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Regulatory and Bailout Decisions in a Banking Union

Abstract

We model a banking union of two countries whose banking sectors differ in their average probability of failure and externalities between the two countries arise from cross-border bank ownership. The two countries face (i) a regulatory decision of which banks are to be shut down before they can go bankrupt, and (ii) a loss allocation – or bailout – decision of who pays for banks that have failed despite regulatory oversight. Each of these choices can either be taken in a centralized or in a decentralized way. In our benchmark model the two countries always agree on a centralized regulation policy. In contrast, bailout policies are centralized only when international spillovers from cross-border bank ownership are strong, and banking sectors are highly profitable.

JEL-Codes: G280, F330, H870.

Keywords: banking union, bank regulation, bailout policies.

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1 Introduction

The financial crisis of 2007/08 has led to increased regulation of banking sectors worldwide. In the United States, for example, the Dodd-Frank Act contains a wide variety of measures that limit the risk exposure of banks and protect U.S. taxpayers from having to bail out banks in case of failure. In Europe, the financial crises led to the Eurocrisis, in the course of which several governments in the Eurozone found themselves unable to refinance their debt in international capital markets. In several of these countries, such as Cyprus, Greece, and Ireland, the government debt crisis was directly linked to liquidity and solvency problems in the national banking sectors. In response to this instability of national banking sectors, and their reinforcing effect on government debt crises, the Eurozone countries have, since 2012, established a banking union.[1]

Bank regulators and governments face two fundamental, and sequential, policy decisions. The first is an ex-ante *regulatory* decision: which banks are allowed to continue operation, and which banks are closed down to prevent them from going bankrupt. The second is an ex-post *loss allocation* decision: who pays for the losses of banks that have failed despite regulatory oversight? This decision importantly includes the decision of whether to bail out some of the failed banks. For a banking union, each of these decisions can either be centralized, or be left in the hands of national governments.

One of the features of the European banking union is an asymmetry with respect to the riskiness of banks in its member countries. Figure 1 shows the distribution of creditworthiness ratings for the 800 largest banks in the Eurozone, divided between two groups of member countries labelled 'North' and 'South'.[2] The figure shows that banks in 'South' have lower ratings of creditworthiness throughout the distribution, with only 3% rated as AAA or AA (as compared to 13% in 'North'), but 38% of the banks in 'South' are rated in the lowest categories B, C and D (as compared to 18% in 'North'). These differences critically affect the viability of coordinated decision-making in the banking union.

The European banking union presently rests on two pillars. The first is a common

[1] Member states of the European Union, which are not members of the Eurozone, can also participate in the European banking union on a voluntary basis. For an overview of the policy issues relating to financial regulation in Europe, see Beck, Carletti and Goldstein (2016).

[2] The 'North' group includes Austria, Belgium, Estonia, Finland, France, Germany, Ireland, Latvia, Lithuania, Luxembourg, Netherlands, Slovakia and Slovenia. The 'South' group covers Cyprus, Greece, Italy, Malta, Portugal and Spain.

Table 1: Risk classification of banks in Eurozone member countries

Risk category	North number	North percent	South number	South percent
AAA-AA	76	13%	9	3%
A	118	21%	24	10%
BBB	127	23%	60	23%
BB	140	25%	68	26%
B-D	100	18%	97	38%
Total	561	100%	258	100%

Source: Own compilation from Bureau van Dijk's ORBIS database (https://orbis.bvdinfo.com). See Appendix B.

supervision – by the European Central Bank – of the largest 130 banks in the Eurozone. The second pillar of the banking union is a common set of rules for the resolution of banks supervised by the ECB that are failing, or are likely to fail. The introduction of a common deposit insurance scheme, which was originally envisaged as a third pillar of the banking union, is instead politically blocked by several member countries, including Germany.

The single supervision mechanism (SSM) establishes centralized regulatory decisions in the European banking union. The single resolution mechanism (SRM), however, foresees a joint financing of the losses from failed banks only to a very limited degree. The resolution mechanism is backed by a common resolution fund, financed by levies on member states' banks, of eventually Euro 55 billion, but this corresponds only to 1% of the covered bank deposits. Moreover, access to this fund is tied to restrictive conditions, including a substantial participation of the bank's creditors ('bail-in').[3] To avoid these strict conditions, which may often be politically unpopular, member states may therefore resort to a national recapitalization of their troubled banks. One example is Italy's national bailout of the bank Monte dei Paschi de Siena with a rescue package of 20 billion Euro, large parts of which came directly from the Italian government.[4] This case indicates that, despite supranational regulation of the largest European banks and

[3] See Hadjiemmanuil (2015) for a detailed account of bank resolution financing in the European Banking Union.

[4] "Italy to bail out Monte dei Paschi di Siena bank." Financial Times, 21 December 2016.

despite the existence, in principle, of a common resolution procedure, bailout decisions for troubled banks will, in practice, often be taken by national governments, and at the costs of taxpayers in the bank's home country (see Hellwig, 2014). In the absence of a common deposit insurance fund, losses from failing banks therefore continue to accrue mostly to the banks' host country.

Against this institutional background, the present paper analyzes centralized versus decentralized decision-making in a banking union with respect to both regulatory decisions and the allocation of losses. With respect to the latter decision, we focus on bailout decisions. In each country, banking sectors are composed of banks that are heterogeneous with respect to their exogenously given success probability. Corresponding to the empirical evidence in Table 1, the distribution of banks' failure probabilities differs in the two countries, leading to asymmetric national banking sectors. Moreover, the model includes cross-border ownership of banks, and it thus incorporates negative spillovers that failing banks in one country have on the neighboring state.

Our analysis proceeds in four stages. In the first stage the policy regime is decided, where both the regulatory decision and the bailout decision can either be centralized, or left decentralized. As a political decision rule, we assume that each of the two different policy measures is centralized only if both national governments agree to it. In the second stage, centralized or decentralized regulatory policies are taken, specifying the minimum success probability that banks must have in order to be allowed to continue their operations. These decisions incorporate both the risk-taking decisions of banks and the costs of bank failure in later stages of the game. In the third stage, banks that pass the regulatory stage decide on the riskiness a their portfolio, given the moral hazard incentives that arise from bailout policies. Finally, in the fourth stage, governments take a bailout decision, which again occurs either at a decentralized or at a centralized level.

In our benchmark model different failure probabilities of national banks are the only asymmetry between the two countries. We show that these differences do not affect the regulatory standard that is set by national regulators; hence regulatory decisions are identical even when regulation policies are decentralized. In this setting, we show that the political equilibrium will always feature a centralized regulatory policy. However, bailout policies will only be centralized when the negative international spillovers arising from failing banks are large, and when the profitability of both national banking sectors is high. High bank profits keep moral hazard effects small in the third stage, and this is more important under centralized than under decentralized bailout policies. Calibrating our model for average domestic ownership shares and bank returns in the Eurozone, we show that these conditions will not be simultaneously fulfilled, and the political equilibrium combines a centralized regulatory policy with decentralized bailout policies. And indeed, this is the situation that currently prevails in the European banking union.

We also consider two extensions of our benchmark model. In the first, the country with the higher failure probability of its banks also faces a higher cost of public bailouts, for example because of its higher government debt. In this case regulation policies between countries differ in the decentralized equilibrium and centralized regulation policy must average over these different policies. As a result an equilibrium with decentralized regulatory *and* decentralized bailout policies becomes possible, if international spillovers from failing banks are small. As a second extension, we assume that the country with the weaker banking sector also has a weak domestic regulator, so that banks in this country can effectively lobby against tight regulation. In this setting centralized regulation policies become a way to avoid the inefficiencies arising from lobbying at the national level. This extension therefore provides another possible rationale for the centralized regulatory but decentralized bailout policies that prevail in the European banking union.

Despite the policy importance of the European banking union, we are not aware of any theoretical study that analyzes bailout decisions on the one hand and regulatory decisions on the other in a common analytical framework. This is the main purpose of the present analysis, which highlights the interdependencies between these two policy choices that arise from banks' moral hazard. In contrast, the existing literature has focused either on regulatory decisions or on bailout decisions taken in isolation.[5]

At the bailout stage, Acharya et al. (2014) model the interaction between bank bailouts and sovereign credit risk and present empirical evidence for a loop between sovereign and bank credit risk. Foarta (2018) takes a political economy perspective with rent-seeking governments that extract resources in the process of providing cross-country transfers for bank bailouts. Goodheart and Schoenmaker (2009) analyze fiscal burden

[5]There is also first event study evidence on the announcement effects of the European banking union. Loipersberger (2018) finds a small, but significant positive effect of the banking union on the stock returns of Eurozone banks, and shows that these benefits were largest in countries with weak regulatory regimes. Pancotto et al. (2020) instead obtain a negative effect on banks' stock prices for the announcement of both the common supervisory and the common resolution regime.

sharing in cross-border banking crises. Faia and Weder di Mauro (2016), Schoenmaker (2018) and Bolton and Oehmke (2019) analyze alternative resolution regimes for multinational banks, and Beck et al. (2020) study the effect of bank resolution on systemic bank risk. Finally, Niepmann and Schmidt-Eisenlohr (2013) analyze bailout decisions in the presence of negative cross-country spillovers, which create a similar argument for centralized bailout policies as exists in this paper.

At the regulatory stage, Beck et al. (2013) and Beck and Wagner (2016) analyze the effects of various cross-country externalities on centralized and decentralized regulatory decisions. Similarly, Nather and Vollmer (2019) analyze the incentives of individual countries to join a banking union. These papers do not consider a subsequent bailout stage, however. Competition in regulatory standards is analyzed by Acharya (2003), Dell'Ariccia and Marquez (2006), Haufler and Maier (2019), Boyer and Kempf (2020) and Gersbach et al. (2020). Among these papers, Acharya (2003) also considers international competition in bailout policies. The regulatory decision in these models is the imposition of minimum capital requirements, however, which is very different from the decision of closing a bank on which we focus here.

Finally, its overall research question links our study to the more general literature analyzing the efficiency and redistributive effects of policy coordination in asymmetric unions or federations (e.g. Persson and Tabellini, 1996; Lockwood, 2002; Alesina, Angeloni and Etro, 2005; Lülfesmann et al., 2015), or the role of fiscal rules and fiscal transfers in a currency union (Ferrero, 2009; Farhi and Werning, 2017).

Section 2 presents the setup of our model. Section 3 analyzes centralized versus decentralized bailout policies. Section 4 turns to the banks' risk-taking choice. Section 5 compares centralized and decentralized regulatory policies. Section 6 addresses the central question of which regulatory and bailout regimes are chosen in the political equilibrium. Section 7 discusses various model extensions and Section 8 concludes.

2 The model

We consider the banking sectors in a region of two countries $i \in \{A, B\}$. Our basic model of banking sector regulation extends the analysis from Beck et al. (2013) and Beck and Wagner (2016) in several dimensions. First, we account for an additional bailout decision that follows the regulation stage. Second, we introduce a moral hazard effect on banks by modelling banks that take excessive risks in response to the bailout policies enacted. Finally, we introduce a fundamental asymmetry between the banking sectors in countries A and B, in the sense that the failure risks of country B's banking sector are higher than those of the banking sector in country A. In all other respects, the two countries are symmetric in our benchmark model.[6]

The mass of banks in each country is normalized to one. Each bank has an initial value of capital equal to $2V$, which it invests in a given project. If the investment is successful, the bank receives an exogenous return RV, with $R > 2$. If the project fails, the bank becomes insolvent. In the absence of a bailout, the bank will then lose its charter value and the value of the bank's capital drops to zero. With a bailout, however, the bank retains its license and its capital loses only a fraction of its initial value. For analytical simplicity we take this fraction to be one half, so that the remaining value of the bank after a bailout is V.[7] Hence the basic motive for government bailouts is to retain the charter value of its banks, as in Acharya (2003).

To finance each bank's operations, a share α comes from domestic investors, whereas the share $(1 - \alpha)$ comes from foreign investors. To simplify notation, we assume that the foreign share is $(1-\alpha)$ for both equity and deposit financing. In this case, the exact composition of the bank's liabilities is irrelevant for our analysis. We will therefore treat both equity holders and depositors as residual claimants of the bank's returns, and we jointly refer to them as the bank's investors.[8] Moreover, we assume that the domestic and foreign investment shares are identical in the two countries. Both the returns to a successful investment and the losses that occur when banks fail and are not bailed out will therefore be borne by domestic and foreign investors with the shares α and $(1 - \alpha)$, respectively. This creates cross-border externalities from both regulatory and bailout decisions. We abstract from any additional, external effects that may be caused by bank failures.[9]

Our model has four stages. In the first stage the two countries decide on whether to centralize their regulatory policies on the one hand, and their bailout policies for failed

[6]Further asymmetries between the two countries will be analyzed in Section 7.

[7]Parameterizing the remaining value of capital after a bailout is conceptually straightforward. However, this offers few additional results while complicating the analysis significantly.

[8]This approach also incorporates intermediate financing instruments, such as contingent convertibles (CoCos). See Beck et al. (2013) for a treatment that allows for different shares of domestic ownership in deposits vs. equity.

[9]Niepmann and Schmidt-Eisenlohr (2013) provide a theoretical analysis of such external contagion effects in international banking.

banks on the other. In the second stage, the regulation of banks is decided either by a common regulator that uses the same regulatory standard for banks in both countries, or by national regulators that may use different standards for their national banks. In the third stage, banks make a risk-taking decision. In the fourth stage, unsuccessful banks are either bailed out with taxpayer money, or go into default. Again this decision can either be centralized, with a common recapitalization fund for banks that are bailed out, or made individually by each country.

The model is solved by backward induction. In the fourth and last stage of the game, governments can bail out banks by injecting public funds to avoid a loss to shareholders. We model the bailout decision as a continuous variable, so that a fraction of all banks with failed projects is saved. In line with our analysis not distinguishing between the different types of creditors of a bank, we also treat bailouts in a broad sense as any measure that uses public funds to avoid losses to private investors of the bank. In this broad definition, bailouts include deposit guarantees, which exist in all OECD countries.[10] By including deposit guarantees in the governments' bailout decision, we also perceive *collective* deposit insurance schemes, such as those originally envisaged in the European banking union, as a common bailout measure.

Bailouts impose real resource costs on the country undertaking them, which arise from diverting taxpayer monies to the banking sector. This implies either that funding opportunities for valuable public projects must be curtailed, or that the country has to increase its level of indebtedness.[11] The benefit from a bailout is that the charter value of the bank is maintained and investors will retain some of their initial capital. The bailout decision in the final stage is taken so as to minimize the total costs arising from failed banks. These total costs are the sum of bailout costs for saved banks, and the costs to investors (i.e. the losses in charter value) for banks which are not saved. Due to cross-border ownership of banks, these gains and losses of bank bailouts will generally differ for a centralized vs. a decentralized (i.e., national) bailout decision.

An important assumption in our model is that governments are unable to make credible no-bailout announcements. Hence the probability of a bailout leads to a moral hazard problem and it affects the bank's risk-taking decision in the third stage of the

[10] See Barth et. al. (2006) for an overview of deposit insurance schemes around the world.

[11] A prime example is Ireland, which fully bailed out its banking sector in 2010. Despite severe spending cuts, the costs of the bailout caused an Irish budget deficit equal to 32% of the country's GDP in 2010 alone.

game. Each of the heterogeneous banks can continuously increase the riskiness of its investment, in exchange for a higher return if the investment succeeds. In the bank's optimum, risk-taking will be 'excessive', in the sense that it reduces national welfare, whenever the probability of a bailout is positive.[12]

In the second stage, the regulator decides whether to shut down a given bank, or let it continue its operations. In making this decision, the regulator factors in both the costs that failing banks impose in the last stage, and the banks' moral hazard that results from bailout expectations. Banks in each country differ exogenously in their probability of success, denoted by λ. The regulatory decision in this stage is therefore based on the signal that the regulator receives about the probability λ with which a given bank's project will succeed. By choosing a minimum success probability $\hat{\lambda}$, below which a bank's operations are terminated, the regulator eliminates all banks with $\lambda < \hat{\lambda}$ from the market. If the bank is shut down at this stage, investors will be able to reclaim their investment at the initial value of $2V$. If the bank continues to operate, it will either succeed (with probability λ) or fail (with probability $1 - \lambda$) in the final stage.

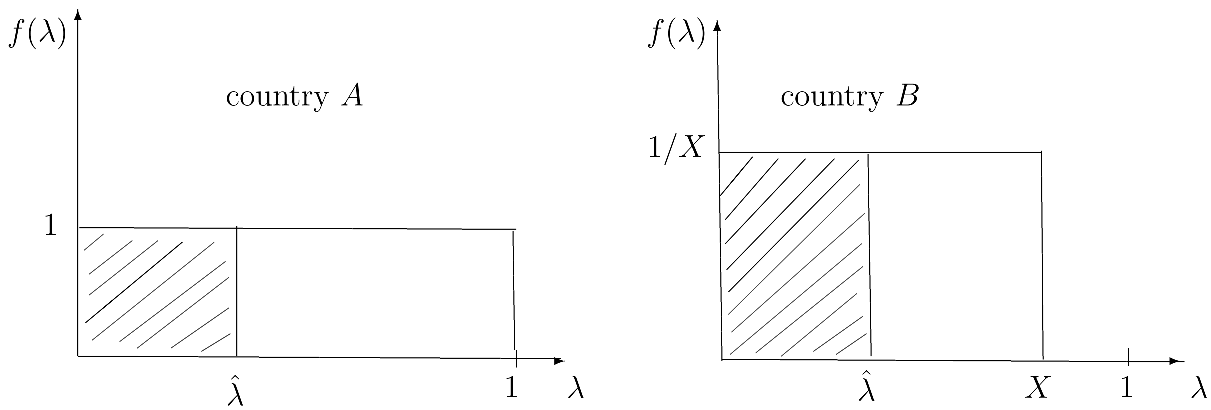
Banking sectors in the two countries differ in their distribution of success probabilities. Specifically, we assume that the probabilities for a bank in country A to succeed are distributed uniformly in the interval [0,1]. In contrast, the probabilities for a bank in country B to succeed are distributed uniformly in the interval [0,X], where $X < 1$. Hence country B's banking sector is generally 'weaker' than that of country A, in the sense of having a lower average probability of success. This is shown in Figure 1, which roughly matches the empirical distribution of banks in the 'North' and the 'South' of the Eurozone in Table 1. Given the different distributions of success probabilities, any common regulatory choice $\hat{\lambda} > 0$ eliminates more banks in country B as compared to country A. These masses correspond to the shaded areas in Figure 1.[13]

Finally, in the first stage, each country compares its welfare under centralized versus decentralized regulation and bailout policies. Our welfare measure in each country includes bank profits and losses accruing to domestic residents, plus the costs of bailouts

[12]Dell'Ariccia et al. (2018) empirically study the trade-offs involved in bank bailout decisions and find evidence for significant increases in risk-taking in response to bailout expectations.

[13]Our analysis does not incorporate differences in the sizes of banking sectors in different countries. With respect to the empirical distribution in Figure 1, note that the total number of banks in 'North' is about twice as large as in 'South', but the 'North' group also includes roughly twice as many countries. Hence the average number of banks *per country* is roughly equal in the two country groups.

Figure 1: Regulation of asymmetric banking sectors



accruing to national taxpayers. A decision is delegated to the supranational level only if both countries agree on this. In principle, there are thus four regimes in which each of the bailout and regulation policies is taken either nationally or supranationally. We will, however, disregard the scenario of common bailout policies following national regulatory decisions, as it seems unlikely that governments are willing to co-finance failed foreign banks that they haven't been able to regulate in a prior stage. This leaves three possible regimes in our model: a *DD regime* with decentralized regulation and decentralized bailout policies, a *CD regime* with a centralized regulation policy but decentralized bailout decisions, and a *CC regime* with centralized regulation and centralized bailout policies. The main question addressed in our following analysis is which regime will result in equilibrium, as a function of the exogenous model parameters.

3 Fourth stage: Bailout policies

In the last stage, governments decide which share of banks with failed projects is bailed out, and which share of banks is sent into default. The objective in this stage is to minimize the total costs arising from those banks which have been allowed to continue in the second stage of the game, and whose projects fail. We consider the cases of decentralized versus centralized bailout decisions in turn.

3.1 Decentralized bailout policies

If each country $i \in \{A, B\}$ chooses the bailout policy for its own banks, then each country has to come up for the fiscal costs of bailouts on its own. Accordingly each country i will trade off these fiscal costs against the benefits that country i's own shareholders receive from the bailout. Let b_i be the share of failed banks that is bailed out by country i. We assume that the costs of bailouts are rising more than proportionally in the bailout share b_i. There are several reasons why this can be expected. If the funds needed to save the banks are raised by additional taxes, then the excess burden of taxation will rise more than proportionally, as more funds have to be collected. Alternatively, if the additional costs are covered by issuing more debt, then the risk premium that has to be paid to holders of government bonds will rise, again leading to costs that are convex in the volume of bailout funds. For simplicity we assume that the costs of bailouts are rising quadratically in the share of banks saved from default.

In our benchmark model, we assume that the costs of public funds are the same in the two countries. For later use (in Section 7), however, our notation allows the constant bailout cost parameters of the two countries, β_i, to differ between countries A and B. Such differences will arise, for example, when countries differ in their pre-existing debt-to-GDP ratio. To capture the excess burden arising from bank bailouts, the costs of public funds must be at least as high as the private value of funds. We normalize the latter to unity, implying that $\beta_i \geq 1 \; \forall \, i$.

The share of banks that is not bailed out will create costs to the investors, who lose the remaining value of their capital (their charter value), V, when the bank goes into default. The share of these costs that arise to domestic investors equals the domestic investment share α; the remaining share $1 - \alpha$ falls on foreign investors.[14] Under a decentralized bailout policy, the government that decides on the bailout will therefore internalize the full costs of the bailout, but only the fraction of the gains that corresponds to the domestic investment share. Letting the superscript D stand for the decentralized solution in the bailout stage, the total costs for each country i (first subscript) from its failed domestic banks (second subscript) are then

$$c_{ii}^D = \beta_i b_i^2 + (1 - b_i)\alpha V, \qquad \forall \, i \in \{A, B\}. \tag{1}$$

Minimizing the total failure costs at this stage yields the fraction of banks that is bailed

[14] Recall that our model assumes domestic and foreign ownership shares in the two countries to be symmetric.

out by country i in the decentralized optimum:

$$b_i = \frac{\alpha V}{2\beta_i} \quad \forall\, i. \tag{2}$$

Hence the optimal bailout share b_i is higher, if the domestic investment share is high, and if the costs of country i's public bailout funds (β_i) are low.[15] Note also that $\alpha \leq 1$ implies that $V < 2\beta_i$ must hold in (2).

Substituting (2) back into (1) gives the minimized costs for country i from the failure of its own banks

$$c_{ii}^{D*} = \alpha V \left(1 - \frac{\alpha V}{4\beta_i}\right) \quad \forall\, i. \tag{3a}$$

For the other country j ($j \neq i$), a failure of country i's banks causes losses to investors. These are

$$c_{ji}^{D*} = (1-\alpha)(1-b_i)V = (1-\alpha)V\left(1 - \frac{\alpha V}{2\beta_i}\right) \quad \forall\, i,\ j,\ i \neq j. \tag{3b}$$

Hence, with decentralized decision-making at the bailout stage, the minimized sum of expected costs for both countries i and j from the failure of country i's banks is

$$c_i^{D*} \equiv c_{ii}^D + c_{ji}^D = V\left(1 - \frac{\alpha(2-\alpha)V}{4\beta_i}\right) \quad \forall\, i, \tag{4}$$

where the negative second term gives the aggregate cost reduction from saving some of country i's banks by means of a bailout.

3.2 Common bailout policy

If the two countries choose a centralized bailout policy, denoted by a superscript C, they share in the fiscal costs of bank bailouts. At the same time, joint bailout policies internalize the expected costs for *both* countries i and j that arise from bank failures in country i. Thus the relevant objective in this stage is to minimize

$$c_i^C = \beta_C b_C^2 + (1 - b_C)V \quad \forall\, i, \tag{5}$$

where b_C is the common share of failed banks that are saved with taxpayer monies and β_C is the average cost of bailout funds in the two countries:

$$\beta_C = \frac{(\beta_A + \beta_B)}{2}. \tag{6}$$

[15] The high share of domestic investors, predominantly small shareholders, was a critical argument for the Italian government to save Monte dei Paschi in 2016 (see footnote 4).

Optimizing over b_C gives

$$b_C = \frac{V}{2\beta_C} \quad \forall\, i. \tag{7}$$

Comparing (7) with equation (2) shows that a centralized bailout decision leads to a higher share of banks saved, as compared to decentralized decisions. This is, of course, because the cross-country externalities from bank failures are now fully internalized. Substituting (7) in (5) gives:

$$c_i^{C*} = V\left(1 - \frac{V}{4\beta_C}\right) \forall\, i. \tag{8}$$

In our benchmark model, where $\beta_i = \beta$, it is straightforward to compare (8) with the corresponding total cost in the decentralized case [eq. (4)]. This gives

$$c_i^{D*} - c_i^{C*} = \frac{(1-\alpha)^2 V^2}{4\beta} \geq 0 \qquad \forall\, i. \tag{9}$$

Thus the total expected costs of bank failures are higher under decentralized bailout policies as compared to the centralized bailout regime whenever $\alpha < 1$, and hence when the default of banks in one country has negative spillovers on the other region.

It remains to divide up the bailout costs between the two countries. We assume that the two countries share equally in the bailout costs of each bank, irrespective of where this bank is located.[16] The total country-specific costs of bank failures are then the sum of each country's contribution to the bailout financing scheme, and the losses to investors from banks that are not bailed out:

$$c_{ii}^C = 0.5\beta_i b_C^2 + \alpha(1-b_C)V, \qquad c_{ji}^C = 0.5\beta_j b_C^2 + (1-\alpha)(1-b_C)V, \tag{10}$$

where the first terms in each expression in (10) give the (equal) shares that each country contributes to the total costs of bailouts.

In our benchmark model we assume that both countries have the same costs of public funds, $\beta_A = \beta_B = \beta$. Hence β is also the average funding cost in the union, $\beta_C = \beta$. Using (7) in (10), the country-specific minimum costs of bank failures are then

$$c_{ii}^{C*} = \frac{V^2}{8\beta} + \alpha V\left(1 - \frac{V}{2\beta}\right) \quad \forall\, i, \tag{11a}$$

$$c_{ji}^{C*} = \frac{V^2}{8\beta} + (1-\alpha)V\left(1 - \frac{V}{2\beta}\right) \quad \forall\, i, j,\ i \neq j. \tag{11b}$$

[16]This would be true with respect to bank depositors, for example, if a common deposit insurance fund were introduced. Recall also that we assume banking sectors of both countries to be of equal size (footnote 13).

4 Third stage: Banks' risk choice

It is well known that the bailout decisions modelled in the previous section are anticipated by banks, and give rise to moral hazard effects.[17] To incorporate this effect into our setting with heterogeneous banks, we interpret λ as the 'fundamental' success probability of each bank's investment and $R > 2$ as the 'base' return in case of success. In the third stage, banks can choose their level of risk-taking, $\gamma \geq 0$, to increase the return, if successful, to $R(1+\gamma)$. However, this comes at the cost of a reduced success probability, which falls to $\lambda(1-\gamma)$ for a bank of type λ. Hence risk taking reduces the banks' expected return to $\lambda R(1-\gamma^2)$. In the absence of bailouts, risk-neutral banks would therefore never choose any positive level of γ. In other words, risk-taking is always 'unproductive' in our setting.[18]

In the presence of bailouts, however, some risk-taking will be profitable for banks of all types. The expected surplus of a bank of type λ in country i with risk-taking choice γ_i, which can be distributed among its investors, is given by[19]

$$\pi_i(\lambda;\gamma_i) = \lambda(1-\gamma_i)(1+\gamma_i)RV + [1-\lambda(1-\gamma_i)]b_iV \quad \forall\, i. \tag{12}$$

The second term in (12) gives the positive expected value of investors' capital in the case of bank failure. This corresponds to the product of the probability of failure $1-\lambda(1-\gamma_i)$ and the probability of a bailout in country i, which leaves a capital value of unity to the bank's investors. Maximizing (12) with respect to γ_i yields

$$\gamma_i = \frac{b_i}{2R} \quad \forall\, i. \tag{13}$$

In the banks' optimum, risk-taking is a rising function of the bailout probability b_i that is expected by a bank in country i. Conversely, risk-taking is falling in the base return R. Intuitively, the more profitable is the bank's investment in the absence of risk-taking, the less will the bank want to reduce its chance of success. This corresponds to the well-known effect that banks tend to take riskier decisions when their profitability is

[17] See, for example Acharya (2003) for a theoretical model with such anticipation effects, and Acharya et al. (2018) for empirical evidence on its significance.

[18] This is, of course, a simplifying assumption. In a more general specification, the return in case of success would increase to $R(1+\gamma\delta)$, where $\delta > 1$ allows for 'productive' risk-taking. This, however, would complicate the algebra significantly and it would not qualitatively change our results.

[19] Subtracting a fixed volume of interest payments from the surplus expression in (12) is immaterial for the bank's risk choice, on which we focus here.

low, for example because of intense competition in the banking sector (Keeley, 1990; Buch et al., 2013). Moreover, note that in our specification optimal risk-taking in (13) is independent of bank type λ.

Equation (13) implies that risk-taking, and hence banks' moral hazard, is stronger under centralized bailout policies [eq. (7)], as compared to national bailout policies [eq. (2)], as centralized bailout policies imply a higher bailout probability for any domestic ownership share $\alpha < 1$. Therefore, while centralized bailout policies in the last stage are more efficient than decentralized policies ex post, they exacerbate the ex-ante inefficiencies arising from banks' moral hazard. This ambiguity enters the regulatory policies in stage 2.

5 Second stage: Regulatory policies

In the second stage, governments choose their regulatory policies, either unilaterally or jointly. The regulator decides on the minimum success probability $\hat{\lambda}$ that is required from each bank in order to permit its continued operation. In making this decision, regulators anticipate both the bailout decisions that will be taken at stage 4, and the risk-taking choices of banks in stage 3. If the banks' operations are discontinued at this stage, then all stakeholders are able to recapture their initial investment, with a value of $2V$.[20]

For country A, banks are uniformly distributed in the interval $(0, 1)$ (see Figure 1). Hence a critical success level $\hat{\lambda}_A$ eliminates a share $\hat{\lambda}$ of country A's banks in the second stage. The remaining banks that are permitted to continue operation are uniformly distributed in the interval $\hat{\lambda}_A \leq \lambda < 1$ and all choose the same risk level γ_A in stage 3. Hence the average success probability for the banks that pass the regulation stage is $(1-\gamma_A)(1+\hat{\lambda}_A)/2$. In country B, banks are uniformly distributed in the interval $(0, X)$, with $X < 1$. Hence a threshold success probability $\hat{\lambda}_B$ eliminates a share $\hat{\lambda}_B/X > \hat{\lambda}_B$ of country B's banks and the conditional success probability for the remaining banks is $(1-\gamma_B)(X+\hat{\lambda}_B)/2$. Table 2 summarizes the average success and failure probabilities of banks in each country, as a function of $\hat{\lambda}$. This will prove helpful in deriving the optimal regulatory policies in the different regimes.

[20]Some loss to shareholders could be incorporated instead, if banks are shut down by regulators at this stage. However, this would add complexity to our model while adding little to the analysis.

Table 2: Country-specific success probabilities for regulatory policy $\hat{\lambda}$

	country A	country B
bank share eliminated in stage 2	$\hat{\lambda}$	$\hat{\lambda}/X$
bank share permitted to stage 3	$1-\hat{\lambda}$	$1-\hat{\lambda}/X$
average success probability in stage 3	$(1-\gamma)\frac{(1+\hat{\lambda})}{2}$	$(1-\gamma)\frac{(X+\hat{\lambda})}{2}$
average failure probability in stage 3	$1-(1-\gamma)\frac{(1+\hat{\lambda})}{2}$	$1-(1-\gamma)\frac{(X+\hat{\lambda})}{2}$

In the following, we consider optimal regulation policies in the different regimes kl where $k \in \{C, D\}$ denotes the regulatory stage and $l \in \{C, D\}$ stands for the bailout stage. Welfare in country A equals the total surplus from the banking sector that accrues to the private investors of country A, less the costs that taxpayers in country A incur under the bailout regime ruling in the last stage. Noting that the costs of failure in the final stage as well as the banks' risk choice γ depend only on the bailout regime l, country A's welfare in regime kl is given by

$$\begin{aligned} W_A^{kl} &= 2\alpha V \hat{\lambda}_A^{kl} + (1-\hat{\lambda}_A^{kl}) \left\{ \alpha[1-(\gamma_A^l)^2]RV \, \frac{(1+\hat{\lambda}_A^{kl})}{2} - c_{AA}^l \left[1-(1-\gamma_A^l)\frac{(1+\hat{\lambda}_A^{kl})}{2} \right] \right\} \\ &+ 2(1-\alpha)V \, \frac{\hat{\lambda}_B^{kl}}{X} + \frac{(1-\hat{\lambda}_B^{kl})}{X} \left\{ (1-\alpha)[1-(\gamma_B^l)^2]RV \, \frac{(X+\hat{\lambda}_B^{kl})}{2} \right. \\ &- \left. c_{AB}^l \left[1-(1-\gamma_B^l)\frac{(X+\hat{\lambda}_B^{kl})}{2} \right] \right\}. \end{aligned} \tag{14a}$$

The first line in (14a) gives country A's net welfare (or income) derived from its own banks. For the share of country A's banks that is closed down at the regulation stage, the initial investment is recovered, multiplied by the share of country A's investment (the first term). The share of banks that is allowed to continue to stage 3 will earn an expected return of $(1-\gamma^2)R$ for the share α of country A's investors, and it will create expected failure costs c_{AA} (borne partly by country A's investors and partly by its taxpayers) that have to be evaluated under the decentralized bailout regime. Weighing these events with their respective probabilities in Table 2 gives the second term in the first line. The second and third lines give country A's welfare derived from its bank ownership in country B. Investment returns are weighed by country A's investment share $(1-\alpha)$ and multiplied by the different probability expressions for country B's banking sector. The third line gives the cost for country A's investors of bank defaults in country B, which are evaluated at country B's bailout policy.

Welfare in country B in regime kl is derived analogously and is given by

$$\begin{aligned} W_B^{kl} &= 2\alpha V \frac{\hat{\lambda}_B^{kl}}{X} + \left(1 - \frac{\hat{\lambda}_B^{kl}}{X}\right) \left\{ \alpha [1 - (\gamma_B^l)^2] RV \frac{(X + \hat{\lambda}_B^{kl})}{2} \right. \\ &- \left. c_{BB}^l \left[1 - (1 - \gamma_B^l) \frac{(X + \hat{\lambda}_B^{kl})}{2} \right] \right\} + 2(1 - \alpha) V \hat{\lambda}_A^{kl} \\ &+ (1 - \hat{\lambda}_A^{kl}) \left\{ (1 - \alpha)[1 - (\gamma_A^l)^2] RV \, \frac{(1 + \hat{\lambda}_A^{kl})}{2} - c_{BA}^l \left[1 - (1 - \gamma_A^l) \frac{(1 + \hat{\lambda}_A^{kl})}{2} \right] \right\}. \end{aligned} \tag{14b}$$

5.1 Decentralized regulation policy

When the regulation policy is decentralized, each country considers only the costs and the benefits to its own banking sector when deciding on the optimal level of $\hat{\lambda}_i$. As discussed earlier, when regulation policies are taken at the national level, common bailout policies seem an implausible scenario. Therefore, we only consider the DD regime in this subsection.

In the DD regime each country chooses its optimal regulatory policy $\hat{\lambda}_i^{DD}$, $i \in \{A, B\}$, taking as given the regulation policy of the other country $\hat{\lambda}_j^{DD}$ and anticipating both the banks' risk-taking and the costs of its failed domestic banks that accrue domestically (c_{ii}^D). Differentiating (14a) with respect to $\hat{\lambda}_A^{DD}$ and (14b) with respect to $\hat{\lambda}_B^{DD}$ shows that the asymmetric distribution of success probabilities does not affect decentralized regulation policies. These are given by

$$\hat{\lambda}_i^{DD} = \frac{2\alpha V + c_{ii}^D}{(1 - \gamma_i^D)[\alpha RV(1 + \gamma_i^D) + c_{ii}^D]} \quad \forall\, i \ \in \{A, B\}. \tag{15}$$

where the cost terms c_{ii}^D are given in (3a). Intuitively, high domestic costs of bank failures induce each country to require a high threshold probability $\hat{\lambda}_i$, and thus to eliminate a large share of domestic banks from the market. In contrast, high returns to successful banks R reduce the minimum success probability required by the regulator. Finally, a higher level of (inefficient) bank risk-taking γ_i reduces national welfare in country i and therefore increases the optimal threshold $\hat{\lambda}_i$.

Equation (15), together with the symmetry of bailout choices the last stage [eq. (2)] implies that both countries will choose the same threshold level, and $\hat{\lambda}_A^{DD} = \hat{\lambda}_B^{DD}$ holds in our benchmark model, where costs of public funds are identical in the two countries. This may seem surprising, given the higher failure probability of country B's banking sector ($X < 1$). Note, however, that identical threshold levels $\hat{\lambda}_i^{DD}$ imply that country B eliminates a larger fraction $\hat{\lambda}/X$ of its national banking sector.

5.2 Centralized regulation policy

When the regulation policy in stage 2 is centralized, we have to consider two different regimes, depending on whether bailout decisions in the last stage are taken in a decentralized way (CD regime), or are also taken jointly (CC regime). Centralized regulation policy maximizes the sum of the welfare levels in countries A and B. For Regime CD we differentiate $W_A^{CD} + W_B^{CD}$ with respect to $\hat{\lambda}_A^{CD} = \hat{\lambda}_B^{CD} \equiv \hat{\lambda}^{CD}$ and note that $c_i^D \equiv c_{ii}^D + c_{ji}^D \; \forall \; i, j$. This gives

$$\hat{\lambda}^{CD} = \frac{2V(1 + 1/X) + c_A^D + c_B^D/X}{(1 - \gamma_A)[RV(1 + \gamma_A) + c_A^D] + (1/X)(1 - \gamma_B)[RV(1 + \gamma_B) + c_B^D]}. \tag{16}$$

For regime CC we proceed analogously. Moreover, in this regime we can set $\gamma_A^C = \gamma_B^C \equiv \gamma^C$, as bailout decisions are centralized [eq. (7)] and hence induce the same level of bank risk-taking [eq. (13)]. This gives

$$\hat{\lambda}^{CC} = \frac{2V(1 + 1/X) + c_A^D + c_B^D/X}{(1 - \gamma^C)[RV(1 + \gamma^C)(1 + 1/X) + c_A^D + c_B^D/X]}. \tag{17}$$

With the symmetry of our benchmark model [$c_A^l = c_B^l = c^l \; \forall \; l \in \{C, D\}$ and $\gamma_A = \gamma_B = \gamma_i$ in (16)], the optimal regulatory policies simplify to

$$\hat{\lambda}^{CD} = \frac{(2V + c^D)}{(1 - \gamma_i)[RV(1 + \gamma_i) + c^D]} \quad \forall \; i, \tag{18}$$

$$\hat{\lambda}^{CC} = \frac{(2V + c^C)}{(1 - \gamma^C)[RV(1 + \gamma^C) + c^C]}, \tag{19}$$

where c^D and c^C are given in (4) and (8).

Which regime leads to the most stringent regulatory policies? To answer this question, we first compare decentralized regulatory policies in the DD regime to centralized regulatory policies in the CD regime. Comparing (15) to (18) yields, after some manipulations (see Appendix A.1):

$$\hat{\lambda}_i^{DD} - \hat{\lambda}^{CD} \propto \frac{\alpha(1 - \alpha)(1 - \gamma^D)V}{4\beta}[R(1 + \gamma^D) - 2] > 0. \tag{20}$$

Hence decentralized regulatory policies in the DD regime will be tighter than centralized policies in the CD regime, and this holds for any share of domestic bank ownership α. Intuitively, under decentralized regulation countries internalize only a fraction α of the benefits of successful banks. At the same time, the regulating country internalizes a fraction greater than α of the costs from bank failures, because in the DD regime each country has to come up for the entire bailout costs in the last stage. Put differently, the bailout decision of each country creates a positive externality for bank owners in the foreign country that is not internalized in the DD regime. Therefore, each country will be more restrictive when it decides unilaterally on its regulatory policies.[21]

Next we compare the strictness of regulatory decisions in (18) and (19), i.e., we ask whether centralized regulatory policies are tighter when bailout decisions are taken unilaterally vs. jointly. This comparison gives ambiguous results, in general. On the one hand, common regulatory policies in the second stage incorporate the costs to *both* countries that arise from failing banks in the last stage. Total failure costs are higher if the bailout decision is made at the national level, $c^D > c^C$ [see eq. (9)]. Since $\hat{\lambda}$ is a rising function of total failure costs, this isolated effect tends to make the common regulatory policy in the CD regime stricter than in the CC regime. On the other hand, centralized bailout policies save more banks from insolvency than do decentralized bailout policies [cf. eqs. (2) and (7)] and therefore induce stronger effects on banks' risk-taking [$\gamma^C > \gamma^D$; cf. eq. (13)]. Since regulatory policies aim to counteract moral hazard incentives, the regulatory response is also stronger in the CC regime. Hence this isolated effect counteracts the first and tends to raise $\hat{\lambda}^{CC}$ above $\hat{\lambda}^{CD}$.

Appendix A.1. shows that the regulatory response to moral hazard is the dominant effect, and regulatory policies are tighter in the CC regime, when bank returns are sufficiently low, and specifically when $R \leq 3$. Given an initial value of 2 per unit of capital, this corresponds to a net return equal to or less than 50%. Intuitively, limiting bank profitability in this way implies that risk-taking by banks is substantial [cf. eq. (13)], and so are the inefficiencies caused by banks' moral hazard. Since regulatory authorities anticipate this increased moral hazard in response to the more generous centralized bailout policy in the CC regime, they will set common regulatory policies

[21] This result differs from the analysis in Beck et al. (2013) where centralized and decentralized regulatory policies coincide when the share of gains that accrues to foreigners is the same as the share in the losses. Clearly, this difference stems from the modelling of an additional bailout stage in our analysis.

accordingly strict. We can thus summarize our results in this section as follows:

Proposition 1 *(i) When the costs of public funds are the same in countries A and B, optimal decentralized policies lead to the same regulatory threshold levels,* $\hat{\lambda}_A^{DD} = \hat{\lambda}_B^{DD}$.
(ii) When bailouts policies are decentralized, decentralized regulation policies are tighter than centralized regulation policies, $\hat{\lambda}_i^{DD} > \hat{\lambda}^{CD}\ \forall\ i$.
(iii) When bank profitability is not too high ($R \leq 3$)*, centralized regulatory policies are stricter when the bailout stage is also centralized,* $\hat{\lambda}^{CC} > \hat{\lambda}^{CD}$.

Proof: *See Appendix A.1.*

Proposition 1 has several implications. First, Proposition 1(ii) shows that common regulation policies can actually be laxer than national regulation policies when – as is currently the case in the European banking union – bailout policies in the final stage are taken by national governments. This is a somewhat surprising result given that one of the main motivations for the European banking union was to regulate large banks more tightly. However, national regulators anticipate that the home country has to bear the full costs of bailouts in the final stage while not considering the positive externalities that national bailouts have on foreign shareholders. These positive externalities of national bailouts are instead factored in by a central regulator, who will therefore choose laxer regulation policies in the optimum.

Second, Proposition 1(iii) is also counterintuitive because one might first suspect that more efficient, centralized bailout policies in the final stage reduce the costs of bank failures and therefore permit a centralized regulatory policy to be less strict. This argument neglects, however, the moral hazard effect induced by bank bailouts, which becomes stronger when more bailouts are made in the last stage under a common bailout policy. If this moral hazard effect is sufficiently strong, given in our analysis by relatively low levels of bank profitability ($R < 3$), the dominant concern of centralized regulation policy in the second stage is to limit this moral hazard by means of stricter regulatory standards.

6 First stage: Regime choice

In the first stage, each country ranks the three different regimes (CC, CD and DD) by their effects on the country's national welfare. By our convention, a common policy in either the regulatory or the bailout stage will only be adopted when this is in the interest of *both* countries. This corresponds, for example, to the unanimity requirement that governs legislation in the European banking union.

To arrive at national welfare in each regime, the stage 4 cost expressions in (3a)–(3b) (for regimes DD and CD) or (11a)–(11b) (for regime CC), the banks' risk choice in (13) and regulatory policies in (15), (18) and (19) are substituted into (14a)–(14b). The resulting reduced-form welfare terms can be compared for any combination of exogeneous parameters. In the following we first focus on the special case without foreign bank ownership and then turn to the general case with varying levels of α.

6.1 Benchmark: no foreign bank ownership

We first compare the three regimes in the benchmark case where cross-border bank ownership is absent and thus $\alpha = 1$. When there are no spillovers effects from bank failures to other countries, decentralized and centralized bailout decisions in (2) and (7) coincide, and so does banks' risk-taking, $\gamma^D = \gamma^C$. Moreover, bank failure costs from the perspective of a national regulator (c_{ii}^D) coincide with the total bank failure costs from the perspective of a centralized regulator ($c_i^D = c_i^C$). Hence regulatory policies in (15), (18) and (19) will also coincide, $\hat{\lambda}_i^{DD} = \hat{\lambda}^{CD} = \hat{\lambda}^{CC}$.

It then follows that national welfare in the DD and CD regimes must be the same for both countries, i.e. $W_i^{DD}\big|_{\alpha=1} = W_i^{CD}\big|_{\alpha=1}$ $\forall\, i \in \{A, B\}$. In the CC regime, however, the country-specific stage 4 payoffs differ. Specifically, countries A and B share the bailout costs for all bank failures in regime CC, no matter where these banks are located. In the CD and DD regimes, in contrast, each country pays for bailing out its own banks. We compute the welfare difference between the CC and CD regimes from the perspective of country A. Using (14a), substituting in from (3a)–(3b) and (11a)–(11b), evaluating at $\alpha = 1$ and simplifying yields

$$(W_A^{CC} - W_A^{CD})\big|_{\alpha=1} = \frac{V^2(1-X)}{8\beta}\left\{\frac{\hat{\lambda}}{X}\left[1-(1-\gamma)\frac{\hat{\lambda}}{2}\right] - \frac{(1-\gamma)}{2}\right\}. \tag{21a}$$

The switch from decentralized to centralized bailout policies causes two distinct effects on country A's welfare. On the one hand, a given level of regulatory tightness eliminates a larger share of country B's banks from the market and hence only a smaller proportion of country B's banks is allowed to continue into the third stage (see Table 1). Since both banking sectors are equally large initially, the higher number of country A banks that remain in operation also implies a higher absolute number of expected bank A failures in the final stage. With failure costs from both banking sectors being shared equally in the CC regime, this isolated effect works in favor of country A, as represented by the positive first term in the curly bracket of (21a). At the same time, however, the remaining banks from country B that are permitted into stage 3 will face a higher failure probability as compared to the banks located in country A. This isolated effect works against country A when failure costs from both banking sectors are shared. It is given by the negative second term in the curly bracket of (21a).

When $\hat{\lambda} = 0$ the first effect is zero and country A unambiguously loses from a centralized bailout policy in the final stage. As the common regulatory standard $\hat{\lambda}$ is increased, the first effect increases and it becomes more likely that country A gains from the switch. Therefore, and intuitively, country A is interested in a high regulatory standard when bailout policies in the final stage are centralized. Moreover, note that higher risk-taking by banks (a higher level of γ) tends to benefit country A. This is because a higher share of country A's banks is admitted to the final stage and a higher degree of risk-taking increases the failure probability of all banks in the same proportion.

Equation (21a) also shows that a lower X, and thus a lower quality of country B's banks, makes it *more* likely that country A gains from a switch to the joint financing of bailout costs. This result may seem surprising because first intuition would suggest that country A is more opposed to sharing the bailout costs for failed banks if the overall quality of country B's banks is low. But this argument neglects the fact that the number of banks that survive to the final stage is itself endogenous. If country B's banking sector is very weak, relative to that of country A (X is small), then a common regulator in stage 2 will ensure that the banks operating in the final stage are mostly from country A. Since sharing the fiscal costs of bailouts is the only 'externality' when cross-border ownership of banks is absent, it is then not surprising that country A gains when the fiscal burden from bailing out a given fraction of all banks that fail in stage 4 is shared equally with the neighboring country B.

Since there are no efficiency gains from centralized bailout policies in the final stage, all changes in national welfare that follow from regime switches are purely redistributive. In other words, the welfare change for country B of switching from the CD to the CC regime is given by

$$\left(W_B^{CC} - W_B^{CD}\right)\big|_{\alpha=1} = -\left(W_A^{CC} - W_A^{CD}\right)\big|_{\alpha=1}. \tag{21b}$$

Comparing eqs. (21a) and (21b) implies that country B will object a common bailout policy precisely when country A will favor it. Given that unanimity is needed to centralize bailout policies this implies that the political equilibrium can never feature a centralized bailout policy when cross-border bank ownership is absent.

6.2 General level of foreign bank ownership

We now turn to the general case with variable levels of foreign bank ownership. We first compare each country's welfare in the DD and CD regimes. Since both regimes feature decentralized bailout policies, and accordingly imply the same level of bank risk-taking, the only difference between the two regimes lies in the regulatory stage. Moreover, we know from Proposition 1(ii) that the common regulatory choice is less strict than the decentralized choice, i.e., $\hat{\lambda}^{CD} < \hat{\lambda}_i^{DD}\ \forall\ i$. Since the centralized regulatory choice incorporates the effects on both countries, it must be more efficient than decentralized regulation. Moreover, since the asymmetry between the two countries' banking sectors does not affect their optimal decentralized regulatory choice [see eq. (15)], this overall efficiency gain must be spread evenly between the two countries. Hence it follows that the CD regime must weakly dominate the DD regime for all levels of α. Appendix A.2 proves this intuitive result.

Next we compare the CD and CC regimes. Our analysis in the previous section has shown that when the foreign ownership share in banks is zero ($\alpha = 1$), there will still be redistributive effects between countries A and B, which will always lead one of the countries to reject a common bailout choice. Hence, an equilibrium in the CC regime can only arise when the switch to a common bailout decision is associated with overall efficiency gains. In general, however, the overall efficiency effects of the switch are ambiguous. The higher bailout share that results from centralized bailout policies generates ex post efficiency gains, but it also leads to larger ex-ante inefficiencies by increasing banks' moral hazard. If the overall efficiency effect of a switch from the CD to the CC regime is negative, then we know that a CC regime cannot occur in equilibrium.

Based on these arguments, we sum over the two countries' welfare levels in (14a) and (14b). Appendix A.2 shows that a sufficient condition for the sum of welfare levels in the two countries to be lower in the CC regime, as compared to the CD regime, is that $R < 3$. From Proposition 1(iii) we know that this is also the condition under which $\hat{\lambda}^{CC} > \hat{\lambda}^{CD}$, as the stronger moral hazard effect in the CC regime dominates the lower total costs of bank failures. It is then intuitive that the same condition will imply higher total efficiency losses in the CC regime, as compared to the CD regime. From our above argument this implies that the CC regime can never be the equilibrium regime when the condition $R < 3$ is met. We summarize our results in:

Proposition 2 (*i*) *With symmetric costs of public funds $\beta_A = \beta_B$, regime DD is weakly dominated by regime CD and is therefore never an equilibrium outcome.*
(*ii*) *Without cross-border bank ownership ($\alpha = 1$), regime CD is preferred to regime CC by exactly one of the two countries, and is the equilibrium outcome.*
(*iii*) *When bank profitability is not too high ($R < 3$), regime CD is preferred to regime CC by at least one of the two countries, and is the equilibrium outcome.*

Proof: *See Appendix A.2*

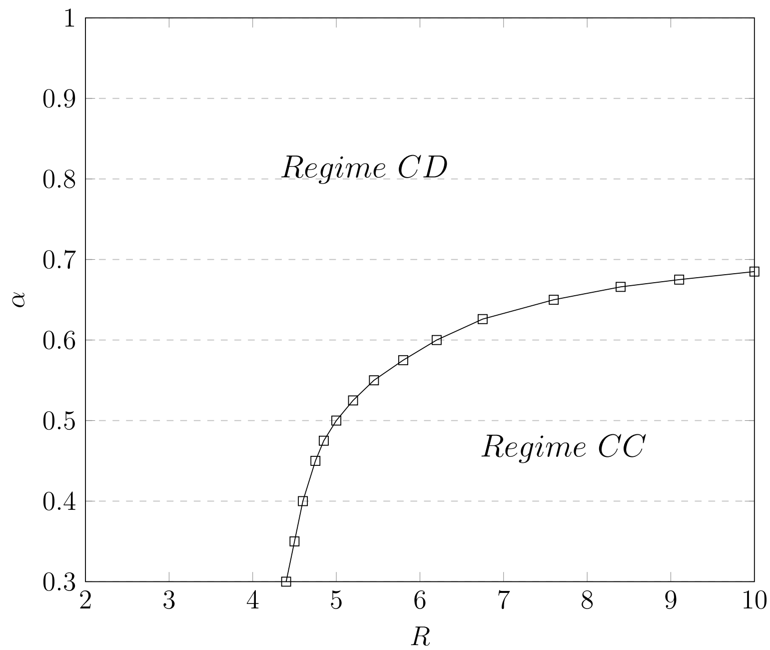
Proposition 2 states that, in our benchmark model, the two countries will agree to centralize regulatory policies in the second stage. Whether bailout policies will also be centralized or remain under national control will depend, however, on the level of cross-border bank ownership and on the profitability of the banking sector. A centralized bailout policy can be the equilibrium outcome only if cross-border bank ownership is sufficiently large *and* if banking sectors are sufficiently profitable to keep banks' risk-taking incentives low. If only one of these conditions is not fulfilled, then the equilibrium regime features common regulatory policies, but no common bailout policy for the asymmetric banking sectors.

Figure 2 specifies the equilibrium regimes, varying banks' returns R on the horizontal axis and the domestic ownership share α on the vertical axis. The parameter X describing the asymmetry in bank risks among the two regions is set at 0.8, in line with the distribution of creditworthiness ratings summarized in Table 1. Finally, we use government debt (in percent of GDP) as a proxy for the value of β. We normalize $\beta = 1$ to correspond to zero government debt and set $\beta = 1.7$, corresponding to a ratio of government debt over GDP of roughly 70% in the average of our Eurozone sample.[22]

Given these specifications, Figure 2 shows that Regime CC can emerge as an equilibrium only for the combination of very high returns R and high shares of cross-border bank ownership (low α). An empirical estimate for α is provided by Beck et al. (2013,

[22]See Table B.1 in Appendix B. Variations in the common level of β affect the graph in Figure 2 only marginally, and change none of our conclusions.

Figure 2: Equilibrium regimes in benchmark model



Parameters: $X = 0.8, \quad \beta = 1.7$

Table 3), who collect a sample of 55 banks from 15 countries in which regulatory interventions took place during the period 2007-2009. For this sample, the average foreign ownership shares is around 35%, corresponding to a level of $\alpha = 0.65$.

To get an empirical estimate for the return R, we calculate the average return on assets (ROA) for the 800 largest banks in the Eurozone and in the rest of the world using the ORBIS database (see Appendix B). The average ROA for the Eurozone banks is 0.40. Given an initial value per unit of capital of 2 in our model, this corresponds to $R \approx 2.8$. Hence, for the Eurozone banks, the condition of our theoretical Proposition 2(iii) is fulfilled and the equilibrium is always in the CD regime. For the rest of the world, which prominently includes banks in the U.S. and the U.K., the ROA is much higher, around 1.15, corresponding to a level of $R \approx 4.3$. Here, the condition in Proposition 2(iii) is violated. Nevertheless, as Figure 2 shows, our model predicts an equilibrium in the CD regime even for these much higher bank returns.

7 Extensions

7.1 Diverging costs of public funds

In this section we introduce further asymmetries between the two countries in the banking union, in addition to the different distribution of success probabilities of national banking sectors. A first extension is to introduce different costs of public funds that are used to bail out banks whose projects have failed. This is a particularly relevant extension for the European banking union, because the banking union was itself a reaction to the twofold challenges arising from instable banking sectors on the one hand and fragile government finances on the other.

Following the overall pattern in the European banking union, as given in Table 1 and Table B.1 in the appendix, we link weaker banking sectors to a weaker state of a country's public finances. We model this by assuming that country B has the higher costs of financing a bailout in stage 4, i.e., $\beta_B > \beta_A$. The description of our benchmark model in Sections 3 to 5 already accounts for the case of diverging costs of public funds. Clearly, with bailouts becoming more costly for country B, the bailout share of this country in the DD regime will now be lower than that of country A [eq. (2)]. Moreover, the total costs of failed banks will be higher for country B, as compared to country A, under both national bailout policies [eqs. (3a)–(3b)] and common bailout policies [eq. (10)]. The lower bailout level of country B in turn implies less risk-taking of country B's banks in stage 3, as compared to the banks in country A [eq. (13)].

These changes feed into the national regulatory choices in the DD regime in the second stage [eq. (15)], which will now differ between the two countries. Substituting in from (3a)-(3b) and (13), multiplying out and simplifying terms gives

$$\hat{\lambda}_A - \hat{\lambda}_B \quad \propto \quad \frac{\alpha^3 V^3}{4}\left(\frac{1}{\beta_A} - \frac{1}{\beta_B}\right)\left(2 - R + \frac{3}{R}\right). \tag{22}$$

The first bracketed term on the RHS of (22) is positive for $\beta_A < \beta_B$, whereas the second bracket is positive for $R < 3$ and negative for $R > 3$. For low levels of R, bank risk-taking is relatively high and the dominant concern in setting regulation policies is to reduce banks' moral hazard. Since the moral hazard effect is stronger under the more generous bailout policy of country A, country A's regulatory policies must accordingly be stricter. Conversely, if R is high and bank risk-taking is low, then decentralized regulation policies will primarily reflect the total costs of failing banks in the last stage of the game. Since these costs are higher for country B, this country will then have the stricter regulatory policies in the DD regime. For the special case of $R = 3$, the differences just offset each other and regulatory policies in the DD regime will be the same for the two asymmetric countries.

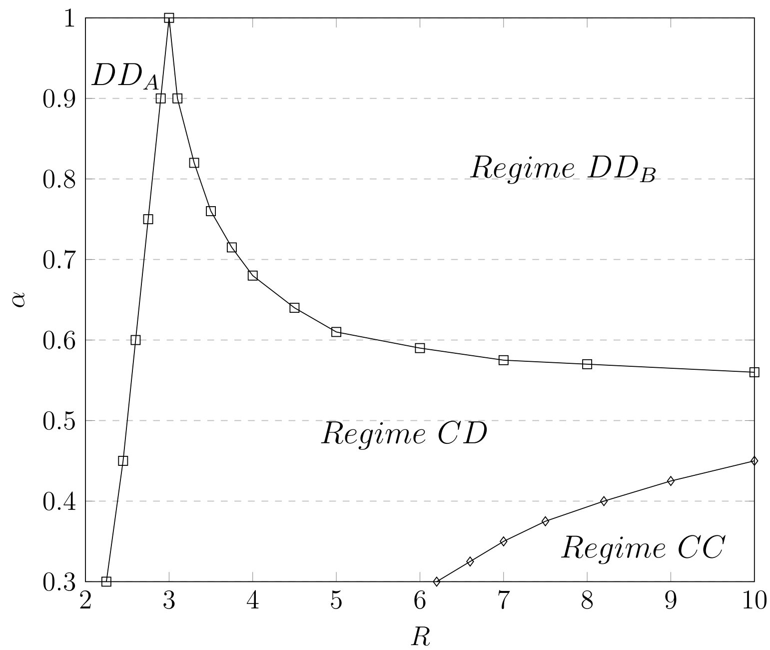
The comparison of regulatory policies in the different regimes follows similar patterns as in our benchmark model.[23] When comparing the DD and CD regimes, accounting for the positive externalities that each country's national bailouts in the final stage cause on the other country will continue to make $\hat{\lambda}_i^{DD}$ stricter, as compared to $\hat{\lambda}^{CD}$, at least for the country that pursues the stricter national regulatory policy [cf. Proposition 1(*ii*)]. Moreover, the comparison of regulatory policies in the CD and CC regimes again depends on the level of cross-country bank ownership $(1 - \alpha)$ on the one hand, and on the level of bank profitability R on the other [cf. Proposition 1(*iii*)].

In the first stage, a core difference to the benchmark model is that welfare in the two countries is no longer the same in the DD and CD regimes when cross-border bank ownership is absent $(\alpha = 1)$. The reason is that the centralized, uniform regulation policy will be some average of the two decentralized regulation policies, which generally differ under this extension [eq. (22)]. Moreover, each country will necessarily prefer its own national regulation policy to the uniform 'policy average' of a central regulator. Since this is the only difference under the CD and DD regimes when $\alpha = 1$, we must have $W_i^{DD}\big|_{\alpha=1} \geq W_i^{CD}\big|_{\alpha=1}$ $\forall\ i \in \{A, B\}$. By continuity, the DD regime must then also be the equilibrium regime when cross-border bank ownership is very low (α is close to unity). In the neighborhood of $R = 3$, however, national regulation policies coincide from eq. (22), and so do W_i^{DD} and W_i^{CD} when both are evaluated at $\alpha = 1$.

Figure 3 plots the equilibrium regimes for a numerical example where the cost of public funds is $\beta_A = 1.5$ in region A and $\beta_B = 2.1$ in region B. Using the same normalization as we have done in Figure 2, this corresponds to average ratios of government debt over GDP of roughly 50% for the 'North' and 110% for the 'South' of the Eurozone (see Table B.1). An equilibrium in the DD regime then results for either very low levels of R, or for sufficiently high values of R. In line with our discussion of eq. (22), country A has the stricter regulatory policy in the DD regime when R is low, whereas country B has the stricter regulatory policy when R is high. In both cases, it is the country with stricter domestic regulation in the DD regime that rejects a common regulatory policy.

[23] Evaluating regulatory policies in the CD and CC regimes under this extension requires to use the expressions in (16) and (17), which do not assume symmetry of the c_i and γ terms.

Figure 3: Equilibrium regimes with asymmetric costs of public funds



Parameters: $X = 0.8, \quad \beta_A = 1.5, \quad \beta_B = 2.1$

DD_i: country i rejects centralized regulation

For intermediate values of R, however, the CD regime remains the equilibrium outcome and in the neighborhood of $R = 3$ this is true for all levels of α. Specifically, for the empirical estimates of the domestic ownership share ($\alpha = 0.65$) and the return on assets of Eurozone banks ($R = 2.8$), regime CD once again emerges as the equilibrium regime, as in our benchmark model. Finally, note that the area of the CC regime shrinks in comparison to the benchmark model. This is because country B, as the high-β country, will find a common bailout policy highly costly, and agree to it only if the efficiency gains from a common bailout regime are very large (α is low and R is large).

7.2 Weak regulator in one country

In a second extension, we additionally assume that there is a 'weak' regulator in one of the countries, which we take to be country B.[24] We thus assume that the regulator in

[24] One possible proxy for this measure, used also in Loipersberger (2018), is the 'corruption perception index' (CPI) of Transparency International (https://www.transparency.org/en/cpi/2020). By this measure, countries in the 'North' of the Eurozone have significantly stronger regulatory powers, on average, than countries in the 'South' (cf. footnote 2 and Appendix B).

country B attaches extra weight to the return R that its banks receive in case of success. This occurs either because a successful project provides extra benefits for the economy of country B in terms of jobs or tax revenue, or because the banks successfully lobby the regulator in country B. In either case, the benefits in case of the bank's success receive a higher weight for the national regulator, $R(1+\phi_B)$, with $\phi_B > 0$. We further assume that the central regulator operating in the CD and CC regimes cannot be influenced by lobbying from country B's banks.

The stage 4 payoffs and accordingly the banks' risk-taking in stage 3 remain unaffected by this model extension. Hence the only change occurs with respect to country B's decentralized regulatory policy in the second stage. Accordingly, eq. (15) changes to

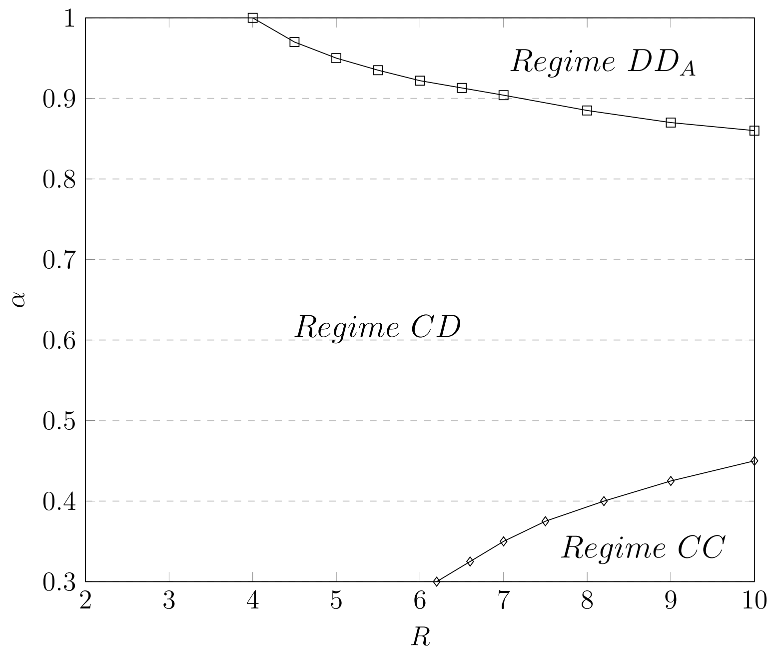
$$\tilde{\lambda}_B^{DD} = \frac{2\alpha V + c_{ii}^D}{(1-\gamma_i^D)[\alpha RV(1+\gamma_i^D)(1+\phi_B) + c_{ii}^D]} < \hat{\lambda}_B^{DD}. \tag{23}$$

Hence lobbying by country B's banks leads to a laxer regulation policy $\tilde{\lambda}_B^{DD}$, implying that the regulator allows more of country B's banks to continue operation. For country A this increases both failure costs and returns from its cross-border bank ownership in country B. When returns are low (R is small) the higher failure costs will dominate and country A loses from the laxer regulation policy in B. When returns are high (R is large) the laxer regulation policy of country B benefits country A.[25]

The results of this extension are shown in Figure 4, which maintains the assumption that the costs of public funds are higher in country B than in country A. The parameter values underlying this figure are thus the same as in Figure 3 above, except for the introduction of the lobbying parameter $\phi_B = 0.05$. The figure shows that the new political equilibrium will fall in the CD regime for a wider range of parameter values, as compared to the setting where the choice of country B's regulator is not biased (Figure 3). In particular, it is now always country A which rejects centralized regulation policies, but this occurs only for high levels of α in combination with high levels of R. As our above discussion has shown, high bank returns imply that country A benefits from country B's lax regulation policy in the DD regime. For country B, switching to a centralized regulation policy offers a possibility to escape from the regulatory capture that arises under national regulation. In terms of its 'true' national welfare [eq. (14b)], country B will therefore always be better off in the CD regime, as compared to the DD regime with the regulatory policy set by (23).

[25] This can be seen by differentiating W_A^{DD} with respect to $\hat{\lambda}_B$; see eq. (A.4) in the appendix. This derivative is falling in R, but positive at $R = 2$.

Figure 4: Equilibrium regimes with weak regulator in country B



Parameters: $X = 0.8, \quad \beta_A = 1.5, \quad \beta_B = 2.1, \quad \phi_B = 0.05$

DD_A: country A rejects centralized regulation

For empirically relevant parameter ranges, with α in the range of $0.5 - 0.7$ and R in the range of $2.5 - 4.0$, the equilibrium once again lies in the CD regime, as in our benchmark model. Weak national regulators are therefore one further argument explaining the support for centralized regulatory policies. This result matches with empirical evidence from an event study of the introduction of the Single Supervisory Mechanism in the European banking union (Loipersberger, 2018). This study finds that bank stock prices increased particularly in countries where the government's supervisory power was weak. This indicates that the switch to centralized regulation policies was perceived to stabilize the banking sector and to reduce the costs of failing banks in these countries, in particular.

8 Conclusion

In this paper we have analyzed centralized versus decentralized policies in a banking union like the one that has recently been established in Europe. We have modelled two principal decisions that must be taken in such a union, the supervision and regulation of banks on the one hand, and the bailout, or recapitalization, decision on the other. Our model features international spillovers by allowing for cross-country bank ownership, and it incorporates different distributions of success probabilities in the two countries' banking sectors.

The results of our benchmark model show that the regulatory decision is likely to be centralized in the political equilibrium, whereas the same is not true for the decision to finance the recapitalization of banks. The consensus on the centralized regulatory decision emerges from the common interest of both countries to internalize the cross-border spillovers that arise from both successful and defaulting banks. Contrary to first intuition, we show that the spillovers from *successful* banks dominate in equilibrium, implying that the central regulator will impose *laxer* standards, as compared to a national regulator.

Countries are less likely to agree on a common bailout policy when banks fail despite regulatory oversight. This holds even though this measure would also generate aggregate efficiency gains by reducing the total costs that arise from failing banks. However, the higher bailout shares under a common bailout policy also exacerbate banks' incentives to choose inefficiently high levels of risk-taking, rendering the overall efficiency effects of a switch to a common bailout policy ambiguous. In addition, with cross-country differences in the distribution of failure probabilities, a conflict of interest will necessarily emerge from an equal sharing of all countries in the costs of bank bailouts.

For a simple calibration with foreign ownership shares and rates of returns collected from a sample of large European banks, our results show that the equilibrium regime will always feature a common regulatory policy, but maintain national bailout policies. This result carries to two model extensions, where we allow for cross-country differences in the costs of public funds and a weak regulator in one of the countries. Our results therefore offer some explanation for why supervision and regulatory powers have already been centralized in the European banking union, whereas a common deposit insurance fund and a common financing scheme for failing banks do not exist yet.

An important assumption of our analysis is that cross-border externalities from bank failures in a banking union arise only through capital losses of foreign investors. However, cross-border externalities can also harm the real sector in foreign countries, either directly when foreign firms do some of their lending abroad, or indirectly through contagion effects that bank failures in one country cause for the foreign banking sector. Incorporating such effects into our analysis is conceptually straightforward, but calibrating their quantitative importance is difficult. If such additional externalities are significant, then the efficiency gains from a common bailout policy increase and the parameter range supporting an equilibrium with common bailout policies is enlarged. Politically, we likewise expect that a renewed experience of cross-country contagion effects in the European banking union, or the fear thereof, may increase the support for a common deposit insurance scheme and for other measures that collectively finance bank failures.

Appendix

Appendix A.1: Proof of Proposition 1

For part (*ii*) of Proposition 1 we substitute eqs. (2) and (4) into (15). This gives

$$\begin{aligned}\hat{\lambda}_i^{DD} - \hat{\lambda}^{CD} \quad \propto \quad & \left(3 - \frac{\alpha V}{4\beta}\right)(1-\gamma^D)\left[R(1+\gamma^D) + 1 - \frac{\alpha(2-\alpha)V}{4\beta}\right] \\ - \quad & \left(3 - \frac{\alpha(2+\alpha)V}{4\beta}\right)(1-\gamma^D)\left[R(1+\gamma^D) + 1 - \frac{\alpha V}{4\beta}\right]. \qquad \text{(A.1)}\end{aligned}$$

Multiplying out, simplifying and rearranging terms gives eq. (20) in the main text.

For part (*iii*) of Proposition 1, substituting eqs. (2), (4), (7), (8) and (13) into (18) and (19) gives

$$\begin{aligned}\hat{\lambda}_i^{CC} - \hat{\lambda}^{CD} \quad \propto \quad & \left(3 - \frac{\alpha V}{4\beta}\right)\left(1 - \frac{\alpha V}{4\beta R}\right)\left[R\left(1 + \frac{\alpha V}{4\beta R}\right) + \left(1 - \frac{\alpha(2-\alpha)V}{4\beta}\right)\right] \\ - \quad & \left(3 - \frac{\alpha(2-\alpha)V}{4\beta}\right)\left(1 - \frac{V}{4\beta R}\right)\left[R\left(1 + \frac{V}{4\beta R}\right) + \left(1 - \frac{V}{4\beta}\right)\right] \qquad \text{(A.2)}\end{aligned}$$

Multiplying out and collecting terms gives

$$\hat{\lambda}_i^{CC} - \hat{\lambda}^{CD} = \frac{(1-\alpha)V}{4\beta}\left[(2-R)(1-\alpha) + \frac{3}{R}\right] + \frac{\alpha V^2}{16\beta^2 R}\left[4\alpha - 3\alpha^2 - 1 - \frac{\alpha(1-\alpha)V}{4\beta}\right]. \qquad \text{(A.3)}$$

Evaluating (A.3) at $\alpha = 0$ eliminates the second term in (A.3) while the first term is non-negative for $R = 3$ and strictly positive for $R < 3$.

For intermediate levels of α, we set $R = 3$. Since $\hat{\lambda}_i^{CC} - \hat{\lambda}^{CD}$ in (A.3) is unambiguously falling in R, this is the highest level of R that meets the constraint $R \leq 3$. Hence it will deliver a sufficient condition for $\hat{\lambda}_i^{CC} - \hat{\lambda}^{CD} > 0$, given the constraint $R \leq 3$. The first term in (A.3) must be positive for $R = 3$ and any $\alpha > 0$. In the second term, we use $V \leq 2\beta$ from (2) with equality. Since the squared bracket in the second term is more negative the lower is β, this yields again a sufficient condition. With these specifications, the squared bracket in the second term reduces to $(7\alpha - 5\alpha^2 - 2)/2$. This yields a quadratic equation in α, which is zero for $\alpha_1^c = 0.4$ and $\alpha_2^c = 1$. In between these two values, the second term is positive. In the last step we confirm that the sum of both terms in (A.3) is positive for all $\alpha \leq 0.4$. Hence $\hat{\lambda}_i^{CC} - \hat{\lambda}^{CD} > 0$ holds for all levels of α, given the constraint $R \leq 3$. □

Appendix A.2: Proof of Proposition 2

To prove Proposition 2(i) we differentiate country A's welfare in the DD regime with respect to $\hat{\lambda}_B$, using $c^D_{AB} = (1-\alpha)[1-\alpha/(2\beta)]$ from (3b). This gives

$$\frac{\partial W^{DD}_A}{\partial \hat{\lambda}_B} = \frac{(1-\alpha)V}{X}\left[2-\hat{\lambda}_B R\left[1-(\gamma^D)^2\right] + [1-\hat{\lambda}_B(1-\gamma^D)]\left(1-\frac{\alpha V}{2\beta}\right)\right], \quad \text{(A.4)}$$

We evaluate this derivative at country B's optimal regulatory policy in the DD regime. From (15), and using $c^D_{BB} = \alpha V[1-\alpha V/(4\beta)]$ from (3a) we have

$$\frac{\partial W^{DD}_B}{\partial \hat{\lambda}_B} = \frac{\alpha V}{X}\left[2-\hat{\lambda}_B R\left[1-(\gamma^D)^2\right] + [1-\hat{\lambda}_B(1-\gamma^D)]\left(1-\frac{\alpha V}{4\beta}\right)\right] = 0, \quad \text{(A.5)}$$

Subtracting the squared bracket in (A.5), which equals zero, from (A.4) gives

$$\left.\frac{\partial W^{DD}_A}{\partial \hat{\lambda}_B}\right|_{\hat{\lambda}^{DD}_B} = \frac{-(1-\alpha)\alpha V^2}{4\beta X}\left[1-\hat{\lambda}_B(1-\gamma^D)\right] < 0. \quad \text{(A.6)}$$

Hence, starting at the symmetric equilibrium in the DD regime, a small *reduction* in $\hat{\lambda}_B$ increases welfare in country A. From Proposition 1(ii) this corresponds to the effect of a switch from the DD to the CD regime, whereas the simultaneous reduction in $\hat{\lambda}_A$ has no first-order welfare effect on W_A. The same argument can be applied for welfare in country B by differentiating W^{DD}_B with respect to $\hat{\lambda}_A$ and evaluating at $\hat{\lambda}^{DD}_A$. □

To prove Proposition 2(iii) we confine the analysis to the banking sector in country A, as the efficiency effects of policy choices are symmetric for the banking sector of country B. The corresponding welfare levels that omit country B's banking sector are denoted by $\tilde{W}^{Cl}_i$. Furthermore, we can compare the efficiency effects of the CD and CC regimes at a common regulatory choice, chosen to be $\hat{\lambda}^{CC}$, as the fundamental efficiency arguments arise in stages 3 and 4 and thus do not depend on the regulatory choice $\hat{\lambda}$. With these specifications we get

$$\begin{aligned}
\Omega &\equiv \tilde{W}^{CC}_A + \tilde{W}^{CC}_B - \left(\tilde{W}^{CD}_A + \tilde{W}^{CD}_B\right) \\
&\propto \frac{(1+\hat{\lambda}^{CC})}{2} RV[1-(\gamma^C)^2] - \left[1-(1-\gamma^C)\,\frac{(1+\hat{\lambda}^{CC})}{2}\right] c^C_A \\
&\quad - \left\{\frac{(1+\hat{\lambda}^{CC})}{2} RV[1-(\gamma^D)^2] - \left[1-(1-\gamma^D)\,\frac{(1+\hat{\lambda}^{CC})}{2}\right] c^D_A\right\}. \quad \text{(A.7)}
\end{aligned}$$

Substituting in from the failure cost expressions (4) and (8) and from the banks' risk choices (13), this reduces to

$$\Omega \propto \frac{(1-\alpha)V}{8\beta}\left[1-\hat{\lambda}^{CC} - \frac{(1+\hat{\lambda}^{CC})}{2R} - \frac{\alpha^2 V(1+\hat{\lambda}^{CC})}{4\beta R}\right]. \quad \text{(A.8)}$$

The last term in (A.8) is unambiguously negative for any $\alpha > 0$. The second and third terms can be further reduced using the expression for $\hat{\lambda}^{CC}$ from (19). Substituting from (8) and (13) we get

$$\hat{\lambda}^{CC} = \frac{12\beta - V}{(R+1)\,4\beta - (V/R) - V} > \frac{12\beta - V}{(R+1)\,4\beta - V} \equiv \underline{\hat{\lambda}}^{CC} \tag{A.9}$$

We denote the sum of the first three terms in the squared bracket in (A.8) by Γ and ask under which conditions it is negative. Since the fourth term in the squared bracket is always negative, this gives a sufficient condition for Ω to be negative. Since Γ is falling in $\hat{\lambda}^{CC}$, using $\underline{\hat{\lambda}}^{CC} < \hat{\lambda}^{CC}$ gives a sufficient condition. With this simplification, and noting that $V < 2\beta$, we get

$$\Gamma \quad \propto \quad 8\beta R^2 - 20\beta R - 16\beta + 2V < 2\beta(4R^2 - 10R - 6) \equiv \overline{\Gamma}. \tag{A.10}$$

Hence, $\overline{\Gamma} < 0$ is a sufficient condition for $\Omega < 0$. From the quadratic equation in R we get $\overline{\Gamma} < 0$ for $R < R^c = 3$. This proves Proposition 2(iii). □

Appendix B: Empirical calibration

Data source

Orbis database of Bureau van Dijk (https://orbis.bvdinfo.com).

Sample

Full sample: 1000 largest banks in Eurozone and 1000 largest banks in non-Eurozone countries (rest of the world, ROW) in 2019

Return on average assets: 1000 Eurozone banks and 999 ROW banks

MORE score: 819 Eurozone banks (of which 561 North, 258 South) and 638 ROW banks

Definitions

Measure of size: Operating revenue in 2019

Eurozone: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain

South: Cyprus, Greece, Italy, Malta, Portugal, Spain

North: Austria, Belgium, Estonia, Finland, France, Germany, Ireland, Latvia, Lithuania, Luxembourg, Netherlands, Slovakia, Slovenia

Bank: Orbis categories: commercial bank, savings bank, cooperative bank, real estate & mortgage bank, investment bank, and bank holding & holding company

Return on average assets (ROAA): Net income divided by average total assets, where average total assets is the average of total assets at the beginning and at the end of a given period

MORE Score: Measure of creditworthiness developed by modeFinance. Scale ranges from AAA to D, with AAA being given to the most creditworthy and D to the least creditworthy companies.

Table B.1: Government consolidated gross debt in % of GDP (2019)

North		South	
Austria	70	Cyprus	94
Belgium	98	Greece	180
Estonia	8	Italy	135
Finland	59	Malta	43
France	98	Portugal	117
Germany	60	Spain	96
Ireland	57		
Latvia	37		
Lithuania	36		
Luxembourg	22		
Netherlands	49		
Slovakia	49		
Slovenia	66		
average	55		111
average (all)		73	

Source: Eurostat. https://ec.europa.eu/eurostat/databrowser/view/gov_10dd_edpt1

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