National versus Supranational Bank Regulation: Gains and Losses of Joining a Banking Union

Maria Näther[1], Uwe Vollmer[2]

Abstract

We ask how the structure of international banking affects the decision of a national regulator to join a banking union. In a banking union regulatory powers of a national supervisor are transferred to the supranational level. We focus on capital requirements, which limit bank leverage, prevent bank risk taking, and restrict bank return in case of project success. A national regulator ignores possible gains or losses, which accrue to other jurisdictions if banks are internationally active, while a supranational regulator takes all of these effects into account. We analyze the origin, size, and determinants of spillover effects and show how they constrain a country´s willingness to participate in a banking union. Our results may explain why some Member States of the European Union currently hesitate to join European Banking Union.

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1. Introduction

Parts of the current debate on financial regulation are about problems associated with multinational banks which do business outside the realm of national bank supervisors (de Haas and van Lelyveld (2006); Allen et al. (2011); Beck et al. (2013)). Such misalignments between banking structures and bank regulation cause coordination failures between national regulators which may result in suboptimal regulatory decisions. A major reason for this are externalities because national regulators do not take into account the possible spillovers of their own regulatory actions on foreign financial markets. In consequence, internationally active banks are often regarded as forming a case for international cooperation in bank regulation and justify the transfer of national powers of supervision to a supranational regulator.

[1]University of Leipzig, Economics Department, Institute for Theoretical Economics, Grimmaische Straße 12, D-04109 Leipzig, Germany (E-Mail address: naether@wifa.uni-leipzig.de) (corresponding author).

[2]University of Leipzig, Economics Department, Institute for Theoretical Economics, Grimmaische Straße 12, D-04109 Leipzig, Germany (Tel.: +49 341 9733571, E-Mail address: vollmer@wifa.uni-leipzig.de).

The European Banking Union (EBU) is a recent example for such a transfer of regulatory powers. Membership in EBU is mandatory for all Member States of the European Monetary Union (EMU), but non-EMU Member States of the European Union have the right to join on an "opt-in" basis and to establish "close cooperation" with the European Central Bank (ECB). In this case at least the three largest domestic banks will be subject to micro-prudential supervision by the ECB. The ECB in turn also influences macro-prudential standards and has a large responsibility in the resolution of systemically important banks within EBU. Sweden and UK have already declared that they will definitively not participate. Denmark and probably Bulgaria and Romania, however, will join EBU. The remaining four Central and Eastern European (CEE) countries, the Czech Republic, Croatia, Hungary, and Poland, currently take a "wait and see" position and will decide only later whether to establish close cooperation or not.

A major objection against EBU participation in these countries is that a banking union takes a holistic view. It focuses on the soundness of a banking group as a whole and pays less attention to particular subsidiaries of multinational banks. This is not in the interest of CEE countries, whose banking sectors largely comprise bank subsidiaries (Instytut Spraw Publicznych (2012); Profant and Toporowski (2014); Reich and Kawalec (2015)). The current paper focuses on this aspect and tries to understand how the structures of the domestic and foreign banking sectors influence the incentives for a national regulator to transfer regulatory powers to a supranational level. We concentrate on capital requirements and model a bank which can go abroad either by establishing a subsidiary in the foreign country or by branching. Subsidiaries are supervised by the host country regulator and branches are supervised by the home country regulator. The bank has given equity, raises (fully insured) deposits and invests into a risky project. The investment is at home or abroad. There is a benevolent (national or supranational) regulator who limits bank leverage by setting a capital requirement. Capital requirements prevent bank risk taking, but also limit the bank's return in case that the project succeeds.

In our model, international banking by subsidiary has the following effects on welfare in the home and host country. (i) A subsidiary's profit contributes positively to the welfare in the home country where the parent bank is located. However, losses accruing to the subsidiary's depositors are covered by the deposit insurance in the host country where the subsidiary is located and contribute negatively to the host country's welfare. The supranational regulator takes into account expected payments to all agents, while the national regulator in the host country ignores the expected profit of the subsidiary. (ii) If the parent bank fails, financial stability in the country hosting the subsidiary is endangered. In contrast to the supranational regulator, the home country regulator supervising the parent bank ignores this spillover to the foreign country.

In consequence of both effects the supranational regulator reduces capital requirements in countries hosting many subsidiaries (first effect), but tightens regulation in countries where many parent banks with foreign subsidiaries are headquartered (second effect). A country hosting many subsidiaries joins a banking union if the benefit implied by the second effect dominates the loss implied by the first effect. This is the case if the stability costs play a major role, i.e., financial stability in the host country is relatively dependent from parent banks' performance. A country with many parent banks that own subsidiaries joins a banking union if the benefit implied by the first effect dominates the loss implied by the second effect. The possibility of branching adds a further effect because it allows the national regulators to supervise projects realized in the foreign country. Both, national and supranational regulation are relaxed if projects realized by branching are relatively profitable; they are tightened, otherwise. The possibility of branching may therefore intensify or attenuate the above effects depending on project profitability.

With these results, our paper is related to previous studies which also discuss the relationship between internationally active banks and bank regulation. One branch of the literature studies a national regulator‘s decision to bail-out or liquidate a failing multinational bank. Freixas (2003) and Goodhart and Schoenmaker (2009) show that coordination failures could occur if national regulators negotiate ex post about burden sharing. In order to prevent any underprovision of recapitalizations, regulators should agree ex ante on a mechanism for fiscal burden sharing. Colliard (2015) and Carletti et al. (2016) analyze the incentives of a local supervisor to collect and surpass necessary information to a supranational regulator. Bolton and Oehmke (2016) and Faia and Weder di Mauro (2016) compare the costs of different procedures for the resolution of multinational banks and show that it is not always in the interest of a single country to choose the first-best procedure. Diemer (2016) argues that it is not always desirable to have a single resolution authority for multinational banks because this could prevent banks from behaving prudently.

Beck et al. (2013) also analyze a regulator‘s decision to liquidate or recapitalize a bank which is partly financed by foreign deposits and foreign equity and holds foreign assets as well. They find that a national regulator‘s incentives to bail-out a bank is distorted whenever the bank does not hold identical shares of foreign deposits, of foreign equity, and of foreign assets. In particular, the national regulator‘s incentive to bail-out a weak bank increases in the foreign equity share and decreases in the shares of foreign deposits and foreign assets. These distortions disappear if the resolution decision is taken by a multinational regulator who cares about the combined welfare of domestic and foreign stakeholders. Closely related to our work Beck and Wagner (2016) show that supranational regulation is more likely to enhance overall welfare if externalities are high and cross-country heterogeneity is low. However, even if supranational regulation is optimal for overall welfare, this is not necessarily the case for welfare of the single countries. Although the research question is very similar, we in contrast distinguish different forms of bank internationalisation (namely branches and subsidiaries) and search for the origin of externalities. Thereby, we can analyze the impact of the banking sector's structure on the size of spillovers and a regulator's incentive to join a banking union.

In this paper, we use a similar model set-up as the one used in Beck et al. (2013), but concentrate on the regulator‘s decision to set capital requirements. This is also done in Acharya (2003), Holthausen and Rønde (2004), and Dell'Ariccia and Marquez (2006) who consider internationally active banks offering cross-border financial services through branches. However, they do not analyze the effects of other forms of internationally banking. They show that for branching, competition among regulators may lead to a "race to the bottom" and to a "competition in laxity", if national regulators set their banking policies non-cooperatively. Therefore, an international regulator should set uniform standards for all banks.

The rest of the paper is organized as follows: Section 2 considers the closed economy case and provides the model set-up. Section 3 turns to the open economy and considers first the case, where a bank can invest at home or abroad by opening a subsidiary in the foreign country. Later, the possibility of branching is also considered. Section 4 applies the model to the current situation within EBU. Finally, section 5 concludes.

2. Capital requirements in the closed economy

2.1. Model setup

We consider a continuum of profit-maximizing banks, each endowed with a given amount $E = 1$ of equity capital. A bank can raise deposits $D > 0$ per unit of equity from households. Deposits are fully insured with an insurance premium normalized to zero. All agents are risk-neutral and the risk-free interest rate is set to zero.

The bank exists for two dates $T = 0, 1$. At $T = 0$, it invests funds (equity plus deposits) into a divisible project with constant returns to scale; the project is risky and runs for one period. At $T = 1$, the (gross) project return per unit invested is either $R > 1$ with probability $p \in [0, 1]$ or zero, otherwise. The bank can engage in costly monitoring. It is assumed that p is determined by the bank and identical with the monitoring effort. The monitoring cost function is quadratic in effort and increasing in the project size $E + D \cdot E = 1 + D$:

$$\frac{c}{2}p^2 (1 + D)$$

with cost parameter $c > 0$. The probability p is known to the bank, only, and not verifiable.

There is a welfare-maximizing regulator who can impose a capital requirement $\kappa \in [0, 1]$ on the bank's unweighted assets and can thereby restrict the amount of deposits that banks are allowed to collect (Vollmer and Wiese (2013)). We have

$$\kappa \leq \frac{E}{E + D \cdot E} = \frac{1}{1 + D}$$

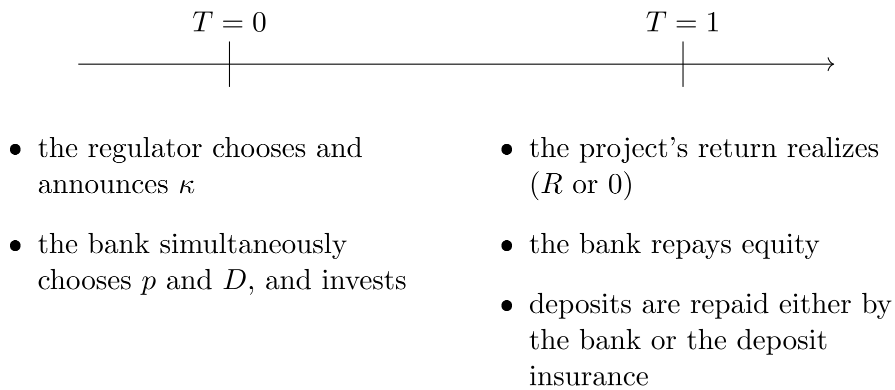


Figure 1: Time structure of the model

or equivalently

$$D \leq \frac{1-\kappa}{\kappa}.$$

All parameters, except monitoring effort p, are common knowledge.

Figure 1 gives the sequence of events. At $T = 0$, the regulator learns the cost parameter c, chooses and announces a capital requirement κ. Afterwards, but still at $T = 0$, the bank learns the cost parameter c and the capital requirement κ, simultaneously chooses the monitoring effort p, raises deposits D, and invests all funds into the project. At $T = 1$, project return (R or 0) is realized, the bank repays equity and deposits are repaid either by the bank or by the deposit insurance.

2.2. Bank behavior

At $T = 0$, the bank's expected profit is given by

$$\begin{aligned} \Pi(p, D) &= p\left[R(D+1) - D - 1\right] + (1-p)(-1) - \frac{c}{2}p^2(1+D) \\ &= \underbrace{p(R-1)D}_{\text{profit from deposits}} + \underbrace{pR - 1}_{\text{profit from equity}} - \underbrace{\frac{c}{2}p^2(1+D)}_{\text{monitoring costs}}. \end{aligned} \tag{1}$$

If the bank chooses the monitoring effort p and the amount of deposits D, the monitoring costs are given by $\frac{c}{2}p^2(1+D)$. With probability p the project returns R on the project volume $1 + D$ and the bank repays deposits D and equity $E = 1$. With probability $1 - p$ the project fails, the deposit insurance repays deposits D and only equity remains on the bank's liability side of the balance sheet. We assume $R - 1 \geq \frac{c}{2}$, because otherwise, investment into a riskless project ($p = 1$) is neither beneficial for a bank nor efficient from a welfare point of view due to large monitoring costs.

Profit-maximizing monitoring effort and project volume follow from:

$$\frac{\partial \Pi}{\partial D} = p(R-1) - \frac{c}{2}p^2 \geq 0, \text{ with equality if and only if } p = 0,$$
$$\frac{\partial \Pi}{\partial p} = (R-1)D + R - cp(1+D).$$

Thus, if $p > 0$, the bank always raises as many deposits as possible, independently of the monitoring effort. If the capital requirement set by the regulator is equal to κ, then the bank raises $D = \frac{1-\kappa}{\kappa}$. Given D, the profit-maximizing bank chooses the monitoring effort

$$p^*(D) = \min\left\{1, \frac{R}{c} - \frac{D}{c(1+D)}\right\},$$

which is always positive. The partial derivatives of p^* with respect to R, c and D are equal to zero if $R - c > \frac{D}{1+D}$ holds and

$$\frac{\partial p^*}{\partial R} = \frac{1}{c} > 0,$$
$$\frac{\partial p^*}{\partial c} = -\frac{R}{c^2} + \frac{D}{c^2(1+D)} = -\frac{R + D(R-1)}{c^2(1+D)} < 0,$$
$$\frac{\partial p^*}{\partial D} = -\frac{1}{c(1+D)^2} < 0,$$

otherwise. Accordingly, optimal monitoring effort is increasing in the project return R, decreasing in the cost parameter c, and decreasing in the volume of deposits D. Intuitively, a larger project return increases the benefit of monitoring. A larger cost parameter c increases monitoring cost. Thus, a larger R or a smaller c increases the profitability of monitoring and thus raises monitoring effort. For reasons of tractability, we concentrate on $c \geq R$ and have

$$p^*(D) = \frac{R}{c} - \frac{D}{c(1+D)}. \tag{2}$$

As otherwise the monitoring effort is equal to one for small D, this assumption does not qualitatively change the results. Altogether, we have two assumptions regarding c and R, namely $\frac{c}{2} + 1 \leq R \leq c$. Note that this implies $c, R \geq 2$.

2.3. Capital requirements

Welfare is defined by expected payments to all agents and is given by

$$W(p, D) = p(R-1)(1+D) + (1-p)(-1-D) - \frac{c}{2}p^2(1+D)$$
$$= (pR-1)(1+D) - \frac{c}{2}p^2(1+D).$$

Welfare differs from the bank's expected profit, because deposits need to be repaid at $T = 1$, even if the project fails. Taking the partial derivatives with respect to p and D yields

$$\frac{\partial W}{\partial D} = pR - 1 - \frac{c}{2}p^2,$$
$$\frac{\partial W}{\partial p} = R(1+D) - cp(1+D). \tag{3}$$

The regulator prefers the bank to choose the monitoring effort

$$p^W = \frac{R}{c},$$

independently from the amount of deposits (in contrast to (2)). Then, from the regulator's point of view, the bank should raise as many deposits as possible:

$$\left.\frac{\partial W}{\partial D}\right|_{p=\frac{R}{c}} = \frac{R^2 - 2c}{2c},$$

which is nonnegative by $R \geq \frac{c}{2} + 1$. Since p is private information of the bank, the regulator cannot control the bank's monitoring effort. The bank's profit-maximizing monitoring effort $p^*(D)$ is smaller than the welfare-maximizing monitoring effort p^W preferred by the regulator:

$$p^*(D) = \frac{R}{c} - \frac{D}{c(1+D)} \leq \frac{R}{c} = p^W,$$

with equality for $D = 0$, due to the fact that the bank does not repay deposits in case of failure. Since $p^*(D) < p^W$, the subject to moral hazard. The bank chooses a monitoring effort p^* smaller than preferred by the regulator.

The benevolent regulator can only influence the bank's monitoring effort by setting a capital requirement. When deciding upon the capital requirement κ at $T = 0$, the regulator faces a trade-off, because κ constrains the project's volume by decreasing the leverage D, but induces a higher monitoring effort $p^*(D)$. Anticipating that the bank chooses monitoring effort $p^*(D)$, welfare (per project) as a function of D is given by

$$W[p^*(D), D] = \frac{R}{c} \cdot [(R-1)D + R] - (1+D) - \frac{[(R-1)D + R]^2}{2c(1+D)}. \tag{4}$$

The regulator's problem is now to choose a capital requirement κ^* such that $D^* = \frac{1-\kappa^*}{\kappa^*}$ is the maximizing argument of $W(D) = W(p^*(D), D)$. More formally,

$$D^* = \arg\max_D W(D), \quad \kappa^* = \frac{1}{1+D^*}.$$

We derive:

Lemma 1. *The welfare-maximizing regulator imposes a positive capital requirement if*

$$2c > R^2 - 1$$

with the maximum amount of deposits that a bank is allowed to raise

$$D^* = \sqrt{\frac{1}{2c + 1 - R^2}} - 1 > 0$$

and the capital requirement given by

$$\kappa^* = \sqrt{2c + 1 - R^2} \in (0, 1) .$$

For $2c \leq R^2 - 1$ *we have* $\kappa^* = 0$.

Proof. See appendix. □

The welfare-maximizing capital requirement κ^* is increasing in the cost parameter c and is decreasing in the project return R. As c increases, the banks monitoring effort decreases. The regulator can react by choosing a higher capital requirement, because this induces banks to increase monitoring effort. In addition, a higher capital requirement decreases the project's volumes and thus monitoring costs. As the project return R increases, banks increase their monitoring effort and the regulator finds it optimal to reduce the capital requirement to allow for larger project volumes. If R is sufficiently large and c sufficiently small such that $2c \leq R^2 - 1$ the bank is not restricted in raising deposits, i.e., the optimal capital requirement is equal to zero.

3. Capital requirements in the open economy

3.1. Model setup, internationalization strategy, and bank behavior

We now extend our analysis to the open-economy case and consider two jurisdictions (or "countries") i and j. We abstract from any exchange rate risk. The two countries do not necessarily have the same size. Banks may not only have a project in the home country, but also in the foreign country. We distinguish between the following two internationalization strategies, which differ in their respective cost structures and allocation of bank supervisory responsibilities (Table 1) :

(i) Banks doing *multinational lending* open a subsidiary in the host country. The subsidiary raises deposits and lends to firms in the host country. Since the subsidiary is located in the same country as the debtor firms, the monitoring cost function is assumed to be the same as for home-country banks (Kudrna (2016)). However, opening the subsidiary

	domestic lending	multinational lending	cross-border lending
regulator:	home country i	host country j	home country i
monitoring costs:	$\frac{c}{2}p^2(1+D)$	$\frac{c}{2}p^2(1+D)$	$\frac{c}{2\delta}p^2(1+D)$
fees:	none	f	none
return:	R_i or 0	R_j or 0	R_j or 0
costs for the home country regulator:	$D \cdot (1-p)$	–	$D \cdot (1-p)$
costs for the foreign country regulator:	–	$D \cdot (1-p)$ $+C(1-p)$	–

Table 1: Types of investment

requires investment costs (or a "fee") $f > 0$, which guarantees, that banks do not always invest in multinational lending.

Subsidiaries are owned by parent banks located in the home country and profits contribute to home country welfare. Yet depositor‘s losses in case of project failure are covered by the deposit insurance of the host country. Subsidiaries are regulated by the host country. Therefore, a project of a bank located in country i realized by multinational lending is subject to regulation of country j although it also contributes to the welfare in country i.

If a home-country project of a parent bank fails, the stability of the subsidiary, and thus the financial market in the foreign country, is affected, too. We model this effect by introducing stability costs C that the foreign country faces if a project of the parent bank fails. C could also be interpreted as a loss in the subsidiary's continuation value (see Bolton and Oehmke (2016)). To some extent C reflects the degree of dependence between subsidiary and parent bank.

(ii) Banks doing *cross-border lending* raise deposits in the home country and lend directly to firms located in the foreign country through branches. Since the bank is located outside the country where the debtor firm resides, monitoring has a lower productivity, i.e., monitoring costs are larger by a factor $\frac{1}{\delta}$ with $\delta \in (0, 1]$. Here, δ reflects cross-country noise, where $\delta = 1$ means absence of cross-country noise. A project realized by cross-border lending contributes to home-country welfare. The home-country deposit insurance bears depositor's losses in case of failure. Branches are regulated by the home-country authority. There are no stability costs C, because deposits are raised in the home country and the branch is supervised by the home-country regulator.

A bank can invest in projects in the home country and in the host country at the same time. Projects abroad are realized either by multinational lending or cross-border lending. As before, all cost parameters are common knowledge. The regulator considers subsidiaries as local banks and is not able or not authorized to charge different capital requirements on projects started by a local bank or by a domestic subsidiary of a foreign parent bank (European Comission (2013); International Monetary Fund (2015)).

The time structure is the same as in the closed economy case. At $T = 0$, regulators in country i and j choose and announce the capital requirements κ_i and κ_j, respectively; banks choose their monitoring efforts and invest. At $T = 1$ the project returns (R_i or 0, and R_j or 0) realize, banks repay equity to bank owners and deposits are repaid either by the bank or the national deposit insurance. We abstract from a supranational deposit insurance.

3.2. National versus supranational regulation: multinational banking

We start by considering multinational banking, only. The bank's choice of monitoring effort depends on the choice of its activity level at home and abroad:

- The expected profit of a bank located in country i that invests only in the home country (superscript *own*) is given by

$$\Pi_i^{own} = p_i^{own}\left(R_i - 1\right) D_i + p_i^{own} R_i - 1 - \frac{c}{2}\left(p_i^{own}\right)^2\left(1 + D_i\right),$$

  optimal monitoring effort is equal to

$$p_i^{own}\left(D_i\right) = \frac{R_i}{c} - \frac{D_i}{c\left(1 + D_i\right)} \tag{5}$$

  and the bank raises as many deposits as possible (compare previous section, again we assume $c \geq R_i \geq \frac{c}{2}+1$ and analogously $c \geq R_j \geq \frac{c}{2}+1$). Thus, if the capital requirement imposed by the regulator of country i is equal to κ_i, the bank raises deposits $D_i = \frac{1-\kappa_i}{\kappa_i}$ in the home country for the home-country project.

- The expected profit of a bank located in country i that invests only in the foreign country (superscript *mult*) is given by

$$\Pi_i^{mult} = p_i^{mult} \cdot \left(R_j - 1\right) D_j + p_i^{mult} R_j - 1 - \frac{c}{2}\left(p_i^{mult}\right)^2\left(1 + D_j\right) - f. \tag{6}$$

  The subsidiary chooses p_i^{mult}, raises deposits D_j from host-country depositors and invests all funds in the host country j. The gross return in case of success is equal to R_j. A fee f has to be deducted.

The bank chooses monitoring effort

$$p_i^{mult}(D_j) = \frac{R_j}{c} - \frac{D_j}{c(1+D_j)}. \tag{7}$$

The fee f of establishing a subsidiary does not affect the monitoring effort. The bank raises as much deposits as possible. If the capital requirement imposed by the regulator in country j is equal to κ_j, the subsidiary raises deposits $D_j = \frac{1-\kappa_j}{\kappa_j}$ in the host country for the multinational project. Additionally, we have $p_i^{mult}(D_j) = p_j^{own}(D_j)$, i.e., a subsidiary located in country j behaves exactly like other banks located in country j.

Note that the regulator of country i cannot influence the bank's behavior although the project contributes also to the welfare of country i. The reason is that the subsidiary is supervised by the regulator in the foreign country j who decides about D_j. If the parent bank engages only in multinational lending, regulation by the home country is evaded.

- Finally, the expected profit of a bank located in country i that invests a share $\mu \in (0,1)$ of its equity at home and a share $(1-\mu)$ of its equity abroad is given by

$$\begin{aligned}\Pi_i &= p_i^{own}(R_i-1)\mu D_i + (p_i^{own}R_i - 1)\mu - \frac{c}{2}(p_i^{own})^2(1+D_i)\mu \\ &+p_i^{mult}\cdot(R_j-1)(1-\mu)D_j + \left(p_i^{mult}R_j-1\right)(1-\mu) - \frac{c}{2}\left(p_i^{mult}\right)^2(1+D_j)(1-\mu) - f,\end{aligned}$$

where the first line describes the profit from the home-country project and the second line describes the profit from the multinational project. We assume that the parent bank's return from the home-country project is not used to repay the depositors of the subsidiary and vice versa. A failure of the parent bank's project, however, causes stability costs for the subsidiary because of a worsening of the group's reputation.

Monitoring efforts at home and abroad differ and are given by (5) and (7), respectively. The bank raises as many deposits as possible.

If the home-country project of the parent bank fails, the stability of the subsidiary is affected. The total expected stability costs are given by

$$(1-p_i^{own})\cdot C.$$

We are now ready to evaluate the welfare effects of setting capital requirements. We proceed in three steps. First, we consider the situation where regulators in both countries set capital requirements individually. Second, we turn to a banking union and ask for the welfare effects on country i when the setting of capital requirements is delegated to a supranational regulator.

Finally, we derive conditions under which the regulator in country i has an incentive to join the banking union.

3.2.1. National setting of capital requirements

With multinational lending, the welfare in each country depends on the masses of projects realized in the home country and in the foreign country, respectively. We denote by K_i^{own} the mass of projects realized in country i by banks from country i. Analogously, K_i^{mult} denotes the masses of projects realized in country j by banks located in country i financed by multinational lending. We have $K_i = K_i^{own} + K_i^{mult}$. In what follows, we assume that $K_i^{own}, K_i^{mult} > 0$ are exogenous and constant. Furthermore, we denote by $\beta_i K_i^{own}, \beta_i > 0$, the mass of projects that are realized in the home country i by parent banks that also realize projects by using a subsidiary. The coefficient β_i thus measures the interconnectedness between domestic and foreign banking markets. A β_i equal to zero means that no parent bank with foreign subsidiaries does also finance home projects. The parent bank is thus a pure holding company. Inversely, a β_i equal to one means that on average every bank financing a home project also provides the same amount of foreign finance through subsidiary banks. The notation is analogous for country j.

Welfare of country i is given by

$$\begin{aligned} W_i(D_i, D_j) = {} & \overbrace{K_i^{own}\left[\left(p_i^{own} R_i - 1\right)(1 + D_i) - \frac{c}{2}\left(p_i^{own}\right)^2 (1 + D_i)\right]}^{(i)} \\ & + \overbrace{K_i^{mult}\left[p_i^{mult}(R_j - 1) D_j + p_i^{mult} R_j - 1 - \frac{c}{2}\left(p_i^{mult}\right)^2 (1 + D_j)\right] - F_i}^{(ii)} \\ & - \underbrace{K_j^{mult}\left(1 - p_j^{mult}\right) D_i}_{(iii)} - \underbrace{\beta_j K_j^{own}\left(1 - p_j^{own}\right) C}_{(iv)}, \end{aligned} \tag{8}$$

where F_i denotes the aggregated fees of all parent banks located in country i that established a subsidiary. In equation (8) the first summand (i) describes the total expected return (net of monitoring costs) to all agents from investment of banks in country i at home. The second summand (ii) stands for the profit of banks in country i from investments abroad using a subsidiary. In comparison to the first summand, depositors' losses in case of project failure are not included. This is because the deposit insurance of country j repays depositors of the subsidiary located in country j if the bank cannot do so. Following this argumentation, the third summand (iii) describes the expected losses of country i's deposit insurance that occur if projects of subsidiaries owned by parent banks in country j fail. The last summand (iv) describes the aggregated expected stability costs that occur if home-country projects of parent banks (located in country j and owning a subsidiary in country i) fail.

After inserting the monitoring efforts (5) and (7) chosen by the banks, equation (8) can be rewritten as:

$$\begin{aligned} W_i\left(D_i, D_j\right) = & K_i^{own}\left[\left(\frac{R_i^2}{2c}-1\right)\left(1+D_i\right)-\frac{D_i^2}{2c\left(1+D_i\right)}\right] \\ & + K_i^{mult}\left[\frac{R_j^2}{2c}\left(1+D_j\right)-1-\frac{R_j}{c}D_j+\frac{D_j^2}{2c\left(1+D_j\right)}\right]-F_i \\ & - K_j^{mult}\left[\frac{c-R_i}{c}+\frac{D_i}{c\left(1+D_i\right)}\right]D_i-\beta_j K_j^{own}\left[\frac{c-R_j}{c}+\frac{D_j}{c\left(1+D_j\right)}\right]C. \end{aligned} \tag{9}$$

The national regulator of country i maximizes the welfare of country i. By setting a capital requirement κ_i the regulator of country i can control the monitoring effort and the amount of deposits raised by banks located in country i. This includes the subsidiaries located in country i of parent banks located in country j. The regulator of country i cannot control monitoring effort and the amount of deposits raised by banks located in country j, including subsidiaries in country j of parent banks in country i. This externality of regulation in country j on country i's welfare is captured by the second summand and by the last summand in equation (9). Formally, the national regulator's problem is given by

$$D_i^* = \arg\max_{D_i} W_i\left(D_i, D_j\right).$$

We obtain:

Lemma 2. *The national regulator of country i imposes a capital requirement $\kappa_i \in (0,1)$ if and only if:*

$$\frac{R_i^2-2c}{2\left(c-R_i\right)} > \frac{K_j^{mult}}{K_i^{own}} > \frac{R_i^2-2c-1}{2\left(c-R_i+1\right)}$$

In this case, he sets

$$D_i^* = \sqrt{\frac{K_i^{own}+2K_j^{mult}}{K_i^{own}\left(2c-R_i^2+1\right)+2K_j^{mult}\left(c-R_i+1\right)}}-1,$$

which corresponds to the following capital requirement:

$$\kappa_i^* = \sqrt{\frac{K_i^{own}\left(2c-R_i^2+1\right)+2K_j^{mult}\left(c-R_i+1\right)}{K_i^{own}+2K_j^{mult}}}.$$

The welfare-maximizing capital requirement κ_i^* is increasing in K_j^{mult}, c and decreasing in K_i^{own}, R_i.

Proof. See appendix. □

The two conditions guarantee that the regulator's problem is not solved by a corner solution. A high project return R_i or low monitoring costs c yield a high monitoring effort and therefore decrease the welfare-maximizing capital requirement. A low K_j^{mult} relative to K_i^{own} also leads to a low capital requirement, because expected losses of country i's deposit insurance decrease with decreasing K_j^{mult}. If $\frac{K_j^{mult}}{K_i^{own}} \leq \frac{R_i^2-2c-1}{2(c-R_i+1)}$ holds, country i's regulator does not impose a capital requirement and sets $\kappa_i^* = 0$. Conversely, a low project return R_i and high monitoring costs c imply a low monitoring effort, yielding a high capital requirement. In contrast, if country i's banking sector is dominated by foreign-owned subsidiaries (i.e., $\frac{K_j^{mult}}{K_i^{own}}$ is relatively high), country i's regulator also imposes a strict capital requirement, because increasing K_j^{mult} increases the expected losses to country i's deposit insurance. If $\frac{R_i^2-2c}{2(c-R_i)} \leq \frac{K_j^{mult}}{K_i^{own}}$ holds, the regulator does not allow any leverage, i.e., $\kappa_i^* = 1$.

Welfare in country i does not only depend on the capital requirement κ_i set by the domestic regulator, but also on the capital requirement κ_j set by the foreign regulator. The regulator of country j influences the welfare of country i in two ways. First, he supervises the subsidiaries of parent banks of country i. Therefore, a project of a parent bank from country i realized by multinational lending in country j is affected by the capital requirement κ_j set by the national regulator of country j. Second, parent banks located in country j that open subsidiaries in country i are supervised by the national regulator of country j. Therefore, the expected stability costs occurring to country i depend on the capital requirement κ_j.

From this follows that decreasing the capital requirement κ_j set by the regulator in country j has two different effects on the welfare in country i. Note that a decrease in κ_j means an increase in the banks' maximum allowed leverage and thus in D_j.

- First, decreasing κ_j increases the expected profit of parent banks from country i realizing projects by multinational lending. This implies a positive effect on welfare of country i, because the deposit insurance of country j (and not the deposit insurance of country i) repays depositors of subsidiaries in country j in case of project failure.

- Second, decreasing κ_j increases total expected stability costs $\left(1 - p_j^{own}\right) C$ and therefore also has a negative effect on the welfare of country i.

However, stability costs are bounded, while there is no upper bound on banks' expected profits. Thus, the regulator of country i prefers $\kappa_j = 0$.

Changes in the capital requirement in country j have an external effect on country i. We can classify this externality and call it "positive", if a reduction of the capital requirement of country j (i.e., an increase in D_j) always leads to an increase in country i's welfare. A negative externality is defined analogously. We state:

Proposition 1. *Welfare W_i in country i is convex in D_j. The welfare-maximizing regulator in country i wants the regulator of country j to choose $\kappa_j = 0$. There is a threshold $\overline{C}$*

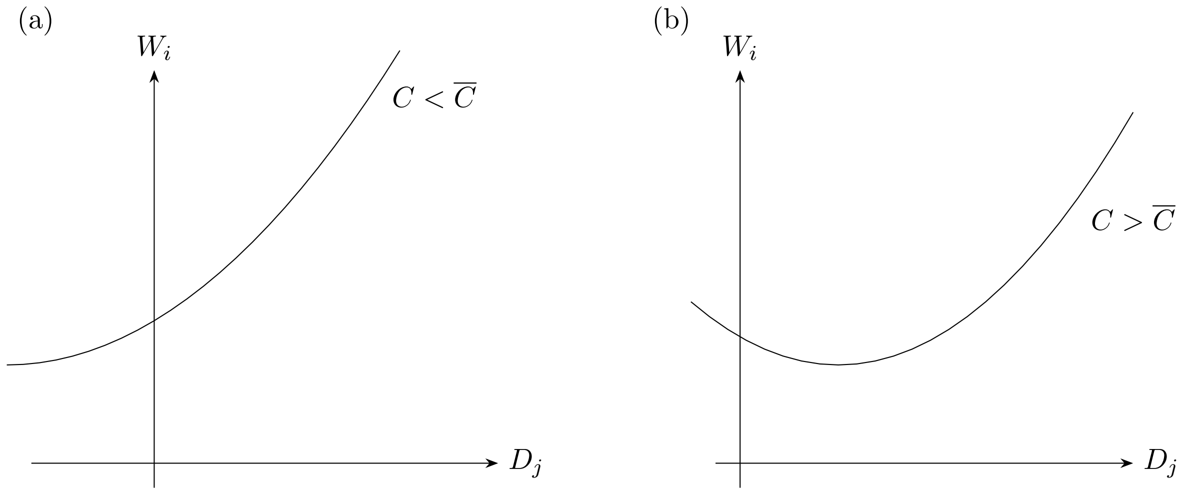


Figure 2: external effect of regulation in j on welfare in i

such that if $C \leq \overline{C}$, the external effect of regulation in country j on country i's welfare is always positive. Otherwise, the external effect is ambiguous. The threshold $\overline{C}$ is increasing in R_j, K_i^{mult} and decreasing in β_j, K_j^{own}.

Proof. See appendix. □

Figure 2 provides some intuition. It shows welfare W_i in country i as a function of D_j for stability costs C below the threshold value (panel (a)) and above the threshold value (panel (b)). In both cases W_i becomes maximal for $D_j \to \infty$ or equivalently $\kappa_j \to 0$. As mentioned before, an increase in κ_j leads to an increase in profit from multinational projects of banks located in country i and to an increase in expected stability costs as well. For low expected stability costs $C < \overline{C}$ the first effect dominates for all $D_j \in [0, \infty)$, such that an increase in D_j always increases welfare in country i. For large expected stability costs $C > \overline{C}$ the last effect dominates only for small values D_j and is dominated by the first effect for large values D_j. Thus, the external effect is ambiguous an depends on D_j. Increasing R_j or K_i^{mult} as well as decreasing β_j or K_j^{own} promotes the second and reduces the first effect.

3.2.2. Supranational setting of capital requirements

We now turn to the case where a supranational regulator simultaneously sets capital requirements for both countries. They do not necessarily have to be identical. Then, joint welfare W_{i+j} is the unweighted sum of welfare in countries i and j (Hardy and Nieto, 2011) and is given by

$$
\begin{aligned}
W_{i+j} = & K_i^{own}\left[\left(\frac{R_i^2}{2c}-1\right)(1+D_i)-\frac{D_i^2}{2c\,(1+D_i)}\right]+K_i^{mult}\left[\left(\frac{R_j^2}{2c}-1\right)(1+D_j)-\frac{D_j^2}{2c\,(1+D_j)}\right]-F_i \\
& + K_j^{own}\left[\left(\frac{R_j^2}{2c}-1\right)(1+D_j)-\frac{D_j^2}{2c\,(1+D_j)}\right]+K_j^{mult}\left[\left(\frac{R_i^2}{2c}-1\right)(1+D_i)-\frac{D_i^2}{2c\,(1+D_i)}\right]-F_j \\
& - \beta_j K_j^{own}\left[\frac{c-R_j}{c}+\frac{D_j}{c\,(1+D_j)}\right]C-\beta_i K_i^{own}\left[\frac{c-R_i}{c}+\frac{D_i}{c\,(1+D_i)}\right]C. \qquad (10)
\end{aligned}
$$

The first line captures the total expected return (net of monitoring costs) to all agents from investment of banks located in country i at home and abroad. The second line shows the analogous expression for country j. The last line captures the expected stability costs.

The supranational regulator maximizes joint welfare and, in contrast to national supervision, takes into account both, the external effect of regulation in country j on country i's welfare and the external effect of country i on country j. More formally the supranational regulator's problem is given by

$$
\left(\hat{D}_i,\hat{D}_j\right)=\arg\max_{(D_i,D_j)} W_{i+j}\left(D_i,D_j\right).
$$

We derive:

Lemma 3. *The benevolent supranational regulator sets $\kappa_i \in (0,1)$ if and only if the following conditions hold:*

$$
\frac{K_j^{mult}}{K_i^{own}}>\frac{2c-R_i^2+2C\beta_i}{R_i^2-2c} \text{ and } 2c-R_i^2+1>0,
$$

In this case the supranational regulator chooses

$$
\hat{D}_i=\sqrt{\frac{K_i^{own}+K_j^{mult}-2C\beta_i K_i^{own}}{\left(K_i^{own}+K_j^{mult}\right)\left(2c-R_i^2+1\right)}}-1,
$$

with the corresponding capital requirement

$$
\hat{\kappa}_i=\sqrt{\frac{\left(K_i^{own}+K_j^{mult}\right)\left(2c-R_i^2+1\right)}{K_i^{own}+K_j^{mult}-2C\beta_i K_i^{own}}}.
$$

The capital requirement $\hat{\kappa}_i$ is increasing in K_i^{own}, c, C, β_i and decreasing in K_j^{mult}, R_i. A symmetric result holds for the supranational regulation of county j.

Proof. See appendix. □

Consider, without loss of generality, again country i. Table 2 lists the reactions of the

monotonicity of ... with respect to ...	$\hat{D}_i$	D_i^*
R_i	increasing	increasing
c	decreasing	decreasing
C	decreasing	constant
K_i^{own}	decreasing	increasing
K_j^{mult}	increasing	decreasing
$(1-\beta_i)\,K_i^{own}$ ($\beta_i K_i^{own}$ constant)	increasing	increasing
β_i	decreasing	constant

Table 2: the influence of different factors on $\hat{D}_i, D_i^*$

maximum leverage $\hat{D}_i$ to various parameter changes and compares it with the reaction of the maximum leverage D_i^* preferred by the national regulator of country i. Note that higher bank leverage corresponds to a lower capital requirement set by the regulator.

As in the case of national regulation, the supranational regulation is relaxed if the project return R_i increases or if the monitoring cost parameter c decreases. If the project return is sufficiently large relative to monitoring costs, the regulator does not restrict the project's volume, i.e., $\hat{\kappa}_i = 0$. Additionally, the supranational regulation is relaxed if the stability costs C or the share β_i of banks causing these stability costs decreases.

In contrast to national regulation, the maximum allowed leverage $\hat{D}_i$ set by the supranational regulator is decreasing in K_i^{own}. This is because the supranational regulator does not only take into account the expected return to all agents from home-country investment, but also the expected stability costs that occur to the foreign country if the home-country projects of multinational banks fail. Moreover, $\hat{D}_i$ is increasing if only $(1-\beta_i)\,K_i^{own}$ increases and $\beta_i K_i^{own}$ stays at the same level, which confirms the above explanation.

Also in contrast to national regulation, the maximum allowed leverage set by the supranational regulator is increasing in K_j^{mult}. The monotonicity differs, because the supranational regulator does not only consider the losses to depositors if multinational projects of foreign-owned banks fail, but the expected return of investment to all agents.

The following Proposition examines under which circumstances the national regulator is more/less strict than the supranational regulator.

Proposition 2. *Consider $D_i^*, \hat{D}_i \in (0,\infty)$. There is a threshold $\widetilde{C} > \overline{C}$ such that $\hat{D}_i > D_i^*$ if and only if $C < \widetilde{C}$. The threshold $\widetilde{C}$ is increasing in R_i, K_j^{mult} and decreasing in c, β_i, K_i^{own}.*

Proof. See appendix. □

The intuition is similar to Proposition 1. If C is sufficiently small, the difference between national and supranational regulation results because the national regulator ignores the benefits of foreign-owned banks' multinational projects and only considers the losses to depositors in case the multinational projects of foreign-owned banks fail. The supranational regulator accounts for the expected returns to all agents. Therefore, supranational regulation is less strict. If otherwise C is sufficiently large, the difference between national and supranational regulation arises because the national regulator, in contrast to the supranational regulator, ignores the expected stability costs occurring to the foreign country because of domestic-owned banks that are active at home and abroad. Therefore, the national regulation is less strict.

3.2.3. Incentives to join the banking union

Comparing the welfare of both countries under national supervision and under supranational supervision, we are now able to determine the value of the banking union for the national regulators and the supranational regulator. Considering joint welfare, supranational regulation is always superior to national regulation:

Lemma 4. *Assume that $\kappa_i^*, \kappa_j^*, \hat{\kappa}_i, \hat{\kappa}_j \in (0,1)$ with $\kappa_i^* \neq \hat{\kappa}_i, \kappa_j^* \neq \hat{\kappa}_j$. Joint welfare always increases if the regulatory regime changes from national supervision to supranational supervision.*

Proof. See appendix □

In contrast, supranational regulation is not necessarily preferable from a national point of view. For country i, joining the banking union and therefore agreeing to supranational regulation is profitable if national welfare is larger under supranational regulation than under national regulation. Formally, country i joins the banking union if

$$W_i\left(\hat{D}_i, \hat{D}_j\right) \geq W_i\left(D_i^*, D_j^*\right)$$

or equivalently

$$\frac{\left(\hat{D}_i - D_i^*\right)^2}{\left(1+\hat{D}_i\right)}\left[K_i^{own}\left(2c - R_i^2 + 1\right) + 2K_j^{mult}\left(c - R_i + 1\right)\right] \leq \left(\hat{D}_j - D_j^*\right)\left(K_i^{mult}\left(R_j^2 - 2R_j + 1\right) - \frac{K_i^{mult} + 2C\beta_j K_j^{own}}{\left(1+D_j^*\right)\left(1+\hat{D}_j\right)}\right). \quad (11)$$

The left-hand side describes the national welfare loss of country i due to the change of the capital requirement/maximum leverage in country i from national to supranational regulation. The right-hand side describes the welfare gain of country i due to the change of the capital requirement/maximum leverage in country j. Both sides are nonnegative. We define that the incentive of country i to join the banking union is larger the larger the right-hand side and the smaller the left-hand side of (11).We obtain:

Proposition 3. *The incentive of country i to join the banking union decreases if*

(a1) K_j^{mult} *increases and* $C \leq \overline{\overline{C}}$*;*

(a2) K_i^{mult} *decreases and* $C \leq C'$*;*

(b1) K_i^{own} *increases and* $C \geq \widetilde{\widetilde{C}}$*; an analogous statement holds if* $\beta_i K_i^{own}$ *increases, while* $(1-\beta_i)\, K_i^{own}$ *remains at the same level;*

(b2) K_j^{own} *decreases and* $C \geq C''$*; an analogous statement holds if* $\beta_j K_j^{own}$ *decreases, while* $(1-\beta_j)\, K_j^{own}$ *remains at the same level;*

(c1) β_i *increases, while* $C > \widetilde{C}$*; or if* β_i *decreases, while* $C < \widetilde{C}$*;*

(c2) β_j *increases, while* $C < C'''$*; or if* β_j *decreases, while* $C > C'''$*;*

Here, $\overline{\overline{C}}, \widetilde{C}, \widetilde{\widetilde{C}}, C', C''$ *and* C''' *are threshold values with* $\overline{\overline{C}} \geq \widetilde{C} \geq \widetilde{\widetilde{C}}$*.*

Proof. See appendix. □

The proposition contains our main result. It shows how a national regulator‘s decision to join a banking union depends on the structure of the home and foreign banking market as well as on the linkages between both markets. While the decision to join a banking union is “all or nothing”, there are threshold parameter values where the decision changes and we know how parameter changes affect these critical values.

In order to understand the intuition behind these results, recall that the difference between national and supranational regulation for national welfare occurs for two reasons:

(i) The supranational regulator considers the expected return to all agents from investments abroad, while the national regulator of country i only considers depositors’ losses (as a host country of foreign subsidiaries, resulting from K_j^{mult}) and banks’ profits (as a home country for domestic parent banks, resulting from K_i^{mult}).

(ii) The supranational regulator considers total expected stability costs (resulting from K_i^{own}, $K_j^{own}, \beta_i, \beta_j, C$) occurring to the foreign country, which is ignored by the national regulator.

If C is sufficiently small, the first effect dominates. Otherwise, the second effect dominates.

This can be illustrated by the help of Figures 3 to 5, where Δ^{old} and Δ^{new} denote country i’s welfare differential between national and supranational regulation before and after the parameter change. Note that country i’s welfare W_i is concave in D_i but convex in D_j.

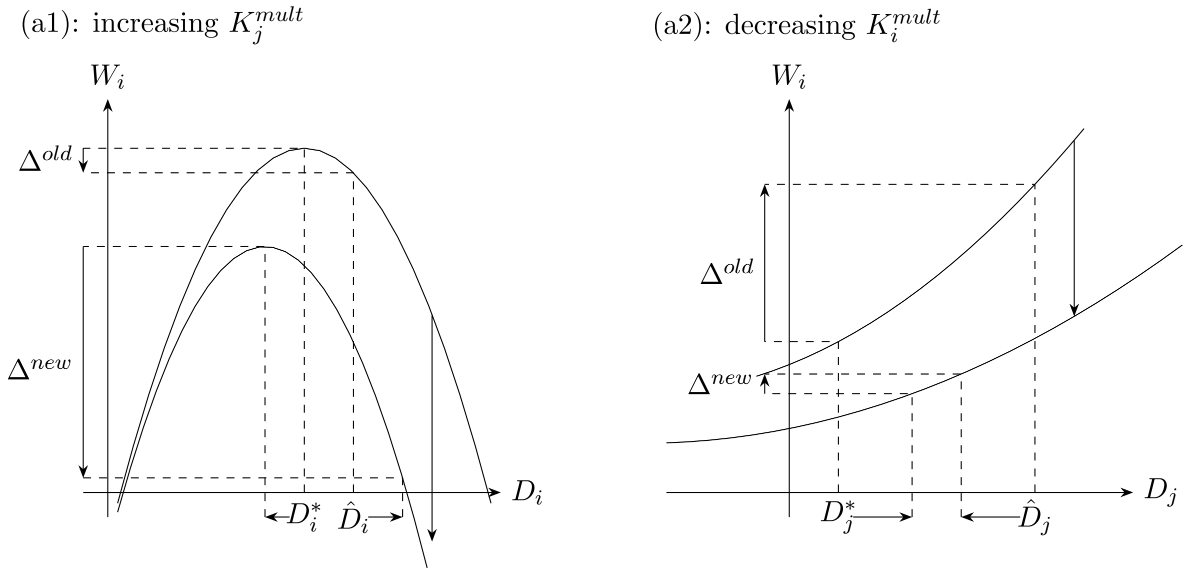


Figure 3: The incentive of country i to join the banking union (a)

- In parts (a1) and (a2) of the proposition, the first effect dominates (i.e., C is sufficiently small). If K_j^{mult} increases, the deposit insurance in country i has to repay more deposits in case of project failure. The W_i-locus in the left-hand panel of Figure 3 is shifted downward. The capital requirement set by the national regulator increases (D_i^* decreases), while the supranational capital requirement is reduced ($\hat{D}_i$ increases), because the supranational regulator also takes into account the expected profits from the investment abroad which accrue to country j. In consequence, the welfare loss of country i when joining the banking union (Δ^{old} versus Δ^{new}) increases. Therefore, the incentive of country i to join a banking union decreases in K_j^{mult}. If instead K_i^{mult} decreases, the supranational regulator expects lower profits accruing to parent banks in country i (the W_i-locus shifts downwards, right panel of Figure 3) and charges a larger capital requirement in country j. This is in contrast to the national regulator in country j who decreases the capital requirement, because he only takes into account the expected payments by the deposit insurance in country j. The welfare gain of country i when joining the banking union decreases. Therefore, the incentive of country i to join a banking union decreases, if K_i^{mult} decreases.

- In parts (b1) and (b2) of the proposition, the second effect dominates (i.e., C is large). If K_i^{own} increases (left panel of Figure 4), expected profits of domestic banks and total expected stability costs for country j increase. The latter is not considered by the regulator in country i when setting the national capital requirement. Thus, a supranational regulator sets a larger capital requirement $\hat{D}_i$ in country i, while the national regulator in country i sets a smaller capital requirement D_i^*. The incentive of the regulator in

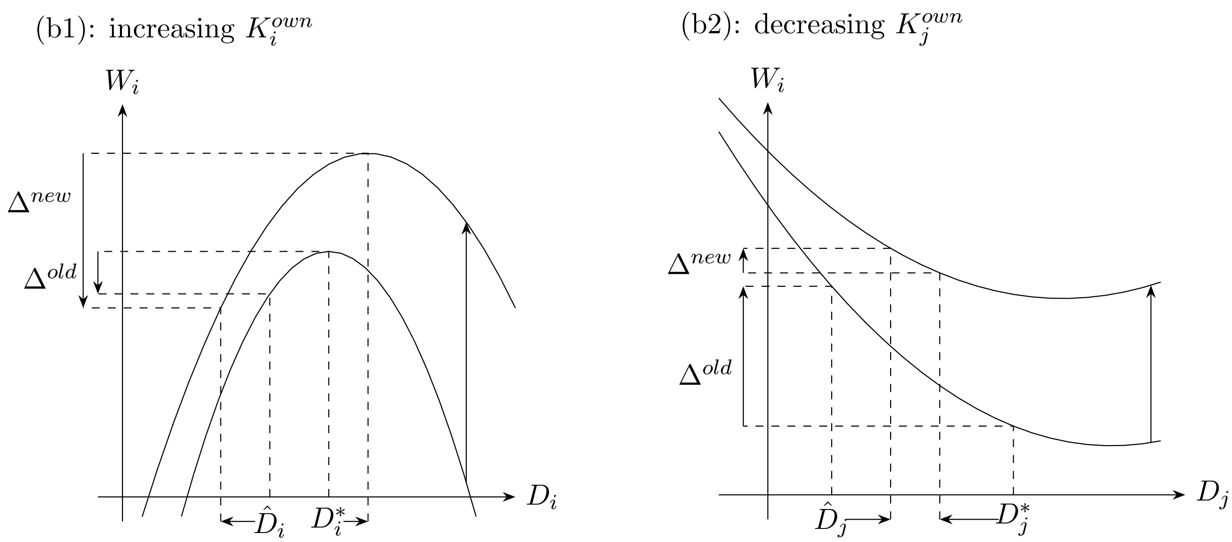


Figure 4: The incentive of country i to join the banking union (b)

country i to join the banking union diminishes in K_i^{own}. Conversely, if K_j^{own} decreases (right panel), total expected stability costs of country i decrease which is not considered by the regulator in country j when setting the national capital requirement. The W_i-locus shifts upwards. The supranational regulator reduces the capital requirement in country j, while the national regulator in country j increases the capital requirement. The incentive of the regulator in country i to join the banking union diminishes, if K_j^{own} falls.

- The percentages β_i and β_j of home-country projects realized by internationally active banks in country i and j are irrelevant for the national regulators, but are taken into account by a supranational regulator. They only affect total expected stability costs. To start with country i, an increase in β_i induces the supranational regulator to rise capital requirements in country i, because total expected stability costs occurring to country j increase. If $C > \widetilde{C}$ holds (upper left panel of Figure 5), the supranational regulation is already more strict than the national regulation ($D_i^* > \hat{D}_i; \kappa_i^* < \hat{\kappa}_i$) and the regulator of country i has to increase capital requirements even more due to an increase in β_i when entering a banking union. This decreases the incentive to join the banking union. The same holds true for $C < \widetilde{C}$, whereby the supranational regulation is less strict than the national regulation ($D_i^* < \hat{D}_i; \kappa_i^* > \hat{\kappa}_i$) (upper right panel). In this case, a decrease in β_i relaxes the supranational regulation even more, increases the difference in capital requirements between national and supranational regulation and also decreases the incentive for country i to enter the banking union.

  Finally, an increase in β_j induces a supranational regulator to rise capital requirements

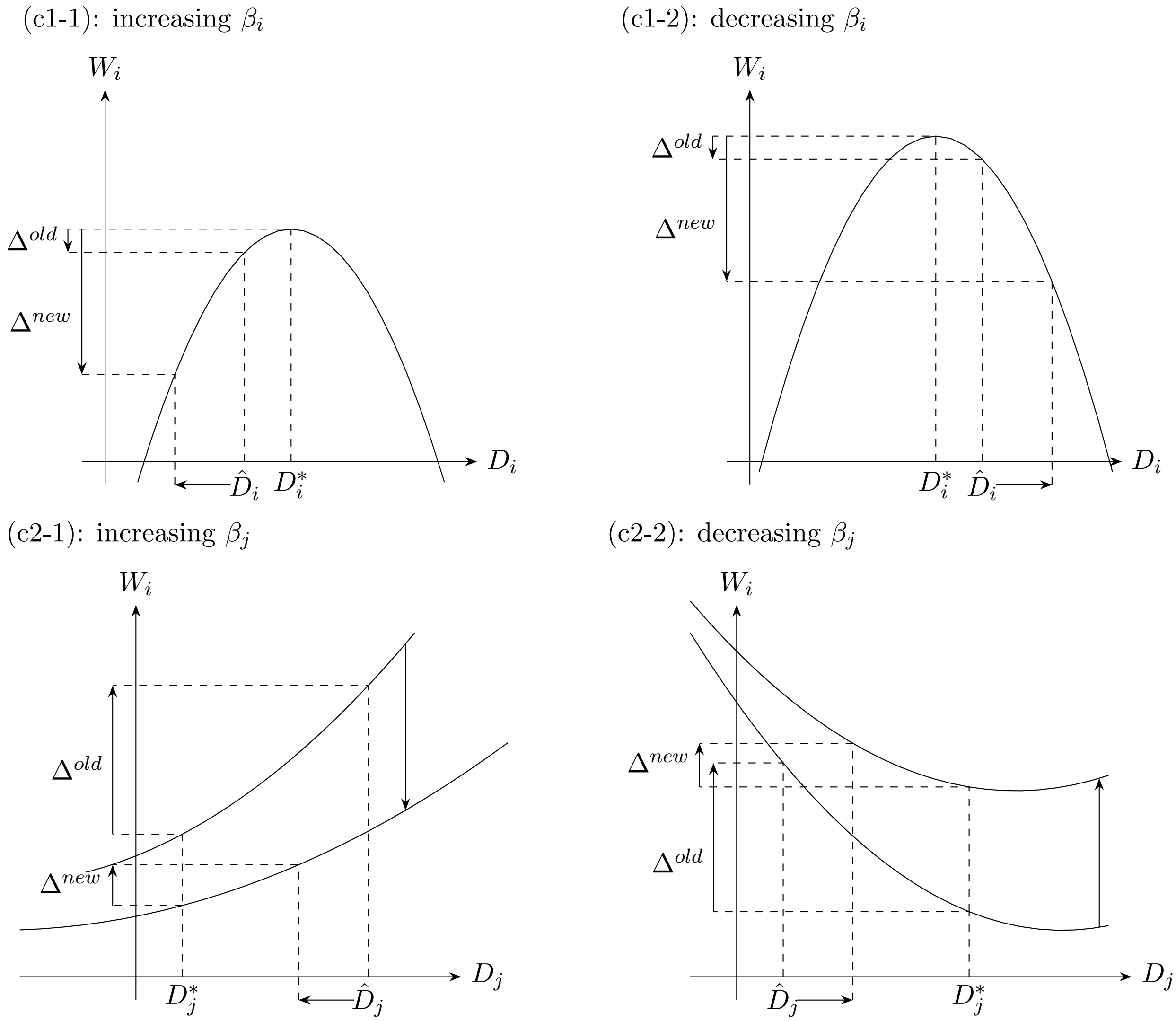


Figure 5: The incentive of country i to join the banking union (c)

in country j, because total expected stability costs occurring to country i increase. If $C < C'''$ holds (lower left panel of Figure 5), the supranational regulation is less strict than the national regulation ($D_j^* < \hat{D}_j$ or $\kappa_j^* > \hat{\kappa}_j$) and country j has to decrease capital requirements less due to an increase in β_j when entering a banking union. This decreases the incentive to join the banking union. If instead $C > C'''$ holds (lower right panel), the supranational regulation is more strict than the national regulation ($D_i^* > \hat{D}_i$ or $\kappa_i^* < \hat{\kappa}_i$). In this case, a decrease in β_j leads country i to hesitate more to enter the banking union.

An inspection of Figures 3 to 5 reveals that a supranational setting of capital requirements has ambiguous effects on welfare in country i. The domestic regulator loses control over domestic banks' leverage which implies a welfare loss for country i. However, the foreign regulator also loses control over the leverage of his banks which implies a welfare gain for country i. We cannot say which effects dominates. However, we know which parameter changes (in K^{mult}, K^{own}, β) imply that the domestic welfare loss due to losing domestic control increases and the welfare gain due to losing foreign control decreases. In these cases, it becomes more likely that the net welfare effect of the banking union becomes negative.

3.3. National versus supranational regulation: cross-border banking

We now allow banks also to do cross-border lending through branches and assume that a bank can go abroad by either establishing a subsidiary or a branch. We consider branching, which dominates subsidiaries in some countries. As before, a bank can invest in the home country, only, or invest in the foreign country, only, by establishing a subsidiary. The bank can also invest a share $\mu \in (0,1)$ of its equity in the home country and a share $(1-\mu)$ of its equity in the foreign country by establishing a foreign subsidiary. With the existence of branching, there are now two more possibilities:

(i) The bank only invests in the foreign country by using a branching structure. In this case of cross-border lending (superscript *cb*), the expected profit for a bank located in country i which realizes a project in country j is given by

$$\Pi_i^{cb} = p_i^{cb}\left(R_j - 1\right)D_i + p_i^{cb}R_j - 1 - \frac{c}{2\delta}\left(p_i^{cb}\right)^2\left(1 + D_i\right). \tag{12}$$

The bank chooses p_i^{cb} and raises deposits D_i in the home country i. It invests the funds in the foreign country j with gross return R_j or 0. Compared to home-country investments, monitoring costs are now larger by the factor $\frac{1}{\delta}$. Remember that $\delta \in (0,1]$ reflects cross-country noise.

The bank raises as many deposits as possible and chooses monitoring effort

$$p_i^{cb} = \frac{\delta}{c}\left(R_j - \frac{D_i}{1 + D_i}\right) \tag{13}$$

(analogously to the previous sections we assume $\frac{c}{\delta} \geq c \geq R_k \geq \frac{c}{2\delta} + 1 \geq \frac{c}{2} + 1$ for $k \in \{i,j\}$). According to (13), the monitoring effort is increasing in the noise term δ. This is intuitive as decreasing δ is equivalent to an increase in the cost parameter c and c.p. in monitoring costs. Increasing δ decreases c.p. the monitoring costs. Therefore, increasing the monitoring effort increases the bank's expected profit.

(ii) The bank invests a share $\nu \in (0,1)$ of its equity in the home country and a share $1-\nu$ of its equity in the foreign country using a branching structure. Accordingly, the expected profit of a bank located in country i that invests at home and abroad using branches is given by

$$\begin{aligned}\Pi_i &= p_i^{own}(R_i-1)\nu D_i + (p_i^{own}R_i-1)\nu - \frac{c}{2}(p_i^{own})^2(1+D_i)\nu \\ &+ p_i^{cb}\cdot(R_j-1)(1-\nu)D_i + \left(p_i^{cb}R_j-1\right)(1-\nu) - \frac{c}{2\delta}\left(p_i^{cb}\right)^2(1+D_i)(1-\nu),\end{aligned}$$

where the first line is the profit from the home-country project and the second line is the profit from the cross-border project. We assume for simplicity that the return of the home country project is not used to repay deposits used for the cross border project and vice versa. Monitoring effort is given by (5) and (13), respectively, and the bank raises as many deposits as possible.

We denote by $K_i^{cb} \geq 0$ the exogenous mass of projects realized by banks located in country i financed by cross-border lending. We then have $K_i = K_i^{own} + K_i^{mult} + K_i^{cb}$ and welfare of country i is now given by

$$\begin{aligned}W_i^{cb}(D_i,D_j) &= W_i(D_i,D_j) \\ &+ K_i^{cb}\left[\left(\frac{\delta R_j^2}{2c}-1\right)(1+D_i) - \frac{\delta D_i^2}{2c(1+D_i)}\right] \qquad (14)\end{aligned}$$

The second line represents the return to all agents (net of monitoring costs) from investment abroad using a branching structure. The rest is analogous to equation (9). Welfare of country j can be derived analogously. Note that welfare from cross-border investments is affected by the capital requirement of the home country's regulator, but not by the capital requirement of the foreign country's regulator. The external effect of regulation in country j on country i's welfare is therefore unaffected by cross-border investments.

Capital requirements differ between national and supranational regulation:

- The national regulator of country i sets the maximum allowed leverage $D_i^{cb,*}$ such that

  $$D_i^{cb,*} = \arg\max_{D_i} W_i^{cb}(D_i,D_j).$$

  The solution $D_i^{cb,*}$ is increasing in the return of cross-border projects R_j because the regulator in country i also supervises branches that are active in country j.

  Since the cross-border investment activity does not affect the external effect of regulation in country j on country i's welfare, Proposition 1 can be adopted one to one. In particular, country i prefers the capital requirement of country j to be as small as possible.

- The supranational regulator maximizes joint welfare which is now given by

$$W_{i+j}^{cb} = W_{i+j} + K_i^{cb}\left[\left(\frac{\delta R_j^2}{2c}-1\right)(1+D_i)-\frac{\delta D_i^2}{2c\,(1+D_i)}\right] + K_j^{cb}\left[\left(\frac{\delta R_i^2}{2c}-1\right)(1+D_j)-\frac{\delta D_j^2}{2c\,(1+D_j)}\right], \tag{15}$$

  where W_{i+j} is given by (10).The supranational regulator sets the maximum allowed leverages $\left(\hat{D}_i^{cb}, \hat{D}_j^{cb}\right)$ such that

$$\left(\hat{D}_i^{cb}, \hat{D}_j^{cb}\right) = \arg\max_{(D_i,D_j)} W_{i+j}^{cb}\left(D_i, D_j\right).$$

We are now able to compare capital requirements under national and supranational regulations. The expected stability costs still determine whether the national regulator is more or less strict than the supranational regulator. We derive

Lemma 5. *Consider $D_i^{cb,*}, \hat{D}_i^{cb} \in (0,\infty)$. There is a threshold $\widetilde{C}^{cb} > \overline{C}$ such that $\hat{D}_i^{cb} > D_i^{cb,*}$ if and only if $C < \widetilde{C}^{cb}$. The threshold $\widetilde{C}^{cb}$ is increasing in R_i and R_j.*

Proof. See appendix. □

Since the Lemma is the equivalent of Proposition 2, the intuition is just the same: Small expected stability costs C imply that the difference between national and supranational regulation mainly arises, because the supranational regulator considers the return to all agents from multinational projects of foreign-owned parent banks and not only the expected losses to depositors (like the national regulator). Therefore, supranational regulation is less strict compared to national regulation. Otherwise if expected stability costs C are sufficiently high, the difference between national and supranational regulation mainly arises, because the national regulator (in contrast to the supranational regulator) ignores expected stability costs. In this case supranational regulation is more strict than national regulation.

It remains to be examined how the incentive of a country to join the banking union may change due to the possibility of cross-border lending. Supranational regulation is superior to national regulation, when considering total welfare. From the point of view of the national regulator in country i joining the banking union is profitable if and only if

$$W_i^{cb}\left(D_i^{cb,*}, D_j^{cb,*}\right) \leq W_i^{cb}\left(\hat{D}_i^{cb}, \hat{D}_j^{cb}\right)$$

or equivalently

$$\frac{\left(D_i^{cb,*}-\hat{D}_i^{cb}\right)^2}{1+\hat{D}_i^{cb}}\left[K_i^{own}\left(2c-R_i^2+1\right)+\delta K_i^{cb}\left(2\frac{c}{\delta}-R_j^2+1\right)+2K_j^{mult}\left(c-R_i+1\right)\right]$$
$$\leq\left(\hat{D}_j^{cb}-D_j^{cb,*}\right)\left[K_i^{mult}\left(R_j^2-2R_j+1\right)-\frac{K_i^{mult}+2\beta_j K_j^{own}C}{\left(1+D_j^{cb,*}\right)\left(1+\hat{D}_j^{cb}\right)}\right].$$

This results in:

Proposition 4. *The incentive of country i to join the banking union decreases if*

(a) K_j^{cb} *increases and* $C \geq C'^{cb}$ *as well as* $R_i < R_i^{'}$*;*

(b) K_j^{cb} *decreases and* $C \geq C'^{cb}$ *as well as* $R_i \geq R_i^{'}$*;*

Here, C'^{cb} *and* $R_i^{'}$ *denote some threshold values, where* R_i' *is increasing in* R_j*.*

Proof. See appendix. □

The incentive to join the banking union does not only depend on stability costs, but also on the project profitability in each country (because R_i' depends on R_j). If stability costs are high, the difference between national and supranational regulation occurs mainly because the national regulator ignores these stability costs. Therefore, a change in K_j^{cb} has a larger impact on national regulation than on supranational regulation. This yields: (a) If R_i is sufficiently small, an increase in K_j^{cb} tightens both capital requirements, but also the difference between national and supranational capital requirement in country j gets smaller. The incentive for country i to participate in the banking union decreases. (b) If R_i is sufficiently large, an increase in K_j^{cb} relaxes both capital requirements, but also the difference between national and supranational regulation increases. The incentive of country i to join the banking union decreases. Therefore, also the incentive to join the banking union crucially depends on the differences in project profitability among countries.

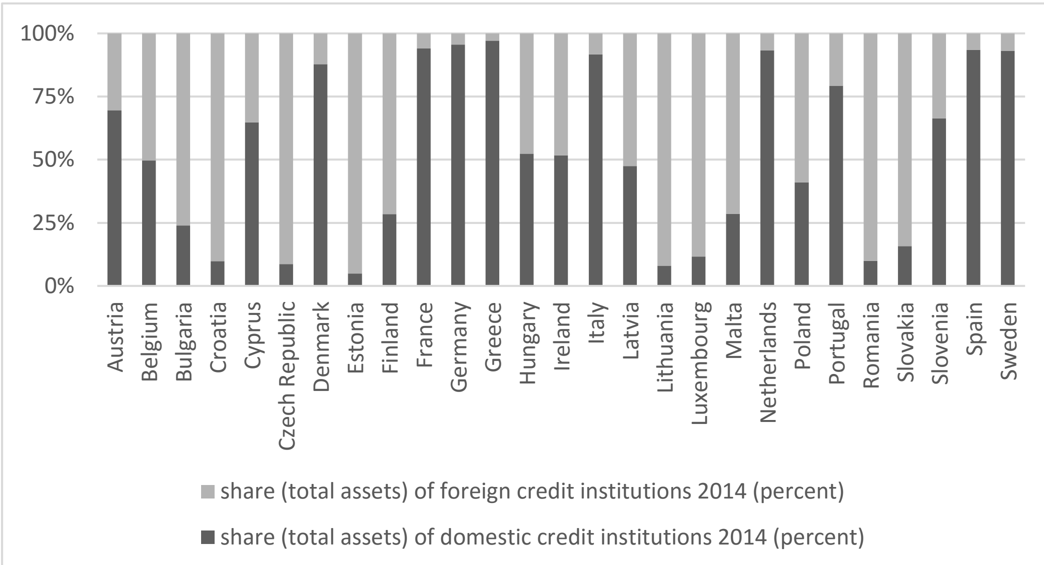
4. Application to the European Banking Union

EBU forms a natural experiment which allows us to verify the validity of the arguments presented in the model section. Some current EU Member States outside the Euro zone have already decided not to join EBU (Sweden, UK), others will join (Denmark), while CEECs take a "wait and see position" which is often motivated by the argument that entry into EBU also implies membership in the Euro zone. It is true that EMU membership becomes more likely once the decision to join the banking union has been taken. Without EMU membership, opt-in countries have only insufficient voting rights in the decision-making process of the ECB and have no access to the fiscal backstop provided by the European Stability Mechanism (Kisgergely and Szombati (2014); Narodowy Bank Polski (2015)). Yet the ultimate decision to apply for membership in EBU has little to do with a single currency, but is strongly connected to multinational banking which is significant in all opt-in countries (Hüttl and Schoenmaker (2016)).

Our results provide some explanation for the current situation with respect to EBU. First, consider the CEE countries, which take a "wait and see" position and where inward banking by foreign owned subsidiaries is very common. According to Figures 6 and 7, a large share of assets in CEE countries is held by foreign credit institutions. Foreign banking activities are almost completely carried out by subsidiaries with parent banks located in EBU countries. These facts correspond to a relatively large $K^{mult}_{j=EBU}$ in comparison with a small $K^{own}_{i\in CEE}$. Moreover, banks from EBU-countries are only poorly active in countries outside EBU (9% of assets, see Hüttl and Schoenmaker (2016)). This means that $\beta_{j=EBU}K^{own}_{j=EBU}$ is relatively small.

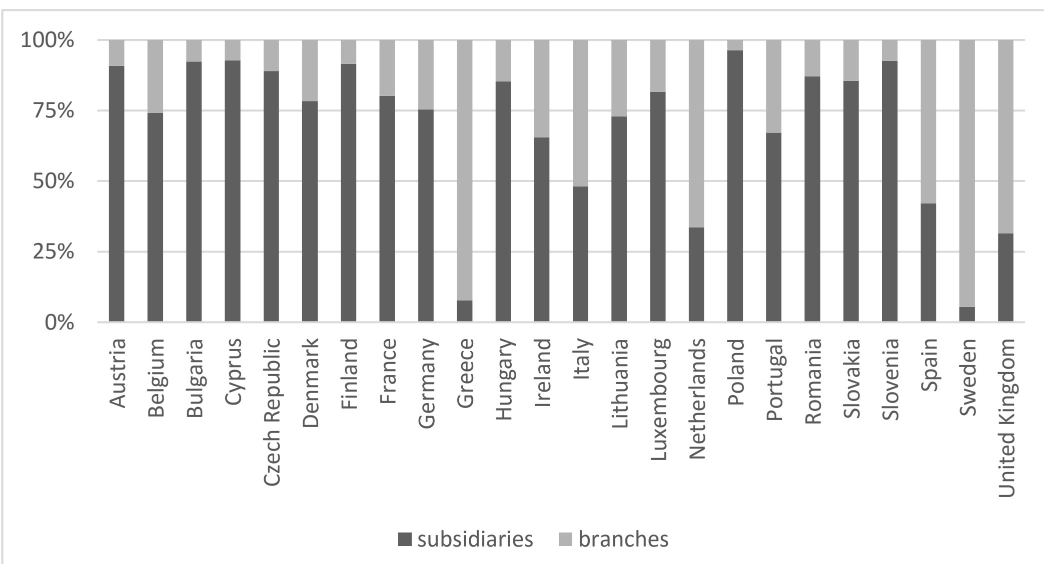
In terms of the above model, the large $K^{mult}_{j=EBU}$ explains why authorities in opt-in countries have a low interest to join EBU, because a supranational regulator would set lower capital requirements than preferred by a national regulator in CEE countries. This is because the supranational regulator would not only take into account depositors' losses in case of failure of multinational projects, but also the possible profits from the project accruing to the parent banks. This effect is only partially compensated by the small value of $K^{own}_{i\in CEE}$ which induces the supranational regulator to set a smaller capital requirement than preferred by the national regulator. The effect is further intensified by the small value of $\beta_{j=EBU}K^{own}_{j=EBU}$ which means that the expected stability costs originating from a failure of parent banks in EBU countries on opt-in countries is small.

In contrast to the CEE countries, Denmark and Sweden are all characterized by a moderate share of inward banking claims, since banking markets are dominated by domestic banks (compare Figure 6). However, the share of outward banking claims towards EBU countries is relatively large compared with CEE countries. Indeed, banks from these two countries are among the top ten largest EU banks outside the banking union (five from the UK, four from Sweden, and one from Denmark), and most of these banks also hold large asset portfolios within EBU countries (Hüttl and Schoenmaker (2016)). This can be modeled by a large $\beta_{i\in Dk;Se}$ which makes EBU membership rather unwelcome. Domestic decision makers have to fear that the supranational regulator would charge larger capital requirements than preferred by the national regulators. Denmark is a special case because its major internationally active bank (Danske Bank Group) runs a subsidiary only in Finland, but uses branches in the other Nordic countries (Darvas and Wolff (2013)). Since the subsidiary belongs to the three largest banks in Finland, it is already regulated by the ECB; the branches are supervised by the Danish Financial Supervisory Authority and their deposits are insured by the Danish deposit



Source: ECB consolidated banking Data

Figure 6: Share of domestic and foreign credit institutions



Source: ECB structural indicators

Figure 7: Distribution of foreign Branches and Subsidiaries of EU countries 2014

insurance. In consequence, bank regulation in Denmark has barely any externalities and the decision whether or not to join EBU is not very much dependent on capital regulations.

5. Conclusion

The purpose of the present paper is to analyze the incentives of a single country to join a banking union and to analyze how the structure of international banking influences the decision of a national regulator to transfer supervisory powers to a supranational agency. We concentrate on capital requirements. Differences between national and supranational regulation occur because (i) the supranational regulator considers the expected return to all agents from investments abroad, while the national regulator only considers depositors' losses (as a host country of foreign subsidiaries) and banks' profits (as a home country for domestic parent banks), and (ii) in contrast to the supranational regulator, the national regulator ignores total expected stability costs occurring to the foreign country because of multinational bank activity.

Consequently, a country hosting many subsidiaries joins a banking union if financial stability in the host country is relatively dependent from parent banks' performance. The implication for a country with many banks owning subsidiaries is vice versa. The possibility of branching adds a further effect because it allows the national regulators to supervise projects realized in the foreign country. Both, national and supranational regulation are relaxed if projects realized by branching are relatively profitable; they are tightened, otherwise. The possibility of branching may therefore intensify or attenuate the above effects depending on project profitability. The results provide a possible explanation why some EU Member States countries currently hesitate to join the European Banking Union.

Our analysis rests on a number of assumptions and it is worthwhile to check how critical they are. First, we assumed that subsidiaries of multinational banks have only small external liabilities because they receive equity capital from their parent bank but raise deposits domestically. This is in line with recent developments in CEECs showing that the traditional funding model ruling before the financial crisis (with parent banks funding the lending of their subsidiaries) has been declining in recent years (European Central Bank (2013)).

Second, we assumed that the return from a bank's home country project is not used to repay deposits in case of failure of the host-country project (and vice versa). We think that this assumption is legitimated in case of multinational banking because foreign subsidiaries form legally independent entities with no obligations for the parent bank to make subsequent capital contributions in case of failure by the subsidiary. The assumption, however, is less justified in the case of branches, which are not foreign incorporated stand-alone entities. Instead, losses have to be covered either by the parent bank or by the home-country deposit insurer. Dropping the assumption implies that returns from a successful project are used to repay losses (to depositors) from a failing project. This mitigates, but does not eliminate the moral hazard problem. Therefore, the bank's monitoring effort is larger but still decreasing in deposits. The mechanisms and qualitative results are thus unaffected by the assumption.

Third, we assumed that banking structures in the home and foreign countries were exogenous and in particular that the masses of projects financed at home and abroad were independent from the regulatory regimes. Abstracting from endogenous banking structures allows us to focus on the effect of the respective strategies on regulators' incentives. While we think, that this assumption is justified at least in the short- or medium run, there is also some evidence showing that other factors than regulatory environment, such as the banks' sizes, the concentration in the banking sector, and the existence of a financial center are more important determinants for the banks' internationalization strategies (Focarelli and Pozzolo (2005); Darvas and Wolff (2013); Ohls et al. (2016)). If these masses were endogenous, in our model decreasing capital requirements would induce domestic banks to convert subsidiaries into branches or to reduce their international activity (as in Calzolari et al. (2016)). Whether this decreases or increases optimal national capital requirements is per se ambiguous: At the one hand, increasing the national capital requirement relieves the domestic deposit insurance and decreases domestic total expected stability costs, because the number of foreign-owned subsidiaries decreases. At the other hand, the national regulator loses regulatory power over banks that decide to convert branches to subsidiaries and may incentivize the foreign regulator to choose an even stricter regulation. The consequences for a regulator's incentive to accept supranational regulation also are ambiguous.

Fourth, the analysis focused only on the setting of capital requirements and abstracted from other possible aspects of a banking union, such as a common bank resolution regime and a single deposit insurance scheme. In particular, we did not analyze any interactions between the several elements of a banking union. We did not consider how a country's decision to submit the setting of capital requirements to a supranational regulator interacts with its incentives to do the same for the other policy elements of the banking union.

Fifth, in the present model capital requirements set by the supranational regulator may differ for different countries. Assuming that this is not feasible implies less flexibility for the supranational regulator. This makes supranational regulation more unattractive and may imply in some cases that central regulation is not even preferred from a supranational point of view. The issue of uniform supranational capital requirements is discussed by Dell'Ariccia and Marquez (2006).

A last aspect concerns the normative implications of the analysis and covers the questions how membership in a banking union could be made more attractive for outsiders given that participation is beneficial for all countries in total. The major problem caused by foreign subsidiaries of multinational banks is that they are international in profits, but national in losses, since profits are transferred to the home-country parent banks, but losses to depositors are covered by host-country deposit insurances (Reich and Kawalec (2015)). A ban of profit transfers from the host-country subsidiary to the home-country parent bank would inhibit international capital flows and is likely to impair the international allocation of capital. A more fruitful alternative could be to make multinational banks subject to a multinational deposit insurance scheme, such as the European Deposit Insurance Scheme (EDIS) which will start in 2017. Such a scheme could increase the attractiveness of EBU for non-participating countries.

Acknowledgments

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Appendix – Proofs

Proof of Lemma 1: Considering the first and the second derivative of W with respect to D,

$$\frac{\partial W}{\partial D} = \frac{R^2-1}{2c} - 1 + \frac{1}{2c\left(1+D\right)^2},$$
$$\frac{\partial^2 W}{\partial D^2} = -\frac{1}{c\left(1+D\right)^3} < 0,$$

we first find that $\frac{\partial W}{\partial D} > 0$ for all D if $2c - R^2 + 1 < 0$. Second, it is never true that for all D: $\frac{\partial W}{\partial D} < 0$, because $R^2 > \left(\frac{c}{2}+1\right)^2 > 2c$. Thus, if $2c > R^2 - 1$, then

$$D^* = \sqrt{\frac{1}{2c+1-R^2}} - 1 \tag{16}$$

with $D^* > 0$, because $R^2 > 2c$. □

Proof of Lemma 2: The first order condition is given by

$$\frac{\partial W_i}{\partial D_i} = \frac{K_i^{own}}{2c}\left(R_i^2 - 2c - 1\right) - \frac{K_j^{mult}}{c}\left(c - R_i + 1\right) + \frac{K_i^{own} + 2K_j^{mult}}{2c\left(1+D_i\right)^2} \stackrel{!}{=} 0$$

We can see that $\frac{K_i^{own}}{2c}\left(R_i^2 - 2c - 1\right) - \frac{K_j^{mult}}{c}\left(c - R_i + 1\right) < 0$ needs to hold – otherwise the derivative is strictly positive and the national regulator does not impose a capital requirement ($\kappa_i^* = 0$). We can transform the first order condition to

$$\left(1+D_i\right)^2 = \frac{K_i^{own} + 2K_j^{mult}}{K_i^{own}\left(2c - R_i^2 + 1\right) + 2K_j^{mult}\left(c - R_i + 1\right)}.$$

If the inequality $\frac{K_i^{own}+2K_j^{mult}}{K_i^{own}\left(2c-R_i^2+1\right)+2K_j^{mult}(c-R_i+1)} > 1$ does not hold, the partial derivative is negative for all D_i and the national regulator chooses $D_i^* = 0$. Otherwise, further transformation of the first order condition yields:

$$D_i^* = \sqrt{\frac{K_i^{own} + 2K_j^{mult}}{K_i^{own}\left(2c - R_i^2 + 1\right) + 2K_j^{mult}\left(c - R_i + 1\right)}} - 1.$$

It is easy to see that the maximum allowed leverage is increasing in R_i and decreasing in c. We form the derivative of $(1 + D_i^*)^2$ with respect to K_i^{own} (with respect to K_i^{mult}) to see that the maximum leverage is increasing in K_i^{own} (decreasing in K_i^{mult}):

$$\frac{\partial\left(1 + D_i^*\right)^2}{\partial K_i^{own}} = \frac{2K_j^{mult}(\overbrace{R_i^2}^{\geq\left(\frac{c}{2}+1\right)^2} - \overbrace{R_i}^{\leq c} - c)}{\left[K_i^{own}\left(2c - R_i^2 + 1\right) + 2K_j^{mult}\left(c - R_i + 1\right)\right]^2} \geq 0,$$

$$\frac{\partial\left(1 + D_i^*\right)^2}{\partial K_j^{mult}} = \frac{-2K_i^{own}(\overbrace{R_i^2}^{\geq\left(\frac{c}{2}+1\right)^2} - \overbrace{R_i}^{\leq c} - c)}{\left[K_i^{own}\left(2c - R_i^2 + 1\right) + 2K_j^{mult}\left(c - R_i + 1\right)\right]^2} \leq 0.$$

□

Proof of Proposition 1: The partial derivative of country i's welfare with respect to D_j is given by

$$\frac{\partial W_i}{\partial D_j} = \frac{K_i^{mult}}{2c}\left(R_j^2 - 2R_j + 1\right) - \frac{K_i^{mult} + 2\beta_j K_j^{own} C}{2c\left(1 + D_j\right)^2}. \tag{17}$$

Considering also the second derivative,

$$\frac{\partial^2 W_i}{\left(\partial D_j\right)^2} = \frac{K_i^{mult} + 2\beta_j K_j^{own} C}{c\left(1 + D_j\right)^3} \geq 0,$$

we can see that welfare W_i is convex in D_j. Therefore, the welfare maximizing leverage D_j is either 0 or ∞. Country i's welfare can be written in the following way:

$$W_i = X + K_i^{mult} \underbrace{\frac{\left(R_j^2 - 2R_j\right) D_j\left(1 + D_j\right) + D_j^2}{2c\left(1 + D_j\right)}}_{\geq 0, \to\infty \text{ for } D_j\to\infty} - \frac{\beta_j K_j^{own} C}{c} \cdot \underbrace{\frac{D_j}{\left(1 + D_j\right)}}_{\to 1 \text{ for } D_j\to\infty},$$

where X summarizes all terms not depending on D_j and represents the welfare level at $D_j = 0$. As the maximum leverage of country j approaches infinity, or equivalently as the capital requirement approaches zero, welfare goes to infinity. Welfare of country i is maximized with respect to the regulation of country j if the regulator of country j does not impose a capital requirement.

Since the derivative of W_i with respect to D_j is given by (17),country i's welfare is minimized for

$$\overline{D}_j := \sqrt{\frac{K_i^{mult} + 2\beta_j K_j^{own} C}{K_i^{mult}\left(R_j^2 - 2R_j + 1\right)}} - 1. \tag{18}$$

The minimizing value $\overline{D}_j$ is not necessarily positive. Country i's welfare W_i is increasing in D_j if $D_j > \overline{D_j}$ and decreasing otherwise. If $\overline{D}_j \leq 0$, then for all $D_j \in [0, \infty)$ welfare W_i is increasing in D_j, which corresponds to a positive external effect of regulation in country j on country i's welfare. The inequality $\overline{D_j} \leq 0$ holds if and only if

$$C \leq \frac{K_i^{mult}}{2\beta_j K_j^{own}} \underbrace{\left(R_j^2 - 2R_j\right)}_{\geq \left(\frac{c}{2}+1\right)^2 - 2c \geq 0} =: \overline{C}_j,$$

which proves the claim. □

Proof of Lemma 3: The first order conditions are given by

$$\begin{aligned}\frac{\partial W_{i+j}}{\partial D_i} &= K_i^{own}\left[\frac{R_i^2 - 1 - 2c}{2c} + \frac{1}{2c\left(1+D_i\right)^2}\right] \\ &+ K_j^{mult}\left[\frac{R_i^2 - 1 - 2c}{2c} + \frac{1}{2c\left(1+D_i\right)^2}\right] - \beta_i K_i^{own}\frac{C}{c\left(1+D_i\right)^2}.\end{aligned}$$

The derivation of conditions (I) and (II) as well as of the capital requirements proceeds analogously to the proof of Lemma **2**. It is easy to see that $\hat{\kappa}_i$ is increasing in c, C, β_i and decreasing in R_i. Additionally, we have

$$\frac{\partial\left(1+\hat{D}_i\right)^2}{\partial K_i^{own}} = \frac{-2C\beta_i K_j^{mult}}{\left(K_i^{own} + K_j^{mult}\right)^2\left(2c - R_i^2 + 1\right)} < 0,$$

$$\frac{\partial\left(1+\hat{D}_i\right)^2}{\partial K_j^{mult}} = \frac{2C\beta_j K_j^{own}}{\left(K_i^{own} + K_j^{mult}\right)^2\left(2c - R_i^2 + 1\right)} > 0,$$

which proves the rest. □

Proof of Proposition 2: We have $\hat{D}_i > D_i^*$ if and only if

$$\frac{K_i^{own} + K_j^{mult} - 2C\beta_i K_i^{own}}{\left(K_i^{own} + K_j^{mult}\right)\left(2c - R_i^2 + 1\right)} > \frac{K_i^{own} + 2K_j^{mult}}{K_i^{own}\left(2c - R_i^2 + 1\right) + 2K_j^{mult}\left(c - R_i + 1\right)}$$

$$\Leftrightarrow C < \frac{K_j^{mult}\left(K_i^{own} + K_j^{mult}\right)\left(R_i^2 - R_i - c\right)}{\beta_i K_i^{own}\left[K_i^{own}\left(2c - R_i^2 + 1\right) + 2K_j^{mult}\left(c - R_i + 1\right)\right]} =: \widetilde{C}_i$$

It is easy to see that $\widetilde{C}_i$ is increasing in R_i and decreasing in β_i and c. Additionally, $\widetilde{C}_i$ is increasing in K_j^{mult}, because

$$\frac{\partial \widetilde{C}}{\partial K_j^{mult}} = \frac{R_i^2 - R_i - c}{\beta_i K_i^{own}} \cdot \frac{\left[(K_i^{own})^2 + 2K_i^{own}K_j^{mult}\right]\left(2c - R_i^2 + 1\right) + 2\left(K_j^{mult}\right)^2\left(c - R_i + 1\right)}{\left[K_i^{own}\left(2c - R_i^2 + 1\right) + 2K_j^{mult}\left(c - R_i + 1\right)\right]^2} > 0$$

and $\widetilde{C}_i$ is decreasing in K_i^{own}, because

$$\frac{\partial \widetilde{C}}{\partial K_i^{own}} = \frac{K_j^{mult}}{\beta_i}\left(R_i^2 - R_i - c\right) \cdot \frac{-K_j^{mult}\left[K_i^{own}\left(2c - R_i^2 + 1\right) + 2K_j^{mult}\left(c - R_i + 1\right)\right] - \left(K_i^{own} + K_j^{mult}\right)K_i^{own}\left(2c - R_i^2 + 1\right)}{(K_i^{own})^2\left[K_i^{own}\left(2c - R_i^2 + 1\right) + 2K_j^{mult}\left(c - R_i + 1\right)\right]} < 0$$

Furthermore, $C \leq \overline{C}$ implies $C \leq \widetilde{C}$: We have $\hat{D}_i > D_i^*$ if and only if

$$\frac{K_i^{own} + 2K_j^{mult} - \left(K_j^{mult} + 2C\beta_i K_i^{own}\right)}{K_i^{own}\left(2c - R_i^2 + 1\right) + 2K_j^{mult}\left(c - R_i + 1\right) - K_j^{mult}\left(R_i^2 - 2R_i + 1\right)} > \frac{K_i^{own} + 2K_j^{mult}}{K_i^{own}\left(2c - R_i^2 + 1\right) + 2K_j^{mult}\left(c - R_i + 1\right)}$$

which is equivalent to

$$\frac{K_j^{mult} + 2C\beta_i K_i^{own}}{K_j^{mult}\left(R_i^2 - 2R_i + 1\right)} < \left(1 + D_i^*\right)^2.$$

The last inequality is true since the left-hand side is smaller than one, because $C \leq \overline{C}$, while the right-hand side is larger than one. □

Proof of Lemma 4: The partial derivative of joint welfare with respect to D_i is given by

$$\frac{\partial W_{i+j}}{\partial D_i} = K_i^{own}\left[\frac{R_i^2-1-2c}{2c}+\frac{1}{2c\left(1+D_i\right)^2}\right] - K_j^{mult}\left[\frac{c-R_i+1}{c}-\frac{1}{c\left(1+D_i\right)^2}\right]$$
$$+K_j^{mult}\left[\frac{R_i^2-2R_i+1}{2c}-\frac{1}{2c\left(1+D_i\right)^2}\right]-\beta_i K_i^{own}\frac{C}{c\left(1+D_i\right)^2}.$$

in case of national regulation (i.e., $D_i = D_i^*$) the first line is equal to zero, but the second line is not. Therefore, joint welfare can be increased by changing D_i. Since $\frac{\partial^2 W_{i+j}}{\partial D_i^2} = \frac{-K_i^{own}-K_j^{mult}+2CK_j^{mult}+2C\beta_i K_i^{own}}{c(1+D_i)^3} < 0$ and $\left.\frac{\partial W_{i+j}}{\partial D_i}\right|_{D_i=\hat{D}_i} = 0$, welfare cannot be increased further by changing D_i if $D_i = \hat{D}_i$ holds. The consideration for D_j is completely analogous. Therefore, we have $W_{i+j}\left(\hat{D}_i,\hat{D}_j\right) \geq W_{i+j}\left(D_i^*,D_j^*\right)$. Equality holds if and only if there are no external effects. □

Proof of Proposition 3: We denote the participation constraint (11) by $LHS \leq RHS$. Using (18) RHS can be rewritten as:

$$RHS = \left(\hat{D}_j - D_j^*\right)\left[1-\frac{\left(1+\overline{D}_j\right)^2}{\left(1+D_i^*\right)\left(1+\hat{D}_i\right)}\right]K_i^{mult}\left(R_j^2-2R_j+1\right).$$

(a1) We have

$$\frac{\partial\frac{\left(\hat{D}_i-D_i^*\right)^2}{1+\hat{D}_i}}{\partial K_j^{mult}} = \frac{\left(\hat{D}_i-D_i^*\right)}{\left(1+\hat{D}_i\right)^2}\cdot\left[\underbrace{\left(\frac{\partial\hat{D}_i}{\partial K_j^{mult}}-\frac{\partial D_i^*}{\partial K_j^{mult}}\right)}_{\geq 0}\left(1+\hat{D}_i\right)+\underbrace{\frac{\partial\frac{1+\hat{D}_i}{1+D_i^*}}{\partial K_j^{mult}}}_{\geq 0}\cdot\left(1+D_i^*\right)^2\right].$$

Therefore, $\frac{\left(\hat{D}_i-D_i^*\right)^2}{1+\hat{D}_i}$ is increasing if $\hat{D}_i > D_i^*$ and decreasing otherwise. Using Proposition 2 and that $\left[K_i^{own}\left(2c-R_i^2+1\right)+2K_j^{mult}\left(c-R_i+1\right)\right]$ is increasing in K_j^{mult}, this proves the claim.

(a2) Taking the partial derivative of RHS with respect to K_i^{mult} yields:

$$\frac{\partial RHS}{\partial K_i^{mult}} = \overbrace{\frac{\partial \hat{D}_j}{\partial K_i^{mult}} \cdot K_i^{mult}\left(R_j^2 - 2R_j + 1\right)}^{(i)} - \overbrace{\frac{\partial D_j^*}{\partial K_i^{mult}}\left[K_i^{mult}\left(R_j^2 - 2R_j + 1\right) - \frac{K_i^{mult} + 2C\beta_j K_j^{own}}{\left(1 + D_j^*\right)^2}\right]}^{(ii)}$$
$$+ \underbrace{\left(\hat{D}_j - D_j^*\right)\left(R_j^2 - 2R_j + 1\right) - \frac{\hat{D}_j - D_j^*}{\left(1 + D_j^*\right)\left(1 + \hat{D}_j\right)}}_{(iii)} - \underbrace{\frac{\partial \hat{D}_j}{\partial K_i^{mult}} \cdot \frac{K_i^{mult} + 2C\beta_j K_j^{own}}{\left(1 + \hat{D}_j\right)^2}}_{(iv)}$$

Terms (i) and (iv) can be ignored since they are decreasing in C and approach zero if C goes to zero. The second term (ii) is smaller than zero for sufficiently small C, because $\frac{\partial D_j^*}{\partial K_i^{mult}} \leq 0$ and $R_j^2 - 2R_j + 1 \geq \left(\frac{c}{2} + 1\right)^2 - 2c + 1 \geq 1 \geq \frac{1}{\left(1+D_j^*\right)^2}$. Term (iii) is larger than zero for sufficiently small C, because in this case $\hat{D}_j \geq D_j^*$ and again $R_j^2 - 2R_j + 1 \geq 1 \geq \frac{1}{\left(1+D_j^*\right)\left(1+\hat{D}_j\right)}$. Thus, the derivative of RHS with respect to K_i^{mult} is positive for sufficiently small K_i^{mult}.

(b1) We have

$$\frac{\partial \frac{\left(\hat{D}_i - D_i^*\right)^2}{1+\hat{D}_i}}{\partial K_i^{own}} = \frac{\left(\hat{D}_i - D_i^*\right)}{\left(1 + \hat{D}_i\right)^2} \cdot \left[\underbrace{\left(\frac{\partial \hat{D}_i}{\partial K_i^{own}} - \frac{\partial D_i^*}{\partial K_i^{own}}\right)}_{\leq 0}\left(1 + \hat{D}_i\right) + \underbrace{\frac{\partial \frac{1+\hat{D}_i}{1+D_i^*}}{\partial K_i^{own}}}_{\leq 0} \cdot (1 + D_i^*)^2\right].$$

Therefore, $\frac{\left(\hat{D}_i - D_i^*\right)^2}{1+\hat{D}_i}$ is increasing if $\hat{D}_i < D_i^*$ and decreasing otherwise. Using Proposition 2 and that $\left[K_i^{own}\left(2c - R_i^2 + 1\right) + 2K_j^{mult}\left(c - R_i + 1\right)\right]$ is increasing in K_i^{own}, this proves the claim. If $\beta_i K_i^{own}$ changes while $\left(1 - \beta_i\right) K_i^{own}$ remains at the same value, the proof proceeds completely analogous.

(b2) If C is sufficiently large, we have $\hat{D}_j = 0$. In this case RHS is given by

$$RHS = -D_j^* K_i^{mult}\left(R_j^2 - 2R_j + 1\right) + \frac{D_j^*}{1 + D_j^*}\left(K_i^{mult} + 2C\beta_j K_j^{own}\right).$$

Then, the partial derivative with respect to K_j^{own} is given by

$$\frac{\partial RHS}{\partial K_j^{own}} = -\underbrace{\frac{\partial D_j^*}{\partial K_j^{own}}}_{\geq 0} K_i^{mult}\left(R_j^2 - 2R_j + 1\right) + \frac{\partial D_j^*}{\partial K_j^{own}} \cdot \frac{\left(K_i^{mult} + 2C\beta_j K_j^{own}\right)}{\left(1 + D_j^*\right)^2} + \frac{D_j^*}{1 + D_j^*} \cdot 2C\beta_j$$

which is positive if C is sufficiently large. If $\beta_j K_j^{own}$ increases, while $(1-\beta_j) K_j^{own}$ stays constant, the proof proceeds completely analogous.

(c1) Changing β_i only affects the left-hand side of the participation constraint. Increasing β_i decreases $\hat{D}_i$ and leaves D_i^* unchanged. We have

$$\frac{\partial}{\partial \beta_i} \frac{\left(\hat{D}_i - D_i^*\right)^2}{\left(1+\hat{D}_i\right)} = \frac{\hat{D}_i - D_i^*}{\left(1+\hat{D}_i\right)^2} \cdot \underbrace{\frac{\partial \hat{D}_i}{\partial \beta_i}}_{\leq 0} \left(1+\hat{D}_i+1+D_i^*\right).$$

Therefore, LHS is increasing with respect to β_i if $D_i^* \geq \hat{D}_i$ and decreasing otherwise.

(c2) Changing β_j only affects the right-hand side of the participation constraint. Increasing β_j decreases $\hat{D}_j$ and thus also decreases $\left(\hat{D}_j - D_j^*\right)$ and increases $\frac{K_i^{mult}+2C\beta_j K_j^{own}}{\left(1+D_j^*\right)\left(1+\hat{D}_j\right)}$. Therefore, RHS is increasing in β_j if $D_j^* \geq \hat{D}_j$ and decreasing otherwise. □

Proof of Lemma 5:

Step 1: Determine $D_i^{cb,*}$

We have

$$\frac{\partial W_i^{cb}}{\partial D_i} = \frac{K_i^{own}}{2c}\left(R_i^2-2c-1\right)+\frac{\delta K_i^{cb}}{2c}\left(R_j^2-2\frac{c}{\delta}-1\right)-2K_j^{mult}\left(c-R_i+1\right)+\frac{K_i^{own}+\delta K_i^{cb}+2K_j^{mult}}{2c\left(1+D_i\right)^2}.$$

Setting this derivative equal to zero and solving for D_i yields that the national regulator of country i imposes a capital requirement $\kappa_i^{cb} \in (0,1)$ if and only if

$$K_i^{own}+\delta K_i^{cb}+2K_j^{mult} > K_i^{own}\left(2c-R_i^2+1\right)+\delta K_i^{cb}\left(2\frac{c}{\delta}-R_j^2+1\right)+2K_j^{mult}\left(c-R_i+1\right) > 0.$$

In this case, he sets

$$D_i^{cb,*} = \sqrt{\frac{K_i^{own}+\delta K_i^{cb}+2K_j^{mult}}{K_i^{own}\left(2c-R_i^2+1\right)+\delta K_i^{cb}\left(2\frac{c}{\delta}-R_j^2+1\right)+2K_j^{mult}\left(c-R_i+1\right)}} - 1.$$

Furthermore,

$$\frac{\partial\left(1+D_i^{cb,*}\right)^2}{\partial K_i^{cb}} = \delta \cdot \frac{K_i^{own}\left(-2\frac{c}{\delta}\left(1-\delta\right)-R_i^2+R_j^2\right)+2K_j^{mult}\left(-\frac{c}{\delta}\left(2-\delta\right)-R_i+R_j^2\right)}{\left[K_i^{own}\left(2c-R_i^2+1\right)+\delta K_i^{cb}\left(2\frac{c}{\delta}-R_j^2+1\right)+2K_j^{mult}\left(c-R_i+1\right)\right]^2}.$$

Therefore, $\kappa_i^{cb,*}$ is increasing in K_i^{cb} if

$$K_i^{own}\left(-2\frac{c}{\delta}(1-\delta)-R_i^2+R_j^2\right)+2K_j^{mult}\left(-\frac{c}{\delta}(2-\delta)-R_i+R_j^2\right)\leq 0$$

or equivalently

$$R_j\leq\sqrt{\frac{K_i^{own}\left(2\frac{c}{\delta}(1-\delta)+R_i^2\right)+2K_j^{mult}\left(\frac{c}{\delta}(2-\delta)+R_i\right)}{K_i^{own}+2K_j^{mult}}}=:R_j^*.$$

Step 2: Determine $\hat{D}_i^{cb}$

Taking the partial derivative of W_{i+j} with respect to D_i yields:

$$\frac{\partial W_{i+j}}{\partial D_i}=\frac{K_i^{own}+K_j^{mult}}{2c}\left(R_i^2-2c+1\right)+\frac{\delta K_i^{own}}{2c}\left(R_j^2-2\frac{c}{\delta}+1\right)+\frac{K_i^{own}+K_j^{mult}+\delta K_i^{cb}-2\beta_i K_i^{own}C}{2c\left(1+D_i\right)^2}$$

We need $K_i^{own}+K_j^{mult}+\delta K_i^{cb}-2\beta_i K_i^{own}C>0$ such that W_{i+j} is not convex in D_i (otherwise, the regulator's problem is solved by a corner solution). Then, $\left(K_i^{own}+K_j^{mult}\right)\left(R_i^2-2c+1\right)+\delta K_i^{cb}\left(R_j^2-2\frac{c}{\delta}+1\right)<0$ needs to hold, otherwise, the partial derivative is larger than zero for all D_i. Lastly, if additionally $K_i^{own}+K_j^{mult}+\delta K_i^{cb}-2\beta_i K_i^{own}C<\left(K_i^{own}+K_j^{mult}\right)\left(2c-R_i^2+1\right)+\delta K_i^{cb}\left(2\frac{c}{\delta}-R_j^2+1\right)$ holds, then the partial derivative is negative for all D_i.

Setting the partial derivative equal to zero and solving for D_i yields that the benevolent supranational regulator sets $\kappa_i\in(0,1)$ if and only if the following conditions hold:

$$K_i^{own}+K_j^{mult}+\delta K_i^{cb}-2\beta_i K_i^{own}C>\left(K_i^{own}+K_j^{mult}\right)\left(2c-R_i^2+1\right)+\delta K_i^{cb}\left(2\frac{c}{\delta}-R_j^2+1\right)>0$$

In this case the supranational regulator chooses

$$\hat{D}_i^{cb}=\sqrt{\frac{K_i^{own}+K_j^{mult}+\delta K_i^{cb}-2\beta_i K_i^{own}C}{\left(K_i^{own}+K_j^{mult}\right)\left(2c-R_i^2+1\right)+\delta K_i^{cb}\left(2\frac{c}{\delta}-R_j^2+1\right)}}-1.$$

Step 3: Actual proof

We have $\hat{D}_i^{cb}>D_i^{cb,*}$ if and only if

$$\begin{aligned}&\frac{K_i^{own}+K_j^{mult}+\delta K_i^{cb}-2\beta_i K_i^{own}C}{\left(K_i^{own}+K_j^{mult}\right)\left(2c-R_i^2+1\right)+\delta K_i^{cb}\left(2\frac{c}{\delta}-R_j^2+1\right)}\\&>\frac{K_i^{own}+\delta K_i^{cb}+2K_j^{mult}}{K_i^{own}\left(2c-R_i^2+1\right)+\delta K_i^{cb}\left(2\frac{c}{\delta}-R_j^2+1\right)+2K_j^{mult}\left(c-R_i+1\right)}\end{aligned}$$

or equivalently

$$2K_j^{mult}\left(K_i^{own}+K_j^{mult}\right)\left(R_i^2-R_i-c\right)+\delta K_i^{cb}K_j^{mult}\left(R_i^2+R_j^2-2R_i-2\frac{c}{\delta}\right)$$
$$>2\beta_i K_i^{own}C\left[K_i^{own}\left(2c-R_i^2+1\right)+\delta K_i^{cb}\left(2\frac{c}{\delta}-R_j^2+1\right)+2K_j^{mult}\left(c-R_i+1\right)\right].$$

The threshold $\widetilde{C}^{cb}$ can be derived directly from the above inequality. Also, it can be seen from the above inequality that $\widetilde{C}^{cb}$ is increasing in R_i. □

Proof of Proposition 4: Changing K_j^{cb} does not influence the left-hand side of the participation constraint. If C is sufficiently large, we have $\hat{D}_j^{cb}=0$. The right-hand side of the participation constraint then simplifies to

$$D_j^{cb,*}\left[\frac{K_i^{mult}+2\beta_j K_j^{own}C}{1+D_j^{cb,*}}-K_i^{mult}\left(R_j^2-2R_j+1\right)\right]$$

with the partial derivative

$$\frac{\partial RHS}{\partial K_j^{cb}}=\frac{\partial D_j^{cb,*}}{\partial K_j^{cb}}\cdot\frac{K_i^{mult}+2\beta_j K_j^{own}C}{\left(1+D_j^{cb,*}\right)^2}-\frac{\partial D_j^{cb,*}}{\partial K_j^{cb}}K_i^{mult}\left(R_j^2-2R_j+1\right).$$

If R_i is sufficiently small, then $\frac{\partial D_j^{cb,*}}{\partial K_j^{cb}}\leq 0$ and thus $\frac{\partial RHS}{\partial K_j^{cb}}\leq 0$, because C is sufficiently large. Analogously, if R_i is sufficiently large, then $\frac{\partial D_j^{cb,*}}{\partial K_j^{cb}}\geq 0$ and $\frac{\partial RHS}{\partial K_j^{cb}}\geq 0$. □

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