TI 2013-184/VI
Tinbergen Institute Discussion Paper

Banking Unions:
Distorted Incentives and Efficient Bank Resolution

Marius A. Zoican[1,3]
Lucyna A. Górnicka[2,3]

[1] *Faculty of Economics and Business Administration, VU University Amsterdam,*
[2] *Faculty of Economics and Business, University of Amsterdam;*
[3] *Tinbergen Institute.*

Tinbergen Institute is the graduate school and research institute in economics of Erasmus University Rotterdam, the University of Amsterdam and VU University Amsterdam.

More TI discussion papers can be downloaded at http://www.tinbergen.nl

Tinbergen Institute has two locations:

Tinbergen Institute Amsterdam
Gustav Mahlerplein 117
1082 MS Amsterdam
The Netherlands
Tel.: +31(0)20 525 1600

Tinbergen Institute Rotterdam
Burg. Oudlaan 50
3062 PA Rotterdam
The Netherlands
Tel.: +31(0)10 408 8900
Fax: +31(0)10 408 9031

Duisenberg school of finance is a collaboration of the Dutch financial sector and universities, with the ambition to support innovative research and offer top quality academic education in core areas of finance.

DSF research papers can be downloaded at: http://www.dsf.nl/

Duisenberg school of finance
Gustav Mahlerplein 117
1082 MS Amsterdam
The Netherlands
Tel.: +31(0)20 525 8579

Banking Union Optimal Design under Moral Hazard

Marius A. Zoican†

Tinbergen Institute

VU University Amsterdam

Lucyna A. Górnicka

Tinbergen Institute

University of Amsterdam

May 16, 2014

† JOB MARKET PAPER

Abstract

A banking union limits international bank default contagion, eliminating inefficient liquidations. For particularly low short term returns, it also stimulates interbank flows. Both effects improve welfare. An undesirable effect arises for moderate moral hazard, as the banking union encourages risk taking by systemic institutions. If banks hold opaque assets, the net welfare effect of a banking union can be negative. Restricting the banking union mandate restores incentives, improving welfare. The optimal mandate depends on moral hazard intensity and expected returns. Net creditor countries should contribute most to the joint resolution fund, less so if a banking union distorts incentives.

Marius Zoican can be contacted at m.a.zoican@vu.nl. Address: FEWEB, De Boelelaan 1105, 1081 HV Amsterdam, Netherlands. Lucyna Górnicka can be contacted at l.a.gornicka@uva.nl. The paper greatly benefited from detailed discussion with Alejandro Bernales, Nina Boyarchenko, Jean-Eduoard Colliard, Ahmed Elnahas, Alexander Guembel, Peter Hoffmann, Simas Kucinskas, Martien Lubberink, Stijn van Nieuwerburgh, Natalya Martynova, Albert Menkveld, Sophie Moinas, Enrico Perotti, Guillaume Plantin, Arjen Siegmann, Jean Tirole, Xavier Vives, Sweder van Wijnbergen, and Tanju Yorulmazer. We are grateful to the participants from the Toulouse School of Economics, University of Amsterdam, VU University Amsterdam, and Duisenberg School of Finance seminars for insightful comments, as well as conference participants at the 8th EBIM Doctoral Workshop in Bielefeld, the 26th Australasian Banking and Finance Conference, and the 50th Eastern Finance Association Meeting. Marius gratefully acknowledges Sophie Moinas for a visiting position at the Toulouse School of Economics, and the C. Willems Foundation for a research grant.

Banking Union Optimal Design under Moral Hazard

Abstract

A banking union limits international bank default contagion, eliminating inefficient liquidations. For particularly low short term returns, it also stimulates interbank flows. Both effects improve welfare. An undesirable effect arises for moderate moral hazard, as the banking union encourages risk taking by systemic institutions. If banks hold opaque assets, the net welfare effect of a banking union can be negative. Restricting the banking union mandate restores incentives, improving welfare. The optimal mandate depends on moral hazard intensity and expected returns. Net creditor countries should contribute most to the joint resolution fund, less so if a banking union distorts incentives.

Keywords: banking union, financial intermediaries , moral hazard, institution design, contagion

JEL Codes: G15, G18, G21

1 Introduction

> It is the most ambitious change in Europe since the launch of the euro: to transfer to European authorities the supervision of euro-zone banks and the power to wind them up, using a common European fund if necessary.
>
> – The Economist, December 2013

The focal point of the post-crisis policy debate in Europe is the design of a banking union to oversee the supervision and resolution of troubled financial intermediaries. To achieve its goals, the banking union needs to properly account for the extensive linkages between European financial systems. Cross-border banking flows in Europe have steadily increased over the last two decades.[1] At the same time, they exhibit a strong directional pattern, as documented in Figure 1. The largest Eurozone economies (e.g., Germany, France, and Netherlands) are net creditors to banking sectors from the highly-indebted GIIPS countries (Greece, Italy, Ireland, Portugal, and Spain).

[insert Figure 1 here]

The contribution of this paper is twofold. From a positive perspective, it argues that a banking union generates a tension between increased regulatory efficiency in responding to bank defaults, on the one hand, and weaker commitment to liquidate failed systemic institutions, on the other hand. The size of the interbank market and the risk taking incentives of banks have a complex effect on this trade-off. The net welfare effect can be negative if banks hold complex assets, for which poor risk management standards have a large impact on asset returns.

From a normative perspective, we study the optimal mandate of a banking union. Restricting the banking union's mandate can restore incentives and improve welfare. The best way to allocate bank default interventions between national and supranational regulators depends on bank risk taking incentives and asset expected returns. Furthermore, we discuss the effect of moral hazard on the resolution fund shares for the members of the banking union.

[1] See also Avdjiev, Upper, and Vause (2010). In 1989, two acts were passed to encourage pan-European flows: the Single Banking Licence and the Second Banking Directive.

The global financial crisis has exposed the potential advantages and drawbacks from implementing a banking union. First, shocks to a country's banking sector easily transmit abroad: e.g., the Franco-Belgian bank Dexia was bailed out three times since 2008, due to large exposures to Greek sovereign debt. The Dexia bailouts[2] also unveiled a different problem: the lack of a coordinated regulatory response and of intervention cost-sharing rules. Allen, Carletti, and Gimber (2011) argue that "*national regulators care first and foremost about domestic depositors*". On the other hand, a banking union is not without risks. Allen, Carletti, Goldstein, and Leonello (2013) argue that regulators with a large pool of financial resources are less likely to be tough on failing banks. For example, in January 2012 the European Central Bank (ECB) insisted that Irish government repay senior debt in the Anglo-Irish Bank at face value, whereas the Irish national bank was willing to impose haircuts.

In the model, the banking union is defined as an ex-post resolution mechanism. Given the default of a financial intermediary in any of the participating countries, the banking union decides between two possible policies: either a costly bailout financed by the taxpayers or the inefficient liquidation of the bank's assets. The costs of both these policies are shared between union members according to an ex-ante contract. The cross-border links between banks create the scope for default contagion, as in Freixas, Parigi, and Rochet (2000) or Allen and Gale (2000). Banks endogenously choose the risk of their portfolios as a function of the regulatory environment.

The banking union eliminates costly regulatory interventions for banks failing due to international contagion, despite a profitable domestic activity. It thus eliminates the cross-border spillover effects, improving the efficiency of liquidity provision. The fiscal burden for taxpayers is reduced. The enhanced efficiency, however, comes at a price. Liquidation or bail-in threats under a banking union become less credible: systemically important banks are bailed out more often to prevent domino defaults. Their incentives to monitor risks are reduced; consequently, systemic banks become more fragile. For a more asymmetric deposit base across countries and for moderate intensities of the moral hazard problem, the incentive effect dominates and the banking union reduces welfare. Without the banking union, larger international liabilities strengthen the national regulator's commitment not to bail out a defaulting bank. In other words, the cross-border interbank market acts as a disciplining force.

[2] As well as the bailout/take-over of Fortis, a Dutch-Belgian bank.

The impact of a banking union on the interbank market generally further amplifies the risk taking incentives of systemic institutions. One exception is worth mentioning. If expected short term returns are very low, banks strategically reduce their foreign borrowing to induce bailouts under national regulation. Since a banking union internalizes creditor bank profits, banks can borrow more internationally without being liquidated upon default. It follows that a banking union stimulates cross-border trading. While banks are always bailed out, the additional interbank return under a banking union helps reduce risk taking incentives.

The normative part of the paper focuses on optimal institutional design. If the banking union distorts incentives, a limited mandate is preferred: the joint regulator resolves only a limited subset of banks defaults, the rest falling under national jurisdiction. The optimal limited mandate depends on the intensity of the moral hazard problem, as well as on the expected returns on bank projects. There is a tradeoff between restoring incentives by reducing the scope of the banking union and limiting its benefits. For relatively low moral hazard, the less restrictive mandate is chosen; as moral hazard increases, the mandate of the banking union should be further limited.

Net creditor countries on the international banking market contribute more than proportionally to joint resolution costs, as they are the main beneficiaries of eliminating default spillovers. If the banking union worsens risk taking incentives, the maximum resolution fund share for creditor countries drops. Most importantly, in the presence of distorted incentives, the set of feasible resolution fund contracts shrinks dramatically. The reason is twofold. First, defaults become more likely: although cost sharing reduces the fiscal cost of a given bank default, creditor countries intervene more often. Secondly, under national regulation, debtor countries have a credible commitment device to liquidate defaulting banks as they do not internalise cross-border spillovers. The commitment is lost under the banking union and the welfare surplus is reduced for debtor countries.

The rest of the paper is structured as follows. Section 2 reviews the relevant literature. We present the model in Section 3. Section 4 discusses optimal resolution policies and welfare implications. Section 5 focuses on the banking union design: optimal mandate and resolution fund structure. Section 6 extends the baseline model to analyze the impact of a banking union on interbank markets. Section 7 concludes. Appendix B presents institutional details on the European banking union project. Appendix D collects all proofs.

2 Related literature

Contribution The paper contributes to the expanding literature on financial institution design and banking regulation. The model proposed contributes to this literature in the following ways. First, it integrates moral hazard into a cross-border banking model with endogenous regulatory architecture. Second, it offers policy proposals on the optimal design of a joint resolution mechanism, evaluating both the mandate of banking union and the structure of the resolution fund. Third, it offers insights into the effects of a banking union on the interbank market.

Closest to our setup, Beck, Todorov, and Wagner (2011) develop a model featuring ex-post regulatory intervention and cross-border banking. They also find that a larger share of cross-border liabilities can incentivise the regulator to liquidate the domestic bank. However, their model abstracts from any moral hazard issues arising with a common regulator, as well as the joint regulator's design. Philippon (2010) argues that coordinated bank bailouts can improve overall system efficiency, whereas individual countries might not have the incentives to bail out their own financial system - as some gains are transferred abroad. Colliard (2013) develops a similar mechanism to study ex-ante supervision in a federal system. In contrast to our paper, the moral hazard is generated by local supervisor's monitoring decisions rather than bank risk taking. Foarta (2014) argues that with imperfect electoral accountability, a banking union can encourage rent-seeking behaviour for politicians in debtor countries and reduce welfare.

Bank default spillovers and moral hazard Brusco and Castiglionesi (2007) argue that opening financial markets improves welfare through coinsurance benefits. Freixas, Parigi, and Rochet (2000) point out the role of the central bank in preventing liquidity shocks spillovers. Rochet and Tirole (1996) find that size of the interbank market certifies the quality of the borrowers. Acharya and Yorulmazer (2007), Farhi and Tirole (2012), and Eisert and Eufinger (2013) argue that banks coordinate on risk and network choices to benefit from larger government guarantees: a "too-many-to-fail" problem. In Allen, Carletti, and Gale (2009), the interbank market is mainly used to hedge liquidity shocks. Kara (2012) finds that national regulators have incentives to cooperate when there is systemic risk.

Ex-ante bank regulation Hellmann, Murdock, and Stiglitz (2000), and Repullo (2004) find that higher capital requirements induce more prudent bank behavior. Dell'Ariccia and Marquez (2006) argue that centralised regulation is preferred by individual countries only if it entails higher regulatory standards for all participating countries. Bengui (2011) shows that prudential regulatory policies are strategic substitutes across countries and thus international coordination is necessary to prevent free-riding on foreign liquidity provision in a crisis. Acharya (2003) argues that common agreements such as Basel III helped establishing a homogenous supervisory framework. Consequently, this paper focuses on the differences in bank resolution standards.

Ex-post bank regulation Mailath and Mester (1994), and Freixas (1999) argue that liquidation policies are inconsistent due to weak commitment. Chari and Kehoe (2013) find that limiting leverage partially mitigates the commitment problem of governments. Acharya and Yorulmazer (2008) consider fiscal costs above the face value of the bailout as a commitment device for the regulators. In Acharya (2003), national regulators are particularly lenient to give domestic banks a comparative advantage over foreign competitors. Allen, Carletti, Goldstein, and Leonello (2013) show that blanket guarantees are not desirable, as authorities with deeper pockets face a more severe commitment problem. Perotti and Suarez (2002) argue that selling failed banks to healthy ones is offers ex-ante incentives for financial intermediaries to stay solvent. Cordella and Yeyati (2003) show that bailouts can increase the charter value of banks.

Policy oriented papers Schoenmaker (2011) reveals a "financial trilemma" in banking regulation: the impossibility of having financial integration, national policies and financial stability at once. Carmassi, Di Noia, and Micossi (2012), and Schoenmaker and Gros (2012) argue for a supervisory institution with full crisis management powers in Europe, similar to the FDIC in the United States, proving that local resolution and central supervision are not incentive compatible. Ferry and Wolff (2012) discuss the fiscal alternatives for a banking union. Schoenmaker and Siegmann (2013) find that a common regulatory institution can deal better with cross-border externalities. On the empirical side, Schoenmaker and Wagner (2013) propose a methodology to compare benefits and cost of financial integration.

3 Model

3.1 Primitives

This section presents the model's primitives. Extensive motivation for these primitives is left to Subsection 3.2. The model is largely based on Acharya and Yorulmazer (2008) and Holmstrom and Tirole (1997). We consider an economy with four dates, $t \in \{-1, 0, 1, 2\}$ and two countries labeled A and B. In each country there are four types of agents: a bank (BK_A and BK_B), a local regulator (RG_A and RG_B), depositors, and "deep pockets" outside investors. At date $t = -1$, local regulators decide whether to merge into a supranational banking union: RG_{BU}.

Depositors. Depositors receive heterogenous endowments at date $t = 0$: depositors in country A receive $1 + \gamma$ units and depositors in country B receive $1 - \gamma$ units, where $\gamma \in (0, 1]$. They have the choice to invest their money in the domestic bank (and earn $r > 1$ at $t = 2$) or in a cash storage technology that yields zero interest rate. At date $t = 1$, a fraction ϕ of depositors receive a liquidity shock and withdraw their deposits without earning interest (as in Diamond and Dybvig (1983), for example); conditional on ϕ, all depositors have an equal chance of being hit by the liquidity shock. Depositors are fully insured by the regulator – there is no bank run equilibrium.

Long-term asset. Both banks have access to a constant returns to scale productive technology that requires an investment of $I \in [0, 1]$ at date $t = 0$ and generates returns at both $t = 1$ and $t = 2$. The investment yields a country specific stochastic return at $t = 1$ of $\tilde{R}_1 = \left\{0, R_1^A\right\}$ per unit for BK_A and $\tilde{R}_1 = \left\{0, R_1^B\right\}$ for BK_B. The second period return per unit of investment is deterministic and equal to $R_2 > 1$ for both banks. In addition, banks also have access to a zero-return cash storage technology.

Assumption 1: The following conditions on R_1^A and R_1^B hold:

1. The maximum project proceeds at $t = 1$ cover all liquidity shocks. There is no default if both projects are successful: $R_1^A + R_1^B \geq 2\phi$.
2. The maximum project proceeds at $t = 1$ for BK_A are insufficient to cover the liquidity shock if the

deposits exceeding the productive capacities are kept as a zero-yield buffer: $R_1^A + \gamma \leq (1+\gamma)\,\phi$, $\forall \gamma \in (0,1]$. The assumption is relaxed in Section 6.

Monitoring. There is a moral hazard friction. Banks can choose whether to monitor their portfolio. The probability of success at $t = 1$ is dependent on the banks' monitoring decisions.

If a bank monitors its loans, $\mathbb{P}\left(\tilde{R}_1 = R_1\right) = p_H$ but the bank manager pays a monitoring cost C. If it chooses not to monitor, then the probability of a positive return at $t = 1$ is reduced to $p_L < p_H$. The difference $p_H - p_L$ is denoted as Δp. Bank effort is not observable or verifiable by the national regulator or the banking union.

Interbank market. At $t = 0$, BK_A can lend any excess funds (not invested in the long term asset) on the interbank market to BK_B. The interbank loans are short-term (they mature at $t = 1$) and yield a gross return of r^I. BK_B has full bargaining power. The interbank market size γ^I and the interest rate r^I are set in two steps:

1. BK_B communicates to BK_A the interest rate r^I at which it is willing to borrow funds.
2. Given r^I, BK_A chooses the size of the loan γ^I that maximizes its expected profit.

Regulators. Regulators can either bail out defaulting banks at $t = 1$, by providing them with additional liquidity, or liquidate them: sell their assets to outside investors.[3] In the case of a bailout, the bank owners continue to operate the loan portfolio at $t = 2$. In the case of a liquidation, outside investors can only obtain $(1 - L)\,R_2$ at $t = 2$ per unit of investment, where $L \in (0, 1)$.

The regulator incurs a linear fiscal cost for the cash it injects in the banking sector. For each monetary unit invested in a regulatory intervention, F units have to be raised in taxes, where $F \in \left(1, \frac{1}{1-L}\right)$. The regulator's objective function is to maximize the total welfare in its own country at $t = 2$. The welfare measure is defined as the sum of payoffs for all agents in the economy.

Assumption 2: The proceeds from bank liquidation are not sufficient to pay domestic depositors in full: $\underbrace{(1-L)\,R_2}_{\text{liquidation proceeds}} \leq \underbrace{\phi\,(1-\gamma)}_{\text{demand deposits}} + \underbrace{(1-\phi)\,(1-\gamma)\,r}_{\text{full maturity deposits}}$. Hence, foreign creditors lose their whole investment.

[3] The model outcomes are the same if liquidated assets are managed by the regulator.

The banking union is a special type of regulator who can choose whether and which defaulting bank to bail out. The banking union can have a partial mandate, acting as a resolution authority only in some states of the world. The contribution to the resolution fund for each union member is set at $t = -1$ as a fraction of the intervention cost. The banking union's objective function is to maximize joint welfare – the sum of payoffs for all agents in both countries, as opposed to welfare in a single country.

The regulatory architecture, i.e., national regulation, a full or a partial mandate banking union, is contracted upon at $t = -1$ and is not renegotiable. Regulators cannot, however, commit to a particular type of intervention given a bank default.

Timeline. The timeline is described in Figure 2.

[insert Figure 2 here]

A list of all model parameters is presented in Appendix A.

3.2 Discussion of the primitives

This subsection presents further motivation and discussion of the key features of the model. The moral hazard problem and government intervention instruments closely follows Acharya and Yorulmazer (2008) and Beck, Todorov, and Wagner (2011).

Heterogeneity. The two countries are endowed with unequal deposit bases: $(1 + \gamma, 1 - \gamma)$, and differ in the cash flows at $t = 1$: $R_1^A < R_1^B$. The heterogeneity in deposits ensures that interbank cash flows do not net out in equilibrium. There is always a net lender (BK_A) and a net borrower (BK_B). Hence, exposure spillovers from debtors to creditors are analyzed in a parsimonious framework, without introducing a complex network structure. Such an assumption is not unrealistic: banks in emerging countries, for example, usually have investments opportunities that exceed their deposit base and draw funds from banks in developed countries. This is also in line with the empirical findings presented in Figure 1.

The difference in the $t = 1$ cash flows in the two countries is a technical condition which guarantees existence of a positive net interest rate that clears the interbank market. The assumption is relaxed in Section 6.

Investment opportunity set. Both banks face a maximum investment opportunity of one unit, which can be scaled down. As the bank's problem is linear and the loan has positive net present value, it will always choose to invest all the domestic deposits in loans.

Only domestic banks can directly invest in their country specific opportunities, whereas foreign banks have to use them as an intermediary. One can think of this assumption as a form of local expertise.

Depositors. Depositors are fully insured by the regulator, ruling out bank runs in equilibrium. Additionally, they have very large transportation costs to the other country (as in Hotelling (1929), for instance): this gives them a strict preference for depositing funds with domestic banks.

Monitoring. The model closely follows Holmstrom and Tirole (1997), where the bank's decision to monitor increases the likelihood of a high payoff, but comes at a positive cost.

Government intervention. We follow Acharya and Yorulmazer (2008) in assuming a linear fiscal cost function and that the bank liquidation results in an efficiency loss $(1-L)$. A marginal fiscal cost of interventions larger than one reflects the distortionary character of taxes. The condition $F < \frac{1}{1-L}$ is imposed to ensure that there are no "profitable liquidations". The fiscal proceeds from liquidated assets are always lower than the actual face value of the debt.

Interbank market. BK_B has full market power on the interbank market, thus BK_A is a competitive creditor. The assumption guarantees that BK_A cannot strategically restrict lending to influence the foreign regulator decision. Alternatively, a representative competitive BK_A is equivalent with a continuum of banks in country A competing for limited investment opportunities abroad.

3.3 A closed economy example

To build intuition, this subsection provides a simplified analysis of the disciplining role of bailouts. To this end, consider a closed economy: a single bank with one unit of deposits and one regulator deciding on bank resolution at $t = 1$.

There is no international banking market and the regulator decides to bailout a failing bank if the fiscal cost of providing liquidity is lower than the efficiency loss from transferring the bank assets to outside investors. Liquidation threats are credible to the extent bailouts are fiscally (and politically) costly, as also argued by Acharya and Yorulmazer (2008).

Bank's monitoring choice. If the bank monitors it earns $R_1 - \phi$ in the first period with probability p_H and continues to the second period without the need for government intervention. With probability $(1 - p_H)$ it fails to produce a positive return in the first period. Then it earns the $t = 2$ profit if and only if the regulator decides to bail it out. The expected profit of the bank as a function of the monitoring decision (π_{BK}) is given by:

$$\pi_{BK}\,(\text{Monitor}) = p_H\,(R_1 + R_2 - (\phi + (1 - \phi)\,r)) + (1 - p_H)\,(R_2 - (1 - \phi)\,r)\,\mathbb{I}_{\text{Bailout}} - C, \text{ and} \tag{1}$$

$$\pi_{BK}\,(\text{Not Monitor}) = p_L\,(R_1 + R_2 - (\phi + (1 - \phi)\,r)) + (1 - p_L)\,(R_2 - (1 - \phi)\,r)\,\mathbb{I}_{\text{Bailout}},$$

where the indicator variable $\mathbb{I}_{\text{Bailout}} = 1$ if the regulator decides to bail out the bank (and zero otherwise). The incentive compatibility constraint can be written as:

$$\pi_{BK}\,(\text{Monitor}) \geq \pi_{BK}\,(\text{Not Monitor})\,. \tag{2}$$

Simplifying, this leads to:

$$\frac{C}{\Delta p} \leq R_1 - \phi + (R_2 - (1 - \phi)\,r)\,(1 - \mathbb{I}_{\text{Bailout}})\,. \tag{3}$$

The incentive compatibility constraint is tightened when $\mathbb{I}_{\text{Bailout}} = 0$. When the regulator does not bail out the bank, the bank chooses to monitor even for larger costs C and smaller Δp, since otherwise it forgoes the second period profits at $t = 2$.

Resolution choice. The regulator decides to bail out the bank if the fiscal cost incurred at time $t = 1$ to provide ϕ (such that the bank pays all demand deposits) is lower than the efficiency loss from selling bank assets to the outside investors.

The welfare includes the final wealth of the banker and depositors, minus the costs of the fiscal intervention. The cost of the fiscal intervention is equal to the regulator's payment to depositors minus any bank liquidation proceeds, multiplied by the marginal fiscal cost F. By assumption, the cost of the fiscal intervention is always positive (liquidation proceeds are never sufficient to pay depositors). The policy dependent expressions for welfare are:

$$\text{Welfare}_{\text{Bailout}} = R_2 - \overbrace{(F-1)\,\phi}^{\text{fiscal cost of deposits}}, \text{ and} \tag{4}$$

$$\text{Welfare}_{\text{Liquidation}} = R_2 - \overbrace{L \times R_2}^{\text{liquidation loss}} + \overbrace{R_2\,(1-L)\,(F-1)}^{\text{fiscal cost savings}} - \overbrace{(\phi + (1-\phi)\,r)\,(F-1)}^{\text{fiscal cost of deposits}}.$$

The bailout condition is given by $\text{Welfare}_{\text{Bailout}} - \text{Welfare}_{\text{Liquidation}} \geq 0$ or:

$$R_2\,(1 - F\,(1-L)) \geq (1-F)\,(1-\phi)\,r. \tag{5}$$

For $F \in \left(1, \frac{1}{1-L}\right)$ the left hand side of the previous equation is larger than zero, and the right hand side is smaller than zero. Hence, the bank is always bailed out and the regulator cannot commit to a liquidation resolution policy that will lead to better incentives for the bank.

4 The impact of a full mandate banking union

In this section, the equilibrium monitoring and resolution strategies, as well as the total welfare, are determined both for a banking union with full mandate and national resolution systems. Banks are allowed to operate on international markets, the *status quo* in the European Union.

A full mandate banking union is defined as a resolution authority with the power to decide between the bailout and liquidation of any defaulting bank, in all possible states of the world. Its objective function is to maximize the joint welfare of participating countries. By contrast, national regulators focus only on domestic welfare, ignoring cross-border externalities generated by spillovers.

4.1 Cross-border spillover mechanism under national bank resolution

Conditional on a BK_B default, RG_B decides between bailout and liquidation, with different consequences for uninsured foreign debt holders. If the regulator opts for a bailout, it has to provide sufficient funds to satisfy the claims of both domestic as well as foreign creditors of the defaulting bank. In the case of liquidation, the proceeds are only used to cover insured domestic depositors in country B. The bank in country A does not receive any of its claims (see Assumption 2). Consequently, RG_A has to also intervene and provide costly liquidity to a distressed BK_A.

For a bailout, RG_B provides a liquidity injection of $\phi(1-\gamma) + r^I\gamma$. In a liquidation, RG_B covers only the domestic depositors' claims: $\phi + (1-\phi)\,r$, partly from liquidation proceeds. The ex-post welfare in the case of a bailout ($\text{Welfare}^B_{\text{Bailout}}$) and in the case of a liquidation ($\text{Welfare}^B_{\text{Liquidation}}$) is:

$$\text{Welfare}^B_{\text{Bailout}} = R_2 + \phi(1-\gamma) - \overbrace{F\left[\phi(1-\gamma) + r^I\gamma\right]}^{\text{fiscal cost: deposits and international debt}}, \text{ and} \tag{6}$$

$$\text{Welfare}^B_{\text{Liquidation}} = R_2 - \overbrace{L \times R_2}^{\text{liquidation loss}} + \overbrace{R_2(1-L)(F-1)}^{\text{fiscal cost savings}} - \overbrace{\left[(\phi + (1-\phi)\,r)(1-\gamma)\right](F-1)}^{\text{fiscal cost of deposits}}.$$

Welfare conditional on liquidation is computed as the cash receipts of insured depositors, minus the regulator's net costs. Hence, BK_B is bailed out by regulator RG_B if the welfare after a bailout exceeds the welfare after a liquidation, condition equivalent to:

$$R_2(1 - F(1-L)) \geq (1-F)(1-\phi)(1-\gamma)\,r + Fr^I\gamma. \tag{7}$$

The outcome for BK_A is a function of the resolution policy in country B, as the proceeds from the interbank loan are wiped out in the case of a liquidation. First, if equation (7) holds and BK_B is bailed out, BK_A is able to pay all liquidity demands and continues operating into $t = 2$ without any regulatory intervention. Otherwise, if BK_B is liquidated, then BK_A defaults too, prompting regulatory intervention. The regulator RG_A steps in and bails out BK_A if the domestic welfare after a bailout is at least equal to the welfare after a bank liquidation:

$$\text{Welfare}^A_{\text{Bailout}} = R_2 + \phi(1+\gamma) - \overbrace{F[\phi(1+\gamma)]}^{\text{fiscal cost of deposits}}, \text{ and} \tag{8}$$

$$\text{Welfare}^A_{\text{Liquidation}} = R_2 - \overbrace{L \times R_2}^{\text{liquidation loss}} + \overbrace{R_2(1-L)(F-1)}^{\text{fiscal cost savings}} - \overbrace{(\phi + (1-\phi)r)(1+\gamma)(F-1)}^{\text{fiscal cost of deposits}}.$$

The bailout condition is given by:

$$R_2(1 - F(1-L)) \geq (1-F)(1-\phi)(1+\gamma)r. \tag{9}$$

In addition to the spillover scenario described above (BK_B defaulting and BK_A being successful at $t = 1$), there are other three possible states of the world, depending on the realisation of R^i_1. The bank profits and country specific welfare in all possible scenarios are detailed in Appendix C.

4.2 National resolution equilibrium

Proposition 1 describes the optimal resolution policies for the national regulators, as well as the monitoring choices of banks under national regulation.

Proposition 1. (Equilibrium with no banking union) *Under national bank regulation:*

(i) ***Resolution policy.*** *The regulator RG_A always bails out the local bank BK_A. The regulator RG_B*

bails out the local bank BK_B if $\gamma \leq \gamma^*$, where the threshold interbank market size is:

$$\gamma^* = \frac{R_2\,(1 - F\,(1 - L)) + (F - 1)\,(1 - \phi)\,r + F\left(R_1^A - \phi\right)}{F\phi + (F - 1)\,(1 - \phi)\,r}. \tag{10}$$

(ii) ***Monitoring decisions.*** *Bank A never monitors. For $\gamma < \gamma^*$, monitoring is optimal for BK_B only if the moral hazard problem is low enough: $\frac{C}{\Delta p} \leq c_1$. If $\gamma \geq \gamma^*$, monitoring is optimal if $\frac{C}{\Delta p} \leq c_2$, where it holds that $c_2 > c_1$. The moral hazard thresholds are given by $c_1 = R_1^A + R_1^B - 2\phi$ and $c_2 = c_1 + R_2 - (1 - \phi)\,(1 - \gamma)\,r$.*

(iii) ***Interbank market.*** *The interbank market clears at the rate: $\underline{r}_I = \frac{\phi(1+\gamma) - R_1^A}{\gamma}$.*

The spillover mechanism and equilibrium resolution policies are further detailed in Figure 3.

[insert Figure 3 here]

The first part of Proposition 1 states that for large enough interbank markets, BK_B will never be bailed out. In the case of a default, RG_B has to repay the short term international debt if it wants to avoid liquidating BK_B. However, it does not internalize the welfare transfer abroad. As a larger γ implies a larger international transfer, the domestic gains from the bailout of BK_B decrease with γ. Over a certain interbank market size threshold (γ^*, as defined in equation (10)), the liquidation loss becomes relatively smaller and BK_B is liquidated.

The intuition behind BK_A always being bailed out relies on the fact that the regulator internalizes the welfare of depositors. Unlike in the case of BK_B, no funds leave the country. Furthermore, if BK_A succeeds at $t = 1$ or is bailed out, international inflows alleviate Bank A's liquidity needs. As bailouts are cheaper than liquidation, RG_A has no ex-post mechanism to impose a higher level of discipline ex-ante by offering monitoring incentives.

Bank A will never monitor its loans: the profit of BK_A at the intermediate date is zero due to BK_B having full bargaining power; the full profit at $t = 2$ is guaranteed by the equilibrium bailout strategy. The interbank market plays a twofold disciplining role for BK_B: both through improved regulatory commitment and leverage effects. First, liquidation threats become a credible instrument for $\gamma > \gamma^*$. As bailouts become sub-optimal, a failure would lead to foregoing not only the profit at $t = 1$, but also at $t = 2$. Bank B's incentives to monitor jump at $\gamma = \gamma^*$, and then increase linearly with γ due to the leverage effect on $t = 2$ profits.

[insert Figure 4 here]

4.3 Banking union equilibrium

The two national regulators are replaced by a single supranational regulator RG_{BU}, operating a common bank resolution mechanism. The regulator's objective is to maximize the joint welfare in the two member countries:

$$\left[\text{Welfare}^A + \text{Welfare}^B\right]_{\text{Bailout}} \geq \left[\text{Welfare}^A + \text{Welfare}^B\right]_{\text{Liquidation}}. \tag{11}$$

Given the new bailout rule (11), the decisions of the joint regulator differ from the national resolution case. Proposition 2 summarizes the properties of the equilibrium under the common resolution mechanism.

Proposition 2. (Equilibrium in a banking union) *Under the banking union:*

(i) ***Strategy independence.*** *The monitoring strategies of BK_B and BK_A are mutually independent.*

(ii) ***Resolution policy.*** *The regulator RG_{BU} always bails out a defaulting bank.*

(iii) ***Monitoring decisions.*** *Monitoring is never optimal for BK_A. BK_B monitors if and only if the moral hazard problem is lower than the threshold: $\frac{C}{\Delta p} \leq c_1$ with c_1 defined in Proposition 1.*

(iv) ***Interbank market.*** *The interbank market clears at the rate: $\underline{r}_I = \frac{\phi(1+\gamma)-R_1^A}{\gamma}$.*

As opposed to the national regulation benchmark, the common regulator always bails out BK_B, independently of the size of the interbank market γ. Intuitively, this happens as the supranational regulator internalizes the negative effect the liquidation of bank B, through the interbank exposure, will have on bank A. In order to avoid further welfare losses, regulator RG_{BU} always bails out BK_B.

The bank in country B also monitors less under a banking union. Since the joint regulator cannot credibly commit to liquidation for any γ, the payoff at $t = 2$ is guaranteed for BK_B: the only incentive to monitor is generated by the expected profits at $t = 1$. For $\gamma > \gamma^*$, this is equivalent to a banking union worsening monitoring incentives for financial intermediaries.

The equilibrium decisions under both national and joint resolution systems are summarized in Table 1.

[insert Table 1 here]

4.4 Welfare effect of a full mandate banking union

The full mandate banking union impact is evaluated through a welfare comparison with the national regulatory systems. Ex-ante, two opposite effects are apparent. First, the banking union eliminates inefficient liquidation outcomes caused by international spillovers. Secondly, the banking union resorts to bailouts in the states of the world where national regulators would have liquidated a defaulting bank. Systemic banks can take more risk and benefit from de facto default insurance. The first effect is welfare improving, while the second is welfare reducing. Consequently, the net effect of the banking union on joint welfare is non-trivial.

For small interbank markets, the following indifference result holds:

Lemma 1. *The welfare under the banking union coincides with the welfare under the national regulators if there are no differences in the ex-post bailout strategies between the two systems ($\gamma < \gamma^*$).*

Lemma 1 is intuitive. As the monitoring decisions of the banks depend on the regulators ex-post optimal resolution, the welfare only differs when the resolution policies of joint and national regulators are not the same. This only happens when the interbank market is large enough: $\gamma > \gamma^*$, such that a bailout of BK_B under national supervision becomes sub-optimal.

Proposition 3 focuses on the $\gamma > \gamma^*$ case, presenting the conditions under which a banking union is welfare improving:

Proposition 3. (Welfare impact of the full mandate banking union) *Under the banking union:*

(i) ***Low moral hazard.*** *If* $\frac{C}{\Delta p} \leq c_1$*, the banking union always improves welfare.*

(ii) ***High moral hazard.*** *If* $\frac{C}{\Delta p} \geq c_2$*, the banking union also always improves welfare. The welfare surplus decreases relative to the case of low moral hazard by a factor of* $\frac{1-p_L}{1-p_H} < 1$.

(iii) ***Intermediate moral hazard.*** *If* $\frac{C}{\Delta p} \in (c_1, c_2)$*, the banking union is only welfare improving if* $\Delta p \leq \overline{\Delta p}$*, where* $\overline{\Delta p}$ *is given by:*

$$\overline{\Delta p} = \frac{(1-p_H)(R_2(1-F(1-L)) + (1-\gamma)(1-\phi)(F-1)r)}{F\left(2\phi - R_1^A\right) + \left(R_1^A + R_1^B - 2\phi\right)}. \tag{12}$$

If the moral hazard is low, i.e., $\frac{C}{\Delta p} \leq c_1$, BK_B monitors both under the banking union and under the national regulator. The introduction of the banking union does not worsen the monitoring incentives of BK_B. The banking union only eliminates the exposure spillover, i.e., the losses for the creditor country due to liquidations in the debtor country. In this case, the banking union is strictly welfare improving.

For high moral hazard intensity, i.e., $\frac{C}{\Delta p} \geq c_2$, BK_B never monitors either under the banking union or national supervision. The incentives of the bank are not affected by the introduction of the union and the only effect is the liquidity spillover being eliminated: the banking union is again strictly welfare improving. Since the probability of a spillover is larger (BK_B fails more often), the welfare surplus from a joint regulator is larger than for low moral hazard.

The most interesting case is for intermediate moral hazard values: $\frac{C}{\Delta p} \in (c_1, c_2)$. Under national regulation, BK_B monitors its assets as the liquidation threat is credible. However, under the banking union it is always bailed out. Consequently, it no longer monitors.

The welfare surplus from the banking union eliminating spillovers can be written as the sum of the benefit from avoiding the inefficient liquidation and the cost of repaying insured deposits from taxpayers' money:

$$\text{Spillover Effect} = \underbrace{R_2\left(1 - F\left(1 - L\right)\right)}_{\text{(net) liquidation costs saved}} + \underbrace{(F - 1)(1 - \gamma)(1 - \phi)\, r}_{\text{fiscal costs of deposits}}. \tag{13}$$

The negative incentive effect of the banking union can be written as the additional bailout cost (banking union bails out both banks instead of only BK_A) plus the expected loss from BK_B realizing a positive payoff at the intermediate date with a lower probability:

$$\text{Incentive Effect} = \underbrace{(F - 1)\left(2\phi - R_A^1\right)}_{\text{additional bailout costs}} + \underbrace{R_B^1}_{\text{profits lost at t=1}}. \tag{14}$$

The total welfare effect of the banking union can be written as a function of either one or both of these components, depending whether the banking union affects risk taking incentives:

$$\mathbb{E}\Delta\text{Welfare}_{BU} = \begin{cases} (1 - p_H)\,\text{Spillover Effect} & \text{if } \frac{C}{\Delta p} \leq c_1, \\ (1 - p_L)\,\text{Spillover Effect} & \text{if } \frac{C}{\Delta p} \geq c_2, \text{ and} \\ (1 - p_H)\,\text{Spillover Effect} - \Delta p \times \text{Incentive Effect} & \text{if } \frac{C}{\Delta p} \in (c_1, c_2). \end{cases} \tag{15}$$

For a large enough Δp, the negative market discipline effect outweighs the benefits of eliminating international contagion and thus the banking union becomes sub-optimal. A large Δp corresponds to a significant effect of monitoring on asset returns. It can be interpreted as a measure of asset complexity or opacity: structured derivative products, for example, require more expertise and effort to monitor. Figure 5 plots the welfare surplus as a function of moral hazard ($\frac{C}{\Delta p}$).

[insert Figure 5 here]

The maximum welfare surplus the banking union can generate corresponds with the case when it does not shift incentives: $(1 - p_H) \times \text{SpilloverEffect}$. The full mandate banking union is welfare improving for $\Delta p \leq \frac{(1-p_H)\text{SpilloverEffect}}{\text{IncentiveEffect}}$. Intuitively, the welfare improving region increases in the surplus from eliminating spillovers and decreases in the loss from incentive distortion.

5 Optimal design of the banking union

This section focuses on two dimensions of banking union design. First, the optimal resolution mandate is analyzed: the set of states for which the banking union, as opposed to national regulators, intervenes after a bank default. Secondly, we investigate the range of feasible resolution fund contracts.

5.1 Optimal resolution mandate

From an ex-post joint welfare perspective, the liquidation of BK_B is always sub-optimal. However, liquidation might be necessary to maximize monitoring incentives. Part of the banking union welfare surplus from spillover effects can be traded off for better risk monitoring.

The second best is achieve by a joint regulator who can commit to ex-post inefficient liquidations. It can select the optimal liquidation probability that minimizes the welfare surplus reduction. Ex-post inefficient actions are however very difficult to implement in practice.

A feasible alternative is a limited mandate (state contingent) banking union. In some states of the world, the default of BK_B is resolved by the national regulator, who finds liquidation optimal. This institutional framework generates a different outcome than the full mandate banking union from Section 4. The optimal mandate design defines the exact scope of joint and national regulator interventions that maximize welfare while offering full monitoring incentives.

5.1.1 Second best resolution policy with random liquidation

The second best case[4] corresponds to a mixed strategy: the banking union randomly liquidates BK_B upon default. The policy implies full ex-ante commitment to ex-post inefficient policies.

[4]The first best corresponds to an economy without the moral hazard friction, where effort is observable and contractible.

For low and high levels of moral hazard, there is no incentive distortion effect and thus no need to implement spillover generating liquidations: the optimal liquidation probability is zero.

For $\frac{C}{\Delta p} \in (c_1, c_2)$, the banking union commits ex-ante to a random bailout policy for BK_B. Given default, BK_B is bailed out with probability α (and liquidated with probability $1 - \alpha$).

Since lower values of α correspond to a larger probability of liquidation, BK_B has better incentives to monitor its assets to earn positive profits at $t = 2$. As α decreases, cross-border spillovers are allowed more often and the efficiency gains from the banking union drop. The joint regulator's problem is to choose α to maximize the welfare surplus of the banking union, subject to the incentive compatibility constraint of BK_B:

$$\max_{\alpha} \Delta\text{Welfare}(\alpha) = \alpha (1 - p_H) \times \text{SpilloverEffect}, \tag{16}$$
$$\text{subject to: } \frac{C}{\Delta p} = c_1 + (1 - \alpha)(c_2 - c_1).$$

The optimal probability of a bailout that eliminates the incentive distortion effect is given by the solution to the monitoring constraint:

$$\alpha^* = \frac{c_2 - \frac{C}{\Delta p}}{c_2 - c_1} \in (0, 1). \tag{17}$$

The equilibrium probability of a bailout decreases with the intensity of the moral hazard problem (α^* drops as $\frac{C}{\Delta p}$ increases). For worse monitoring incentives of BK_B, the banking union has to liquidate it more often upon default to encourage monitoring. At the same time, a higher liquidation probability translates into a higher cross-border spillover probability, which reduces the joint welfare surplus.

The full mandate banking union following a random resolution policy maximizes the welfare surplus in the presence of moral hazard. It eliminates the incentive distortion problem by sacrificing the least possible from the benefits of the banking union. However, in practice, regulators may not be able to commit to ex-post inefficient policies and thus achieve the second best.

The next subsection studies an alternative institutional design that can partially alleviate moral hazard, i.e., a banking union with a limited mandate.

5.1.2 Limited mandate banking union

From Proposition 2, a full mandate banking union always bails out defaulting banks. This resolution policy is optimal under low and high moral hazard intensities, as stated by Lemma 2. Thus, a restricted mandate does not improve welfare.

Lemma 2. *A full mandate banking union is weakly optimal for low ($\frac{C}{\Delta p} \leq c_1$) and high ($\frac{C}{\Delta p} \geq c_2$) levels of moral hazard.*

Under intermediate moral hazard problems, $\frac{C}{\Delta p} \in (c_1, c_2)$, a limited mandate can improve on the outcome of a full banking union. This is particularly vital when the full mandate banking union reduces welfare. For relatively larger values of moral hazard in (c_1, c_2), a limited mandate banking union can still fail to improve incentives.

The limited mandate is defined as a state-contingent contract: the banking union only intervenes in a subset of defaults, the rest falling under national jurisdiction. We consider two alternative limited banking unions.

Definition 1. The limited mandate banking union possible designs are defined as follows:

1. **Independent default mandate.** The banking union intervenes either when BK_A alone, or both banks default on domestic investments: $\left(0, R_1^B\right)$ and $(0, 0)$.
2. **Contagion mandate.** The banking union intervenes either when BK_A alone, or BK_B alone defaults on domestic investments: $\left(0, R_1^B\right)$ and $\left(R_1^A, 0\right)$.

Proposition 4 states the conditions under which a limited mandate banking union improves on the outcome of both the full mandate banking union and national resolution.

Proposition 4. (Limited mandate banking union) *For intermediate moral hazard values:* $\frac{C}{\Delta p} \in (c_1, c_2)$*, a limited mandate improves welfare if:*

(i) the full mandate union improves welfare ($\Delta p < \overline{\Delta p}$)*, but the incentive effect is large enough:* $\Delta p > \min\{p_L, 1 - p_L\} \overline{\Delta p}$.

(ii) the full mandate union reduces welfare ($\Delta p \geq \overline{\Delta p}$) *and moral hazard is below a certain threshold:* $\frac{C}{\Delta p} < c_1 + \max\{p_L, 1 - p_L\}(c_2 - c_1)$.

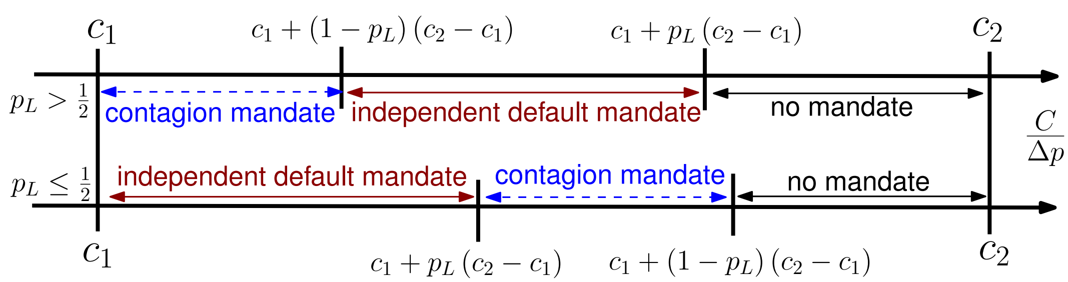
The optimal limited mandate depends on the value of p_L. Keeping p_H fixed, a large p_L translates into a small impact of monitoring on success probability: the case of less complex banking products, easy to understand and to monitor. Alternatively, keeping Δp fixed, a larger p_L can be interpreted as a good economic environment, where investments have a large success probability. Conversely, a small p_L is interpreted as an economy with complex banking products, where monitoring has a large impact on success probabilities, as well as poor investment opportunities. Bloom, Floetotto, Jaimovich, Saporta-Eksten, and Terry (2012) find that microeconomic uncertainty is more pronounced in recessions, consistent with both interpretations of lower values for p_L.

If both the limited and the full mandate banking unions improve welfare, but the surplus from the restricted joint regulator is larger, the optimal limited mandate only depends on p_L. For p_L smaller than one half, the independent default mandate is optimal, otherwise the contagion mandate is preferred. The optimal limited mandate is selected to maximize the probability of a joint intervention.

If the full mandate banking union reduces welfare, the moral hazard friction intensity also influences the optimal limited mandate. For relatively low moral hazard, a limited mandate banking union should focus on the most likely distress situations. A small liquidation probability is sufficient to provide monitoring incentives, and a lower share of welfare surplus needs to be sacrificed to achieve them. The limited mandate choice changes if moral hazard is larger and a higher liquidation probability is needed to restore incentives. In this case, the welfare surplus is further reduced by additionally limiting bailouts.

Corollary 1. (Limited mandate choice for $\Delta p \geq \overline{\Delta p}$) *For relatively low moral hazard levels,* $\frac{C}{\Delta p} \in (c_1, c_1 + \min\{p_L, 1 - p_L\}(c_2 - c_1))$*, the limited mandate with highest welfare surplus is selected: the independent default mandate for* $p_L < \frac{1}{2}$ *and the contagion mandate otherwise. For higher moral hazard,* $\frac{C}{\Delta p} \in (c_1 + \min\{p_L, 1 - p_L\}(c_2 - c_1), c_1 + \max\{p_L, 1 - p_L\}(c_2 - c_1))$*, the alternative limited mandate needs to be chosen to restore incentives.*

The optimal choice of limited mandates for $\Delta p \geq \overline{\Delta p}$ is summarized below:



When the monitoring strategy has a large impact on the return distribution, i.e., for relatively more complex bank assets, the banking union optimally intervenes after BK_B's default only when the creditor bank also defaults on its domestic portfolio. In this case, the systemic crisis is not mainly driven by the contagion effect. Otherwise, for a low impact of monitoring on success probabilities, the joint regulator only intervenes after BK_B's default when contagion is the main driver of the systemic crisis (BK_A is successful but BK_B fails).

The welfare surplus of a banking union with a full and with a limited mandate, as well as the second best surplus, are presented in Figure 6.

[insert Figure 6 here]

Further implications

If a limited mandate banking union improves the outcome over a full mandate joint regulator, there are two additional implications. First, it also represents an improvement over ex-post transfers between countries, even in the absence of bargaining frictions. Second, a limited mandate banking union can be more lenient ex-ante than a full mandate banking union.

The case for a limited mandate union over ex-post agreements An alternative to setting up a banking union is relying on an ex-post fund transfer from RG_A to RG_B. However, ex-post transfers can be very costly. International exposures of banks are difficult to measure, especially if they involve complex instruments. Informational asymmetries complicate the bargaining process, potentially increasing liquidation costs and delaying resolution. In principle, a full mandate banking union is equivalent to an ex-post transfer from country A to country B. Both arrangements implement the ex-post optimal outcome, as follows from the Coase (1960) theorem. A corollary of the analysis in this subsection is that if a limited mandate banking union improves welfare relative to a full mandate banking union, it also improves welfare relative to ex-post transfers.

Implications on supervision policy One of the salient policy implications of our model is that bank supervision under a joint resolution mechanism needs to be stronger. Stronger ex-ante regulatory requirements can limit the risk taking behaviour amplified by a more lenient ex-post resolution policy. There are several caveats to stronger supervision. First, Colliard (2013) argues there exist agency frictions between local and joint bank supervisors. Second, Górnicka (2014) finds that banks respond to tougher capital requirements by moving risky assets off their balance sheets, while using taxpayer money to insure them. A limited mandate banking union improves on the ex-post outcome, thus reducing the need for particularly tough ex-ante measures and further distortions.

5.2 Resolution fund contributions

In this subsection, national regulators endogenously decide to join the banking union at $t = -1$. The banking union is created if it is individually optimal for both regulators to move away from local resolution policies.

For simplicity, we focus on linear resolution fund contracts: RG_A supports a share $\beta \in (0, 1)$ of all intervention costs, whereas RG_B supports $1 - \beta$. Thus, if a bailout requires a liquidity injection of X, country A will pay $\beta F \times X$ and country B will pay $(1 - \beta) F \times X$, where $F > 1$ is the marginal fiscal cost of providing funds.

The goal of the analysis is to determine the feasible range for β which offers incentives to both regulators to join the banking union. The following incentive compatibility constraints should hold simultaneously:

$$\mathbb{E}\left[\text{Welfare}^A_{BU} - \text{Welfare}^A_{National}\right] \geq 0, \text{ and} \tag{18}$$

$$\mathbb{E}\left[\text{Welfare}^B_{BU} - \text{Welfare}^B_{National}\right] \geq 0. \tag{19}$$

Two cases exist. First, when $\gamma \geq \gamma^*$, the banking union changes the bailout policy for BK_B and has a positive effect on welfare, as described in Section 4.4. Second, when $\gamma < \gamma^*$, the banking union does not change bailout policies or affect welfare. The case when the effect on welfare is negative is left out, as the banking union is never optimal.

The banking union improves joint welfare when $\gamma > \gamma^*$ and $\Delta p < \overline{\Delta p}$. Table 2 presents the welfare impact of a full mandate banking union for each country and state of the world.

[insert Table 2 here]

Three cases arise. The first two are concerned with the situation when the full mandate banking union does not shift incentives (low and high moral hazard values). If the full mandate banking union worsens the incentives of BK_B, the joint welfare surplus is reduced, and the full mandate banking union is no longer necessarily optimal. Proposition 5 describes the feasible contract sets when the full mandate banking union is optimal.

Proposition 5. (Full mandate intervention cost sharing) *When $\gamma > \gamma^*$ and the full mandate banking union is optimal, the cost sharing contracts $(\beta, 1-\beta)$ depend on moral hazard:*

(i) ***Low moral hazard.*** *If $\frac{C}{\Delta p} \leq c_1$, there exists: $1 \geq \overline{\beta}_M > \underline{\beta}_M \geq \frac{1}{2}$, such that for any $\beta \in \left(\underline{\beta}_M, \overline{\beta}_M\right)$ the full mandate banking union is feasible.*

(ii) ***High moral hazard.*** *If $\frac{C}{\Delta p} \geq c_2$, there exists a $\underline{\beta}_N$ and $\overline{\beta}_N$ such that $\overline{\beta}_M > \overline{\beta}_N > \underline{\beta}_N > \frac{1}{2}$ and for any $\beta \in \left(\underline{\beta}_N, \overline{\beta}_N\right)$ the full mandate banking union is feasible.*

(iii) ***Intermediate moral hazard.*** *If $\frac{C}{\Delta p} \in (c_1, c_2)$, the welfare surplus is reduced: there exists a $\underline{\beta}_D < \overline{\beta}_D$ such that $\left(\underline{\beta}_D, \overline{\beta}_D\right) \subset \left(\underline{\beta}_N, \overline{\beta}_N\right)$ and for any $\beta \in \left(\underline{\beta}_D, \overline{\beta}_D\right)$, the full mandate banking union is feasible.*

The maximum resolution fund shares the creditor country is willing to pay as a function of moral hazard are related by equation 20:

$$\overline{\beta}_M \geq \overline{\beta}_N \geq \overline{\beta}_D. \tag{20}$$

When the limited banking union mandate is optimal, similar cost sharing contracts are available:

> **Lemma 3.** (Limited mandate intervention cost sharing) *There exist pairs $\underline{\beta}_I < \overline{\beta}_I$ and $\underline{\beta}_C < \overline{\beta}_C$ such that the independent default mandate banking union is feasible for $\beta \in \left(\underline{\beta}_I, \overline{\beta}_I\right)$ and the contagion mandate banking union is feasible for $\beta \in \left(\underline{\beta}_C, \overline{\beta}_C\right)$. Moreover, $\overline{\beta}_C = 1$: the creditor country is willing to pay the full costs under the contagion mandate banking union.*

The result that $\overline{\beta}_C = 1$ is intuitive. Under the limited mandate banking union that focuses on the contagion case, the creditor country reaps all the benefits of the union: spillovers are partially eliminated while incentives are restored. Furthermore, creditor countries never contribute to cross-border bailouts if their own national bank system also defaults due to domestic reasons.

When $\gamma < \gamma^*$, the policies are identical under national and joint resolution mechanisms. Hence, the banking union has a zero net welfare effect. Table 2 shows that with zero net welfare effect of the banking union, one country's surplus is another country's loss in each scenario. Hence, the only way for the incentive constraint (18) to hold is if $\mathbb{E}\left[\text{Welfare}^A_{\text{BU}} - \text{Welfare}^A_{\text{National}}\right] = 0$. Lemma 4 uniquely identifies the linear contract between the two countries that satisfies this condition.

> **Lemma 4.** (Banking union with zero welfare effect) *When $\gamma < \gamma^*$, β is unique and given by:*
>
> *(i) If BK_B monitors its loans, $\beta = \beta^{ZS}_M$, where $\beta^{ZS}_M = \frac{(1-p_L)R^A_1}{2(1-p_H)\phi + \Delta p R^A_1} < \overline{\beta}_M$.*
>
> *(ii) If BK_B does not monitor its loans, $\beta = \beta^{ZS}_N$, where $\beta^{ZS}_N = \frac{R^A_1}{2\phi} \in \left(0, \frac{1}{2}\right)$.*

Figure 7 plots the resolution fund shares $(\beta, 1-\beta)$ as a function of the interbank market size:

[insert Figure 7 here]

The national regulator in country A is less willing to contribute to the resolution fund if the union worsens the risk taking incentives in country B compared with the case when BK_B never monitors the loans. By not joining an incentive-shifting banking union, RG_A intervenes less often, as spillover frequency is lower. When moral hazard intensity is very high, the decision of RG_A to give up its resolution mechanism does not influence the probability of a spillover.

Incentive shifting reduces the space of potential resolution fund contracts. As $\overline{\beta}_D - \underline{\beta}_D < \overline{\beta}_N - \underline{\beta}_N$, the feasible set for β is reduced. The total welfare surplus from the union drops. As previously discussed, RG_A demands even more of the declining surplus. Furthermore, RG_B loses the liquidation commitment device by joining the banking union. To compensate, it asks for a larger share of the total surplus. Consequently, the feasible contract space shrinks.

For $\gamma > \gamma^*$, RG_A pays a larger share of the resolution fund than for $\gamma < \gamma^*$. Formally, $\underline{\beta}_M > \beta_M^{ZS}$ and $\underline{\beta}_N > \beta_N^{ZS}$. The result follows from the fact that the banking union solves a spillover externality that affects mostly country A. As $\underline{\beta}_D > \underline{\beta}_N > \beta_N^{ZS}$, the result is unaffected by incentive distortion effects. At the same time, RG_B also demands a lower share in the union costs as its contribution to BK_B bailouts are also more frequent.

6 Banking union effect on the interbank market

This section studies the effect of a banking union on the interbank market size and interest rate. The baseline model in Section 3 studies the case when BK_A needs to lend on the interbank market to be able to repay early depositors. The assumption guarantees an interbank transfer of γ and also fixes the interest rate to $r^I = \frac{\phi(1+\gamma)-R_1^A}{\gamma}$. To allow the regulatory framework to impact the interbank market, the baseline model is extended by relaxing Assumption 1. We analyze the situation when BK_A is able to fulfil all claims at $t = 1$ without lending on the interbank market:

$$R_1^A + \gamma - \phi(1 + \gamma) > 0. \tag{21}$$

Let $\gamma^I \in [0, \gamma]$ denote the equilibrium size of the interbank loan and r^I denote the equilibrium gross interbank interest rate. In what follows, BK_B has full bargaining power. At $t = 0$, it communicates to BK_A the interest rate r^I at which it is willing to borrow funds. Given r^I, BK_A chooses the size of the loan γ^I that maximizes its expected profit.

Lemmas 5 through 7 provide useful intermediate results to derive the interbank market equilibrium.

Lemma 5. *For a given interest rate $r^I \geq 1$, the success probability on domestic loans for both BK_A and BK_B weakly increases with γ^I.*

The expected profit for BK_B increases with the size of the interbank loan, due to the investment returns to scale. Part of the increase in the expected profit for BK_B is shared with BK_A through the interest rate $r^I \geq 1$. The larger expected profit offers better incentives to monitor for both banks. The effect on incentives is amplified if γ^I becomes large enough to trigger bank liquidations.

Lemma 6. *Conditional on the BK_B resolution policy, the expected profit of BK_A weakly increases with the interbank market size. If BK_B is bailed out given default, a competitive creditor BK_A accepts any interest rate $r^I \geq 1$. The expected profit of BK_B decreases with r^I.*

If BK_B is bailed out given default, the interbank loan is always repaid. The expected profit of BK_A increases with the interbank market size for any given $r^I > 1$. For BK_A, investing in the interbank market or in the liquid asset are equivalent. It follows that BK_A accepts an interbank market rate as low as the return on liquidity ($r^I = 1$). If BK_B is liquidated given default, then Lemma 5 implies that a higher interbank market size increases the repayment probability of the interbank loan through better monitoring incentives for BK_B. As a consequence, the expected profit for BK_A increases.

Lemma 7. *For $R_2 < \frac{F}{1-F(1-L)}$, there exists an interbank market threshold $\underline{\gamma}^I_{National} < \gamma$ such that the national regulator RG_B liquidates BK_B for $\gamma^I > \underline{\gamma}^I_{National}$. If neither bank obtains a positive payoff at $t = 1$, or if liquidating BK_B triggers the default of BK_A, then the banking union bails out both banks. Else, for $R_2 < \underline{R_2} < \frac{F}{1-F(1-L)}$, there exists an interbank market threshold $\underline{\gamma}^I_{Union} < \gamma$ such that the banking union liquidates BK_B for $\gamma^I > \underline{\gamma}^I_{Union}$. Also, $\underline{\gamma}^I_{Union} > \underline{\gamma}^I_{National}$.*

Both the national regulator and the banking union always bailout BK_A given default, as in the baseline case. If the returns at $t = 2$ are not too high, RG_B liquidates the domestic bank for large enough interbank markets.

The banking union liquidates BK_B if three conditions hold simultaneously. First, the liquidation of BK_B does not trigger or increase the costs of an intervention on BK_A. The banking union only liquidates BK_B if its default is isolated: the creditor BK_A can fully cover the interbank losses without needing additional liquidity. Second, R_2 is lower than a threshold $\underline{R_2} < \frac{F}{1-F(1-L)}$. For $R_2 \in \left(\underline{R_2}, \frac{F}{1-F(1-L)}\right)$, the national regulator liquidates BK_B for large interbank loans, but a banking union never does. Third, the interbank market γ^I is larger than $\underline{\gamma}^I_{\text{Union}}$. The banking union internalizes the interest losses for BK_A from the liquidation of BK_B. As a result, both the return and the interbank market size bailout thresholds are less restrictive for the banking union than for national regulation.

Proposition 6 describes the effect of the banking union on the interbank market, as a function of the asset returns at $t = 1$ and $t = 2$.

Proposition 6. (Interbank market effect) *The equilibrium interbank market size and interest rate are:*

(i) for $R_2 < \underline{R_2}$ *and* $R_1^B > \overline{R_1}^B(R_2)$: $\gamma^I_{Union} = \gamma^I_{National} = \gamma$ *and* $r^I_{Union} > r^I_{National} > 1$;

(ii) for $R_2 < \underline{R_2}$ *and* $R_1^B \in \left(\underline{R_1}^B(R_2), \overline{R_1}^B(R_2)\right)$: $\gamma^I_{Union} < \gamma^I_{National} = \gamma$ *and* $r^I_{Union} = 1 < r^I_{National}$;

(iii) for $R_2 < \frac{F}{1-F(1-L)}$ *and* $R_1^B < \underline{R_1}^B(R_2)$: $\gamma \geq \gamma^I_{Union} > \gamma^I_{National}$ *and* $r^I_{Union} = r^I_{National} = 1$;

(iv) for $R_2 \in \left(\underline{R_2}, \frac{F}{1-F(1-L)}\right)$ *and* $R_1^B > \underline{R_1}^B(R_2)$: $\gamma^I_{Union} = \gamma^I_{National} = \gamma$ *and* $r^I_{Union} = 1 < r^I_{National}$; *and*

(v) for $R_2 > \frac{F}{1-F(1-L)}$: $\gamma^I_{Union} = \gamma^I_{National} = \gamma$ *and* $r^I_{Union} = r^I_{National} = 1$,

where $\underline{R_1}^B(R_2) < \overline{R_1}^B(R_2)$ *are continuous functions of* R_2.

The regions that correspond to the various interbank market equilibria are graphed in Figure 8.

[insert Figure 8 here]

For large returns and liquidation costs i.e., $R_2 > \frac{F}{1-F(1-L)}$, both the national regulator and the banking union always bail out a defaulting bank. It follows that the banking union has no real welfare effect. For

$R_2 < \frac{F}{1-F(1-L)}$, we group the equilibria by their implication on the effects of a banking union.

Banking union worsens incentives (A+B+C) The banking union worsens BK_B monitoring incentives for $R_1^B > \underline{R_1}^B(R_2)$, corresponding to the regions (A), (B), and (C) in Figure 8.

Under national regulation, BK_B borrows the maximum available amount on the interbank market and pays a positive interest rate $r^I_{\text{National}} > 1$. If it defaults, it is liquidated by the national regulator. The investment returns (R_1^B and R_2) are high enough for BK_B to accept the default risk. The creditor BK_A is compensated for the default risk through a positive net interest rate.

A banking union worsens monitoring incentives in three ways: through more bailouts, through higher interest rates, or through thinner interbank markets. It always bails out BK_B more often than the national regulator.

In regions (A) and (B), BK_B faces a trade-off between borrowing the full surplus γ on the interbank market or $\underline{\gamma}^I_{\text{Union}} < \gamma$. If it borrows γ, BK_B earns an additional return on the marginal investment $\gamma - \underline{\gamma}^I_{\text{Union}}$. On the other hand, it faces non-zero liquidation risk and has positive interest costs, as $r^I_{\text{Union}} > 1$. If BK_B borrows the lower amount $\underline{\gamma}^I_{\text{Union}}$, then it foregoes the additional return, but it is always bailed out and has zero interest costs.

In region (A), for high R_1^B, the additional investment return effect dominates. BK_B borrows the full surplus γ on the interbank market. The banking union bails out BK_B only when both banks fail independently. The interest rate is larger under a banking union than under the national resolution mechanism: $r^I_{\text{Union}} > r^I_{\text{National}} > 1$. Intuitively, a banking union bails out BK_B for higher foreign loan values than a national regulator. It follows that the implicit insurance provided by a bailout is more valuable under a joint resolution mechanism, thus BK_A requires a larger compensation to renounce it. Both the bailout and the interest rate effects imply weaker monitoring incentives for BK_B under a joint regulator.

In region (B), for lower R_1^B, the additional investment return is low enough that BK_B prefers not to borrow the whole amount γ. BK_B borrows $\underline{\gamma}^I_{\text{Union}} < \gamma$, such that it is always bailed out. The trading surplus and monitoring incentives are reduced relative to the national regulation case.

If R_2 is large enough, the banking union always bails out BK_B, irrespective of the size of the interbank loan.

In region (C), BK_B can borrow up to γ without ever being liquidated. The full trading surplus is restored to national regulation levels, but monitoring incentives worsen since a banking union is more lenient.

Banking union improves incentives (D) If R_B^1 is low enough i.e., $R_1^B < \underline{R_1}^B(R_2)$, the banking union improves the monitoring incentives of BK_B and has an unequivocal positive welfare impact.

For $R_1^B < \underline{R_1}^B(R_2)$, BK_B has very little incentives to take any default risk. For both national and joint resolution mechanisms, BK_B borrows funds only up to the maximum level that does not trigger liquidation on default. In a banking union this liquidation threshold for γ^I is higher. It follows that BK_B borrows more on the interbank market under a banking union. The trade surplus increases and consequently the monitoring incentives of BK_B improve.

Summary To sum up, a banking union worsens moral hazard for systemically important banks in all the cases where a national regulator can credibly commit to ex-post liquidation. Extending the model to allow for an endogenous interbank market reveals an additional benefit of the banking union in the situation where national regulators cannot commit to ex-post liquidation. If banks strategically limit their foreign borrowing to increase the probability of being bailed out by a national regulator, then a banking union allows them to borrow more without bearing default risk. A larger interbank market, caeteris paribus, stimulates monitoring and increases the trade surplus, improving welfare.

7 Concluding remarks

This paper contributes to the recent European debate around a Single Resolution Mechanism. We study the welfare impact and optimal design of a banking union, from both a positive and a normative standpoint. We make policy proposals regarding the mandate of the banking union and the structure of the resolution fund.

Implications of a banking union The banking union provides liquidity more efficiently, reducing the taxpayers' burden. It eliminates international contagion at the price of increased leniency towards systemically important institutions. The net effect on welfare is negative if poor risk management significantly reduces expected returns. This is particularly the case if banks hold complex and opaque products, such as structured derivatives.

The interbank market amplifies the incentive distortion of a banking union, unless the short term returns are particularly low. In the latter case, neither the national nor the joint resolution authority can credibly commit to liquidate failed banks in equilibrium. However, a banking union creates the incentives for more interbank trading, increasing welfare.

Policy recommendations Incentives can be restored by a more sophisticated institutional design, in which the banking union and national resolution systems coexist, with clearly delimited intervention jurisdictions. A limited mandate banking union necessarily allows in equilibrium for a positive probability of contagion, thus falling short of the second-best outcome.

Net creditor countries should contribute most to the resolution default fund, as they are the main beneficiaries from eliminating contagion effects. However, when the banking union worsens market discipline, all countries seek to contribute lower shares to the joint intervention fund, as the welfare surplus of a single resolution mechanism is reduced.

References

Acharya, Viral V., 2003, Is the international convergence of capital adequacy regulation desirable?, *The Journal of Finance* 58, 2745–2781.

———, and Tanju Yorulmazer, 2007, Too many to fail: An analysis of time-inconsistency in bank closure policies, *Journal of Financial Intermediation* 16, 1–31.

———, 2008, Cash-in-the-market pricing and optimal resolution of bank failures, *Review of Financial Studies* 21, 2705–2742.

Allen, Franklin, Elena Carletti, and Douglas Gale, 2009, Interbank market liquidity and central bank intervention, *Journal of Monetary Economics* 56, 639–652.

Allen, Franklin, Elena Carletti, and Andrew Gimber, 2011, *Banking Union for Europe: Risks and Challenges* (London, Centre for Economic Policy Research.).

Allen, Franklin, Elena Carletti, Itay Goldstein, and Agnese Leonello, 2013, Government guarantees and financial stability, Manuscript.

Allen, Franklin, and Douglas Gale, 2000, Financial contagion, *Journal of Political Economy* 108, 1–33.

Allen, Jason, James Chapman, Federico Echenique, and Matthew Shum, 2012, Efficiency and bargaining power in the interbank loan market, Working Papers 12-29 Bank of Canada.

Avdjiev, Stefan, Christian Upper, and Nicholas Vause, 2010, Highlights of international banking and financial market activity, Discussion paper, Bank of International Settlements Quarterly Report (June).

Beck, Thorsten, Radomir Todorov, and Wolf Wagner, 2011, Bank supervision going global? a cost-benefit analysis, *European Banking Center Discussion Paper* 2011-033.

Bengui, Julien, 2011, Macro-prudential policy coordination and global regulatory spillovers, Manuscript.

Bloom, Nicholas, Max Floetotto, Nir Jaimovich, Itay Saporta-Eksten, and Stephen Terry, 2012, Really uncertain business cycles, *NBER Working Paper Series* 18245.

Brusco, Sandro, and Fabio Castiglionesi, 2007, Liquidity coinsurance, moral hazard, and financial contagion, *The Journal of Finance* 62, 2275–2302.

Carmassi, Jacopo, Carmine Di Noia, and Stefano Micossi, 2012, Banking union: A federal model for the european union with prompt corrective action, *CEPS Policy Brief* No. 282.

Chari, Varadarajan V., and Patrick J. Kehoe, 2013, Bailouts, time inconsistency, and optimal regulation, *National Bureau of Economic Research Working Paper Series* No. 19192, –.

Coase, Ronald H., 1960, The problem of social cost, *Journal of Law and Economics* 3, 1–44.

Colliard, Jean E., 2013, Monitoring the supervisors: optimal regulatory architecture in a banking union., Manuscript.

Cordella, Tito, and Eduardo Levy Yeyati, 2003, Bank bailouts: moral hazard vs. value effect, *Journal of Financial Intermediation* 12, 300–330.

Dell'Ariccia, Giovanni, and Robert Marquez, 2006, Competition among regulators and credit market integration, *Journal of Financial Economics* 79, 401–430.

Diamond, Douglas W., and Philip H. Dybvig, 1983, Bank runs, deposit insurance, and liquidity, *Journal of Political Economy* 91, 401–419.

Eisert, Tim, and Christian Eufinger, 2013, Interbank network and bank bailouts: Insurance mechanism for non-insured creditors?, Manuscript.

Farhi, Emmanuel, and Jean Tirole, 2012, Collective moral hazard, maturity mismatch, and systemic bailouts, *American Economic Review* 102, 60–93.

Ferry, Jean P., and Guntram B. Wolff, 2012, The fiscal implications of a banking union, *Bruegel Policy Brief* 2012/02.

Foarta, Octavia D., 2014, The limits to partial banking unions: A political economy approach, Manuscript.

Freixas, Xavier, 1999, Optimal bailout policy, conditionality and constructive ambiguity, *LSE Financial Markets Group, Discussion Paper No. 237*.

———, Bruno M. Parigi, and Jean-Charles Rochet, 2000, Systemic risk, interbank relations, and liquidity provision by the central bank, *Journal of Money, Credit and Banking* 32, 611–638.

Górnicka, Lucyna A., 2014, Shadow banking and traditional bank lending: The role of implicit guarantees, *Tinbergen Institute Discussion Paper* 14-035/VI/DSF74.

Hellmann, Thomas F., Kevin C. Murdock, and Joseph E. Stiglitz, 2000, Liberalization, moral hazard in banking, and prudential regulation: Are capital requirements enough?, *The American Economic Review* 90, 147–165.

Holmstrom, Bengt, and Jean Tirole, 1997, Financial intermediation, loanable funds, and the real sector, *The Quarterly Journal of Economics* 112, 663–691.

Hotelling, Harold, 1929, Stability in competition, *The Economic Journal* 39, 41–57.

Kara, Gazi I., 2012, International competition and coordination for the regulation of systemic risk, Manuscript.

Mailath, George J., and Loretta J. Mester, 1994, A positive analysis of bank closure, *Journal of Financial Intermediation* 3, 272–299.

Perotti, Enrico C., and Javier Suarez, 2002, Last bank standing: What do i gain if you fail?, *European Economic Review* 46, 1599–1622.

Philippon, Thomas, 2010, Debt overhang and recapitalization in closed and open economies, *IMF Economic Review* 58, 157–178.

Repullo, Rafael, 2004, Capital requirements, market power, and risk-taking in banking, *Journal of Financial Intermediation* 13, 156–182.

Rochet, Jean-Charles, and Jean Tirole, 1996, Interbank lending and systemic risk, *Journal of Money, Credit and Banking* 28, 733–762.

Schoenmaker, Dirk, 2011, The financial trilemma, *Economics Letters* 111, 57–59.

———, and Daniel Gros, 2012, A european deposit insurance and resolution fund - an update, *CEP* No. 283.

Schoenmaker, Dirk, and Arjen Siegmann, 2013, Efficiency gains of a european banking union, *Tinbergen Institute Discussion Papers* 13-026/IV/DSF51.

Schoenmaker, Dirk, and Wolf Wagner, 2013, Cross-border banking in europe and financial stability, *International Finance* 16.

Appendix

A Notation summary

Model parameters and interpretation

Parameter	Definition
γ	international asymmetry of available funds (deposit base).
ϕ	intensity of liquidity shock; fraction of deposits withdrawn before maturity.
r	exogenous deposit interest rate.
r^I	interest rate on the short-term interbank market.
η	market power of BK_A on the interbank market. Set to $\eta = 0$.
$\tilde{R}_1^i$ and R_2	bank project returns. $\tilde{R}_1^i$ is country-specific and stochastic; R_2 is deterministic.
p_H and p_L	bank project success probabilities with / without monitoring: $p_L < p_H$.
C	cost of project monitoring for banks.
F	marginal fiscal cost of regulatory intervention ($F > 1$).
L	project value percentage loss upon liquidation: $L \in (0, 1)$.

B The road to a banking union in Europe

Initial response to GFC. Initially, the response of European authorities to the destabilizing situation in the financial system has been carried out within two funding programs: the European Financial Stability Facility (EFSF) and European Financial Stabilization Mechanism (EFSM), established on May 10, 2010. The two programs had the authority to raise up to EUR 500 bilion, guaranteed by the European Commission and the EU member states. The mandate of EFSF and EFSM was to “safeguard financial stability in Europe by providing financial assistance" to Eurozone member countries.

The financial help from the two Facilities could be obtained only after a request made by a Eurozone member state and was conditional on implementation of a country-specific programme negotiated with the European Commission and the IMF.

In September 2012, the two programs were replaced by the European Stability Mechanism (ESM). The ESM support, again conditional on acceptance of a structural reforms program, was designed also for direct bank recapitalization.

Path to the banking union. On June 29, 2012, during the Eurozone summit, European leaders called for a single supervisory mechanism of national financial systems within the European Central Bank (ECB).

On September 12, 2012, as a response to the Eurozone summit debate, the European Commission’s proposes that ECB becomes the direct supervisor of all EU banks (with the right to grant and retract banking licenses).

In the first half of 2013, the key elements of the European banking union take shape. Two main pillars are proposed: the Single Supervisory Mechanism (on March, 19) and the Single Resolution Mechanism (on June, 27).

Single Supervisory Mechanism (SSM) According to the proposals as of January 2014, the participation in the SSM will be mandatory for all Eurozone countries, and only optional for other EU member states.

Within the SSM, only banks viewed as “systemically important" will be supervised by the ECB directly. Approximately 150 institutions are included, which satisfy at least one of five following requirements:

1. value of assets exceeds EUR 30 billion,
2. value of assets exceeds EUR 5 billion and 20% of the GDP of the given member state,
3. the institution is among top three largest banks in the country of the location,
4. the institution is characterized by large cross-border activities, or
5. the institution is a receiver of support from the EU bailout programs.

All other banks will remain under direct supervision of national regulators, with the ECB keeping the overall supervisory role. The supreme body of the SSM will be the Supervisory Board consisting of the national regulators - members of the SSM - and representatives of the ECB. The Supervisory Board, although administratively separated, will however remain legally subordinate to the Governing Council of the ECB.

Single Resolution Mechanism (SRM) The resolution of troubled banks will be entrusted to the Single Resolution Board (SRB), consisting of the representatives from the ECB, the European Commission and relevant national authorities. In case of a bank distress, based on the SRB’s recommendation, the decision regarding the future of the defaulting institution will be made by the European Commission.

The resolution tools made available to the SRB include:

1. the sale of business,
2. setting up a bridge institution with the purpose of asset sales in the future,
3. separation of assets with the use of asset management vehicles and,
4. bail-in, when the claims of unsecured bank creditors will be converted into equity or written down.

The availability of funding support will be guaranteed through the Single Bank Resolution Fund (SBRF) financed with contributions from financial institutions under the SSM. The use of SBRF will be restricted to 5% of total liabilities of the distressed institution and will be made conditional on the bail-in of at least 8% of total liabilities.

C Bank profits and ex-post welfare: full scenario analysis

The bank profits and welfare for the case when BK_A earns R_1^A and BK_B earns 0 at the intermediate date are presented in subsection 4.1. The other three possible scenarios are detailed below.

C.1 Scenario 1: both banks earn maximum payoffs

First, at $t = 1$: BK_A receives R_1^A from the project, $r^I\gamma$ from the interbank loan and pays $\phi(1+\gamma)$ as domestic demand deposits. BK_B receives R_1^B from the project, pays $r^I\gamma$ to bank A in the interbank market and $\phi(1-\gamma)$ as domestic demand deposits. In the second period, at $t = 2$, BK_A receives R_2 from the project, while it pays back $r(1-\phi)(1+\gamma)$ to its own depositors. Bank B receives R_2 from the project and pays $(1-\gamma)(1-\phi)r$ to domestic depositors. The final bank profits are:

$$
\begin{aligned}
\pi_{BK_A} &= \underbrace{R_1^A + R_2 - \phi(1+\gamma) - (1-\phi)(1+\gamma)r}_{Loan\,Profits} + \underbrace{r^I\gamma}_{Interbank\,Market} \\
\pi_{BK_B} &= \underbrace{R_1^B + R_2 - (\phi + (1-\phi)r)(1-\gamma)}_{Loan\,Profits} - \underbrace{r^I\gamma}_{Interbank\,Market}
\end{aligned}
\tag{22}
$$

There is no regulatory intervention in the banking sectors, the ex-post welfares in the two countries are equal to:

$$
\begin{aligned}
\text{Welfare}^A &= R_1^A + R_2 + \gamma r^I \\
\text{Welfare}^B &= R_1^B + R_2 - \gamma r^I
\end{aligned}
\tag{23}
$$

C.2 Scenario 2: BK_A earns zero and BK_B earns R_1^B

As BK_B is successful at $t = 1$, there is no need for government intervention in country B. The final payoff to BK_B and country B's welfare are again as in (22) and (23). Meanwhile, at $t = 1$, BK_A earns 0 from the productive investment, $r^I\gamma$ from the interbank loan and has to pay $\phi(1+\gamma)$ as demand deposits. Given any interbank interest rate r^I that is incentive compatible for both banks, the proceeds $r^I\gamma$ are not sufficient to keep bank A from defaulting, as $r^I\gamma - \phi(1+\gamma) < 0$.

The regulator RG_A bails bank A out if the domestic welfare after a bailout is higher or equal to the welfare in case of liquidation, where:

$$
\begin{aligned}
\text{Welfare}^A_{Bailout} &= R_2 - F\left[\phi(1+\gamma) - r^I\gamma\right] + \phi(1+\gamma) \\
\text{Welfare}^A_{Liquidation} &= (1+\gamma)(\phi + (1-\phi)r)(1-F) + F(1-L)R_2 + F \times r^I\gamma
\end{aligned}
\tag{24}
$$

The welfare conditional on liquidation is given by the cash receipts of insured depositors, substracting the net costs of the regulator: the liquidity provision needs net of the liquidation proceeds. The bailout condition is thus given by:

$$
R_2(1 - F(1-L)) \geq (1-F)(1-\phi)(1+\gamma)r \tag{25}
$$

The payoffs to both banks can be summarised as follows:

$$\begin{aligned}\pi_{BK_A} &= \mathbb{I}_{Bailout_A}\left[R_2 - (1-\phi)(1+\gamma)r\right] \\ \pi_{BK_B} &= R_1^B + R_2 - (\phi + (1-\phi)r)(1-\gamma) - r^I\gamma\end{aligned} \tag{26}$$

C.3 Scenario 3: both BK_A and BK_B earn zero

In the final case, BK_B defaults and the bailout condition for the regulator RG_B is identical to (7). Bank A also defaults, because even in the case of a bailout of bank B, the proceeds $r^I\gamma$ are not sufficient to satisfy depositors' demand. The bailout condition for the regulator RG_A is then given by (9) . Payoffs to both banks are:

$$\begin{aligned}\pi_{BK_A} &= \mathbb{I}_{Bailout_A}\left[R_2 - (1-\phi)(1+\gamma)r\right] \\ \pi_{BK_B} &= \mathbb{I}_{Bailout_B}\left[R_2 - (1-\phi)(1-\gamma)r\right]\end{aligned} \tag{27}$$

D Proofs

Proposition 1

Proof. **Resolution policy**. We begin with the bailout strategies of the regulator in country B. In a default event, RG_B bails out the bank only if the after-bailout domestic welfare is higher or equal to the welfare resulting from the bank liquidation. Moreover, Bank B only defaults if its $t = 1$ payoff is equal zero. Thus, the ex-post welfares (for the bailout and the liquidation decision) are given by (6) and the regulator opts for the bailout if:

$$\begin{aligned} R_2(1 - F(1-L)) \geq (1-F)(1-\gamma)(1-\phi)r + Fr^I\gamma \\ \Leftrightarrow \\ \gamma \leq \frac{R_2(1-F(1-L)) + (F-1)(1-\phi)r}{Fr^I + (F-1)(1-\phi)r}\end{aligned} \tag{28}$$

Replacing r^I with $\underline{r}_I = \frac{(1+\gamma)\phi - R_1^A}{\gamma}$ gives the bailout condition when Bank B has a full bargaining power in the interbank market:

$$\gamma \leq \frac{R_2(1-F(1-L)) + (F-1)(1-\phi)r + F\left(R_1^A - \phi\right)}{F\phi + (F-1)(1-\phi)r} = \gamma^* \tag{29}$$

Bank A defaults following one of two events: 1) the $t = 1$ payoff is equal zero, or 2) the $t = 1$ payoff is R_1^A but Bank B in country B defaults and is liquidated. In the latter case Bank A does not receive the amount $r^I\gamma$ back and is not able to satisfy all domestic deposit demands at $t = 1$, by Assumption 1. In both situations the regulator in country A decides on bailout if the after-bailout welfare is higher or equal to the domestic welfare following the bank liquidation. Moreover, in both cases the after-bailout and after-liquidation welfares are given by (24):

$$\text{Welfare}^A_{Bailout} = R_2 - F\left[\phi(1+\gamma) - r^I\gamma\right] + \phi(1+\gamma)$$
$$\text{Welfare}^A_{Liquidation} = (1+\gamma)(\phi + (1-\phi)r)(1-F) + F(1-L)R_2 + F \times r^I\gamma$$

The bailout takes place if:

$$R_2(1 - F(1-L)) \geq (1-F)(1+\gamma)(1-\phi)r \tag{30}$$

Under assumption $1 < F < \frac{1}{1-L}$ (Section 3.1), the LHS of (30) is always positive, as $F(1-L) < 1$, and the RHS is always negative because $F > 1$. Therefore, regulator RG_A always bails out Bank A.

Monitoring decisions. Consider next Bank B's monitoring decision when $\gamma \leq \gamma^*$, i.e. when BK_B is always bailed out. The expected profit for Bank B if it monitors and if it does not monitor are equal respectively:

$$\pi_B(\text{Monitor}) = R_2 - (1-\gamma)(1-\phi)r + p_H\left(R_1^B + (1-\gamma)\phi - r^I\gamma\right) + (1-p_H) - C \tag{31}$$
$$\pi_B(\text{Not Monitor}) = R_2 - (1-\gamma)(1-\phi)r + p_L\left(R_1^B - (1-\gamma)\phi - r^I\gamma\right)$$

The two expressions do not depend on the monitoring decision of Bank A, because payoffs to Bank B are independent of the payoffs to the foreign bank. A direct comparison of the two expressions yields the monitoring condition:

$$\frac{B}{\Delta p} \leq R_1^B - (1-\gamma)\phi - r^I\gamma = c_1^B$$

When $\gamma > \gamma^*$, expected payoffs to Bank B are lower, because in case of a default regulator RG_B never bails out Bank B:

$$\pi_B(\text{Monitor}) = p_H\left(R_1^B + R_2 - (1-\gamma)\phi - (1-\gamma)(1-\phi)r - r^I\gamma\right) \tag{32}$$
$$\pi_B(\text{Not Monitor}) = p_L\left(R_1^B + R_2 - (1-\gamma)\phi - (1-\gamma)(1-\phi)r - r^I\gamma\right) - C$$

Bank B monitors if:

$$\frac{C}{\Delta p} \leq R_1^B + R_2 - (1-\gamma)\phi - (1-\gamma)(1-\phi)r - r^I\gamma = c_2^B$$

and the new threshold is always smaller than the threshold c_1^B for $\gamma \leq \gamma^*$. It is again independent of the monitoring decision of Bank A.

Now we consider the monitoring decision of Bank A. Since it is always bailed out by the regulator in country A and its profits at $t = 0$ are zero (since it has no bargaining power on the interbank market), it will never monitor.

Interbank market. In this part of the proof, the interbank interest rate r^I is determined. The incentive compatibility conditions for both banks to trade in the interbank market are explicitly stated.

Bank A The result in Proposition 1 ensures that BK_A always receives the non-stochastic profit at $t = 2$. Without investing in the interbank market however, it will never be able to fulfill the liquidity demand at $t = 1$ and thus earn a positive payoff in the interim period. Hence, it would accept any interest rate r^I which ensures a positive profit at $t = 1$, conditional on its own success (with probability p):

$$\text{InterbankGains}_A = p\left(R_1^A - \phi(1+\gamma) + \gamma r^I\right) \geq 0 \Longrightarrow r^I \geq \frac{\phi(1+\gamma) - R_1^A}{\gamma} \tag{33}$$

Let $\underline{r}_I = \frac{\phi(1+\gamma)-R_1^A}{\gamma}$ the minimum interest rate required by bank A to trade in the interbank market.

Bank B BK_B gains from borrowing on the interbank market as it can leverage up its return. If successful (for expositional purposes, we will use probability p_H), it gains thus a maximum of:

$$\text{InterbankGains}_B = p_H\left[\left(R_1^B + R_2\right)\gamma - r^I\gamma\right]$$

Without borrowing on the interbank market, BK_B will always be bailed out given default. However, by borrowing the full amount, for $\gamma > \gamma^*$, it is no longer bailed out by the local government. The expected losses in this case are given by the expected foregone profit at $t = 2$:

$$\text{InterbankLosses}_B = (1 - p_H)(1-\gamma)(R_2 - (1-\phi)r)$$

The incentive compatibility constraint therefore reads:

$$r^I \leq \left(R_1^B + R_2\right) - \frac{(1-\gamma)(1-p_H)}{\gamma p_H}(R_2 - (1-\phi)r)$$

Let $\overline{r}_I = \left(R_1^B + R_2\right) - \frac{(1-\gamma)(1-p_H)}{\gamma p_H}(R_2 - (1-\phi)r)$ be the maximum rate bank B is willing to pay on the interbank rate, in the situation where borrowing is least favourable for it. If $\gamma + p_H \geq 1$, then $\overline{r}_I > \underline{r}_I$ and thus the full amount γ is traded on the interbank market.

Under the assumption that BK_B has full bargaining power, the interbank market clears at $r_I^* = \underline{r}_I$. This assumption is in line with the work of Allen, Chapman, Echenique, and Shum (2012), who empirically find the bargaining power on the interbank market to be sharply tilted towards the borrowers. Furthermore, focusing on a borrower's market makes the externality we are focusing on the weakest: a lower interest rate maximises the incentives of the borrower to monitor and makes a bailout more likely.

□

Proposition 2

Proof. **Resolution policy.** In what follows, we calculate the welfares for $r^I = \underline{r}_I = \frac{(1+\gamma)\phi - R_1^A}{\gamma}$. The supranational regulator, RG_{BU}, maximises the sum of domestic welfares in countries A and B (we assume that both countries receive the same weight in the objective function of the banking union's regulator). In order to determine the bailout strategy of the new regulator, four scenarios described in Section 4 have to be considered again: 1) Bank A receives R_1^A and Bank B receives R_1^B at $t = 1$. There are no defaults.

2) Bank A receives zero and Bank B's payoff is R_1^B at $t = 1$. Bank A defaults and the regulator RG_{BU} decides on the bailout, according to the rule (11). In particular, the banking union's welfare after the bailout of Bank

A is:

$$\left[\text{Welfare}^A + \text{Welfare}^B\right]_{Bailout} = 2R_2 + R_1^B + (1-F)\,R_1^A$$

and the welfare after liquidation of Bank A is:

$$\left[\text{Welfare}^A + \text{Welfare}^B\right]_{Liquidation} = R_2 + R_1^B + R_1^A + (1+\gamma)(1-\phi)\,r\,(1-F) - F\left(R_1^A - R_2\,(1-L)\right)$$

The bailout takes place if:

$$R_2\,(1 - F\,(1-L)) \geq (1-F)(1+\gamma)(1-\phi)\,r$$

which, under the assumption that $1 < F < \frac{1}{1-L}$, always holds. Therefore, the supranational regulator, RG_{BU}, always bails out defaulting Bank A.

3) Bank A receives R_1^A and Bank B's payoff is zero at $t = 1$. Within this case several scenarios can be considered. In particular, if the regulator does not decide to bail out Bank B, then Bank A will enter into a default, in which case the regulator can decide either to bail out or not to bail out Bank A. Consider first the welfare following the decision to bail out Bank B immediately:

$$\left[\text{Welfare}^A + \text{Welfare}^B\right]_{BailoutB} = 2R_2 + 2\phi - F\left(2\phi - R_1^A\right) \tag{34}$$

If, instead, the regulator RG_{BU} opts for liquidation, then it has to decide whether allow also Bank A to fall and be liquidated or to bail it out. The ex-post welfares for the two alternative cases are respectively:

$$\left[\text{Welfare}^A + \text{Welfare}^B\right]_{Liquidation} = (2\phi + 2\,(1-\phi)\,r)(1-F) + F\left(R_1^A + 2\,(1-L)\,R_2\right) \tag{35}$$

$$\left[\text{Welfare}^A + \text{Welfare}^B\right]_{BailoutA} = F \times R_1^A + R_2 + (2\phi + (1-\gamma)(1-\phi)\,r)(1-F) + F\,((1-L)\,R_2) \tag{36}$$

A direct comparison of (34) with (35) and (36) gives two conditions that need to be satisfied for the regulator RG_{BU} to prefer the immediate bailout of Bank B:

$$R_2\,(1 - F\,(1-L)) \geq (1-F)(1-\phi)\,r$$
$$R_2\,(1 - F\,(1-L)) \geq (1-F)(1-\phi)(1-\gamma)\,r$$

Again, for $1 < F < \frac{1}{1-L}$, the two conditions always hold and the supranational regulator always bails out Bank B.

4) Both Bank A and Bank B receive zero at $t = 1$. The banking union's regulator needs to choose between four options: 1) bailing out Bank A only, 2) bailing out Bank B only, 3) bailing out both banks, and 4) liquidating both banks. The respective ex-post welfares corresponding to the four cases are:

$$\left[\text{Welfare}^A + \text{Welfare}^B\right]_{BailoutA} = (2\phi + R_2 + (1-\gamma)(1-\phi)\,r)(1-F) + F\,((1-L)\,R_2) \tag{37}$$
$$\left[\text{Welfare}^A + \text{Welfare}^B\right]_{BailoutB} = (2\phi + R_2 + (1+\gamma)(1-\phi)\,r)(1-F) + F\,((1-L)\,R_2)$$
$$\left[\text{Welfare}^A + \text{Welfare}^B\right]_{BailoutAB} = 2R_2 + 2\phi - F(2\phi)$$
$$\left[\text{Welfare}^A + \text{Welfare}^B\right]_{Liquidation} = (2\phi + 2\,(1-\phi)\,r)(1-F) + F\,(2\,(1-L)\,R_2)$$

Again, a direct comparison of the four expressions results in two conditions that need to be satisfied for the regulator RG_{BU} to always bail out both banks:

$$R_2(1-F(1-L)) \geq (1-F)(1+\gamma)(1-\phi)r - Fr^I\gamma$$
$$R_2(1-F(1-L)) \geq (1-F)(1-\phi)r$$

We conclude that the two conditions always hold and the supranational regulator always bails out both banks.

Monitoring decisions. Focus on the case when $r^I = \underline{r}_I = \frac{(1+\gamma)\phi - R_1^A}{\gamma}$. Consider Bank A first: in case of default it is always bailed out by the regulator RG_{BU}. Its interbank return $r^I\gamma$ is also secured in case of Bank B's default, as the union's regulator never allows for liquidation of Bank B. The monitoring condition for Bank A is thus the same as under national regulatory system: Bank A never monitors in presence of the banking union. Bank B's payoffs are also the same as under $\gamma < \gamma^*$ and under the national regulatory system (Bank B is always bailed out after a default). Thus, the monitoring decision can be summarised by the condition:

$$\frac{C}{\Delta p} \leq R_1^B - (1-\gamma)\phi - r^I\gamma = c_1$$

We conclude that under the banking union there is now only one threshold value of $\frac{C}{\Delta p}$ below which Bank B monitors.

Interbank market. The interbank market result is identical with the one in the previous proof. □

Lemma 1

Proof. Immediate mathematical calculation. □

Proposition 3

Proof. We consider three parameter sets for which there is a difference in welfare under the banking union and under the national regulators:

1. $\gamma > \gamma^*$ **and** $\frac{C}{\Delta p} \leq c_1$
Bank B always monitors, is always bailed out by the supranational regulator RG_{BU}, but never by the domestic regulator RG_B. Global ex-ante welfare under domestic regulation is equal:

$$\begin{aligned} \text{Welfare}^{A+B}_{National} = {} & p_H(p_L)\left[R_1^A + R_1^B + 2R_2\right] \\ & + p_H(1-p_L)\left[R_1^B + 2R_2 + R_1^A - F\left(R_1^A\right)\right] \\ & +(1-p_H)(p_L)\left[R_2 + 2\phi + (1-\gamma)(1-\phi)r - F\left(2\phi + (1-\gamma)(1-\phi)r - R_1^A - (1-L)R_2\right)\right] \\ & +(1-p_H)(1-p_L)\left[R_2 + 2\phi + (1-\gamma)(1-\phi)r - F(2\phi + (1-\gamma)(1-\phi)r - (1-L)R_2)\right] \end{aligned} \tag{38}$$

Under the banking union welfare is:

$$\begin{aligned}\text{Welfare}^{A+B}_{BU} = p_H(p_L)\left[R^A_1 + R^B_1 + 2R_2\right] \\ +p_H(1-p_L)\left[R^B_1 + 2R_2 + R^A_1 - F\left(R^A_1\right)\right] \\ +(1-p_H)(p_L)\left[2R_2 + 2\phi - F\left(2\phi - R^A_1\right)\right] \\ +(1-p_H)(1-p_L)\left[2R_2 + 2\phi - F\left(2\phi\right)\right]\end{aligned} \tag{39}$$

Using that $r^I = \underline{r}_1$ and thus $r^I\gamma = (1+\gamma)\phi - R^A_1$, comparison of the two values yields:

$$\begin{aligned}\text{Welfare}^{A+B}_{National} \geq W^{A+B}_{BU} \Leftrightarrow \\ (1-p_H)\left[R_2\left(1 - F\left(1-L\right)\right) + \left(F-1\right)\left(1-\gamma\right)\left(1-\phi\right)r\right] \geq 0\end{aligned} \tag{40}$$

where equation (40) always holds. Thus, the introduction of the banking union is welfare-improving in this case.

2. $\gamma > \gamma^*$ **and** $c_1 < \frac{C}{\Delta p} \leq c_2$
Bank B does not monitor in the baking union, but does so under the national resolution mechanism. In case of a default, it is bailed out by RG_{BU} but never by RG_B. Global welfare under national regulators is the same as in (38).Welfare in the banking union changes, as the probabilities of reaching high payoff states at $t = 1$ are now different:

$$\begin{aligned}\text{Welfare}^{A+B}_{BU} = (p_L)^2\left[R^A_1 + R^B_1 + 2R_2\right] \\ +(p_L)(1-p_L)\left[R^B_1 + 2R_2 + R^A_1 - F\left(R^A_1\right)\right] \\ +(1-p_L)(p_L)\left[2R_2 + 2\phi - F\left(2\phi - R^A_1\right)\right] \\ +(1-p_L)^2\left[2R_2 + 2\phi - F\left(2\phi\right)\right]\end{aligned} \tag{41}$$

Again, a direct comparison of (41) with (38) yields:

$$\begin{aligned}\text{Welfare}^{A+B}_{National} \geq W^{A+B}_{BU} \Leftrightarrow \\ \Delta p \leq \frac{(1-p_H)\left(R_2\left(1-F\left(1-L\right)\right) + \left(1-\gamma\right)\left(1-\phi\right)\left(F-1\right)r\right)}{F\left(2\phi - R^A_1\right) + \left(R^A_1 + R^A_1 - 2\phi\right)} = \Delta p^*\end{aligned}$$

The banking union is welfare improving only for the values of Δp small enough.

3. $\gamma > \gamma^*$ **and** $\frac{C}{\Delta p} > c_2$

Bank B never monitors. In case of a default, it is bailed out by RG_{BU} but never by RG_B. The global welfare under banking union is the same as in (41), while the welfare under domestic regulations is now:

$$\begin{aligned}\text{Welfare}^{A+B}_{National} = (p_L)^2\left[R^A_1 + R^B_1 + 2R_2\right] \\ +(p_L)(1-p_L)\left[R^B_1 + 2R_2 + R^A_1 - F\left(R^A_1\right)\right] \\ +(1-p_L)(p_L)\left[R_2 + 2\phi + (1-\gamma)(1-\phi)r - F\left(2\phi + (1-\gamma)(1-\phi)r - R^A_1 - (1-L)R_2\right)\right] \\ +(1-p_L)^2\left[R_2 + 2\phi + (1-\gamma)(1-\phi)r - F\left(2\phi + (1-\gamma)(1-\phi)r - (1-L)R_2\right)\right]\end{aligned} \tag{42}$$

Comparing (42) with (41) yields the condition:

$$\begin{aligned} \text{Welfare}^{A+B}_{National} \geq W^{A+B}_{BU} \Leftrightarrow \\ (1 - p_L)\left[R_2\left(1 - F\left(1 - L\right)\right) + \left(F - 1\right)\left(1 - \gamma\right)\left(1 - \phi\right) r\right] \geq 0 \end{aligned} \tag{43}$$

which always holds. Thus, the banking union again improves the global welfare, by the amount in (43).

□

Lemma 2

Proof. Under low ($\frac{C}{\Delta p} \leq c_1$) and high ($\frac{C}{\Delta p} \geq c_2$) levels of moral hazard, the banking union does not shift monitoring incentives. A limited mandate union simply reduces the spillover surplus without providing any benefits, being thus sub-optimal. □

Proposition 4

Proof. We consider separately the cases when the full mandate banking union is improving or reducing welfare, while distorting bank risk taking incentives.

Full mandate banking union is improving welfare. Start with the independent default mandate. The welfare values for this limited mandate and a full mandate is given by:

$$\begin{aligned} \text{Welfare}^{A+B}_{\text{IndDef}} &= (1 - p_H)\,(1 - p_L)\,\text{SpilloverEffect} \\ \text{Welfare}^{A+B}_{\text{FullMandate}} &= (1 - p_H)\,\text{SpilloverEffect} - \Delta p \times \text{IncentiveEffect} \end{aligned}$$

The condition for the independent default mandate to be optimal can be rewritten as:

$$\text{Welfare}^{A+B}_{\text{IndDef}} - \text{Welfare}^{A+B}_{\text{FullMandate}} > 0 \Leftrightarrow \Delta p \times \text{IncentiveEffect} > p_L\,(1 - p_H)\,\text{SpilloverEffect}$$

The latter condition can be rewritten as:

$$\Delta p > p_L \frac{(1 - p_H)\,\text{SpilloverEffect}}{\text{IncentiveEffect}} = p_L \overline{\Delta p}$$

The reasoning is similar for the contagion mandate. The welfare values for this limited mandate and a full mandate is given by:

$$\begin{aligned} \text{Welfare}^{A+B}_{\text{Contagion}} &= (1 - p_H)\,p_L \text{SpilloverEffect} \\ \text{Welfare}^{A+B}_{\text{FullMandate}} &= (1 - p_H)\,\text{SpilloverEffect} - \Delta p \times \text{IncentiveEffect} \end{aligned}$$

The condition for the independent default mandate to be optimal can be rewritten as:

$$\text{Welfare}^{A+B}_{\text{IndDef}} - \text{Welfare}^{A+B}_{\text{FullMandate}} > 0 \Leftrightarrow \Delta p \times \text{IncentiveEffect} > (1 - p_L)\,(1 - p_H)\,\text{SpilloverEffect}$$

The latter condition can be rewritten as:

$$\Delta p > (1 - p_L)\,\frac{(1 - p_H)\,\text{SpilloverEffect}}{\text{IncentiveEffect}} = (1 - p_L)\,\overline{\Delta p}$$

Hence, for $\Delta p < \min\{p_L, 1 - p_L\}\,\overline{\Delta p}$, at least one limited mandate improves welfare upon a full mandate banking union which distorts incentives.

Full mandate banking union is reducing welfare. Consider first the bank monitoring decision and the welfare under a banking union with a independent default mandate (liquidation of BK_B in the state $(R_1^A, 0)$ only). Bank B monitors if:

$$\begin{gathered} p_H\left[R_1^B + R_2 - (1-\gamma)\phi - (1-\gamma)(1-\phi)r - r^I\gamma\right] + \\ (1-p_H)(1-p_L)\left[R_2 - (1-\gamma)(1-\phi)r\right] - C \geq \\ p_L\left[R_1^B + R_2 - (1-\gamma)\phi - (1-\gamma)(1-\phi)r - r^I\gamma\right] + \\ (1-p_L)(1-p_L)\left[R_2 - (1-\gamma)(1-\phi)r\right] \end{gathered}$$

which is equivalent to the following constraint on $\frac{c}{\Delta p}$:

$$\frac{C}{\Delta p} \leq \underbrace{R_1^A + R_1^B - 2\phi}_{=c_1} + p_L(R_2 - (1-\gamma)(1-\phi)r) = c_1 + p_L(c_2 - c_1) = c_2^s$$

Thus, for $\frac{C}{\Delta p} \in (c_1, c_2^s]$ bank B monitors its loans, and for $\frac{C}{\Delta p} \in (c_2^s, c_2)$ it does not. It can be easily shown that when bank B is monitoring under the banking union with a independent default mandate, the new banking union yields a positive welfare surplus in comparison to national regulation:

$$\text{Welfare}^{A+B}_{\text{IndDef}} - \text{Welfare}^{A+B}_{\text{National}} = (1 - p_H)(1 - p_L)\text{SpilloverEffect} > 0$$

On the contrary, when bank B does not monitor, the banking union with a independent default mandate is welfare reducing even in comparison to the full mandate banking union (which in turn yields welfare value lower than under national regulation):

$$\text{Welfare}^{A+B}_{\text{IndDef}} - \text{Welfare}^{A+B}_{\text{National}} = -\,p_L(1 - p_L)\text{SpilloverEffect} < 0$$

Consider next the banking union with a contagion mandate (liquidation of BK_B in the state $(0, 0)$ only). Bank

B monitors loans if:

$$\begin{aligned}
p_H\left[R_1^B + R_2 - (1-\gamma)\phi - (1-\gamma)(1-\phi)r - r^I\gamma\right] + \\
(1-p_H)p_L\left[R_2 - (1-\gamma)(1-\phi)r\right] - C \geq \\
p_L\left[R_1^B + R_2 - (1-\gamma)\phi - (1-\gamma)(1-\phi)r - r^I\gamma\right] + \\
(1-p_L)p_L\left[R_2 - (1-\gamma)(1-\phi)r\right] \iff \\
\frac{C}{\Delta p} \leq \underbrace{R_1^A + R_1^B - 2\phi}_{=c_1} + (1-p_L)(R_2 - (1-\gamma)(1-\phi)r) = c_1 + (1-p_L)(c_2 - c_1) = c_2^c
\end{aligned}$$

Again, it can be shown that the banking union is welfare improving (in comparison to the national regulation) whenever bank B monitors the loans ($\frac{C}{\Delta p} \in (c_1, c_2^c]$) and is welfare reducing otherwise ($\frac{C}{\Delta p} \in (c_2^c, c_2)$):

$$\text{Welfare}^{A+B}_{\text{Contagion}} - \text{Welfare}^{A+B}_{\text{National}} = (1-p_H)p_L \text{SpilloverEffect} > 0$$

and

$$\text{Welfare}^{A+B}_{\text{Contagion}} - \text{Welfare}^{A+B}_{\text{National}} = -(1-p_L)(1-p_L)\text{SpilloverEffect} > 0$$

□

Corollary 1

Proof. To verify which of the two alternative banking unions (independent default mandate versus contagion mandate) is preferable, consider three cases:

Case 1: $p_L < \frac{1}{2} \Rightarrow c_2^c > c_2^s$**.** In this case, as long as $\frac{C}{\Delta p} \in (c_1, c_2^s]$, bank B monitors under the two alternative banking unions considered, but the welfare surplus under the banking union with a independent default mandate is higher, as:

$$(\text{Welfare}^{A+B}_{\text{IndDef}} - \text{Welfare}^{A+B}_{\text{FullMandate}}) - (\text{Welfare}^{A+B}_{\text{Contagion}} - \text{Welfare}^{A+B}_{\text{National}}) > 0$$

For higher levels of moral hazard, i.e. $\frac{C}{\Delta p} \in (c_1^s, c_2^c]$ bank B monitors under the banking union with contagion mandate only and therefore only such banking union is welfare improving. When $\frac{C}{\Delta p} \in (c_2^c, c_2)$, none of the partial mandate banking unions improves welfare and thus the national regulation is optimal.

Case 2: $p_L > \frac{1}{2} \Rightarrow c_2^c < c_2^s$**.** The order of preference between alternative banking unions changes. For $\frac{C}{\Delta p} \in (c_1, c_2^c]$, bank B monitors under the two alternative banking unions considered, but the banking union with a contagion mandate is preferred as:

$$(\text{Welfare}^{A+B}_{\text{IndDef}} - \text{Welfare}^{A+B}_{\text{FullMandate}}) - (\text{Welfare}^{A+B}_{\text{Contagion}} - \text{Welfare}^{A+B}_{\text{National}}) < 0$$

When $\frac{C}{\Delta p} \in (c_1^c, c_2^s]$ bank B monitors under the banking union with a independent default mandate only and therefore such mandate is preferred. When $\frac{C}{\Delta p} \in (c_2^s, c_2)$ the national regulation is chosen.

Case 3: $p_L = \frac{1}{2} \Rightarrow c_2^c = c_2^s$**.** The two partial mandate banking unions yield the same welfare outcomes and the same monitoring decisions of bank B. The regulators should implement one of the partial mandate banking unions whenever $\frac{C}{\Delta p} \in (c_1, c_2^s]$. For $\frac{C}{\Delta p} \in (c_2^s, c_2)$, the national regulation is preferred. □

Proposition 5

Proof. **1.** $\gamma > \gamma^*$ **and** $\frac{C}{\Delta p} \leq c_1$ OR $\gamma > \gamma^*$ **and** $\frac{C}{\Delta p} > c_2$

The probabilities of reaching particular payoff states do not change when moving from national regulations to the banking union and thus we can write the participation constraints for both countries as conditions on their share of the expected welfare surplus. For country A we have:

$$\mathbb{P}\left(0, R_1^B\right)(1-\beta) F R_1^A + \mathbb{P}\left(R_1^A, 0\right)(1-\beta) F\left(2\phi - R_1^A\right) + \mathbb{P}(0,0)(F\phi(1+\gamma) - 2F\beta\phi) \geq 0$$

which is a linear decreasing function of β and can be rewritten as an upper bound for feasible βs:

$$\beta \leq \frac{\mathbb{P}\left(0, R_1^B\right) F R_1^A + \mathbb{P}\left(R_1^A, 0\right) F\left(2\phi - R_1^A\right) + \mathbb{P}(0,0)(F\phi(1+\gamma))}{\mathbb{P}\left(0, R_1^B\right) F R_1^A + \mathbb{P}\left(R_1^A, 0\right) F\left(2\phi - R_1^A\right) + 2\mathbb{P}(0,0) F\phi} \in (0,1) \tag{44}$$

The β upper bound establishes thus the minimum share of the welfare surplus (or the maximum share of the bailout costs) RG_A requires in order to participate in the banking union. The country B regulator, RG_B has a similar participation constraint:

$$\mathbb{P}\left(0, R_1^B\right)(\beta - 1) F R_1^A + \mathbb{P}\left(R_1^A, 0\right)(\beta - 1) F\left(2\phi - R_1^A\right) + \\ \mathbb{P}(0,0)(2F\beta\phi) - F\phi(1+\gamma) + \mathbb{E}\Delta p {W^i}_{BU} \geq 0$$

with $i = M, N, D$, that yields a lower bound for β:

$$\beta \geq \frac{\mathbb{P}\left(0, R_1^B\right) F R_1^A + \mathbb{P}\left(R_1^A, 0\right) F\left(2\phi - R_1^A\right) + \mathbb{P}(0,0)(F\phi(1+\gamma)) - \mathbb{E}\Delta \text{Welfare}_{BU}^i}{\mathbb{P}\left(0, R_1^B\right) F R_1^A + \mathbb{P}\left(R_1^A, 0\right) F\left(2\phi - R_1^A\right) + 2\mathbb{P}(0,0) F\phi}$$

The probabilities of reaching each of the four payoff states can be expressed in terms of monitoring effort of both banks:

(1a) $\gamma > \gamma^*$ **and** $\frac{C}{\Delta p} \leq c_1$
Bank B monitors both under the national regulation and under the banking union. The upper bound for the feasible βs is equal:

$$\beta \leq \frac{(1-p_L) p_H F R_1^A + (p_L)(1-p_H) F\left(2\phi - R_1^A\right) + (1-p_L)(1-p_H)(F\phi(1+\gamma))}{(1-p_L) p_H F R_1^A + (p_L)(1-p_H) F\left(2\phi - R_1^A\right) + 2(1-p_L)(1-p_H) F\phi}$$

and a similar expression for the lower bound of βs, which together can be further simplified to:

$$\beta \leq \frac{(1-p_H)(1-\Delta p+p_H(1-\gamma)+\gamma(1+\Delta p))\phi+\Delta p R_1^A}{2(1-p_H)\phi+\Delta p R_1^A} = \overline{\beta}_M$$

$$\beta \geq \overline{\beta}_M - \frac{\mathbb{E}\Delta \mathrm{W}_{BU}^M}{2F(1-p_H)\phi+F\Delta p R_1^A} = \underline{\beta}_M$$

It is straightforward to verify that $\overline{\beta}_M$ is smaller than 1. We further notice that $\overline{\beta}_M > \beta_M^{ZS}$ since:

$$\overline{\beta}_M > \beta_M^{ZS} \Leftrightarrow$$
$$(1-\Delta p+p_H(1-\gamma)+\gamma(1-\Delta p))\phi \geq R_1^A$$

which by Assumption 1 always holds if the LHS is larger than ϕ. This allows us to further simplify the condition to:

$$p_H(1-\gamma)\phi-\Delta p\phi+(\gamma-\Delta p\gamma)\phi \geq 0$$

Because $p_H \geq \Delta p$, the LHS is always positive and thus $\overline{\beta}_M \in \left(\beta_M^{ZS}, 1\right)$.

(1b) $\gamma > \gamma^*$ **and** $\frac{C}{\Delta p} > c_2$
Bank B never monitors under the national regulation and under the banking union. The upper bound for the feasible βs is given by:

$$\beta \leq \frac{(1-p_L)(p_L)FR_1^A+(p_L)(1-p_L)F\left(2\phi-R_1^A\right)+(1-p_L)^2(F\phi(1+\gamma))}{(1-p_L)(p_L)FR_1^A+(p_L)(1-p_L)F\left(2\phi-R_1^A\right)+2(1-p_L)^2F\phi}$$

with a similar expression for the lower bound of βs, which together leads to:

$$\beta \leq \frac{1+p_H(1-\gamma)+\gamma(1+\Delta p)-\Delta p}{2} = \overline{\beta}_N$$

$$\beta \geq \overline{\beta}_N - \frac{\mathbb{E}\Delta \mathrm{W}_{BU}^N}{2F\phi(1-p_L)} = \underline{\beta}_N$$

It is also straightforward to prove that $\underline{\beta}_M > \beta_M^{ZS}$. This is equivalent to showing that:

$$(1-p_H)FR_1^A \leq (1-p_H)F(1-\Delta p+p_H(1-\gamma)+\gamma+\Delta p\gamma)\phi$$
$$-(1-p_H)[R_2(1-F(1-L))+(1-\gamma)(1-\phi)r(F-1)]$$

Since $R_1^A < \phi$ it is enough to prove:

$$(1-p_H)F\phi \leq (1-p_H)F(1-\Delta p+p_H(1-\gamma)+\gamma+\Delta p\gamma)\phi-(1-p_H)\,\text{SpilloverEffect}$$

Some further algebraic manipulation yields the equivalent condition:

$$0 \leq (1-p_H)F\phi(p_H(1-\gamma)+\gamma+\Delta p(\gamma-1))-(1-p_H)\,\text{SpilloverEffect}$$

Since we have $\gamma > \gamma^*$ it holds that:

$$R_2 (1 - F (1 - L)) + (F - 1)(1 - \phi) r (1 - \gamma) + F \left(R_1^A - \phi \right) \leq F \phi \gamma$$

The original condition becomes then the true inequality:

$$0 \leq F \phi \left[(p_L)(1 - \gamma) \right] + F \left((R_1^A - \phi \right)$$

(2) $\gamma > \gamma^*$ **and** $c_1 < \frac{C}{\Delta p} \leq c_2$
Introduction of the banking union shifts the incentives of BK_B from monitoring to not monitoring (the disciplining effect), and the surplus for regulator A is reduced by the shift in the probabilities. Moreover, only if $\Delta p \leq \Delta p^*$ the difference in welfares is actually positive. Assuming $\Delta p \leq \Delta p^*$, the upper bound for the feasible range for βs is derived from the two participation constraints for individual countries. The participation constraint for country A, that gives the upper bound for β is given by:

$$\mathbb{E}\text{Welfare}_{BU}^A \geq \mathbb{E}\text{Welfare}_{National}^A$$

Let W_1^i , W_2^i , W_3^i and W_4^i be short hand notations (for exposition purposes) for the country i welfare under national regulation in the four states of the world: $\left(R_1^A, R_1^B\right), \left(0, R_1^B\right), \left(R_1^A, 0\right)$ and $(0, 0)$. Let also S_i , $i \in \{1, 2, 3, 4\}$ be the welfare surpluses for country A in all states of the world. Then, we have:

$$\mathbb{E}\text{Welfare}_{BU}^A = (p_L)^2 \left[W_1 + S_1 \right] + (1 - p_L)(p_L) \left[W_2 + S_2 \right] +$$
$$(1 - p_L)(p_L) \left[W_3 + S_3 \right] + (1 - p_L)^2 \left[W_4 + S_4 \right]$$

$$\mathbb{E}\text{Welfare}_{National}^A = p_H (p_L) W_1 + (1 - p_L) p_H W_2 +$$
$$(1 - p_H)(p_L) W_3 + (1 - p_L)(1 - p_H) W_4$$

The banking union feasibility condition for country A reads then, after trivial simplification:

$$(p_L)^2 S_1 + (1 - p_L)(p_L) S_2 + (1 - p_L)(p_L) S_3 +$$
$$(1 - p_L)^2 S_4 + \Delta p (p_L) \left[W_3 - W_1 \right] + \Delta p (1 - p_L) \left[W_4 - W_2 \right] \geq 0$$

The first four terms of the above equation disregard the externality. Setting to zero the previous expression and disregarding the last 2 terms would thus yield $\overline{\beta}_N$. However, we have that:

$$\Delta p (p_L) \left[W_3 - W_1 \right] + \Delta p (1 - p_L) \left[W_4 - W_2 \right] = -\Delta p F \left((1 + \gamma) \phi - R_1^A \right)$$

For simplicity, we denote:

$$C_1 = (1 - p_L)(p_L) F R_1^A + (p_L)(1 - p_L) F \left(2\phi - R_1^A \right) + (1 - p_L)^2 \left(F \phi (1 + \gamma) \right)$$

$$C_2 = (1 - p_L)(p_L) F R_1^A + (p_L)(1 - p_L) F \left(2\phi - R_1^A \right) + 2 (1 - p_L)^2 F \phi$$

Note that, as we proved above, $\overline{\beta}_N = \frac{C_1}{C_2}$. Then, the upper limit $\overline{\beta}_D$ is given by:

$$C_1 - C_2\overline{\beta}_D - \Delta p F\left((1+\gamma)\phi - R_1^A\right) = 0 \Longleftrightarrow \overline{\beta}_D = \overline{\beta}_N - \frac{\Delta p F\left((1+\gamma)\phi - R_1^A\right)}{C_2}$$

Or, after further simplification:

$$\overline{\beta}_D = \overline{\beta}_N - \frac{\Delta p\left((1+\gamma)\phi - R_1^A\right)}{2\phi(1-p_L)} = \overline{\beta}_N - \frac{\Delta p\left[W_1^A - W_3^A\right]}{2\phi(1-p_L)F}$$

We can provide a similar computation for country B and obtain the lower bound:

$$\underline{\beta}_D = \underline{\beta}_N + \frac{\Delta p\left[W_1^B - W_3^B\right]}{2\phi(1-p_L)F} \tag{45}$$

Since $W_1^B - W_3^B \geq 0$ under the model assumptions (the welfare is larger in country B when bank B succeeds at t=1), we trivially have that:

$$\underline{\beta}_D > \underline{\beta}_N$$

To prove $\overline{\beta}_D > \underline{\beta}_D$, it is enough to show (using the definitions of the two measures) that:

$$\overline{\beta}_N - \underline{\beta}_N - \frac{\Delta p\left(W^A\left[R_1^A, R_1^B\right] - W^A\left[R_1^A, 0\right]\right)}{2F\phi(1-p_L)} - \frac{\Delta p\left(W^B\left[R_1^A, R_1^B\right] - W^B\left[R_1^A, 0\right]\right)}{2F\phi(1-p_L)} \geq 0$$

We know that $\overline{\beta}_N - \underline{\beta}_N = \frac{\mathbb{E}\Delta W_{BU}^N}{2F\phi(1-p_L)}$. Replacing the expression for $\mathbb{E}\Delta W_{BU}^N$, the fact that $\mathbb{E}\Delta W_{BU}^D > 0$ allows us to write:

$$\begin{gathered}(1-p_L)\left[R_2(1-F(1-L)) + (F-1)(1-\gamma)(1-\phi)r\right] > \\ \Delta p\left[F\left(2\phi - R_1^A\right) + \left(R_1^A + R_1^B - 2\phi\right)\right] + \Delta p\left[R_2(1-F(1-L)) + (F-1)(1-\gamma)(1-\phi)r\right]\end{gathered}$$

Now, replacing in the expressions $W^i\left[R_1^A, R_1^B\right]$ and $W^i\left[R_1^A, 0\right]$, the proof of the corollary is reduced to simply showing that:

$$\begin{gathered}\Delta p\left[F\left(2\phi - R_1^A\right) + \left(R_1^A + R_1^B - 2\phi\right)\right] + \Delta p\left[R_2(1-F(1-L)) + (F-1)(1-\gamma)(1-\phi)r\right] > \\ \Delta p\left[R_1^A + R_1^B + R_2(1-F(1-L)) - (1+\phi)\gamma + F\left[(1+\gamma)\phi - R_1^A\right] + (F-1)((1-\gamma)\phi + (1-\gamma)(1-\phi)r)\right]\end{gathered}$$

Some further simplification leads to the inequality:

$$2\phi F - 2\phi > F\phi + F\phi\gamma + (F-1)\phi - (F-1)\gamma\phi \iff -2\phi > -2\phi - 2\phi\gamma$$

which is true since $\phi > 0$ and $\gamma > 0$. □

Lemma 3

Proof. We consider separately the case of independent default and contagion mandates. The only cases of interest are when partial mandates restore incentives and the total expected welfare surplus is positive: $\Delta\text{Welfare} = (1-p_H)\max\{p_L, 1-p_L\}\,\text{Spillover} > 0$.

Independent default mandate With an independent mandate default, there is no welfare surplus relative to national regulation if BK_A succeeds on national projects. In the other two states of the world, the welfare surplus in countries A and B is given by:

State	Probability	Surplus A	Surplus B
$\left(0, R_1^B\right)$	$p_H(1-p_L)$	$(1-\beta)F \times R_1^A$	$-(1-\beta)F \times R_1^A$
$(0,0)$	$(1-p_H)(1-p_L)$	$F\phi(1+\gamma) - 2F\beta\phi$	$\Delta\text{Welfare} - F\phi(1+\gamma) + 2F\beta\phi$

The incentive compatibility constraints for RG_A is:

$$p_H(1-p_L)(1-\beta)F \times R_1^A + (1-p_H)(1-p_L)(F\phi(1+\gamma) - 2F\beta\phi) > 0$$

This gives the upper bound for β:

$$\beta \le \overline{\beta}_I = \frac{p_H \times R_1^A + (1-p_H)(1+\gamma)\phi}{p_H \times R_1^A + 2(1-p_H)\phi} < 1$$

The incentive compatibility constraints for RG_B is:

$$-p_H(1-p_L)(1-\beta)F \times R_1^A + (1-p_H)(1-p_L)(\Delta\text{Welfare} - F\phi(1+\gamma) + 2F\beta\phi) > 0$$

This gives the lower bound for β:

$$\beta \ge \underline{\beta}_I = \overline{\beta}_I - \frac{(1-p_H)\,\text{SpilloverEffect}}{F\left(p_H \times R_1^A + 2(1-p_H)\phi\right)} < \overline{\beta}_I$$

Contagion mandate With a contagion mandate, there is no welfare surplus relative to national regulation if either both banks fail or both banks succeed. In the other two states of the world, the welfare surplus in countries A and B is given by:

State	Probability	Surplus A	Surplus B
$\left(0, R_1^B\right)$	$p_H(1-p_L)$	$(1-\beta)F \times R_1^A$	$-(1-\beta)F \times R_1^A$
$\left(R_1^A, 0\right)$	$p_L(1-p_H)$	$(1-\beta)F \times \left(2\phi - R_1^A\right)$	$\Delta\text{Welfare} - (1-\beta)F \times \left(2\phi - R_1^A\right)$

The incentive compatibility constraints for RG_A is:

$$p_H(1-p_L)(1-\beta)F\times R_1^A + p_L(1-p_H)(1-\beta)F\times\left(2\phi - R_1^A\right)0$$

The equation hold for any $\beta \leq 1$, so the upper bound for β is $\overline{\beta}_I = 1$.

The incentive compatibility constraints for RG_B is:

$$-p_H(1-p_L)(1-\beta)F\times R_1^A + p_L(1-p_H)\left(\Delta\text{Welfare} - (1-\beta)F\times\left(2\phi - R_1^A\right)\right) > 0$$

This gives the lower bound for β:

$$\beta \geq \underline{\beta}_C = 1 - \frac{p_L\Delta\text{Welfare}}{p_L(1-p_H)F\left(2\phi - R_1^A\right) + F(1-p_L)p_H\times R_1^A} < \overline{\beta}_C = 1$$

□

Lemma 4

Proof. With zero net welfare effect of the banking union, one country's surplus is another country's loss, as for each scenario the total welfare difference is zero. Hence, the only way for (18) to hold is if $\mathbb{E}\left[\text{Welfare}_{BU}^A - \text{Welfare}_{National}^A\right] = 0$. The monitoring strategy of BK_B is unchanged by the introduction of the banking union - see Proposition 2. We also know BK_A never monitors its loans in equilibrium (Propositions 1 and 2)

If BK_B never monitors its loans we have the $\mathbb{E}\left[\text{Welfare}_{BU}^A - \text{Welfare}_{National}^A\right] = 0$ is equivalent to:

$$(1-p_L)p_L(1-\beta)FR_1^A - p_L(1-p_L)\beta F\left(2\phi - R_1^A\right) + (1-p_L)^2\left(FR_1^A - 2\beta F\phi\right) = 0$$

From this condition we can derive the equilibrium fiscal cost share of country A:

$$\beta_N^{ZS} = \frac{R_1^A}{2\phi}$$

which, by Assumption 1, is in the interval $\left(0, \frac{1}{2}\right)$.
In the other case, if BK_B is monitoring, we have that the following condition should hold:

$$(1-p_L)p_H(1-\beta)FR_1^A - p_L(1-p_H)\beta F\left(2\phi - R_1^A\right) + (1-p_L)(1-p_H)\left(FR_1^A - 2\beta F\phi\right) = 0$$

and the corresponding equilibrium fiscal cost share of country A is:

$$\beta_M^{ZS} = \frac{(1-p_L)R_1^A}{2(1-p_H)\phi + \Delta p R_1^A}$$

which is positive and, again by Assumption 1, is always smaller than 1. □

Lemma 5

Proof. If it is bailed out upon default, BK_B monitors its loans if the costs are low enough. A larger interbank market improves monitoring incentives, as the returns from a successful project increase with the investment size:

$$\frac{C}{\Delta p} \leq \left(1-\gamma+\gamma^I\right) R_1^B - \phi(1-\gamma) - \gamma^I r^I \Leftrightarrow \gamma^I \geq \frac{\frac{C}{\Delta p} + (1-\gamma)\left(\phi - R_1^B\right)}{R_1^B - r^I}. \tag{46}$$

If it not bailed out upon default, BK_B monitors its loans if the costs are low enough. It monitors for higher cost levels than when it is bailed out (see equation (46)). Again, a larger interbank market improves monitoring incentives:

$$\frac{C}{\Delta p} \leq \left(1-\gamma+\gamma^I\right)\left(R_1^B + R_2\right) - \phi(1-\gamma) - (1-\phi)(1-\gamma) r - \gamma^I r^I \Leftrightarrow \gamma^I \geq \frac{\frac{C}{\Delta p} + (1-\gamma)\left(\phi(r-1) + r - R_1^B - R_2\right)}{R_1^B + R_2 - r^I}. \tag{47}$$

The monitoring thresholds for BK_B are increasing in γ^I, caeteris paribus.

BK_A monitors if the cost level is low enough and the payoff at $t=1$ is relatively high:

$$\frac{C}{\Delta p} \leq R_1^A + \gamma - \phi(1+\gamma) + \gamma^I r^I \mathbb{P}(\text{interbank loan reimbursed}) - 1 \Leftrightarrow \gamma^I \geq \frac{\frac{C}{\Delta p} - R_A^1 - \gamma + \phi(1+\gamma)}{\mathbb{P}(\text{interbank loan reimbursed})\, r^I - 1}. \tag{48}$$

□

Lemma 6

Proof. The interbank loan reimbursement probability (p_{IB}) is:

$$p_{\text{IB}} = \mathbb{P}(BK_B \text{ succeeds at } t=1) + \mathbb{P}(BK_B \text{ succeeds at } t=1) \times \mathbb{P}(BK_B \text{ is bailed out}). \tag{49}$$

Consider first Bank A's payoff at $t=1$. If Bank B is bailed out, then $p_{\text{IB}} = 1$ and the payoff for Bank A is:

$$\pi_A^{t=1} = R_1^A + \left(\gamma - \gamma^I\right) - \phi(1+\gamma) + \gamma^I r^I.$$

The intuition is that with BK_B being bailed out, the repayment is guaranteed by the regulator of BK_B. For any positive interest rate, the loan returns increase with the investment size. For BK_A, investing in this market is equivalent to holding the surplus as liquidity, so it will accept the return on liquidity: $r^I = 1$.

If Bank B is not bailed out, then $p_{\text{IB}} = \mathbb{P}(BK_B \text{ succeeds at } t=1)$ and the payoff for Bank A is:

$$\pi_A^{t=1} = \begin{cases} R_1^A + \left(\gamma - \gamma^I\right) - \phi(1+\gamma) + \mathbb{P}(BK_B \text{ succeeds at } t=1)\gamma^I r^I & \text{, if } R_1^A + \left(\gamma-\gamma^I\right) - \phi(1+\gamma) \geq 0 \\ \mathbb{P}(BK_B \text{ succeeds at } t=1)\left(R_1^A + \left(\gamma-\gamma^I\right) - \phi(1+\gamma) + \gamma^I r^I\right) & \text{, if } R_1^A + \left(\gamma-\gamma^I\right) - \phi(1+\gamma) < 0 \end{cases}.$$

The payoff piecewise increases in γ^I, as from Lemma 5 the success probability of BK_B is non-decreasing in γ_I. Since the payoff function is continuous,[5] it is increasing in γ^I on its full domain. The payoff of BK_B is

[5]It takes the value $\mathbb{P}(BK_B \text{ succeeds at } t=1)\gamma^I r^I$ for $R_1^A + \left(\gamma-\gamma^I\right) - \phi(1+\gamma) < 0$.

given below, where p^* stands for the equilibrium probability of success on the domestic loans:

$$\pi_B = p^* \left[\left(1-\gamma+\gamma^I\right) R_1^B - \phi\,(1-\gamma) - \gamma^I r^I\right] + \left(p^* + (1-p^*)\,\mathbb{I}_{\text{Bailout B}}\right)\left[\left(1-\gamma+\gamma^I\right) R_2 - (1-\phi)\,(1-\gamma)\,r\right]. \tag{50}$$

The payoff function decreases with the interbank interest rate r^I. First, the repayment in case of success is larger. Second, a larger r^I makes a bailout less likely, as the regulator incurs a larger fiscal cost when repaying foreign creditors. Conditional on r^I, the payoff is increasing with the interbank market size for any given bailout policy, since the investment has constant returns to scale. □

Lemma 7

Proof. The national regulator in country A always bails out the domestic bank. The welfare values for country B following a bailout or a liquidation are given by:

$$\begin{aligned} \text{Welfare}_{B,\text{Bailout}} &= \left(1-\gamma+\gamma^I\right) R_2 + (1-F)\,(1-\gamma)\,\phi - F r^I \gamma^I, \text{ and} \\ \text{Welfare}_{B,\text{Liquidation}} &= \left(1-\gamma+\gamma^I\right) R_2\,(1-L)\,F + (1-F)\left[(1-\gamma)\,\phi + (1-\gamma)\,(1-\phi)\,r\right]. \end{aligned}$$

It follows that the national regulator in country B bails out the domestic bank only for small enough interbank markets:

$$\underline{\gamma}^I_{\text{National}} = \frac{(F-1)\,(1-\phi)\,(1-\gamma)\,r + (1-\gamma)\,R_2\,(1-F\,(1-L))}{F r^I - R_2\,(1-F\,(1-L))}. \tag{51}$$

A banking union always bails out bank A upon default and bank B in the situation where both banks fail independently (zero payoff at $t = 1$). If BK_A obtains R_1^A at time $t = 1$ and BK_B obtains zero, then the liquidation decision of BK_B depends on the interbank market size.

Consider first the case where the failure of BK_B does not imply cross-border contagion, or equivalently: $R_1^A + \gamma - \gamma^I - (1+\gamma)\,\phi \geq 0$. The joint welfare values following a bailout or a liquidation are given by:

$$\begin{aligned} \text{Welfare}^{\text{Joint}}_{\text{Bailout}} &= R_1^A + R_2 + \gamma - \gamma^I + r^I\gamma^I\,(1-F) + \left(1-\gamma+\gamma^I\right) R_2 + (1-F)\,(1-\gamma)\,\phi, \text{ and} \\ \text{Welfare}^{\text{Joint}}_{\text{Liquidation}} &= R_1^A + R_2 + \gamma - \gamma^I + \left(1-\gamma+\gamma^I\right) R_2\,(1-L)\,F + (1-F)\,(1-\gamma)\,(1-\phi)\,r. \end{aligned}$$

Next, consider first the case where the failure of BK_B generates cross-border contagion, or $R_1^A + \gamma - \gamma^I - (1+\gamma)\,\phi < 0$. The joint welfare values following a bailout or a liquidation are given by:

$$\begin{aligned} \text{Welfare}^{\text{Joint}}_{\text{Bailout}} &= R_1^A + R_2 + \gamma - \gamma^I + r^I\gamma^I\,(1-F) + \left(1-\gamma+\gamma^I\right) R_2 + (1-F)\,(1-\gamma)\,\phi, \text{ and} \\ \text{Welfare}^{\text{Joint}}_{\text{Liquidation}} &= R_2 + 2\,(1-F)\,\phi + F\left(R_1^A + \gamma - \gamma^I\right) + \left(1-\gamma+\gamma^I\right) R_2\,(1-L)\,F + (1-F)\,(1-\gamma)\,(1-\phi)\,r. \end{aligned}$$

The bailout condition, $\Delta\text{Welfare} = \text{Welfare}^{\text{Joint}}_{\text{Bailout}} - \text{Welfare}^{\text{Joint}}_{\text{Liquidation}} \geq 0$ can be written as:

$$\Delta\text{Welfare} = \begin{cases} \overbrace{\gamma^I\left(R_2\,(1-F\,(1-L)) - (F-1)\,r^I\right) + \Theta\,(\gamma,\phi,r,F,L)}^{\Delta\text{Welfare}^{\text{Joint}}_{\text{Contagion}}}, & \text{if } R_1^A + \gamma - \gamma_I - \phi\,(1+\gamma) \geq 0 \\ \Delta\text{Welfare}^{\text{Joint}}_{\text{Contagion}} + (1-F)\left(R_1^A + \gamma - \gamma_I - \phi\,(1+\gamma)\right), & \text{if } R_1^A + \gamma - \gamma_I - \phi\,(1+\gamma) < 0 \end{cases} \tag{52}$$

where $\Theta(\gamma, \phi, r, F, L) = (1-\gamma)(R_2(1-F(1-L))) + (F-1)(1-\phi)(1-\gamma)r > 0$.

First, the function ΔWelfare is continuous. The difference in welfare ΔWelfare decreases with r^I. The maximum interbank market size is thus achieved for $r^I = 1$. From Lemma 6BK_A accepts a rate of $r^I = 1$ as long as BK_B is bailed out.

For $R_2(1-F(1-L)) - (F-1) > 0$, if follows that ΔWelfare increases in γ^I. Hence, a banking union always bails out BK_B, regardless of the size of the interbank market. The equilibrium is given by $\gamma^I = \gamma$ and $r^I = 1$.

If $R_2(1-F(1-L)) - (F-1) < 0$, then ΔWelfare decreases with γ^I if $\gamma^I < R_1^A + \gamma - \phi(1+\gamma)$: the no contagion case, and increases with γ^I if $\gamma^I > R_1^A + \gamma - \phi(1+\gamma)$. If:

$$R_2(1-F(1-L)) \geq (F-1)\left(R_1^A + \gamma - (1+\gamma) - (1-\phi)(1-\gamma)r\right) \geq 0,$$

then a banking union always bails out BK_B as ΔWelfare > 0 for $\gamma^I = \gamma$ and $r^I = 1$.

It follows that the banking union only liquidates BK_B only for idiosyncratic defaults, if the interbank markets is small enough to not generate contagion:

$$\gamma < \underline{\gamma}^I_{\text{Union}} = \frac{(F-1)(1-\phi)(1-\gamma)r + (1-\gamma)R_2(1-F(1-L))}{(F-1)r^I - R_2(1-F(1-L))} < \gamma_{\text{Contagion}} = R_1^A + \gamma - \phi(1+\gamma), \quad (53)$$

and $R_2 < \underline{R_2}$, where $\underline{R_2}$ is defined below:

$$\underline{R_2} = \min\left\{\frac{F-1}{1-F(1-L)}, \frac{F-1}{1-F(1-L)}\left(R_1^A + \gamma - (1+\gamma)\phi - (1-\phi)(1-\gamma)r\right)\right\}. \quad (54)$$

For any r^I it follows that $\underline{\gamma}^I_{\text{Union}} > \underline{\gamma}^I_{\text{National}}$, as $(F-1)r^I < Fr^I$. □

Proposition 6

Proof. From the results in Lemmas 6 and 7 it follows that BK_A chooses between two possible interbank market sizes. For a given interest rate r^I, BK_A either lends the full surplus γ or the maximum amount for which BK_B is bailed out given default.

An equilibrium on the interbank market is defined by an interbank market size γ^I and an interbank interest rate r^I: $\left(\gamma^I, r^I\right)$. Only two interbank market equilibria are possible for each regulatory architecture. With national regulation, the equilibrium is either $\left(\underline{\gamma}^I_{\text{National}}, 1\right)$ or $\left(\gamma, r^I_{\text{National}} \geq 1\right)$. With a banking union, the equilibrium is either $\left(\underline{\gamma}^I_{\text{Union}}, 1\right)$ or $\left(\gamma, r^I_{\text{Union}} \geq 1\right)$.

Equilibrium interest rates The unique equilibrium interest rate solves equation (55) if BK_A can lend the whole amount to BK_B without being affected by contagion:

$$\gamma^I_{\text{National/Union}}\left(r^I\right)\left(r^I - 1\right) - \gamma r^I p^* + \gamma = 0 \text{ , if } R_1^A - \phi(1+\gamma) > 0, \quad (55)$$

and equation (56) if BK_A defaults if it lends γ to BK_B and BK_B fails:

$$\gamma^I_{\text{National/Union}}\left(r^I\right)\left(r^I-1\right)-\gamma r^I p^*+\gamma+(1-p^*)\left(R_1^A-\phi(1+\gamma)\right)=0\text{ , if } R_1^A-\phi(1+\gamma)\leq 0. \tag{56}$$

The intuition is that BK_B selects the minimum interest rate that makes BK_A indifferent between lending $\gamma^I_{\text{National/Union}}$ and be insured through the bailout policy, or lend the full surplus γ and be repaid at $t=1$ with probability p^*. The interest rate is the minimum compensation for risk to offer incentives for a full transfer on the interbank market.

Since $\gamma^I_{\text{National/Union}}\left(r^I\right)\left(r^I-1\right)$ decreases with r^I, both equations are monotonous with respect to r^I. Moreover, the expressions are positive for $r^I=1$ The equilibrium interest rate r^I exists and is unique for each regulatory regime. From $\underline{\gamma}^I_{\text{Union}}>\underline{\gamma}^I_{\text{National}}$ and monotonicity, $r^I_{\text{Union}}>r^I_{\text{National}}$. It follows that an unique positive equilibrium interest rate exists for both national regulation and banking union regimes. Further, $r^I_{\text{Union}}>r^I_{\text{National}}$.

Bank B selects to borrow the full γ from the interbank market if R_1^B is large enough. Its payoff from borrowing γ and being liquidated upon default is:

$$p^*\left(R_1^B+R_2-\phi(1-\gamma)-(1-\phi)(1-\gamma)r-\gamma r^I\right). \tag{57}$$

and from borrowing $\gamma^I_{\text{National/Union}}$ and being bailed out:

$$(1-\gamma+\gamma^*)\left(p^*R_1^B+R_2\right)-p^*\left(\phi(1-\gamma)-(1-\phi)(1-\gamma)r-\gamma^I\right). \tag{58}$$

The difference between equation (57) and (58) is given by:

$$p^*\left(\gamma-\gamma^I\right)R_1^B+p^*\left(\gamma^I-\gamma r^I\right)+(p-(1-\gamma+\gamma^*))R_2\geq 0. \tag{59}$$

Hence, a larger R_1^B, caeteris paribus, incentives BK_B to lend the full γ at a positive interest rate. Note that since $\underline{\gamma}^I_{\text{Union}}>\underline{\gamma}^I_{\text{National}}$ and the monitoring incentives are better under the national regulation, the threshold is larger for a banking union than for national regulation. □

Tables and Figures

Table 1: **Resolution and monitoring equilibrium decisions.**

This table presents the regulator's resolution decision on defaulted banks, as well as the monitoring decisions of individual banks. The decisions depend on the size of the interbank market (γ), the monitoring cost scaled by the shift in the project success probability ($\frac{C}{\Delta p}$), and the regulatory environment: either national or a banking union. The interbank market threshold is defined as:

$$\gamma^* = \frac{R_2 (1 - F(1 - L)) + (F - 1)(1 - \phi) r + F\left(R_1^A - \phi\right)}{F\phi + (F - 1)(1 - \phi) r}$$

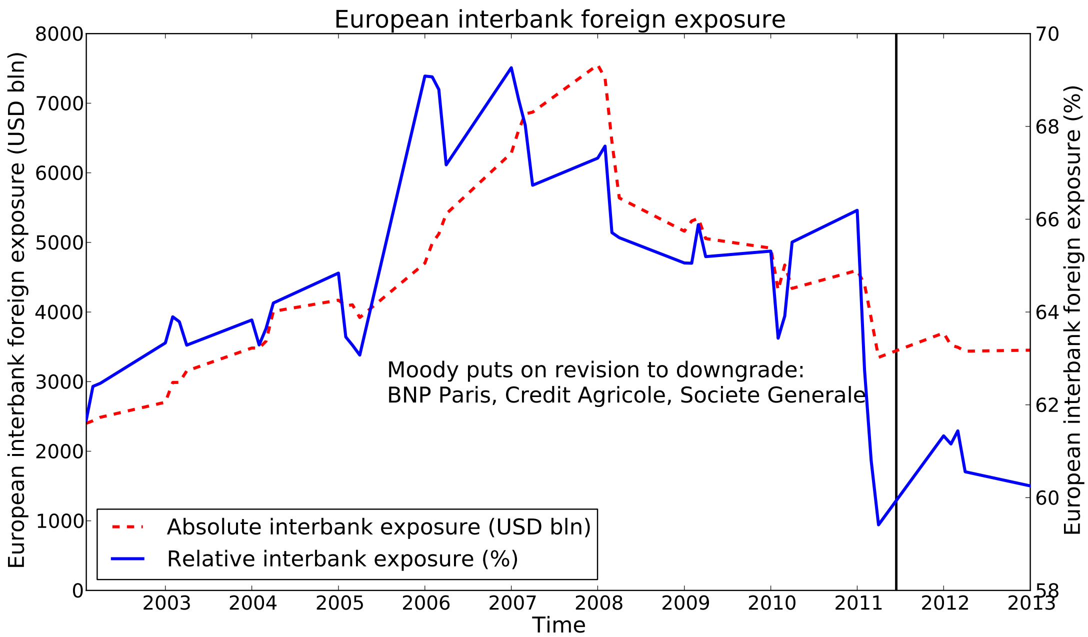
The monitoring thresholds are defined as: $c_1 = 2\left(R_1^B - \phi\right)$ and $c_2^B = c_1 + R_2 - (1 - \phi)(1 - \gamma) r$. The highlighted cells point out differences between the national resolution system and the banking union.

γ range	$\frac{C}{\Delta p}$ range	Regulator	Resolution upon bank default		Monitoring	
			Bank A	Bank B	Bank A	Bank B
$\gamma < \gamma^*$	$(0, c_1)$	all	bailout	bailout	no	yes
$\gamma > \gamma^*$	$(0, c_1)$	national	bailout	liquidation	no	yes
$\gamma > \gamma^*$	$(0, c_1)$	banking union	bailout	**bailout**	no	yes
$\gamma > \gamma^*$	(c_1, c_2)	national	bailout	liquidation	no	yes
$\gamma > \gamma^*$	(c_1, c_2)	banking union	bailout	**bailout**	no	**no**
$\gamma > \gamma^*$	(c_2, ∞)	national	bailout	liquidation	no	no
$\gamma > \gamma^*$	$(c_2 \infty)$	banking union	bailout	**bailout**	no	no

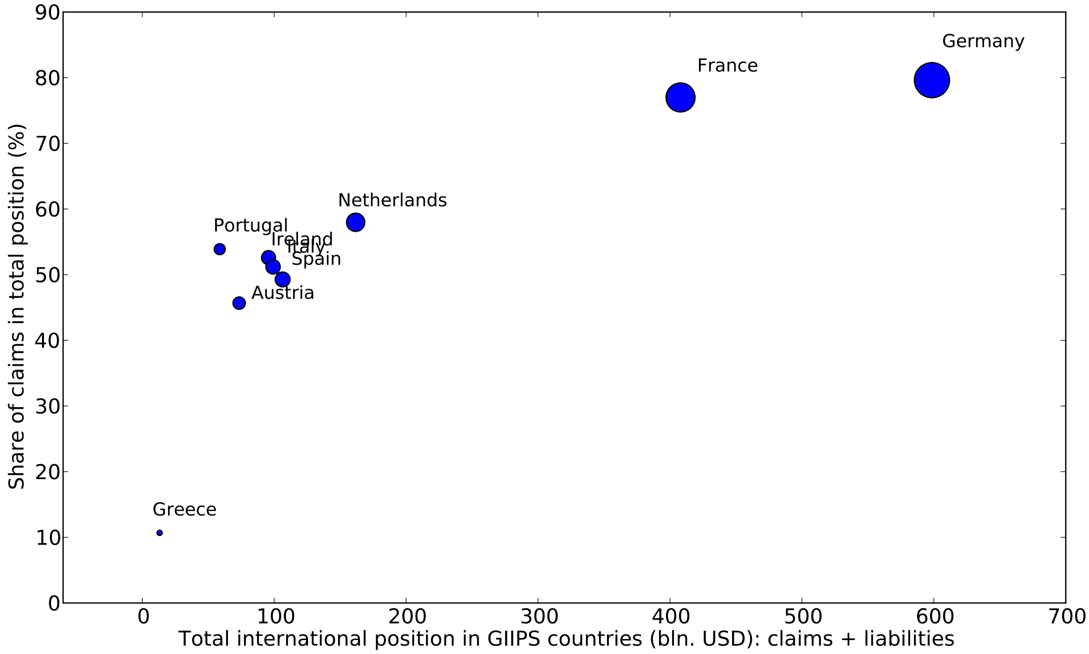
Table 2: **Welfare impact of a full mandate banking union for individual members.**

The table shows the welfare changes for each individual country under a full mandate banking union relative to national regulation, in each state of the world at $t = 1$. Intervention costs are split between countries A and B such that for each Euro injected in the banking system, country A (country B) supports β (supports $1-\beta$) Euros. A distinction is made between the cases when $\gamma < \gamma^*$ (zero net welfare effect of the banking union) and $\gamma \geq \gamma^*$ (positive net welfare effect of the banking union).

$(\text{Payoff}_A, \text{Payoff}_B)$	Country A	Country B
	Small interbank market: $\gamma < \gamma^*$	
$\left(R_1^A, R_1^B\right)$	0	0
$\left(0, R_1^B\right)$	$(1-\beta)\, FR_1^A$	$-(1-\beta)\, FR_1^A$
$\left(R_1^A, 0\right)$	$-\beta F\left(2\phi - R_1^A\right)$	$\beta F\left(2\phi - R_1^A\right)$
$(0, 0)$	$FR_1^A - 2\beta F\phi$	$2\beta F\phi - FR_1^A$
	Large interbank market: $\gamma \geq \gamma^*$	
$\left(R_1^A, R_1^B\right)$	0	0
$\left(0, R_1^B\right)$	$(1-\beta)\, FR_1^A$	$-(1-\beta)\, FR_1^A$
$\left(R_1^A, 0\right)$	$(1-\beta)\, F\left(2\phi - R_1^A\right)$	$\Delta\text{Welfare}_{BU} - (1-\beta)\, F\left(2\phi - R_1^A\right)$
$(0, 0)$	$F(1+\gamma)\,\phi - 2\beta F\phi$	$\Delta\text{Welfare}_{BU} - F(1+\gamma)\,\phi + 2\beta F\phi$



(a) Dynamics of Eurozone interbank foreign exposures



(b) Share of claims against GIIPS countries and total positions.

Figure 1: **Eurozone interbank exposures**

This figure describes the interbank exposures across Eurozone banks. Panel (A) shows the exposure of Eurozone banks in 11 countries (GIIPS: Greece, Ireland, Italy, Portugal and Spain; Austria, Germany, Spain, Finland, France, the Netherlands and Portugal) to the European banking sector, both in absolute terms and as a fraction of total foreign exposure. Panel (B) presents net and international balances of banks from selected countries against GIIPS countries, between 2008:Q1 and 2013:Q1. The size of the marker is proportional to the total position. *Source: Bank for International Settlements.*

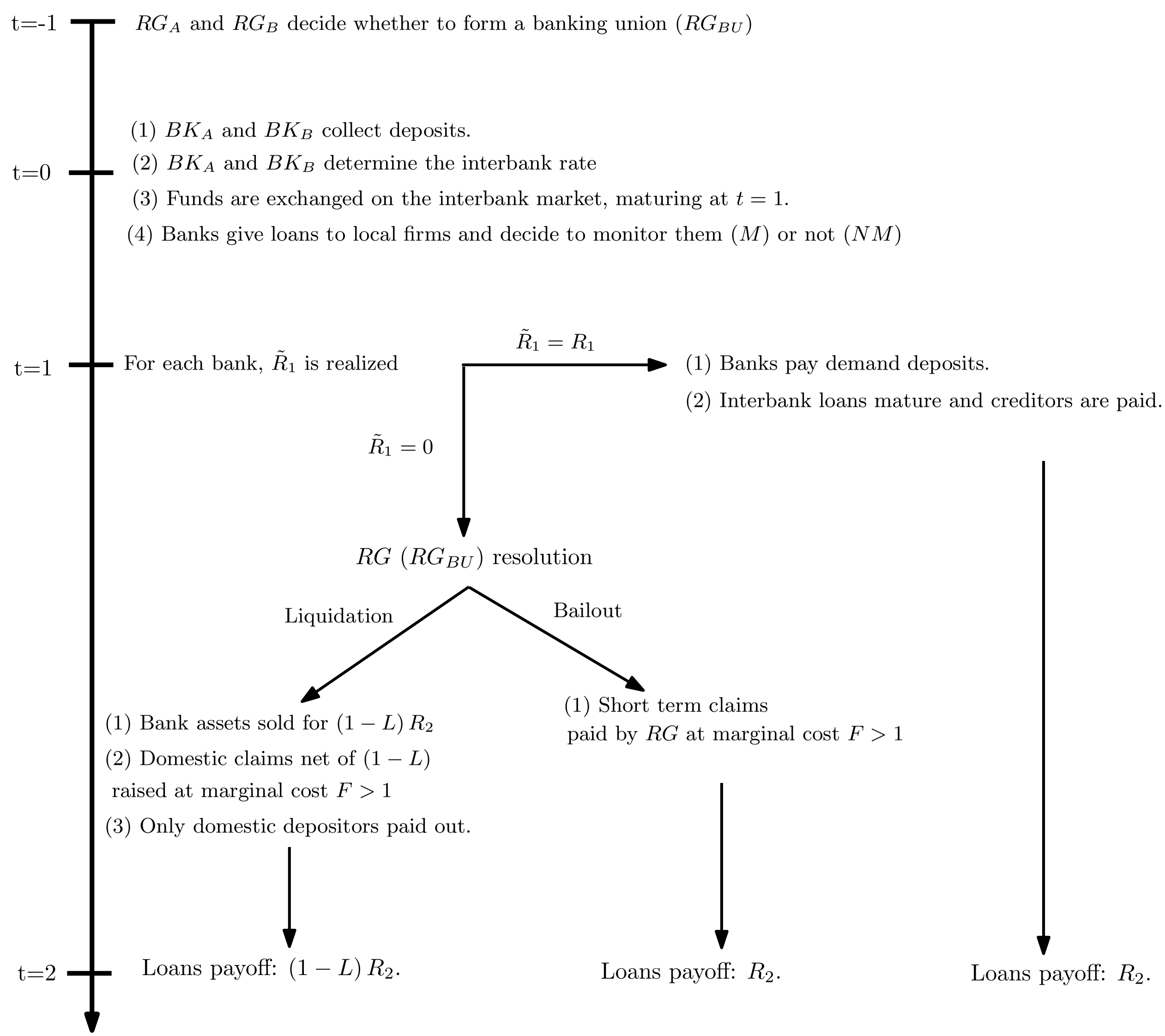


Figure 2: **Model timing**

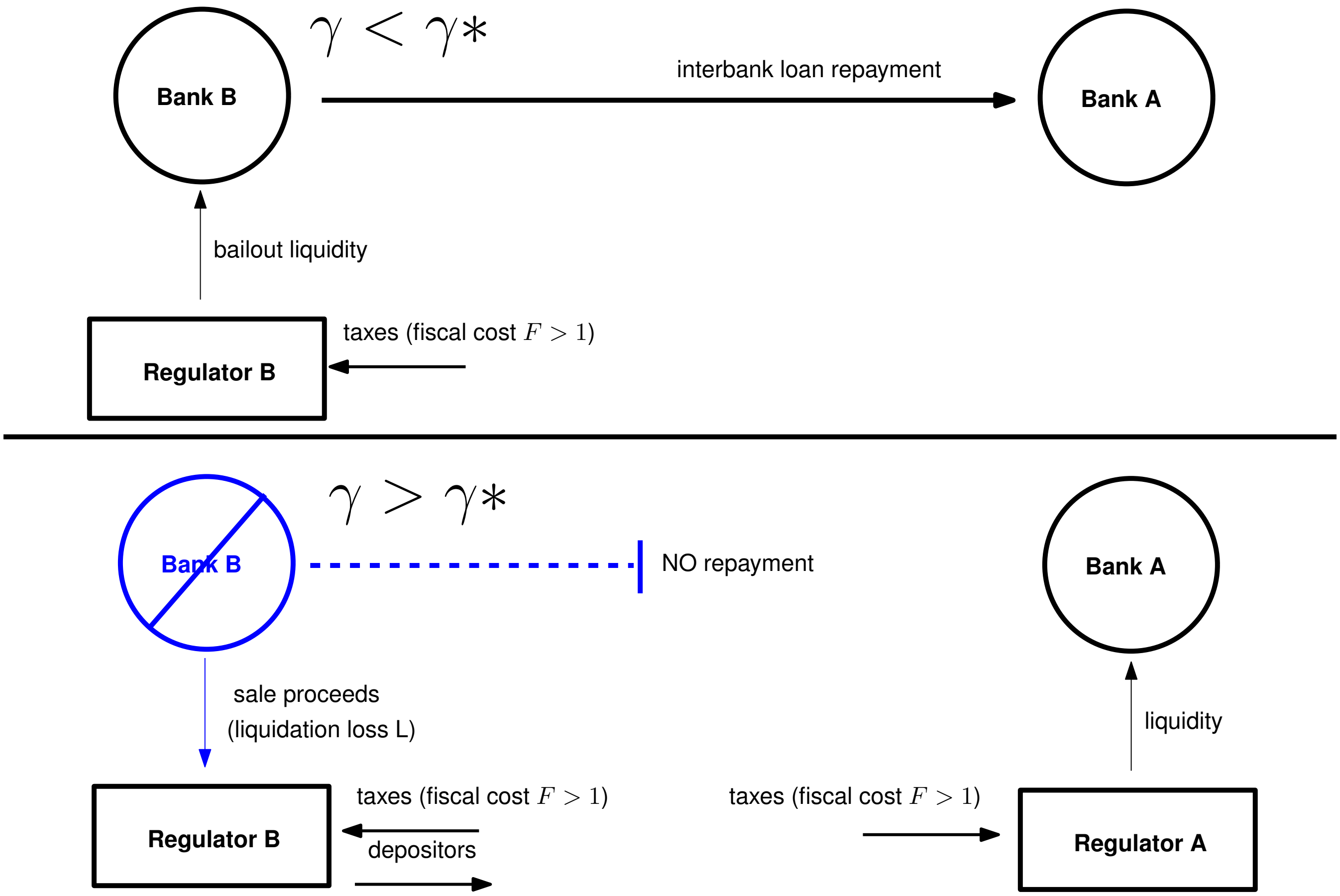


Figure 3: **Spillover mechanism conditional on BK_B default**

The figure shows the mechanism through which shocks are transmitted across borders in the model. For $\gamma < \gamma^*$, there is no spillover effect - if BK_B defaults, it is bailed out and can pay its short term debt to BK_A. Conversely, if $\gamma \geq \gamma^*$, the national regulator liquidates BK_B and none of the proceeds reach BK_A. An (inefficient) intervention of the national regulator in country A is now necessary.

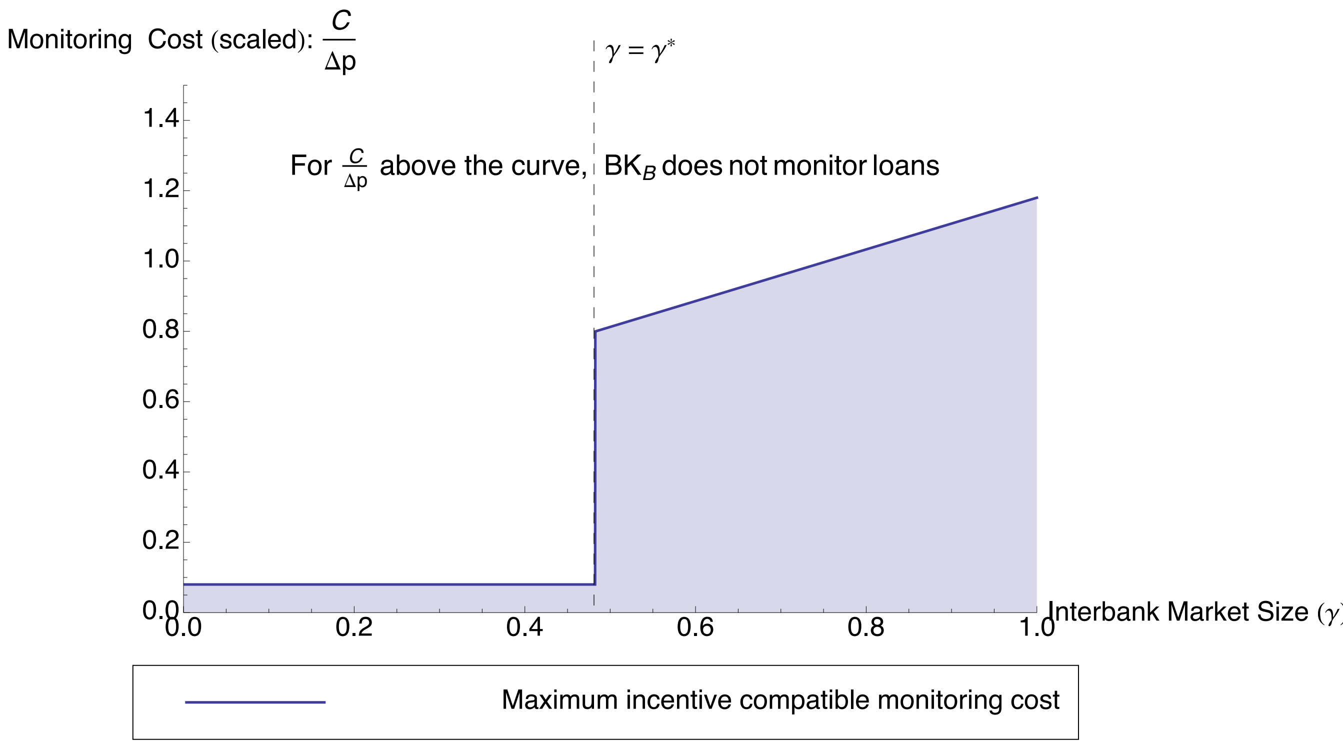


Figure 4: **Equilibrium monitoring decisions of BK_B under national regulation**

The figure shows the indifference curve of BK_B with national resolution policy. For a given interbank market size and private benefit, BK_B monitors in the shaded region (below the indifference curve). Note that the liquidation threat becomes credible for $\gamma \geq \gamma^*$ and the bank has better incentives to monitor its loans.

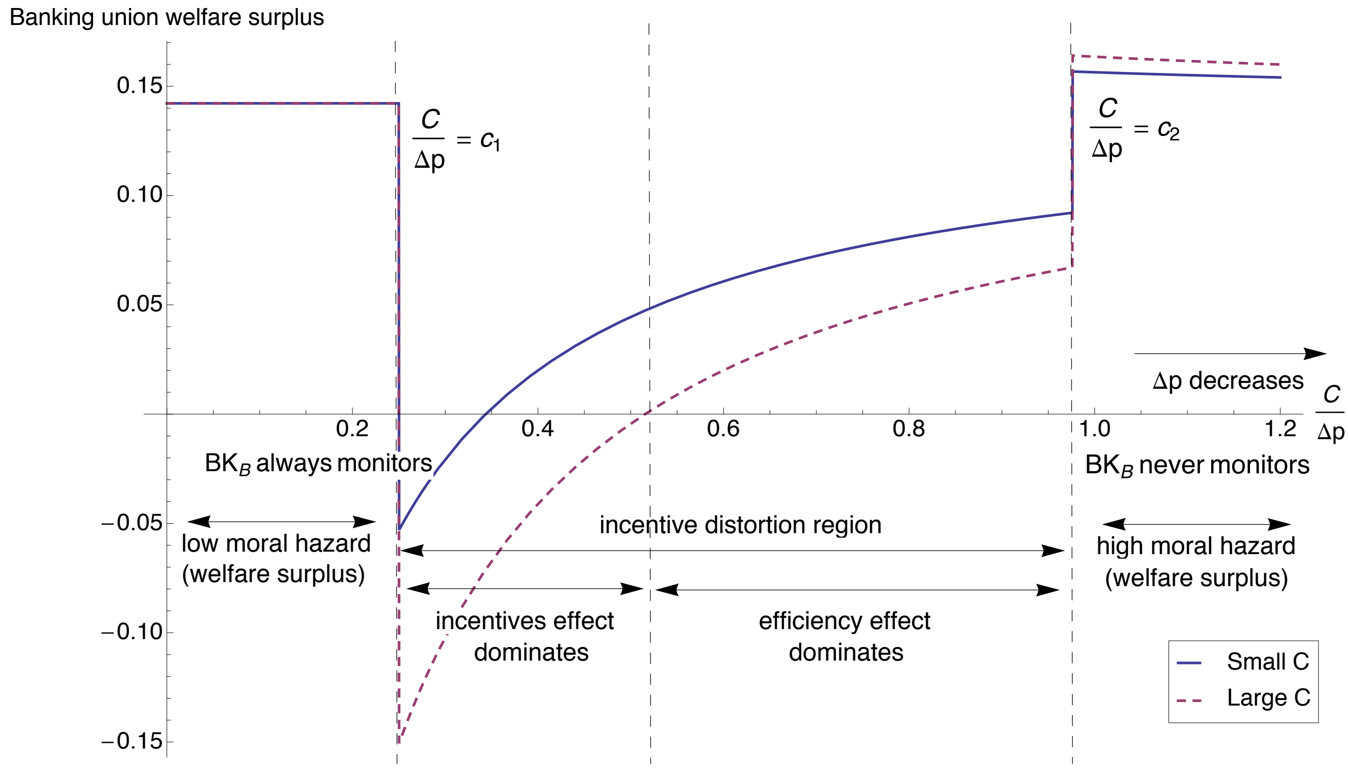
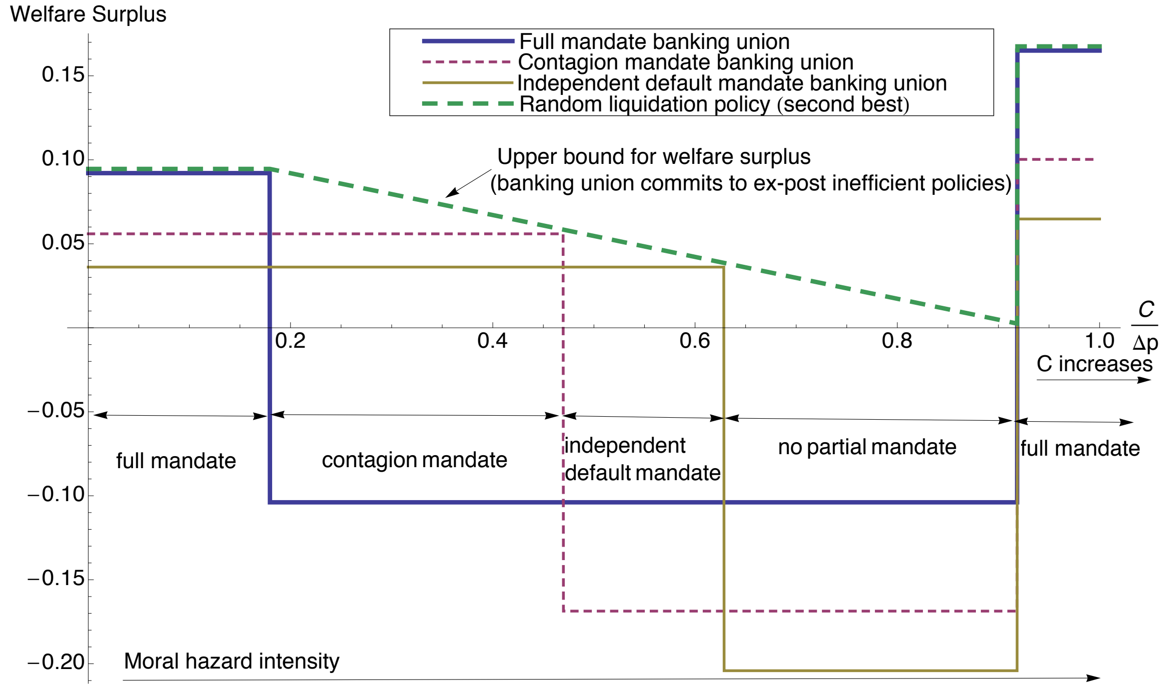
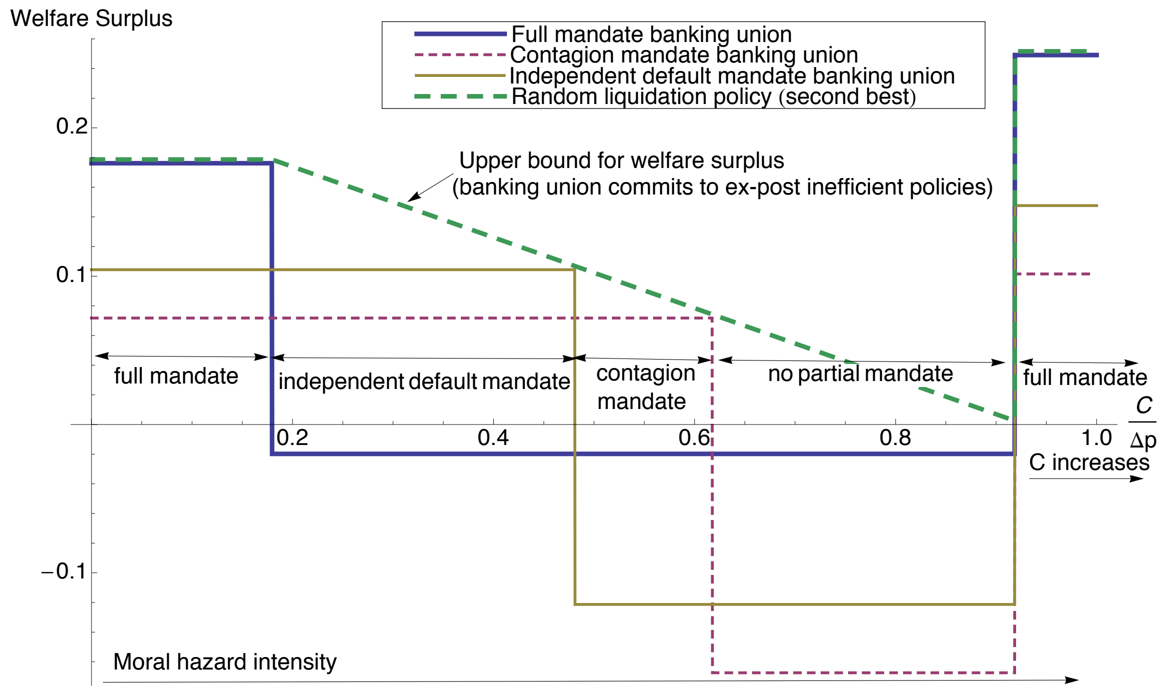


Figure 5: **Banking union welfare surplus and moral hazard**
The figure shows the welfare surplus from the banking union relative to national regulation systems as a function of the moral hazard effects $\frac{C}{\Delta p}$. For low or high values of $\frac{C}{\Delta p}$, the banking union never distorts incentives and always improves welfare by eliminating spillovers. For intermediate values of $\frac{C}{\Delta p}$, it is possible that the loss of market discipline outweighs the benefits from lower spillovers and the banking union is suboptimal.



(a) Optimal limited mandate when $p_L > \frac{1}{2}$.



(b) Optimal limited mandate when $p_L \leq \frac{1}{2}$.

Figure 6: **Welfare surplus and banking union design.**

The figure plots the welfare surplus of the banking union with different mandates and commitment levels. The full mandate, no commitment banking union is optimal for very low and very high levels of moral hazard. For intermediate moral hazard, a limited mandate can offer a positive welfare surplus. The exact optimal mandate depends on the investment opportunity set (size of p_L).

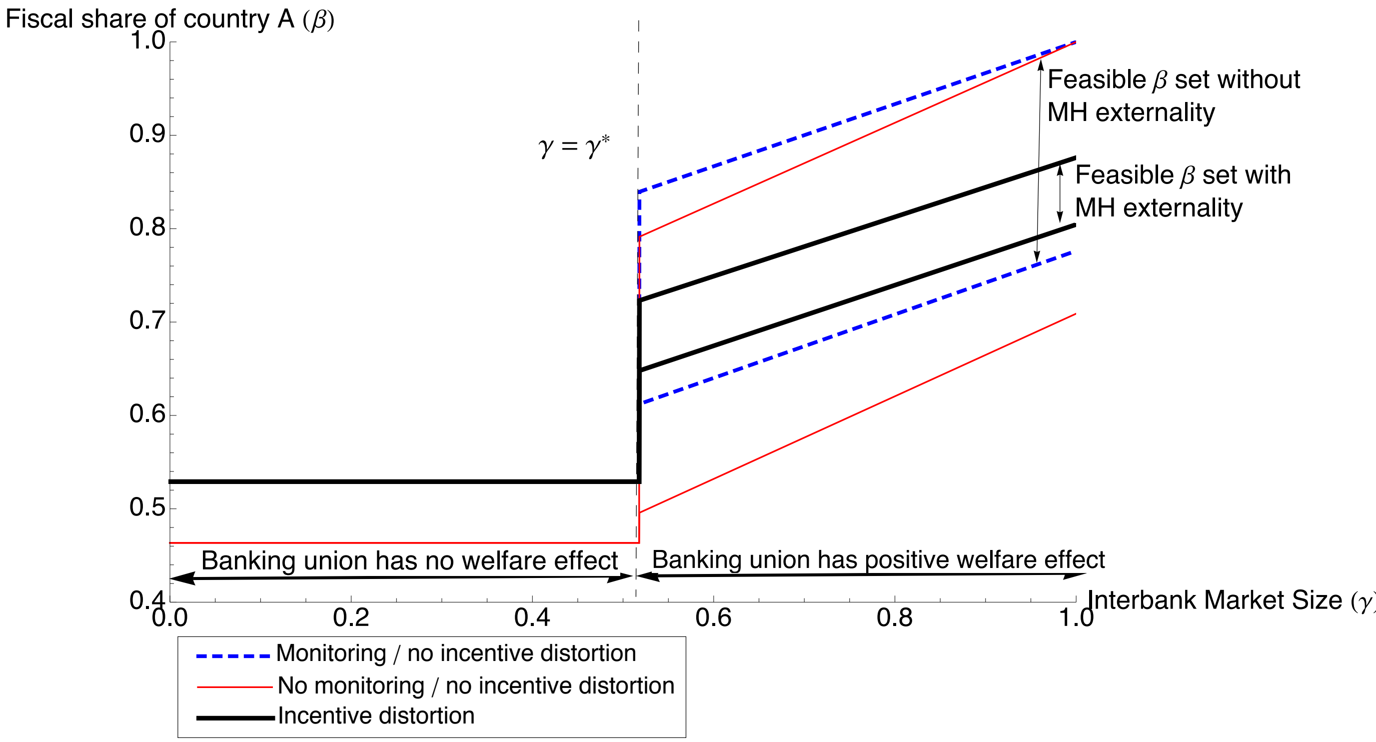


Figure 7: **Feasible cost sharing rules for the full mandate banking union**
The figure shows the feasible linear sharing rules of the fiscal cost of the form {Country A:β, Country B:$1-\beta$}. For small sizes of the interbank market, the banking union does not improve welfare and there is an unique way to split the costs between countries. For situations when there is a positive welfare surplus from the banking union (large γ), the country which benefits from resolving the externality also internalises the largest part of the fiscal cost.

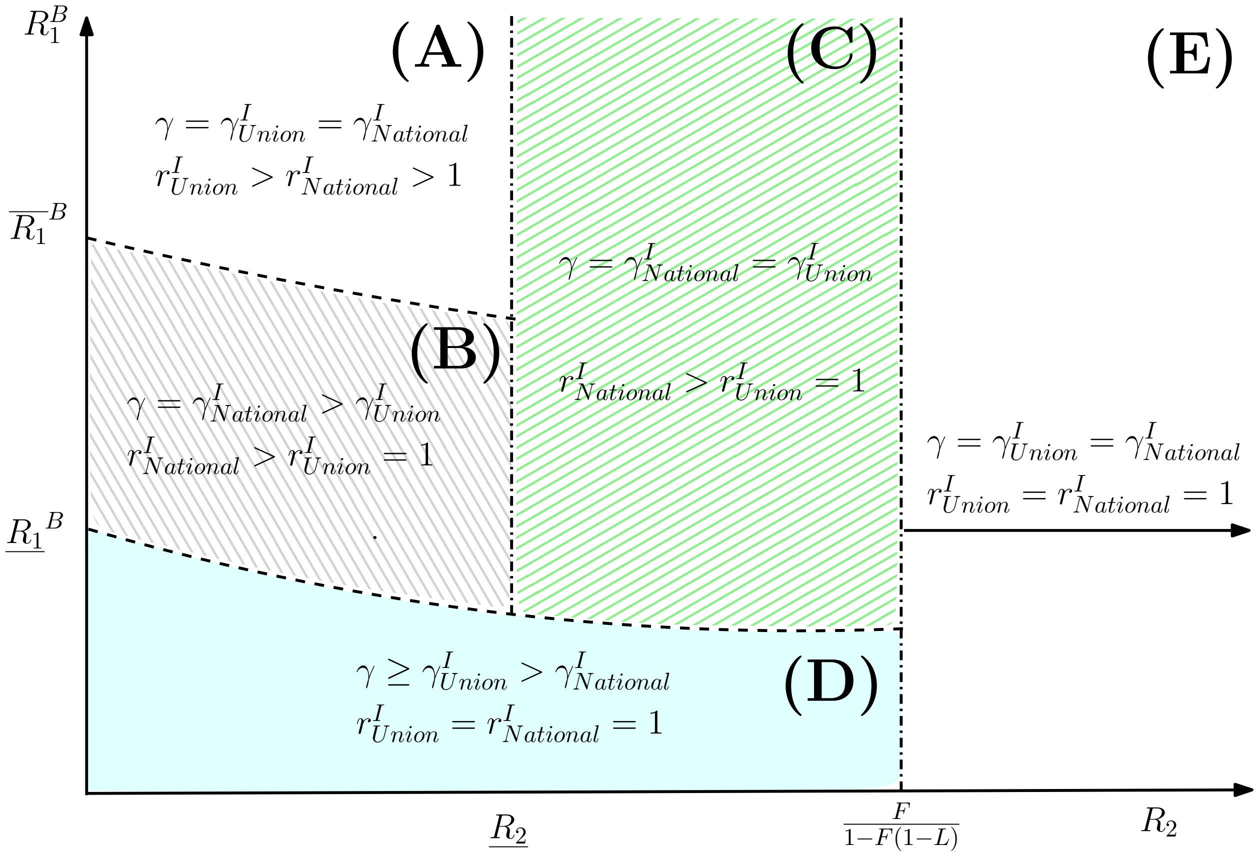


Figure 8: **Banking union impact on the interbank market**

The figure presents the interbank market equilibria: the size of the interbank loan γ^I and the interest rate r^I, for both the national regulation and the banking union setting. Five regions are identified as a function of the investment returns at $t = 1$, R^1_B and at $t = 2$, R_2. The implicit functions $\underline{R_1}^B(R_2)$ and $\overline{R_1}^B(R_2)$ are convex for $p - (1 - \gamma + \gamma^*) > 0$ and concave otherwise. The figure only graphs the convex case.