. This, however, would complicate the notation without affecting any of our results.

allocates the share γ_i of its total equity to its home affiliate, and the share $(1-\gamma_i)$ to the foreign affiliate. Hence $E_{ii} = \gamma_i E_i$ and $E_{ji} = (1-\gamma_i)E_i$, where $i \neq j$. If the capital requirements in (7) are binding, the lending of bank i in markets i, j is then given by

$$L_{ii} = \frac{\gamma_i E_i}{k_i}, \qquad L_{ji} = \frac{(1-\gamma_i)E_i}{k_j}, \quad \forall\, i, j,\ i \neq j. \tag{8}$$

We now specify the capital costs (or the costs of finance) of each bank affiliate. As savings deposits do not face any risk due to the existence of deposit insurance, we assume that depositors supply their savings to the bank for a fixed return, normalized to unity. Some of the equity holders in bank i reside in country i, but others may be residents of a third country outside the union.[11] This is consistent with a setting where countries i and j are small in the world capital market, but investors in each country exhibit a home bias for their national bank. Moreover we assume, for analytical simplicity, that each bank's cost of equity is also unity.[12]

The costs of capital for bank i's affiliates in its domestic and foreign markets are then given by

$$\begin{aligned} C_{ii} &= 1 - (1 - q_{ii})\,(1 - k_i)\,, \\ C_{ji} &= 1 + \tau - (1 - q_{ji})\,(1 - k_j)\,. \end{aligned} \tag{9}$$

In the expression for C_{ji}, the term τ reflects the additional compliance cost of supplying a loan through an affiliate in the bank's foreign market.[13] Such costs arise, for example, from the extra legal and advisory services that are needed for a foreign-based bank to comply with the tax and regulatory system of the host country. The existence of such compliance costs for cross-border banking is consistent with the empirical evidence that international transactions in financial services are falling in the distance between

[11] In other words, bank i's profit may accrue only partially to domestic residents. As we will see below, cross-ownership of country j's residents in bank i has the same implications as domestic ownership in our analysis, since we focus on symmetric equilibria and do not consider policy competition between countries i and j.

[12] The usual assumption in the literature is that the cost of equity is fixed at a level equal to or higher than the cost of savings deposits (Dell' Ariccia and Marquez, 2006; Allen, Carletti and Marquez, 2011). In such a setting, higher capital requirements increase the bank's cost of equity for two reasons, the higher cost of equity and the reduced subsidization by taxpayers. We simplify the analysis by eliminating the first of these effects but, importantly, maintain the second.

[13] Compliance costs also arise for the domestic affiliate of a multinational, but these costs are normalized to zero in our analysis.

the parent country and the host country of a multinational banking unit (Portes, Rey, and Oh, 2001; Portes and Rey, 2005).[14]

The last term in each expression in (9) reflects the implicit subsidy from the taxpayers in the host country that the bank affiliate will receive as a result of deposit insurance. The subsidy equals the product of the probability of default in a host country h $(1-q_{hi})$, and the share of financing through deposits in the host country $(1-k_h)$. This implies that the subsidies from taxpayers are larger for a bank affiliate if it provides more risky loans to its customers.

To keep the analysis tractable, we assume that, for each bank affiliate, the risks of its loans are perfectly correlated so that the failure probability of firms equals the probability that the bank affiliate will also fail. In this case, the expected costs of bank failures are partly borne by the taxpayers of the bank affiliate's host country. An increase in the capital requirement k_h reduces this implicit subsidy to the bank and thus raises an affiliate's cost of capital C_{hi}.

2.3.1 Monitoring decision

We assume that a bank can affect the probability that a firm succeeds through the level of monitoring, or support, that the bank provides.[15] The greater the monitoring, the greater the likelihood that the good will be produced and sold, and the higher the probability that the loan will be repaid. Suppose that the likelihood of a firm's success is linear in monitoring such that (with the appropriate normalisation) q_{hi} of monitoring by the affiliate of bank i to a firm in country h yields a probability of industrial success equal to q_{hi}. Thus monitoring of q_{hi} results in the bank's expected earnings on the loan equalling $R_h q_{hi}$.

While monitoring raises the expected return on a loan, it is costly to provide. We assume that monitoring costs are quadratic in the amount of monitoring and that they

[14]Similar gravity models are used to regress the level of FDI on the distance between parent and subsidary firms in the manufacturing sector. See Egger and Pfaffermayr (2004) and Kleinert and Toubal (2010).

[15]One possible interpretation is that by monitoring the producing entrepreneur, the bank induces him to supply more effort, thus increasing the probability of success (Besanko and Kanatas, 1993). Alternatively, monitoring can be interpreted as the bank acquiring a knowledge that is complementary to that of the firm, thus helping the firm to raise its chance of success (Boot and Thakor, 2000).

are sufficiently large that there will never be perfect monitoring in equilibrium. For domestic loans, the monitoring costs of bank i are given by $sq_{ii}^2/2$, where $s\,(>0)$ is a constant. Foreign loans face higher monitoring costs, as a result of higher information costs for foreign customers. For example, the foreign affiliate of a multinational bank may involve a local bank as an intermediary in its lending transactions, because of the latter's superior information about the borrowing clients. In such a case the profit margin of the local bank would directly increase the information costs of a cross-border loan transaction. In our model, these costs are specified as $s(1+\sigma)q_{ji}^2/2$, where $\sigma\,(>0)$ parameterizes the additional information costs of foreign loans.

A multinational bank based in country i maximizes its total expected operating profit Π_i, which is the sum of the net expected earnings of its home and the foreign affiliates. This can be written as

$$\Pi_i = \alpha_{ii} L_{ii} + \alpha_{ji} L_{ji}, \tag{10}$$

where α_{ii} and α_{ji} are the net expected returns on a loan for bank i's affiliates in countries i and j, respectively:

$$\alpha_{ii} \equiv R_i q_{ii} - C_{ii} - \frac{s}{2}\, q_{ii}^2; \qquad \alpha_{ji} \equiv R_j q_{ji} - C_{ji} - \frac{s\,(1+\sigma)}{2}\, q_{ji}^2. \tag{11}$$

In (11), the costs of finance are as given in (9), while the last term in each expression represents the monitoring costs for domestic and foreign loans, respectively.

Each affiliate of a multinational bank is a legally independent unit, and hence there is no obligation on the home-country affiliate of the bank to cover any losses of its foreign affiliate, or *vice versa*. In our setting, it is then clearly optimal for each unit of a multinational bank to repudiate the losses of its related affiliate in the other country. In taking this position, the bank maximizes the implicit subsidies received from national deposit insurance, and hence the expected profits of its international operations.[16]

It follows from this legal separation that each bank affiliate will make a separate decision as to how much monitoring it should conduct on each loan. As firms are assumed to be identical, each bank will optimally choose the same level of monitoring for all firms

[16]Cerutti, Dell'Ariccia and Martinez Peria (2007) list some cases where parent companies have come up for the losses of legally independent subsidiaries, even though they had no obligation for doing so. In these examples the core motivation for the parent bank was to avoid reputational losses. These, however, play no role in our static analysis.

in a particular (domestic or foreign) market. While banks will take the effect on loan prices into account when deciding on the allocation of equity between their affiliates (as is shown below), they take the loan price R_i [which equals the expected price of output from (5)] as given when making their monitoring choice. The reason why banks will not strategically exploit their market power through their monitoring decision is that the bank perceives the risks of firms in each country as being perfectly correlated. Therefore, while lowering q_{hi} would increase the probability that all firms fail, it will not increase the market price that firms receive when they - simultaneously - succeed.

Substituting (11) into (10) and differentiating with respect to levels of monitoring (treating expected price as a constant), yields first-order conditions for the profit-maximising levels of monitoring in both markets:

$$q_{ii}^{*} = \frac{R_i - (1 - k_i)}{s}; \qquad q_{ji}^{*} = \frac{R_j - (1 - k_j)}{s\,(1 + \sigma)}. \tag{12}$$

Each bank affiliate's monitoring of firms is positively related to both the price and the capital requirement facing the bank. High loan prices make successful performance more rewarding while a higher capital constraint, by reducing the share of subsidized deposit financing, increases the cost of failure from the bank's perspective. Finally and importantly, the probability of a failing loan is always greater for the foreign affiliate of a bank, because of the higher information costs associated with foreign lending.

The monitoring levels in (12) can be substituted into (11) to find the expected earnings on optimally monitored loans in each market:

$$\alpha_{ii}^{*} = \frac{[R_i - (1 - k_i)]^2}{2s} - k_i; \qquad \alpha_{ji}^{*} = \frac{[R_j - (1 - k_j)]^2}{2s\,(1 + \sigma)} - (k_j + \tau)\,. \tag{13}$$

2.3.2 Allocation of equity

The duopolistic market structure in both countries becomes critical when each multinational bank decides how to allocate its equity between its two affiliates. Each bank takes the equity allocation, and hence the loan volumes of the other bank in the two markets, as given and considers that its own lending in each market will cause falling consumer prices, and hence falling loan rates. Consequently, as in the Brander and Krugman (1983) model, it is optimal for each of the two banks to divide its total equity, and hence its lending, between the two markets. This remains true even when the total amount of lending is limited by binding equity requirements in both countries.

The optimal share of equity allocated to the home market of bank i is found by differentiating expected profits in (10) with respect to γ_i, taking into account the derived demand functions for loans (6) and the lending shares in each market (8). This gives

$$\frac{\partial \Pi_i}{\partial \gamma_i} = \frac{\alpha_{ii}^*}{k_i} - \frac{\alpha_{ji}^*}{k_j} - bE_i \left[\frac{\gamma_i q_{ii}^{*2}}{k_i^2} - \frac{(1-\gamma_i) q_{ji}^{*2}}{k_j^2} \right] = 0. \tag{14}$$

Solving for γ_i and rearranging yields the optimal allocation of lending

$$\gamma_i^* = \frac{1}{\Theta} \left[\frac{2bE_i \phi_j^2}{k_j^2} + \frac{\phi_i^2 s(1+\sigma)^2}{k_i} - \frac{\phi_j^2 s(1+\sigma)}{k_j} + \frac{2\tau s^2 (1+\sigma)^2}{k_j} \right], \tag{15}$$

$$\Theta \equiv 2bE_i \left[\frac{\phi_i^2 (1+\sigma)^2}{k_i^2} + \frac{\phi_j^2}{k_j^2} \right],$$

where ϕ_i and ϕ_j are the bank's return on a successful loan in each market, net of the cost of deposit finance:

$$\phi_i \equiv R_i - (1 - k_i), \qquad \phi_j \equiv R_j - (1 - k_j). \tag{16}$$

2.3.3 Symmetry

In much of our following analysis we will focus on fully symmetric outcomes, in that the two countries are identical in every respect including the behaviour of their banking regulators. Hence countries will choose the same capital requirements $k = k_i = k_j$ while equilibrium prices (for goods and loans) will be identical such that $R = R_i = R_j$. Together, this implies $\phi_i = \phi_j \equiv \phi$ in (16). We also assume that the banks behave optimally with respect to their monitoring and lending decisions such that we can suppress the asterisk (*) for the remainder of our analysis.

We can use the symmetry to determine the values of the exogenous parameters in our model that will ensure that the banks' optimal monitoring decisions yield interior solutions. For both $q_{ii} < 1$ and $q_{ji} < 1$ to hold in (12) we need that $\phi < s$. At the same time, to ensure that expected earnings in both markets are positive, $\alpha_{ii} > 0$ and $\alpha_{ji} > 0$, in (13) requires that $\phi^2 > 2s(1+\sigma)(k+\tau)$. These conditions can be simultaneously fulfilled only if

$$s > \phi > 2(1+\sigma)(k+\tau). \tag{17}$$

Condition (17) thus places an upper bound on the additional monitoring cost in the foreign market, σ, relative to both the domestic monitoring cost parameter s, and the banks' return on a successful loan ϕ. We will use this condition in our analysis below.

We can further exploit the symmetry in order to simplify expression (15) for the optimal share of lending allocated to the home market:

$$\gamma_i = \frac{1}{b(E_i/k)\left[(1+\sigma)^2+1\right]}\left[b(E_i/k) + \frac{s\,(1+\sigma)\,\sigma}{2} + \frac{\tau s^2\,(1+\sigma)^2}{\left[R-(1-k)\right]^2}\right]. \tag{18}$$

If the banks do not face any additional costs for operating in the foreign market, then both $\tau = 0$ and $\sigma = 0$. Consequently, (18) further simplifies to $\gamma_i = 1/2$ (see Dell'Ariccia and Marquez, 2006).

More generally, however, the share of domestic bank loans, γ_i, can be greater or less than $1/2$. To see this, we focus on the role of the cross-border information cost σ and set $\tau = 0$ in (18). Subtracting $1/2$ from both sides gives

$$\gamma_i|_{\tau=0} - \frac{1}{2} = \frac{\sigma[s(1+\sigma) - b(E_i/k_i)(2+\sigma)]}{2b(E_i/k_i)[(1+\sigma)^2+1]} \gtrless 0. \tag{19}$$

Equation (19) shows an important property of our model. Even though foreign bank affiliates face higher information costs for their loans, banks may provide more loans through their foreign affiliate than through their domestic one. This is because banks are effectively subsidized by taxpayers through the deposit insurance scheme. Since this subsidy is proportional to the risk of failure, the loans of the foreign affiliate receive a disproportionate subsidy compared to the domestic affiliate. This leads to the (expected) marginal costs of capital being lower for the foreign affiliate compared to the domestic affiliate, if the compliance cost parameter τ is low [see (9), taking into account that $q_{ii} > q_{ji}$ from (12)]. Hence, banks will enter foreign markets "aggressively" when the costs of failure is shared with taxpayers.

Specifically, when τ is low, $\gamma_i > 1/2$ will arise in our model only when the information cost parameter s (acting as a multiplier for the foreign information costs σ) is large and when the subsidy share implicit in deposit insurance is low (k is large). In the opposite case, where s and k are both small, the higher subsidization of foreign loans is the dominant effect and $\gamma_i < 1/2$ holds in equilibrium.

3 Government regulation

The banking regulator of the government in country i can intervene in the financial market through setting k_i, the equity requirement for all bank affiliates operating in

country i. We first consider the case where no capital requirements are set by national regulators and hence the constraint (7) does not bind. We then look at the implications of increases in k_i that are sufficiently large to affect banks' lending decisions.

3.1 Non-binding capital regulation

When the total loan volume that can be made by a bank affiliate exceeds its desired volume of lending, government equity requirements do not limit the activities of the bank. In such a setting, each multinational bank makes independent decisions regarding its lending through its domestic and the foreign affiliates. Thus, rather than making a decision regarding the allocation of limited lending between the two markets to maximize (14), bank i is free to choose its lending in each market to maximize each of $\Pi_{ii} \equiv \alpha_{ii} L_{ii}$ and $\Pi_{ji} \equiv \alpha_{ji} L_{ji}$. The financial products provided by domestic and foreign bank affiliates to firms in a particular market will not be the same, in that the level of monitoring of loans adopted by the domestic affiliate will differ from that chosen by the competing foreign affiliate.

Total lending in market i will result from each bank affiliate in country i choosing its optimal number of loans, given its rival's lending decision.[17] Differentiating the bank's profits in each market, we can solve the first-order conditions to obtain the optimal loan volumes:

$$L_{ii} = \frac{\alpha_{ii}}{q_{ii}^2}, \qquad L_{ij} = \frac{\alpha_{ij}}{b q_{ij}^2}. \tag{20}$$

Taking into account the inverse demand function (3) that links the lending levels of the two banks, we can derive the reaction functions for lending by the domestic and the foreign affiliates in the market:

$$\begin{aligned} L_{ii}\left(L_{ij}\right) &= \frac{1}{2b}\left[\frac{A-(1-k_i)}{q_{ii}} - \frac{s}{2} - \frac{k_i}{q_{ii}^2}\right] - \frac{q_{ij}}{q_{ii}}\frac{L_{ij}}{2}; \\ L_{ij}\left(L_{ii}\right) &= \frac{1}{2b}\left[\frac{A-(1-k_i)}{q_{ij}} - \frac{(1+\sigma)\,s}{2} - \frac{k_i+\tau}{q_{ij}^2}\right] - \frac{q_{ii}}{q_{ij}}\frac{L_{ii}}{2}. \end{aligned} \tag{21}$$

It is immediately apparent from (21) that one bank's lending is a strategic substitute for loans from the other bank. Further, we can see that lending by the affiliate of the

[17] We assume that each bank behaves as a Cournot competitor in that, in making its decision as to the quantity of loans that it will offer in a market, it assumes that its competitor's response will be to maintain its level of lending.

foreign bank is affected negatively by both the compliance cost τ that it faces, as well as the additional information cost of lending abroad σ.

The slopes of the two reaction functions depend upon the levels of monitoring established by the domestic and foreign banks, q_{ii} and q_{ij}, respectively. If these were the same, both reaction functions would have a slope of (negative) 1/2. With different monitoring costs, however, we get $q_{ij} = q_{ii}/(1+\sigma)$ from (12), showing that the loans of the foreign affiliate are less well-monitored than those made by the affiliate of the local bank. We can then use (21) to find the optimal lending volumes of both bank affiliates in country i. Solving yields:

$$\begin{aligned} L_{ii} &= \frac{1}{3b}\left\{\left[\frac{A-(1-k_i)}{q_{ii}} - \frac{s}{2}\right] - \frac{\left[(1+\sigma)\,\tau - (1-\sigma)\,k_i\right]}{q_{ii}^2}\right\}; \\ L_{ij} &= \frac{(1+\sigma)}{3b}\left\{\left[\frac{A-(1-k_i)}{q_{ii}} - \frac{s}{2}\right] - \frac{\left[2\,(1+\sigma)\,\tau + (1+2\sigma)\,k_i\right]}{q_{ii}^2}\right\}. \end{aligned} \tag{22}$$

We see from (22) that compliance costs τ reduce lending of both affiliates but this effect is stronger for the affiliate of the foreign bank j. The role of the additional information cost σ facing the foreign affiliate is less clear. If this cost is sufficiently large, the second term in the expression for L_{ij} will outweigh the first term, such that there is no lending by the foreign subsidiary. However, when τ and k_i are both small (so that the second terms in the braces are negligible) while σ is positive, this will lead to the subsidiary of the foreign bank j lending more in market i than its domestic rival. In the face of higher information costs, the foreign affiliate will provide an inferior (that is, less well-monitored) product than that offered by the local affiliate and this may crowd out the superior local product. As discussed above [eq. (19)], this is due to implicit government subsidies that are proportional to the banks' risk taking and thereby favour the foreign over the domestic lending operations of each bank.

Finally, we can add together the two expressions in (22) to obtain the total amount of lending for a multinational bank based in country i when the capital requirements in both countries are the same ($k_i = k_j = k$). Note that capital requirements k still increase banks's lending costs, even if they do not impose an overall constraint on the bank's lending volume, because they reduce the implicit subsidization of banks' capital costs through the deposit insurance scheme [see eq. (9)]. Denoting this unconstrained

level of aggregate lending by L_i^u we find

$$L_i^u \equiv L_{ii} + L_{ji} = \frac{(2+\sigma)}{3b}\left[\frac{A-(1-k)}{q_{ii}} - \frac{s}{2}\right] - \frac{[(1+\sigma)(1+2\sigma)\tau + 2(1+\sigma+\sigma^2)k]}{3bq_{ii}^2}. \tag{23}$$

In the following we shall compare L_i^u to the level of lending in the constrained regime.

3.2 Binding capital regulation

We now consider how the allocation of lending changes when each multinational bank's total lending is constrained by the equity requirements (7) imposed by regulators in the host countries of the bank's affiliates. We analyze the effects of *coordinated* changes in the two countries' capital requirements. In other words, we assume that the two, symmetric countries jointly set their capital requirements so as to maximize their combined welfare. This assumption reflects the fact that, at least in the developed world, bank regulation has been closely coordinated through the various Basel agreements.[18] Also, since our focus is on the effects of economic and financial integration, rather than on regulatory competition between governments, our assumption of a coordinated regulatory regime is an analytically simpler way to pin down optimal levels of k_i.[19] Consequently, we continue our analysis under the assumption that there is a common capital requirement k across the region. From eq. (8) this implies that lending by a multinational bank based in country i is $L_i \equiv L_{ii} + L_{ji} = E_i/k$.

We first discuss the conditions under which the lending constraint actually has an impact on the equilibrium. Comparing the unconstrained level of lending in (23) with the constrained level $L_i = E_i/k$ shows that $L_i^u < L_i$ must hold as $k \to 0$. This is because the available lending L_i approaches infinity as k approaches zero, whereas L_i^u converges towards a finite value. Hence the economy can only be in the constrained

[18]The recent Basel III agreement, enacted in 2013, has increased the ratio of core capital (common equity) to risk-weighted assets from 3.5% to 4.5%. In addition, an anticyclical capital buffer of 2.5% of risk-weighted assets is to be built up until 2019.

[19]In the literature on regulatory competition, Sinn (1997) and Dell'Ariccia and Marquez (2006) have shown that the non-cooperative setting of capital standards leads to a "race to the bottom" when each government is mainly interested in the profits of its banking sector. Haufler and Maier (2016) have recently demonstrated, however, that this result may be turned around, and a "race to the top" in capital regulation occurs when governments give equal weighting to banks' profits, tax revenues and consumer surplus.

regime when k is sufficiently positive. Alternatively, when we evaluate expressions at the maximum capital ratio, $k = 1$ (which requires full equity financing of the bank's loans), a necessary condition for the constrained regime to occur for some levels of k is then:

$$L_i|_{k=1} = E_i < L_i^u|_{k=1}\,. \tag{24}$$

Clearly, condition (24) must hold when the bank's equity E_i is sufficiently low, relative to the exogenous parameters that determine L_i^u in (23). We make this assumption in the following.

We assume that the two governments set their common capital requirement to maximize their joint welfare. The welfare function of each country is a weighted sum of the expected profits of the multinational bank (Π_i), tax revenues (T_i), and consumer surplus (CS_i):

$$W_i = \beta_1\Pi_i + \beta_2 T_i + \beta_3 CS_i, \qquad \beta_1, \beta_2, \beta_3 \geq 0. \tag{25}$$

This welfare function allows for several specifications, depending upon the weights β_1, β_2, and β_3 on profits, tax revenues, and consumer surplus, respectively. For example, if the bank's profits accrue partly to foreigners from outside the region (cf. footnote 11), then β_1 would be set lower than β_2 and β_3. Moreover, the expected subsidies paid to banks may have to be financed by increases in distortive taxes, creating an excess burden over and above the direct fiscal cost of the subsidy. This would imply setting β_2 above both β_1 and β_3.

The first component of (25), bank profits in country i, is given in eq. (10). The expected value of tax losses in country i equals the fraction of failed loans made by both bank affiliates operating in i, which is backed by insured deposits as opposed to being funded from the banks' own equity. Tax revenue T_i is therefore negative and given by:

$$T_i = -(1-k)\left[(1-q_{ii})\gamma_i L_i + (1-q_{ij})(1-\gamma_j)L_j\right]. \tag{26}$$

Finally, consumer surplus in country i depends on the number of successful loans extended by both bank affiliates operating in country i:

$$CS_i = \frac{b}{2}\left[q_{ii}\gamma_i L_i + q_{ij}(1-\gamma_j)L_j\right]^2. \tag{27}$$

Appendix A.1 derives the effects of the coordinated capital requirement k for the case where compliance costs are negligible ($\tau = 0$) under our assumption that the countries are symmetric. Hence, for the remainder of this paper, we drop the subscript i from

variables. Appendix A.1 first shows that higher capital requirements k raise the loan price and the domestic loan share γ of multinational banks [cf. eqs. (A.1)–(A.2)]:

$$\frac{\partial R}{\partial k} > 0, \qquad \frac{\partial \gamma}{\partial k} > 0. \tag{28}$$

Since higher capital standards reduce the implicit subsidization of bank loans through deposit insurance, the increase in loan prices follows directly from the increase in banks' cost of capital [eq. (9)]. Moreover, since foreign loans are more heavily subsidized, due to their higher failure probability, their capital cost rises more strongly when k is increased. This leads to a higher share of domestic lending in the bank's optimum.

Based on these effects, Appendix A.1 [eqs. (A.4), (A.6) and (A.7)] further shows that higher capital requirements reduce bank profits and consumer surplus, while increasing tax revenues:

$$\frac{\partial \Pi}{\partial k} < 0, \qquad \frac{\partial T}{\partial k} > 0, \qquad \frac{\partial CS}{\partial k} < 0. \tag{29}$$

These results are intuitive as higher capital requirements reduce lending volumes by banks, impairing both their profits and consumer surplus. At the same time, higher capital requirements increase tax revenues (more correctly, they reduce expected subsidies) by decreasing the share of subsidized deposit funding, and through the reduced equilibrium loan volumes. Hence, by choosing a coordinated capital requirement, the two governments directly affect the degree of "bail-in" *versus* "bail-out", that is, the share of losses borne by equity holders and taxpayers, respectively.

Finally, Appendix A.1 analyzes the conditions under which an interior value for the coordinated capital requirement is obtained. This implies that the lending constraint (7) is binding in the governments' optimum, but the optimized capital standard is less strict than requiring all loans to be financed by equity. This is summarized in:

Proposition 1 *If the welfare weights on bank profits and tax revenues are equal and sufficiently larger than the welfare weight on consumer surplus ($\beta_1 = \beta_2 > \beta_3$), then the first-order condition for a joint policy optimum is fulfilled for an interior capital requirement with $\tilde{k} < k < 1$, where $\tilde{k}$ is the capital standard at which the lending constraint* (7) *becomes binding.*

Proof: See Appendix A.1.

Note that the conditions specified in Proposition 1 are sufficient, but not necessary, for the first-order condition to be met at an interior level of the policy variable k.

Assuming that the sufficient second-order condition for a maximum holds, it is then straightforward to determine how the optimal capital requirement k responds to the weights attached to the different components of national welfare. From (29) and the implicit function theorem, we get

$$\frac{\partial k}{\partial \beta_1} = -\frac{\partial \Pi / \partial k}{\partial^2 W / \partial k^2} < 0, \quad \frac{\partial k}{\partial \beta_2} = -\frac{\partial T / \partial k}{\partial^2 W / \partial k^2} > 0, \quad \frac{\partial k}{\partial \beta_3} = -\frac{\partial CS / \partial k}{\partial^2 W / \partial k^2} < 0. \tag{30}$$

This shows that the optimal capital requirement k is rising in β_2, the weight that governments attach to tax revenues, and falling in both β_1 and β_3, the weights that they attach to bank profits and consumer surplus, respectively.

Our results in this section are consistent with the empirical finding that worldwide levels of cross-border lending have fallen since 2008 (see Figure 1). During this period, capital requirements have been increased through the coordinated Basel III process (see footnote 18), but also through unilateral measures taken in several countries, including the United States and Switzerland. In the setting of our model, this increase in k can be motivated by a higher valuation of taxpayer costs (an increase in β_2) following the public bailout of banks that has occurred in many countries. Our above analysis has shown that higher capital requirements not only reduce the overall volume of bank lending, but also shift lending activities towards the domestic market [eq. (28)]. This strongly suggests that the change in regulation policy that occurred after the financial crisis has contributed to lower levels of cross-border lending.[20]

In our analysis of financial integration in the following section, we treat the capital requirement k as exogenous (and common to both countries), but interpret it as having been chosen optimally before any changes in the costs of foreign lending have occurred. In Section 5, we will then analyze, by means of numerical simulations, how the optimal coordinated capital requirement is affected by this financial integration.

4 Financial integration

Improvements in technology or information can reduce the cost to a bank of lending in a foreign market. This enhances the entry of financial institutions into foreign markets

[20] See Buch, Neugebauer and Schröder (2014) for a detailed empirical analysis supporting this claim. For a more general empirical analysis showing that tighter regulation in a country deters foreign entry, see Merz, Overesch and Wamser (2017).

and has implications for the overall level of lending as well as the quality of loans. In our model, we have two parameters that capture different elements of financial integration. Firstly, a reduction in the compliance cost parameter τ facilitates access to the foreign market but leaves unchanged the extra costs of monitoring foreign loans. Secondly, improved information on foreign loans are captured by a decrease in the foreign information cost parameter σ. As we shall show, changes in these two parameters have very different welfare implications in the model.

4.1 Reduced compliance costs for cross-border loans

We initially consider the effect of reducing the cost τ of complying with a foreign tax and regulatory system, recalling that we normalize the compliance costs of domestic banks to zero (see footnote 13). In this interpretation, compliance costs are reduced, in particular, by the international harmonization of the relevant laws and regulations in the banking sector. One important example in Europe was the introduction of a "single banking license" (through the principle of mutual recognition) in the Second Banking Directive, which became effective in 1992.[21] Another example is the current initiative to create a capital markets union among the EU member states. A core element in this initiative is the increased use of "simple, transparent and standardized" securitization, which is aimed explicitly at reducing the costs of cross-border lending (see European Commission, 2015a,b).

We start out by deriving the effects of this policy change on a bank's allocation of its total lending and on the price of loans. In a second step, we then derive the effects on profits, tax revenues and consumer surplus. The analysis of changes in compliance costs starts from an arbitrary initial equilibrium where τ is strictly positive.

Effect on market shares and prices. Differentiating a bank's allocation of loans between its affiliates in (18) and the loan price in (6) with respect to τ yields

$$\frac{\partial \gamma}{\partial \tau} = \frac{s^2(1+\sigma)^2}{\phi^2 bL\varepsilon} > 0, \qquad \frac{\partial R}{\partial \tau} = \frac{-s^2\sigma(1+\sigma)^2}{\phi\varepsilon} < 0, \tag{31}$$

where $\varepsilon \equiv [(1+\sigma)^2+1][s(1+\sigma)+bL(1+\gamma\sigma)] - \tau s^2\sigma(1+\sigma)^2 > 0$.

[21] See Buch (2003) for an empirical analysis that finds significantly positive effects of the Second Banking Directive on cross-border lending in Europe.

The comparative static results in (31) are critical for our further analysis. By lowering the compliance cost of supplying loans through its foreign subsidiary, a fall in τ changes a bank's allocation of equity, and hence lending, towards its foreign market. Moreover, since the fall in τ redirects a fixed loan volume of each bank towards its foreign affiliate, where there is a lower probability of success [see eq. (12)], total output falls raising the price of output and bank loans.

Welfare effects. Differentiating optimized profits in (13) and using (31) gives

$$\frac{\partial \Pi}{\partial \tau} = -(1-\gamma)L + \frac{s(1+\sigma)}{2\phi^2 b\varepsilon}\left[\phi^2\sigma\eta + 2s\tau(1+\sigma)\mu\right] \gtrless 0, \tag{32a}$$

where $\mu\,(>0)$ is given in (A.3) and $\varepsilon\,(>0)$ is defined in (31), while (using $L = E/k$)

$$\eta \equiv s(1+\sigma) - b(1+\gamma\sigma)E/k \gtrless 0.$$

The effects of reduced compliance costs on bank profits are generally ambiguous. The direct effect, given by the first term in (32a), is negative: lower compliance costs *raise* banks' profits by making their foreign loans less expensive. The indirect, second effect in (32a) captures the effects on profits resulting from the higher share of foreign lending induced by a lower τ [eq. (31)]. A fall in compliance costs will hurt the bank's profits through this second effect, if the foreign market is less profitable than the domestic market. This will be the case when $\eta > 0$, implying that the higher information costs of foreign lending [the first term in η] dominate the higher subsidies received through deposit insurance [the second term in η]. This is, in turn, more likely when the governments' regulation policy is strict (k is high). Conversely, if the regulation policy is lax and $\eta < 0$, then each bank will benefit from shifting its lending activities towards its more highly subsidized foreign affiliate, provided that τ is small initially.[22] In this latter case, a fall in compliance costs τ unambiguously increases bank profits.

Next, we consider the effects on taxpayers. Differentiating (26), substituting in from (31) and simplifying gives

$$\frac{\partial T}{\partial \tau} = (1-k)\,\frac{s^2\sigma(1+\sigma)^2}{b\phi\varepsilon} > 0. \tag{32b}$$

As this effect is unambiguously positive, a fall in compliance costs *reduces* tax revenue, in that it increases the subsidy payments from taxpayers to the bank. Lower compliance costs increase the share that each bank lends through its foreign affiliate, which

[22] Note that, from (18), $\tau > 0$ unambiguously makes reliance on the home market more profitable.

monitors its loans less due to higher information costs. Thus, a fall in τ results in a larger share of loans being exposed to the higher risk of failure.

Finally, the effects on consumer surplus are obtained from (27), Using (31) gives

$$\frac{\partial CS}{\partial \tau} = \frac{s^2\sigma(1+\sigma)^2}{\phi\varepsilon}Q > 0. \tag{32c}$$

This effect is again positive, implying that lower compliance costs *reduce* consumer surplus. Since the overall loan volume does not change, due to the constraint imposed by binding capital requirements, a fall in τ affects consumer surplus only through the increased share of lending in the foreign market. The lower success probability of foreign loans means that expected output falls, with a consequent decline in consumer surplus.

In comparing the impact of reduced compliance costs in (32a)–(32c), we see that there is a potential conflict between the interests of banks on the one hand and consumers and taxpayers on the other. A fall in compliance costs will benefit banks, at least when regulation policy is lax (k is low) and compliance costs τ are low in the initial equilibrium. At the same time, the fall in τ induces each bank to shift a larger share of its loans to the foreign market, where monitoring levels are lower. This implies higher failure rates for loans, harming both taxpayers and consumers.

Given these conflicting effects, the implications of lower compliance costs for welfare in each of the two symmetric countries [eq. (25)] will generally be ambiguous. However, when the welfare weight on bank profits (β_1) is sufficiently low, for example because a large share of the banks is owned by residents of third countries, then trade integration will harm both countries in the region. We summarize these results in:

Proposition 2 *A reduction in the compliance costs of cross-border lending (τ) reduces consumer surplus and raises the expected losses of taxpayers in both countries. When the weight of bank profits in national welfare functions (β_1) is sufficiently low, lower compliance costs also reduce aggregate welfare in each country.*

Proposition 2 shows that financial integration in the banking sector may have different, and more negative effects, as compared to trade integration in manufacturing or other services. The welfare results in Brander and Krugman (1983) are ambiguous in general but can be signed in special cases. In particular, when trade costs are low, further reductions are welfare improving as the increase in competition yields higher consumer surplus while the increased two-way trade in the identical product is almost

costless. The contrast in results arises for two reasons. First, in our model of lending, financial integration cannot expand the overall supply of loans when binding capital requirements are set by regulators, while production expands in Brander and Krugman. Moreover, by incorporating a failure probability that is higher for loans of each bank's foreign affiliate, financial integration increases the aggregate risks in the banking sector which, in our model, are partly shifted onto taxpayers by means of savings deposit insurance. At the same time, banks are likely to welcome financial integration, partly because of the higher implicit subsidies they receive from taxpayers when they expand their foreign lending.

4.2 Reduced information costs abroad

We now turn to the effects of a decline in the foreign information cost parameter σ. As we have argued above, these costs arise from the affiliate of a foreign-based bank being less familiar with the customers in a given country, compared to a local bank affiliate. As a result, foreign affiliates often rely on the *costly* intermediation services of a local bank.[23] One example of reducing such cross-country, consumer-information costs are credit registers, which publicize financial data on bank customers. Such credit registers exist in most developed countries, and they are collected either by private credit bureaux or by public agencies (typically central banks).[24] Another example are stress tests for banks, which have been carried out by supervisory agencies in all OECD countries since the financial crisis. Stress tests provide information on the liquidity of banks in other countries. This reduces the information costs for cross-border lending, because a substantial share of lending abroad occurs to foreign financial institutions (even though this is not modelled here), and because foreign banks may be involved as intermediaries in lending to final customers.

[23]In empirical work, these information costs are generally proxied by geographical distance and a different language; see Portes, Rey and Oh (2001), Portes and Rey (2005), or Buch (2003). Of these studies, Buch (2003) distinguishes information costs from regulatory (or compliance) costs and finds separate, positive effects of a fall in either type of costs on cross-border lending.

[24]Giannetti, Jentzsch and Spagnolo (2010) use these sources to assemble a comprehensive dataset for the EU-27 member states over the period 1999-2007. They show that the existence of public credit registers, in particular, has a positive impact on the market entry of foreign-based multinational banks.

Effect on market shares and prices. We proceed in the same way as above, but simplify the analysis by evaluating the derivatives at $\tau = 0$. Differentiating each bank's allocation of loans in (18) with respect to σ and evaluating at $\tau = 0$ gives

$$\left.\frac{\partial \gamma}{\partial \sigma}\right|_{\tau=0} = \frac{s[(1+\sigma)^2 + (2\sigma+1)] - 4bL(1+\sigma)}{2bL[(1+\sigma)^2+1]} \gtrless 0. \tag{33a}$$

In contrast to a fall in compliance costs τ that unambiguously reduces γ [see eq. (31)], a fall in the information costs for lending abroad has an ambiguous effect on the bank's allocation of loans. A lower level of σ will reduce the domestic loan share γ only when the information cost parameter s is large and the capital requirement k is high, implying a low equilibrium loan level from $L = E/k$ [cf. the discussion of eq. (19)]. In this case, a fall in σ reduces the cost disadvantage of foreign loans and therefore lowers γ. In contrast, a fall in σ will increase γ when the regulation policy is lax and the loan allocation is primarily determined by the higher taxpayer subsidy on foreign loans. The fall in σ then reduces this subsidy advantage of foreign loans and raises γ, shifting lending to the domestic market.

The effect on the loan price in (6) is derived in Appendix A.2 and given by

$$\left.\frac{\partial R}{\partial \sigma}\right|_{\tau=0} = \frac{\phi b L}{\mu}\left[\frac{(1-\gamma)}{(1+\sigma)} - \sigma\frac{\partial \gamma}{\partial \sigma}\right] > 0 \quad \Longleftrightarrow \quad \frac{bE}{k}[(1+\sigma)^2 + 1 + 2\sigma] - s\sigma(2+\sigma) > 0, \tag{33b}$$

where $\mu(> 0)$ is defined in Appendix A.1 [eq, (A.3)]. Equation (33b) shows that the direct effect of σ on the loan rate is positive, implying that lower information costs for foreign loans reduce the loan rate. This is because a smaller σ increases the monitoring of foreign loans, raising expected output and lowering its price. The indirect effect is ambiguous and depends on the change in γ, as given in (33a). A sufficient, but not a necessary, condition for the overall effect to be positive is that $\partial\gamma/\partial\sigma < 0$ holds. In this case a fall in σ will reallocate loans towards each bank's home affiliate, which has the higher success probability. Even if $\partial\gamma/\partial\sigma > 0$, such that a decline in σ shifts lending to the more risky foreign market, a fall in σ will still reduce the loan rate when the capital requirement k is not too high in the initial equilibrium. In the following we assume that this condition is met so that $\partial R/\partial\sigma > 0$ holds in (33b).

Welfare effects. The impact of a fall in σ on each bank's profits is again found by differentiating (10), using (33a)–(33b) to yield:

$$\frac{\partial \Pi}{\partial \sigma} = \frac{-\phi\eta}{2bs(1+\sigma)}\frac{\partial R}{\partial \sigma} \gtrless 0. \tag{34a}$$

A fall in σ has a similarly ambiguous effect on bank profits as a reduction in τ [see eq. (32a)]. When condition (33b) holds, the sign of $\partial\Pi/\partial\sigma$ depends once again on the sign of η. When regulation policy is tight and k is relatively large, then $\eta > 0$. In this case, each bank profits from the lower information costs of its foreign affiliate. When k is low, however, we get $\eta < 0$. The fall in σ then increases γ from (33a), as subsidies for foreign loans are reduced. At the same time, in this case each bank's foreign affiliate has the higher profit margin so that banks lose from the reallocation of their lending towards the home market.

To obtain the impact on taxpayers, we differentiate (26) and use (33b) to get

$$\frac{\partial T}{\partial \sigma} = \frac{-(1-k)}{b}\frac{\partial R}{\partial \sigma} < 0. \tag{34b}$$

This is negative for $\partial R/\partial\sigma > 0$, implying that taxpayers benefit from a reduction in σ. Intuitively, since the total lending volume is fixed by capital requirements, the effect of a lower σ on tax revenue depends only on the average share of loans that are successful. Since reduced information costs for foreign loans increase optimal monitoring levels for these loans, risks for taxpayers are reduced and tax revenue rises.

Finally, differentiating (27) with respect to σ shows that consumers also benefit from lower information costs abroad:

$$\frac{\partial CS}{\partial \sigma} = -Q\frac{\partial R}{\partial \sigma} < 0. \tag{34c}$$

The fall in σ causes the share of successful loans to rise through increased monitoring by the foreign affiliates. This reduces the loan rate and expands output, translating directly into a positive effect on consumer surplus.

Collecting these effects on the components of national welfare, we see that the benefits of financial integration *do* materialize for a reduction in the information costs for foreign loans. We summarize these results as follows:

Proposition 3 *If capital regulation is not too strict [such that $\partial R/\partial\sigma > 0$ holds in* (33b)*], a reduction in the information costs of cross-border lending, σ, increases tax revenues and consumer surplus in both countries. If the direct effect of falling information costs dominates for banks [$\eta > 0$ holds in* (32a)*], their profits will also rise. National welfare will then increase in both countries, for any combination of welfare weights ($\beta_1, \beta_2, \beta_2$).*

A comparison of Propositions 2 and 3 reveals that the effects of financial integration can be very different, depending on the type of cost to cross-border lending that is lowered. In particular, if the compliance costs for foreign loans are reduced, while the information costs for these loans remain unchanged, then financial integration may well have detrimental welfare effects. This could be the case, for example, when deregulation is accompanied by internationally harmonized laws and regulations, so that the compliance costs for foreign lending are low, but information costs for foreign loans remain high. In the following we will study how governments optimally adjust their regulatory policies to such a situation.

5 Financial integration and optimal regulation

In this section we analyze how reductions in the compliance cost parameter τ and the foreign information cost parameter σ affect the optimal, coordinated choice of capital requirements k. The determinants of the optimal capital requirement, as discussed in Section 3.2, are too complex, however, to answer this question analytically. We therefore consider some numerical examples that highlight the patterns of optimal responses.

Table 1 reports the results from a first set of numerical simulations that show the effects of reducing the compliance cost parameter τ. The table is divided into two cases, corresponding to different values of β_2, the welfare weight on tax revenues. In Case 1, the weight on tax revenues is relatively low ($\beta_2 = 3$) while Case 2 has a higher weight ($\beta_2 = 8$). From (30) this implies a higher capital requirement in the government's optimum in Case 2. Rows (1)-(3) correspond to Case 1 while rows (4)-(6) repeat the same set of exercises for Case 2.

Rows (1) and (4) in Table 1 give the values of the variables of interest in an initial equilibrium with compliance costs equal to $\tau = 0.25$. Rows (2) and (5) report the effects of a fall in compliance costs to $\tau = 0$ when the capital requirement is held fixed at its initial level. The resulting changes in equilibrium values thus correspond to our analytical results in Section 4.1, where we have also held capital requirements fixed. Finally, rows (3) and (6) give the equilibrium values for all variables when capital requirements are optimally adjusted to the reduction in τ. In all numerical examples, we have confirmed that the total volume of lending is indeed below the firms' optimized

Table 1: Reducing compliance costs for foreign loans (τ)

	τ	k	γ	R	Π	T	CS	W
		Case 1: Low welfare weight of tax revenue ($\beta_2 = 3$)						
(1)	$\tau = 0.25$	0.516	0.695	7.543	6.377	-0.686	3.018	7.339
(2)	$\tau = 0\|_{k=\bar{k}}$	0.516	0.606	7.604	6.530	-0.715	2.870	7.254
(3)	$\tau = 0$	0.475	0.583	7.480	6.764	-0.888	3.176	7.277
		Case 2: High welfare weight of tax revenue ($\beta_2 = 8$)						
(4)	$\tau = 0.25$	0.929	0.963	8.259	5.109	-0.029	1.516	6.391
(5)	$\tau = 0\|_{k=\bar{k}}$	0.929	0.844	8.317	4.939	-0.034	1.416	6.087
(6)	$\tau = 0$	0.937	0.848	8.326	4.918	-0.029	1.402	6.088

Note: Parameters held constant: $E = 2$, $s = 10$, $A = 10$, $b = 1$, $\sigma = 0.5$, $\beta_1 = \beta_3 = 1$

lending volumes in the unconstrained model of Section 3.1.[25]

A first result that emerges from Table 1 is that total welfare does indeed fall following a reduction in τ, and this is true in both Cases 1 and 2. Bank profits rise in Case 1 but fall in Case 2, whereas tax revenues and consumer surplus fall in both cases when the capital requirement remains fixed [rows (2) and (5)]. These results correspond to our findings in Section 4.1, as summarized in Proposition 2. The new result is that the optimal capital requirement falls in Case 1 but rises in Case 2, demonstrating that the endogenous response of k to a reduction in τ is ambiguous. Intuitively, when the welfare weight of tax revenues is sufficiently low, as in Case 1, the optimal adjustment of k is dominated by the increased profit opportunities of banks resulting from the lower compliance costs. Hence the capital requirement is relaxed, in order to increase the total volume of lending. In Case 2, in contrast, where the welfare weight of tax revenues is large, the optimal response is to tighten the capital requirement in order to limit tax revenue losses following the fall in τ. Finally, note that the endogenous response of k does not overturn the negative overall welfare effects caused by the reduction in τ, which is stated in Proposition 2.

We now turn to the effects of reducing the extra information cost of foreign lending, σ. The results for this set of numerical exercises in given in Table 2. Here we consider only a single case, but reduce σ in several steps. Again we report the results when the

[25]The optimized capital standards fulfill the requirements for an interior solution, $\tilde{k} < k < 1$, even though the welfare weights used in the simulations differ from the sufficient conditions in Proposition 1.

Table 2: Reducing information costs for foreign loans (σ)

	σ	k	γ	R	Π	T	CS	W
(1)	$\sigma = 0.75$	0.762	0.533	6.971	7.198	-0.216	4.588	10.706
(2)	$\sigma = 0.5\|_{k=\bar{k}}$	0.762	0.513	6.874	7.372	-0.193	4.886	11.294
(3)	$\sigma = 0.25\|_{k=\bar{k}}$	0.762	0.498	6.720	7.631	-0.156	5.379	12.228
(4)	$\sigma = 0\|_{k=\bar{k}}$	0.762	0.500	6.486	7.978	-0.101	6.174	13.649
(5)	$\sigma = 0.5$	0.695	0.495	6.714	7.531	-0.314	5.400	11.360
(6)	$\sigma = 0.25$	0.639	0.481	6.380	7.894	-0.389	6.552	12.498
(7)	$\sigma = 0$	0.601	0.500	6.003	8.199	-0.397	7.987	14.200

Note: Parameters held constant: $E = 3$, $s = 7$, $A = 10$, $b = 1$, $\tau = 0$, $\beta_1 = \beta_3 = 1$, $\beta_2 = 5$.

capital requirement is held fixed at its initial level [rows (2) to (4)], and when it is free to adjust optimally to the changed exogenous conditions [rows (5) to (7)].

Table 2 shows that, in contrast to the reduction in the compliance cost parameter τ, a fall in the foreign information cost parameter σ increases profits, tax revenues and consumer surplus, and thereby increases aggregate welfare when the capital requirement is held fixed. This corresponds to our analytical results in Section 4.2, as summarized in Proposition 3. Moreover, the induced change in the share of domestic lending γ_i is, indeed, ambiguous. It initially falls below 1/2 and then returns to 1/2 as σ is incrementally reduced. Finally, the optimal coordinated capital requirement falls continuously as σ falls. The difference in this case to that of the falling compliance cost τ, is that the decline in information costs benefits all components of national welfare when the capital requirement is held fixed. As the gains to consumers and banks rise more than proportionately as total lending volume increases, whereas losses to taxpayers increase (roughly) linearly, the optimal policy is to reduce k for a wide range of welfare weights β_2.

6 Conclusion

In this paper we have set up a two-country model with multinational banks that are engaged in duopoly competition in both their home and foreign markets. Loans are made to competitive, producing firms and therefore have real effects on the economy. Banks are constrained in their aggregate lending activity by government regulation,

but can decide how to allocate their total equity between their domestic and foreign affiliates, while determining how strictly they monitor their customers in each country. Banks face limited liability when their loans fail, because their funds partly come from savings deposits that are guaranteed by national governments. This part of the default risk is effectively shifted to taxpayers, causing a moral hazard problem in terms of the banks' monitoring decision and distorting their lending activities towards the foreign market. Governments choose capital requirements so as to maximize domestic welfare, given the exogenous weights they put on the interests of banks, taxpayers and consumers.

In this setting we have analyzed the effects of financial integration on the different agents in our model, as well as on aggregate national welfare. We find that the desirability of integration depends crucially on the type of costs for cross-border lending that are reduced. If financial integration is mainly associated with a fall in compliance costs, the monitoring levels for foreign loans cannot be expected to rise. More risky foreign lending may then replace safer domestic lending in equilibrium, with adverse consequences for consumers and taxpayers. On the other hand, if financial integration is driven mainly by a fall in the information costs for foreign loans, then the optimal monitoring of these loans will rise and banks, consumers and taxpayers can all be expected to benefit from this financial integration. We conclude financial intergration that merely reduces the compliance costs of cross-border lending can be harmful, unless this are accompanied by measures that reduce the information costs specific to foreign lending.

These results are particularly relevant for the European Union, where the "single banking license" has significantly lowered compliance costs for cross-border lending and plans are under way to reduce these costs further in a capital markets union. Our results suggests that it is then essential for the European Union to reduce the information costs of foreign lending at the same time. The Single Supervisory Mechanism of the European banking union represents a step in this direction by providing information on the liquidity of the EU's largest banks and by harmonizing the standards of financial institutions, among which a substantial part of cross-border lending occurs. Another measure would be to make national public credit registers mandatory for all member states, and to share the information collected in these credit registers.

Many more interesting questions can be raised. One possible extension would be to

introduce a more complex output sector that is characterized by imperfect competition and some market power *vis-à-vis* banks in determining the equilibrium loan rate. Another extension would be to incorporate a richer set of government policies. One example would be for host countries to apply differentiated capital ratios for domestic and foreign affiliates, reflecting the different failure rates of loans (whereas current risk weights under the Basel process depend on the asset classes of banks). Similarly, it would be possible to consider policy measures that impact upon foreign lenders alone, say through a special levy on the costs of lending by non-domestic institutions. We leave these extensions to further research.

References

Acharya, V. (2003). Is the international convergence of capital adequacy regulation desirable? *Journal of Finance 58*, 2745-2781.

Acharya, V., Hasan, I., Sauners, A. (2006). Should banks be diversified? Evidence from individual bank loan portfolios. *Journal of Business 49*, 1355-1412.

Allen, F., Carletti, E., Marquez, R. (2011). Credit market competition and capital regulation. *Review of Financial Studies 24*, 983-1018.

Allen, F., Gale, D. (2004). Competition and financial stability. *Journal of Money, Credit and Banking 36*, 453-480.

Beltratti, A., Stulz, R.M. (2012). The credit crisis around the globe: Why did some banks perform better? *Journal of Financial Economics 105*, 1-17.

Bank for International Settlements (2010). Long-term issues in international banking. CGFS Papers No. 41. BIS, Basel.

Barth, J., Lee, C., Phumiwasana, T. (2006). Deposit insurance schemes. In: Ch. Lee and A. Lee (eds.), *Encyclopedia of Finance*, 299-306.

Besanko, D., Kanatas, G. (1993). Credit market equilibrium with bank monitoring and moral hazard. *Review of Financial Studies 6*, 213-232.

Berger, A., Miller, N., Petersen, M., Rajan, R., Stein, J. (2005). Does function follow organizational form? Evidence from the lending practices of large and small banks. *Journal of Financial Economics 76*, 237-268.

Boot, A., Thakor, A. (2000). Can relationship banking survive competition? *Journal of Finance 55*, 679-713.

Brander, J., Krugman, P. (1983). A "reciprocal dumping" model of international trade. *Journal of International Economics 15*, 313-321.

Buch, C. (2003). Information or regulation: What drives the international activities of commercial banks? *Journal of Money, Credit and Banking 35*, 851-869.

Buch, C., Koch, C.T., Koetter, M. (2011). Size, productivity, and international banking. *Journal of International Economics 85*, 329-334.

Buch, C., Koch, C.T., Koetter, M. (2013). Do banks benefit from internationalization? Revisiting the market power-risk nexus. *Review of Finance 17*, 1401-1435.

Buch, C., Neugebauer, K., Schröder, C. (2014). Changing forces of gravity: How the crisis affected international banking. ZEW Discussion-Paper No. 14-006. Mannheim.

Calzolari, G., Loranth, G. (2011). Regulation of multinational banks: A theoretical inquiry. *Journal of Financial Intermediation 20*, 178-198.

Cerutti, E., Dell'Ariccia, G., Martinez Peria, M. (2007). How banks go abroad: Branches or subsidiaries? *Journal of Banking and Finance 31*, 1669-1692.

Claessens, S., van Horen, N. (2014). Foreign banks: Trends and impact. *Journal of Money, Credit and Banking 46 (Supplement No.1)*, s295-s326.

De Blas, B., Russ, K.N. (2013). All banks great, small, and global: Loan pricing and foreign competition. *International Review of Economics and Finance 26*, 4-24.

Dell'Ariccia, G., Marquez, R. (2006). Competition among regulators and credit market integration. *Journal of Financial Economics 79*, 401-430.

Demirgüç-Kunt, A., Detriagiache, E. (2002). Does deposit insurance increase banking system stability? An empirical investigation. *Journal of Monetary Economics 49*, 1373-1406.

Diamond, D., Dybvig, P. (1983). Bank runs, deposit insurance, and liquidity. *Journal of Political Economy 91*, 401-419.

Diamond, D.W., Rajan, R. (2009). The credit crisis: Conjectures about causes and remedies. *American Economic Review 99, Papers and Proceedings*, 606-610.

Eaton, J. (1994). Cross-border banking. NBER Working Paper No. 4686. Washington, D.C.

Egger, P., Pfaffermayr, M. (2004). Distance, trade and FDI: A SUR Hausman-Taylor approach. *Journal of Applied Econometrics 19*, 227-246.

European Commission (2015a). Action plan on building a capital markets union. Document COM(2015) 468. Brussels.

European Commission (2015b). Proposal for a regulation laying down common rules on securitization and creating a European framework for simple, transparent and standardized securitization. Document COM(2015) 472. Brussels.

Francois, J, Hoekman, B. (2010). Services trade and policy. *Journal of Economic Literature 48*, 642-692.

Giannetti. C., Jentzsch, N., Spagnolo, G. (2010). Information sharing and cross-border entry in European banking. European Credit Research Institute, Research Report No. 11. Brussels.

Goetz, M., Laeven, L., Levine, R. (2016). Does the geographic expansion of bank assets reduce risk? *Journal of Financial Economics 120*, 346-362.

Haufler, A., Maier, U. (2016). Regulatory competition in capital standards with selection effects among banks. CESifo Working Paper No. 5839. Munich.

Haufler, A., Wooton, I. (2010). Competition for firms in an oligopolistic industry. The impact of economic integration. *Journal of International Economics 80*, 239-248.

Hellman, T., Murdock, K., Stiglitz, J. (2000). Liberalization, moral hazard in banking, and prudential regulation: Are capital requirements enough? *American Economic Review 90*, 147-165.

Huizinga, H., Nicodème, G. (2006). Deposit insurance and international bank liabilities. *Journal of Banking and Finance 30*, 965-987.

Jiang, L., Levine, R., Lin, C. (2017). Does competition affect bank risk? NBER Working Paper No. 23080. Cambridge, Mass.

Keeley, M.C. (1990). Deposit insurance, risk and market power in banking. *American Economic Review 80*, 1183-1200.

Kind, H.J., Midelfart, K.H., Schjelderup, G. (2005). Corporate tax systems, multinational enterprises, and economic integration *Journal of International Economics 65*, 507-521.

Kleinert, J., Toubal, F. (2010). Gravity for FDI. *Review of International Economics 18*, 1-13.

Lehner, M., Schnitzer, M. (2008). Entry of foreign banks and their impact on host countries. *Journal of Comparative Economics 36*, 430-452.

Merz, J., Oversch, M., Wamser, G. (2017). The location of financial sector FDI: Tax and regulation policy. *Journal of Banking and Finance 78*, 14-26.

Niepmann, F. (2015). Banking across borders. *Journal of International Economics 96*, 244-265.

Ongena, S., Popov, A., Udell, G. (2013). "When the cat's away the mice will play": Does regulation at home affect bank risk-taking abroad? *Journal of Financial Economics 108*, 727-750.

Ottaviano G., van Ypersele, T. (2005). Market size and tax competition. *Journal of International Economics 67*, 25-46.

Portes, R., Rey, H. (2005). The determinants of cross-border equity flows. *Journal of International Economics 65*, 269-296.

Portes, R., Rey, H., Oh, Y. (2001). Information and capital flows: The determinants of transactions in financial assets. *European Economic Review 45*, 783-796.

Rochet, J.-Ch. (1992). Capital requirements and the behaviour of commercial banks. *European Economic Review 36*, 1137-1178.

Sinn, H.W. (1997). The selection principle and market failure in systems competition. *Journal of Public Economics 66*, 247-274.

Appendix

A.1 Proof of Proposition 1

We first derive the effects of coordinated changes in capital requirements on each bank's allocation of loans and on equilibrium loan prices. We then use these results to derive the welfare effects. All effects are evaluated for low compliance costs ($\tau = 0$). Countries are assumed to be symmetric and subscripts i are dropped where possible.

Effect on market shares and loan prices. Differentiating (18) with respect to the common capital requirement k, evaluating at $\tau = 0$ and using symmetry gives

$$\left.\frac{\partial \gamma}{\partial k}\right|_{\tau=0} = \frac{s\sigma(1+\sigma)}{2bL[(1+\sigma)^2+1]k} > 0. \tag{A.1}$$

The effect on loan prices is given by differentiating (6) and using $R_i = P_i$ from (5). This gives, in a first step

$$\begin{aligned}\left.\frac{\partial R_i}{\partial k}\right|_{\tau=0} = -b \quad & \left[\frac{\gamma_i L_i}{s}\left(\frac{\partial R_i}{\partial k}+1\right) + q_{ii}L_i\frac{\partial \gamma_i}{\partial k} + q_{ii}\gamma_i\frac{\partial L_i}{\partial k}\right. \\ + \quad & \left.\frac{(1-\gamma_j)L_j}{s(1+\sigma)}\left(\frac{\partial R_j}{\partial k}+1\right) - q_{ij}L_j\frac{\partial \gamma_j}{\partial k} + q_{ij}(1-\gamma_j)\frac{\partial L_j}{\partial k}\right].\end{aligned}$$

Using symmetry, substituting $\partial\gamma/\partial k$ from (A.1) and substituting out for γ using (18) gives

$$\left.\frac{\partial R}{\partial k}\right|_{\tau=0} = \frac{bL}{\mu}\left[\frac{\phi}{k}\left(1+\frac{\sigma}{[(1+\sigma)^2+1]}\right) - (1+\gamma\sigma)\right] > 0, \tag{A.2}$$

where ϕ is defined in (16) and

$$\mu \equiv s(1+\sigma) + bL(1+\gamma\sigma) > 0. \tag{A.3}$$

Eq. (A.2) can then be signed with the help of condition (17), using $\tau = 0$.

Welfare effects. The effect on bank profits are obtained by substituting (13) into (10). Differentiating and using symmetry yields

$$\frac{\partial \Pi}{\partial k} = \left\{-B - \left[\frac{\phi^2(1+\gamma\sigma)}{2s(1+\sigma)k} - 1\right] + \frac{\phi^2\sigma}{2s(1+\sigma)}\frac{\partial \gamma}{\partial k} + \frac{(1+\gamma\sigma)\phi}{s(1+\sigma)}\frac{\partial R}{\partial k}\right\} L < 0, \tag{A.4}$$

where

$$B \equiv (1-q_{ii})\gamma_i + (1-q_{ji})(1-\gamma_j) = 1 - \frac{\phi(1+\gamma\sigma)}{s(1+\sigma)} > 0, \tag{A.5}$$

which is positive from (17). The net effect in (A.4) can be signed, because a binding constraint on lending must imply that $\partial\Pi/\partial L > 0$. Differentiating Π with respect to L, holding k fixed and noting that $\partial L/\partial k = -L/k$ shows that the negative second effect must dominate the sum of the third and fourth effects [where (A.1) and (A.2) are substituted].

Differentiating tax revenues in (26) and using (A.2) yields:

$$\frac{\partial T}{\partial k} = \left\{ B + \frac{(1-k)B}{k} + \frac{(1-k)(1+\gamma\sigma)}{s(1+\sigma)} + \frac{(1-k)\phi\sigma}{s(1+\sigma)}\frac{\partial \gamma}{\partial k} \right\} L > 0, \tag{A.6}$$

which is unambiguously positive from (26), (A.1) and (A.5).

Finally, differentiating the consumer surplus expression in (27) yields:

$$\frac{\partial CS}{\partial k} = -QL\frac{\partial R}{\partial k} < 0, \tag{A.7}$$

where $Q > 0$ is expected national output [see (2)] and $\partial R/\partial k > 0$ from (A.2).

Optimal capital regulation. We substitute the effects on profits, tax revenues and consumer surplus in (A.4), (A.6) and (A.7) into the welfare function (25). To analyze the conditions under which an interior optimum for k exists, we first show that $\partial W/\partial k > 0$ holds at a lower bound for k. This lower bound is the level of k at which the constraint (7) just binds so that the unconstrained model (Section 3.1) and the constrained model (Section 3.2) yield the same allocation. We denote this level by $\tilde{k}\,(>0)$. Since lending is unconstrained at $\tilde{k}$, the indirect effects on banks' profits, as given by the second, third and fourth effects in (A.4), must sum to zero. Moreover the negative first term in the profit equation (A.4) is offset by the positive first term in the revenue equation (A.6) when the welfare weight on taxpayers is at least as high as that on bank profits ($\beta_1 \leq \beta_2$). The remaining condition for welfare to be rising in k at $k = \tilde{k}$ is that the positive indirect effects in the revenue expression (A.6) dominate the negative effect on consumer surplus in (A.7). This requires β_2 to be sufficiently large, relative to β_3.

In the other extreme case where $k = 1$, the second, third and fourth terms in (A.6) are all zero, while the first term in (A.6) exactly offsets the first term in (A.4) when $\beta_1 = \beta_2$. Moreover, the sum of the remaining effects on bank profits in (A.4) is negative at $k = 1$, as the banks' lending volume is constrained. Finally, the effect on consumer surplus in (A.7) is negative. Hence $\partial W/\partial k < 0$ holds at $k = 1$ when $\beta_1 = \beta_2$.

Combining these effects, $\partial W/\partial k < 0$ holds at $\tilde{k}$ but $\partial W/\partial k > 0$ holds at $k = 1$, if $\beta_1 = \beta_2 >> \beta_3$. Moreover, W must be continuous in k, because all components of national welfare are continuous in k. Hence there must be at least one interior level $\tilde{k} < k < 1$ that fulfills the first-order condition for a welfare maximum, $\partial W/\partial k = 0$. □

A.2 Derivation of equation (33b)

Differentiating (6) with respect to σ gives in a first step

$$\left.\frac{\partial R_i}{\partial \sigma}\right|_{\tau=0} = b\left[\frac{(1-\gamma_j)L_j\phi}{s(1+\sigma)^2} - \frac{\gamma_i L_i}{s}\frac{\partial R_i}{\partial \sigma} - q_{ii}L_i\frac{\partial \gamma_i}{\partial \sigma} - \frac{(1-\gamma_j)L_j}{s(1+\sigma)}\frac{\partial R_j}{\partial \sigma} + q_{ij}L_j\frac{\partial \gamma_j}{\partial \sigma}\right].$$

Using symmetry and collecting terms gives

$$\left.\frac{\partial R}{\partial \sigma}\right|_{\tau=0} = \frac{\phi b L}{\mu}\left[\frac{(1-\gamma)}{(1+\sigma)} - \sigma\frac{\partial \gamma}{\partial \sigma}\right],$$

which corresponds to the first part of eq. (33b) in the main text. Substituting in $\partial\gamma/\partial\sigma$ from (33a) and using

$$\frac{(1-\gamma)}{(1+\sigma)} = \frac{2bL(1+\sigma) - s\sigma}{2bL[(1+\sigma)^2+1]}$$

from (18), gives

$$\left.\frac{\partial R}{\partial \sigma}\right|_{\tau=0} = \frac{\phi(1+\sigma)}{\mu[(1+\sigma)^2+1]^2}\left\{bL[(1+\sigma)^2+1+2\sigma] - s\sigma(2+\sigma)\right\}. \qquad \text{(A.8)}$$

From (A.8) follows the condition for $\partial R/\partial\sigma > 0$ in eq. (33b). □