

Banking Union Optimal Design under Moral Hazard

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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, since 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 a joint resolution fund, less so if a banking union distorts incentives.

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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, since 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 a joint resolution fund, less so if a banking union distorts incentives.

Keywords: Bank resolution, moral hazard, institution design, contagion, systemic risk

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

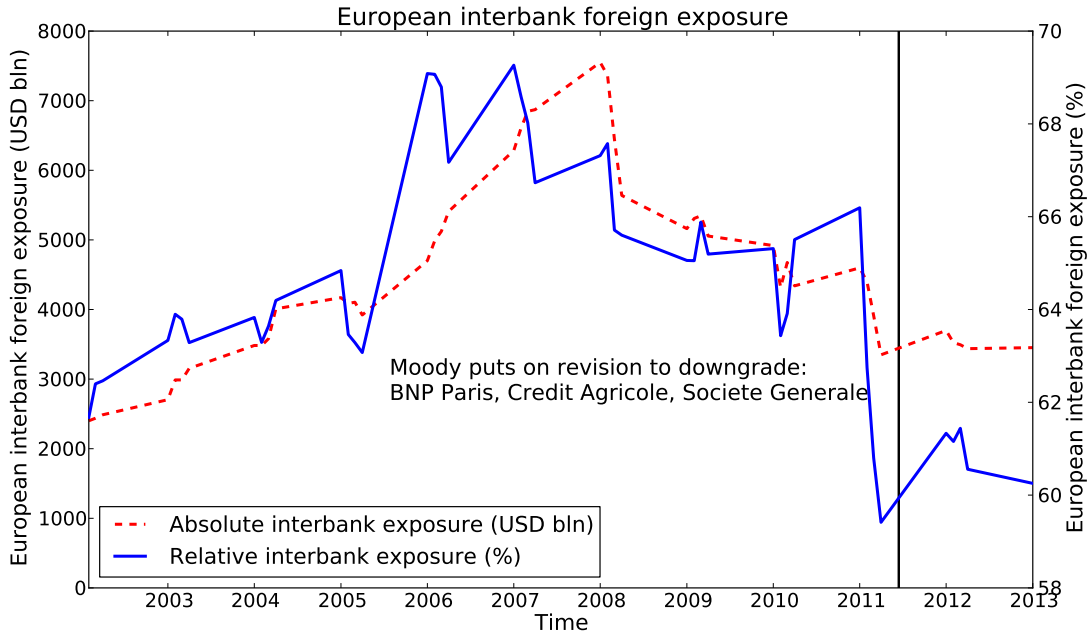
The global financial crisis ignited the debate around a common regulatory framework for European banks. The [International Monetary Fund \(2013\)](#) emphasized the threat of contagion, since bank sectors in Europe are highly interconnected. [Figure 1](#) documents asymmetric exposures, with larger Eurozone economies (e.g., Germany, France, and the Netherlands) as net creditors to Greece, Ireland, Italy, Portugal, and Spain (GIIPS). The Dexia and Fortis bailouts unveiled the need for coordinated regulatory response at the supranational level.¹ Is a single regulator also stricter with insolvent systemic institutions? Not necessarily: In January 2012 the European Central Bank (ECB) insisted that the Irish government repay senior debt in the Anglo-Irish bank at face value. At the same time, the Irish national bank was willing to impose haircuts.

The contribution of this paper is twofold. From a positive perspective, it argues that a single-resolution mechanism (SRM) generates 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.

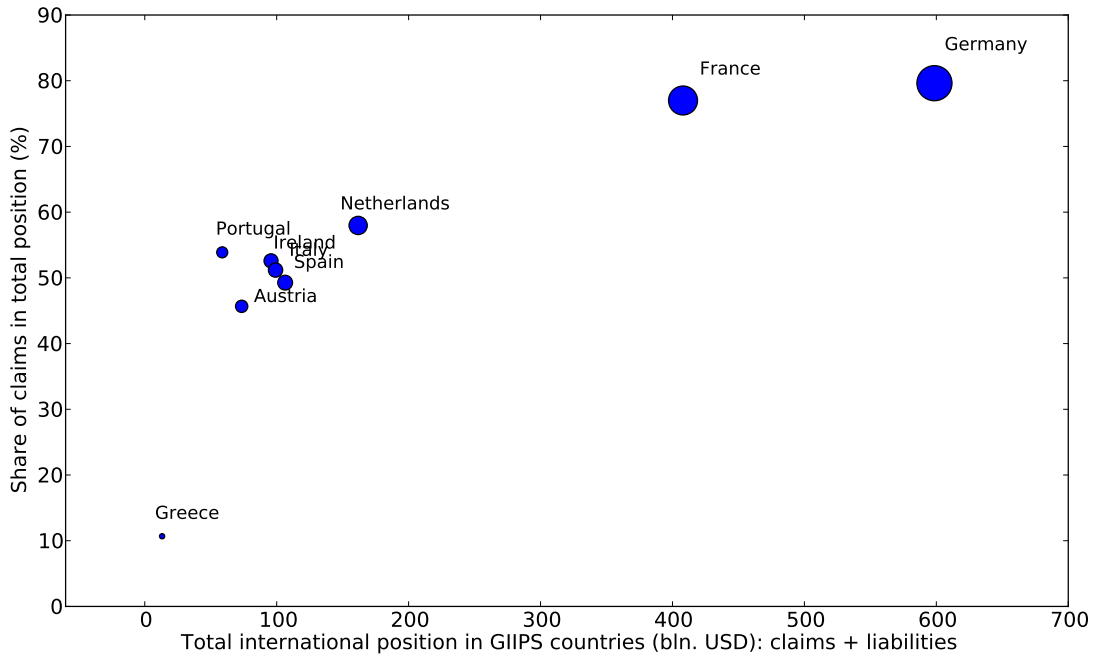
From a normative perspective, we study the optimal mandate of a banking union, particularly the single-resolution mechanism. Restricting the banking union's mandate can restore incentives and improve welfare. The best way to allocate bank default interventions between national and supranational regulators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

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 must decide between two possible policies: either a costly bailout financed by the taxpayers or an inefficient liquidation of the bank's assets. The costs of both these policies are shared between union members according to an ex ante contract.

¹[Allen, Carletti, and Gimber \(2011\)](#) argue that “national regulators care first and foremost about domestic depositors”.



(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 interbank exposures across Eurozone banks. Panel A shows the exposure of Eurozone banks in 11 countries (GIIPS countries, Austria, Germany, Finland, France, the Netherlands, and Portugal) to the European banking sector, in both absolute terms and as a fraction of total foreign exposure. Panel B presents the net and total 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.*

The cross-border links between banks create the scope for default contagion, as noted by Freixas, Parigi, and Rochet (2000) and 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 profitable domestic activity. It thus eliminates 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 avoid 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.

For very low short-term asset returns, however, the relative leniency of a banking union improves risk taking incentives. In this situation, debtor banks strategically reduce their foreign borrowing under national regulation to induce bailouts upon default. A banking union is more lenient and debtor banks can increase their borrowing without triggering liquidation in the insolvency state. Thus, the banking union stimulates cross-border trading while the bailout policy is unchanged. The additional interbank return for the debtor bank helps to 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 trade-off 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, since they are the main beneficiaries of eliminating the default spillover. If the banking union increases risk taking incentives, the maximum resolution fund share for creditor countries diminishes. 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. Second, under national regulation, debtor countries have a credible commitment device to liquidate defaulting banks since they do not internalize 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. Section 3 presents the model. Section 4 discusses optimal resolution policies and welfare implications. Section 5 focuses on the banking union design, namely the 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 the study.

2 Related literature

The paper contributes to the expanding literature on financial institution design and banking regulation 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 a banking union and the structure of the resolution fund. Third, it offers insights into the effects of the banking union on the interbank market.

The model shares the same interbank contagion mechanism as [Beck, Todorov, and Wagner \(2011\)](#) and [Colliard \(2013\)](#). However, their models abstract from ex ante banks risk taking incentives, as well as optimal design analysis. For [Colliard \(2013\)](#), moral hazard is due to local supervisors' monitoring decisions rather than bank risk taking. In the same spirit, [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. [Foarta \(2014\)](#) looks at the banking union from a political economy perspective and argues that, with imperfect electoral accountability, a banking union can encourage rent-seeking behavior for politicians in debtor countries and reduce welfare.

Our paper relates to the literature on bank default contagion and moral hazard. [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, generating a “too many to fail” problem. Despite the existence of contagion risk, [Brusco and Castiglionesi \(2007\)](#) and [Allen, Carletti, and Gale \(2009\)](#) argue in favour of financial integration: Markets improve welfare through coinsurance benefits. Additionally,

Rochet and Tirole (1996) point out the certification role played by the interbank market. The role of regulatory cooperation in preventing systemic crises, close in spirit to the banking union, is discussed by Freixas, Parigi, and Rochet (2000) and Kara (2012).

A number of papers study the weak commitment of regulators to liquidating defaulting banks: Mailath and Mester (1994), Freixas (1999), Perotti and Suarez (2002) for an analysis of the role of charter values, Cordella and Yeyati (2003) for the relation with leverage, and Acharya and Yorulmazer (2008), who distinguish between various intervention rules. Allen, Carletti, Goldstein, and Leonello (2013) show that authorities with deeper pockets face a more severe commitment problem, even if governments can fail to provide full deposit insurance (giving rise to “fundamental panics”). Our model extends the analysis to discuss weak commitment problems for a supranational regulator.

A number of relevant policy papers analyze the European banking union from an empirical and institutional point of view: Schoenmaker and Gros (2012), Carmassi, Di Noia, and Micossi (2012), and Ferry and Wolff (2012) for fiscal alternatives and Schoenmaker and Siegmann (2013) for an analysis of cross-border externalities. Schoenmaker and Wagner (2013) propose a methodology to compare the benefits and costs of financial integration. Our model complements the policy discussion by providing a mechanism design perspective on the European banking union.

3 Model

3.1 Primitives

The model primitives follow Acharya and Yorulmazer (2008) and Beck, Todorov, and Wagner (2011). We consider an economy with four dates, $t \in \{-1, 0, 1, 2\}$, and two countries, labeled A and B . In each country 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. On date $t = -1$, local regulators decide whether to merge into a supranational banking union RG_{BU} .

Depositors. Depositors receive heterogeneous endowments on date $t = 0$: Depositors receive $1 + \gamma$ units in the country A (the “rich” country) and $1 - \gamma$ units in country B (the “poor” country), where $\gamma \in (0, 1]$. They can invest their endowment in the domestic bank for a return $r > 1$ on the final date. On the intermediate

date, as for [Diamond and Dybvig \(1983\)](#), a fraction ϕ of depositors randomly receive a liquidity shock. Consequently, they withdraw their deposits at zero interest. Depositors are fully insured by the regulator. Hence, there is no bank run equilibrium.

The heterogeneity in deposits ensures that interbank cash flows do not net out in equilibrium for any given bank. Exposure spillover from debtors to creditors is 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 investment opportunities that exceed their deposit base and draw funds from banks in developed countries.

Long-term assets. Both banks have access to a productive technology with constant returns to scale that requires an investment of $I \in [0, 1]$ on 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 $\tilde{R}_1 = \{0, R_1^A\}$ per unit for BK_A and $\tilde{R}_1 = \{0, R_1^B\}$ for BK_B . The second period's return per unit of investment is deterministic and equal to $R_2 > 1$ for both banks. In addition, banks 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. Bank BK_A cannot cover the liquidity shock without investing on the interbank market: $R_1^A + \gamma \leq (1 + \gamma)\phi$, $\forall \gamma \in (0, 1]$. The assumption is relaxed in Section 6.

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.

Monitoring. There is moral hazard as for [Holmstrom and Tirole \(1997\)](#). Banks can choose whether to monitor their portfolios. The probability of success at $t = 1$ is dependent on the banks' monitoring decisions. If a bank monitors its loans, $\mathbb{P}(\tilde{R}_1 = R_1) = p_H$ 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 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 long-term assets) 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 . The interbank market size γ^I and the interest rate r^I are set in two steps:

1. Bank 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.

The bank 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's decision. Alternatively, a representative competitive BK_A is equivalent to a continuum of banks in the rich country competing for limited investment opportunities abroad.

Regulator. We model the regulator's decision according to [Acharya and Yorulmazer \(2008\)](#). A regulator can either bail out defaulting banks at $t = 1$, by providing them with additional liquidity, or liquidate them, selling their assets to outside investors.² 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 into the banking sector. For each monetary unit invested in a regulatory intervention, F units have to be raised in taxes, where $F \in (1, \frac{1}{1-L})$. A marginal fiscal cost of intervention larger than one reflects the distortionary character of taxes. The regulator's objective function is to maximize 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.

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.

Assumption 2: The proceeds from bank liquidation are not sufficient to pay domestic depositors in full:

$$\underbrace{(1 - L)R_2}_{\text{liquidation proceeds}} \leq \underbrace{\phi(1 - \gamma)}_{\text{demand deposits}} + \underbrace{(1 - \phi)(1 - \gamma)r}_{\text{full maturity deposits}}. \text{ Hence, foreign creditors lose their whole investment.}$$

The banking union is a special type of regulator that can choose whether to bail out a particular defaulting bank. 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

²The model outcomes are the same if the liquidated assets are managed by the regulator.

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, that is, 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 illustrated in Figure 2. A list of all model parameters is presented in Appendix A.

3.2 A closed economy example

To build intuition, this section 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 bail out a failing bank if the fiscal cost of providing liquidity is lower than the efficiency loss from transferring BK_A 's assets to outside investors. Liquidation threats are credible to the extent that bailouts are fiscally (and politically) costly, as also argued by Acharya and Yorulmazer (2008).

Bank 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 profit at $t = 2$ profit if and only if the regulator decides to bail it out. The expected profit of BK_A is a function of the monitoring decision (π_{BK}), given by

$$\begin{aligned}\pi_{BK}(\text{Monitor}) &= p_H (R_1 + R_2 - (\phi + (1 - \phi)r)) + (1 - p_H) (R_2 - (1 - \phi)r) \mathbb{I}_{\text{Bailout}} - C \\ \pi_{BK}(\text{Not Monitor}) &= p_L (R_1 + R_2 - (\phi + (1 - \phi)r)) + (1 - p_L) (R_2 - (1 - \phi)r) \mathbb{I}_{\text{Bailout}}.\end{aligned}\tag{1}$$

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

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

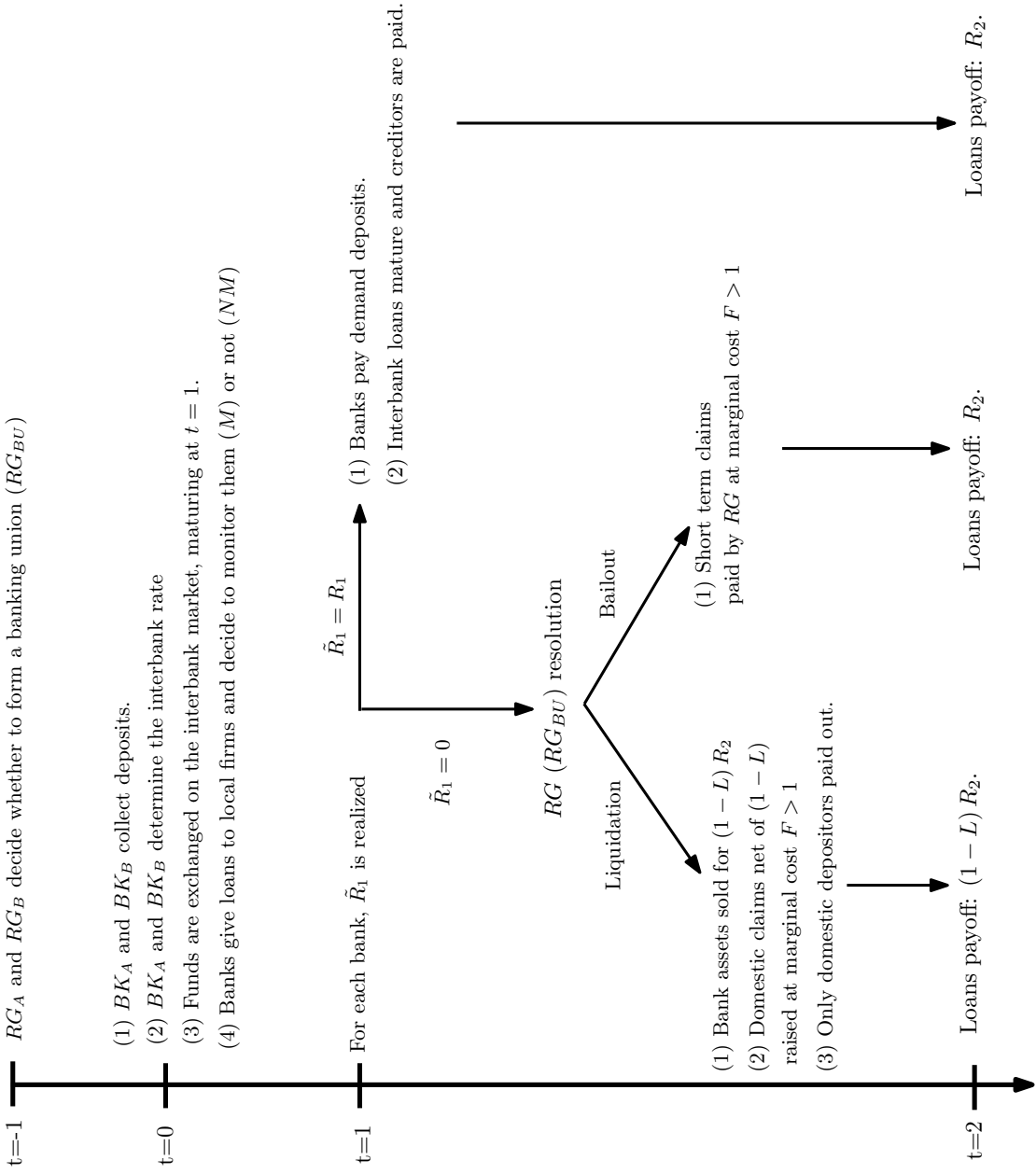


Figure 2: **Model timing**

Simplifying, this leads to

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

The incentive compatibility constraint is loosened 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 BK_A 's assets to outside investors.

Welfare includes the final wealth of the banker, depositors, and outside investors, 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

$$\begin{aligned} \text{Welfare}_{\text{Bailout}} &= R_2 - \overbrace{(F-1)\phi}^{\text{fiscal cost of deposits}} \\ \text{Welfare}_{\text{Liquidation}} &= R_2 - \overbrace{L \times R_2}^{\text{liquidation loss}} + \overbrace{R_2(1-L)(F-1)}^{\text{fiscal cost savings}} - \overbrace{(\phi + (1-\phi)r)(F-1)}^{\text{fiscal cost of deposits}}. \end{aligned} \quad (4)$$

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

$$R_2(1 - F(1 - L)) \geq (1 - F)(1 - \phi)r. \quad (5)$$

For $F \in \left(1, \frac{1}{1-L}\right)$ the left-hand side of equation (5) 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, equilibrium monitoring and resolution strategies, as well as total welfare, are determined for both 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 (EU).

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 bank default.

4.1 Cross-border spillover mechanism under national bank resolution

Conditional on BK_B 's 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 the 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 must 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 ($\text{Welfare}_{\text{Bailout}}^B$) and in the case of a liquidation ($\text{Welfare}_{\text{Liquidation}}^B$) is, respectively,

$$\begin{aligned} \text{Welfare}_{\text{Bailout}}^B &= R_2 + \phi(1 - \gamma) - \overbrace{F[\phi(1 - \gamma) + r^I \gamma]}^{\text{fiscal cost: deposits and international debt}} \\ \text{Welfare}_{\text{Liquidation}}^B &= R_2 - \overbrace{L \times R_2}^{\text{liquidation loss}} + \overbrace{R_2(1 - L)(F - 1)}^{\text{fiscal cost savings}} - \overbrace{[(\phi + (1 - \phi)r)(1 - \gamma)](F - 1)}^{\text{fiscal cost of deposits}}. \end{aligned} \tag{6}$$

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, conditionally 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, since 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 to $t = 2$ without any regulatory intervention. Otherwise, if BK_B is liquidated, then BK_A defaults too, prompting regulatory intervention. 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:

$$\begin{aligned} \text{Welfare}_{\text{Bailout}}^A &= R_2 + \phi(1 + \gamma) - \overbrace{F[\phi(1 + \gamma)]}^{\text{fiscal cost of deposits}} \\ \text{Welfare}_{\text{Liquidation}}^A &= R_2 - \overbrace{L \times R_2}^{\text{liquidation loss}} + \overbrace{R_2(1 - L)(F - 1)}^{\text{fiscal cost savings}} - \overbrace{(\phi + (1 - \phi)r)(1 + \gamma)(F - 1)}^{\text{fiscal cost of deposits}}. \end{aligned} \quad (8)$$

The bailout condition is given by

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

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 realization of R_1^i , which are similar to the one country setting in Section 3.2.

4.2 National resolution equilibrium

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

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

(i) **Resolution policy.** *Regulator RG_A always bails out local bank BK_A . Regulator RG_B bails out local bank BK_B if and only if $\gamma \leq \gamma^*$, where the threshold interbank market size is*

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

(ii) **Monitoring decisions.** *Bank BK_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*

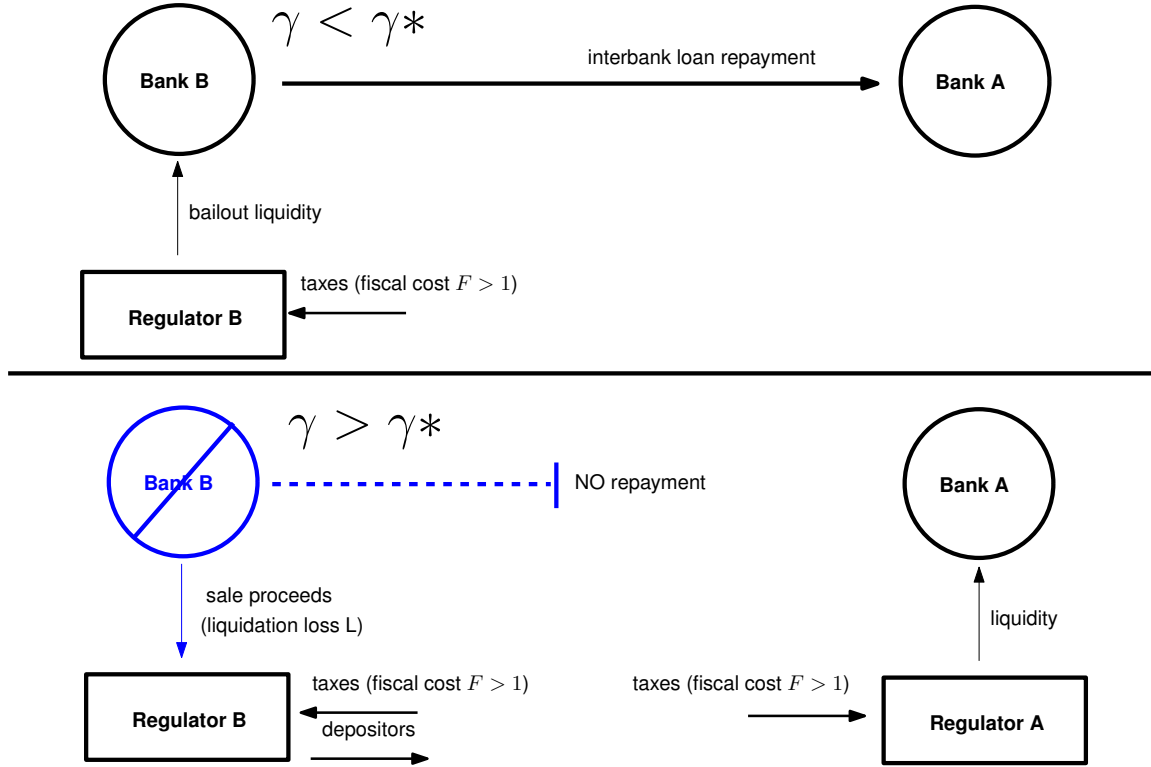


Figure 3: Spillover mechanism conditional on BK_B default

This 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.

$\frac{c}{\Delta p} \leq c_2$, where $c_2 > c_1$. The moral hazard thresholds are given by $c_1 = R_1^A + R_1^B - 2\phi$ and $c_2 = c_1 + R_2 - (1 - \phi)(1 - \gamma)r$ respectively.

(iii) **Interbank market.** The interbank market clears at a rate $r_I = \frac{\phi(1+\gamma) - R_1^A}{\gamma}$.

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

The first part of Proposition 1 states that for large enough interbank markets, BK_B will never be bailed out. In the case of 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. Since 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 is 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

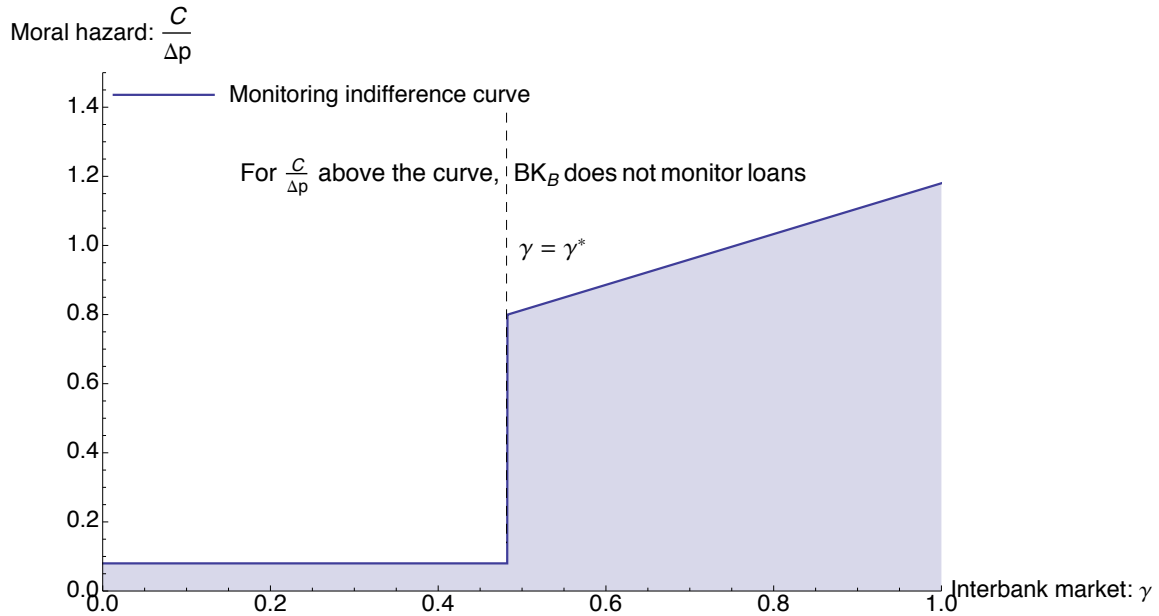


Figure 4: **Equilibrium monitoring decisions of BK_B under national regulation**

This figure shows the monitoring indifference curve of BK_B with a national resolution policy. For a given interbank market size and monitoring cost, 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.

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 BK_A 's liquidity needs. Since 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 BK_A never monitors its loans: Its profit on 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 , through both improved regulatory commitment and leverage effects. First, liquidation threats become a credible instrument for $\gamma > \gamma^*$. As bailouts become suboptimal, failure would lead to foregoing the profit not only at $t = 1$, but also at $t = 2$. Bank BK_B 's incentives to monitor jump at $\gamma = \gamma^*$ and then increase linearly with γ due to the leverage effect on profits at $t = 2$.

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:

$$\max_{\text{Bailout}_A, \text{Bailout}_B, \text{Liquidation}_A, \text{Liquidation}_B} \text{Welfare}^A + \text{Welfare}^B. \quad (11)$$

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

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

- (i) **Resolution policy.** *Regulator RG_{BU} always bails out a defaulting bank.*
- (ii) **Monitoring decisions.** *Monitoring is never optimal for BK_A . Bank 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. The monitoring strategies of BK_B and BK_A are mutually independent.*
- (iii) **Interbank market.** *The interbank market clears at a rate $r_I = \frac{\phi(1+\gamma) - R_1^A}{\gamma}$.*

As opposed to the national regulation benchmark case, the common regulator always bails out BK_B , independent of the size of the interbank market, γ . Intuitively, this happens because the supranational regulator internalizes the negative effect the liquidation of BK_B , through interbank exposure, will have on BK_A . 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 decreasing monitoring incentives for financial intermediaries.

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

4.4 Welfare effect of a full mandate banking union

The impact of a full mandate banking union 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. Second, the banking union resorts to bailouts in states of the world where national regulators would have liquidated a defaulting bank. Systemic banks can take on more risk and benefit from de facto default insurance. The first effect is welfare improving, while the

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's probability of success ($\frac{C}{\Delta p}$), and the regulatory environment, whether national or a banking union. The interbank market threshold is defined as:

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

The monitoring thresholds are defined as $c_1 = 2(R_1^B - \phi)$ 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	
			BK_A	BK_B	BK_A	BK_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, ∞)	banking union	bailout	bailout	no	no

second is welfare reducing. Consequently, the net effect of the banking union on joint welfare is non-trivial.

For small interbank markets, the following result holds:

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

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

Proposition 3 focuses on the case of $\gamma > \gamma^*$, 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, the following holds.*

- (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:*

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

If moral hazard is low, that is, $\frac{C}{\Delta p} \leq c_1$, BK_B monitors both under the banking union and under the national regulator. The introduction of the banking union does not decrease the monitoring incentives of BK_B . The banking union only eliminates the exposure spillover, that is, 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, that is, $\frac{C}{\Delta p} \geq c_2$, BK_B never monitors either under the banking union or under national supervision. The incentives of BK_A are not affected by the introduction of the union and the only effect

is the elimination of the liquidity spillover; the banking union is again strictly welfare improving. Since the probability of 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, since 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 of avoiding inefficient liquidation and the cost of repaying insured deposits from taxpayer money:

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

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 on the intermediate date with a lower probability:

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

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

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

For a large enough Δp , the negative market discipline effect outweighs the benefits of eliminating international contagion and thus the banking union becomes suboptimal. 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 welfare surplus

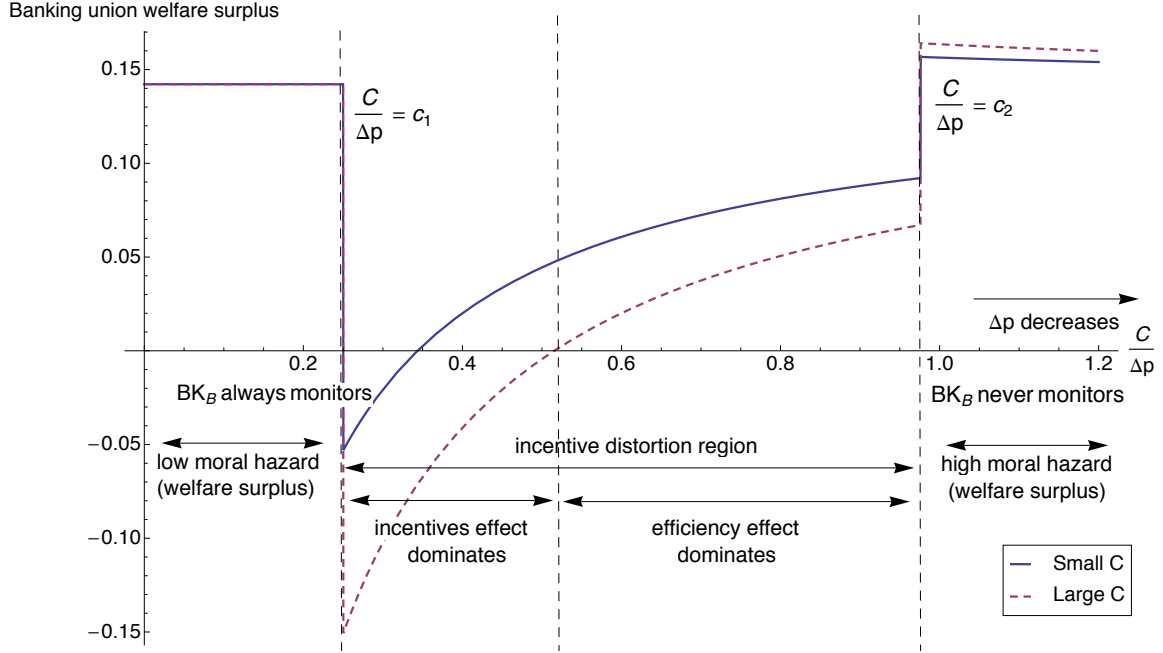


Figure 5: **Banking union welfare surplus and moral hazard**

This figure shows the welfare surplus from the banking union relative to national regulation systems as a function of moral hazard $\frac{C}{\Delta p}$. 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.

as a function of moral hazard ($\frac{C}{\Delta p}$).

The maximum welfare surplus the banking union can generate corresponds with the case when it does not shift incentives: $(1 - p_H) \times \text{Spillover Effect}$. The full mandate banking union is welfare improving for $\Delta p \leq \frac{(1-p_H)\text{Spillover Effect}}{\text{Incentive Effect}}$. 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, that is, the set of states for which the banking union, as opposed to national regulators, intervenes after a bank default. Second, 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 suboptimal. 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 achieved by a joint regulator that can commit to ex post inefficient liquidation. 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, which finds liquidation optimal. This institutional framework generates a different outcome from the full mandate banking union of 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 case³ 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.

For low and high levels of moral hazard, there is no incentive distortion effect and thus no need to implement a spillover-generating liquidation: 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, the cross-border spillover is 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 :

³The first best corresponds to an economy without the moral hazard friction, where effort is observable and contractible.

$$\begin{aligned} \max_{\alpha} \Delta \text{Welfare}(\alpha) &= \alpha(1 - p_H) \times \text{Spillover Effect}, \\ \text{subject to: } \frac{C}{\Delta p} &= c_1 + (1 - \alpha)(c_2 - c_1). \end{aligned} \quad (16)$$

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

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

The equilibrium probability of a bailout decreases with the intensity of the moral hazard problem (α^* drops as $\frac{C}{\Delta p}$ increases). For lower 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 to thus achieve the second best.

The next subsection studies an alternative institutional design that can partially alleviate moral hazard, that is, 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 upon 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 when either BK_A alone or both banks default on domestic investments: $(0, R_1^B)$ or $(0, 0)$, respectively.
2. **Contagion mandate.** The banking union intervenes when either BK_A alone or BK_B alone defaults on domestic investments: $(0, R_1^B)$ or $(R_1^A, 0)$, respectively.

Proposition 4 states the conditions under which a limited mandate banking union improves upon 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 relative to the full mandate banking union 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:*

$$\frac{c}{\Delta p} < c_1 + \max \{p_L, 1 - p_L\} (c_2 - c_1).$$

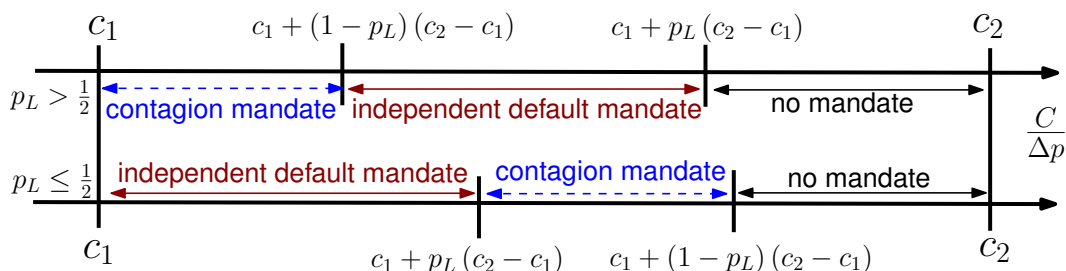
The optimal limited mandate depends on the value of p_L . Keeping p_H fixed, a large p_L translates into a small impact of monitoring on the probability of success, that is, the case of less complex banking products, easy to understand and to monitor. Alternatively, with Δp kept fixed, a larger p_L can be interpreted as a good economic environment, where investments have a high probability of success. 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 limited and full mandate banking unions improve welfare but the surplus from the restricted joint regulator is larger, the optimal limited mandate depends only 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 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 greater and a higher liquidation probability is needed to restore incentives. In this case, welfare surplus is further reduced by additionally limiting bailouts.

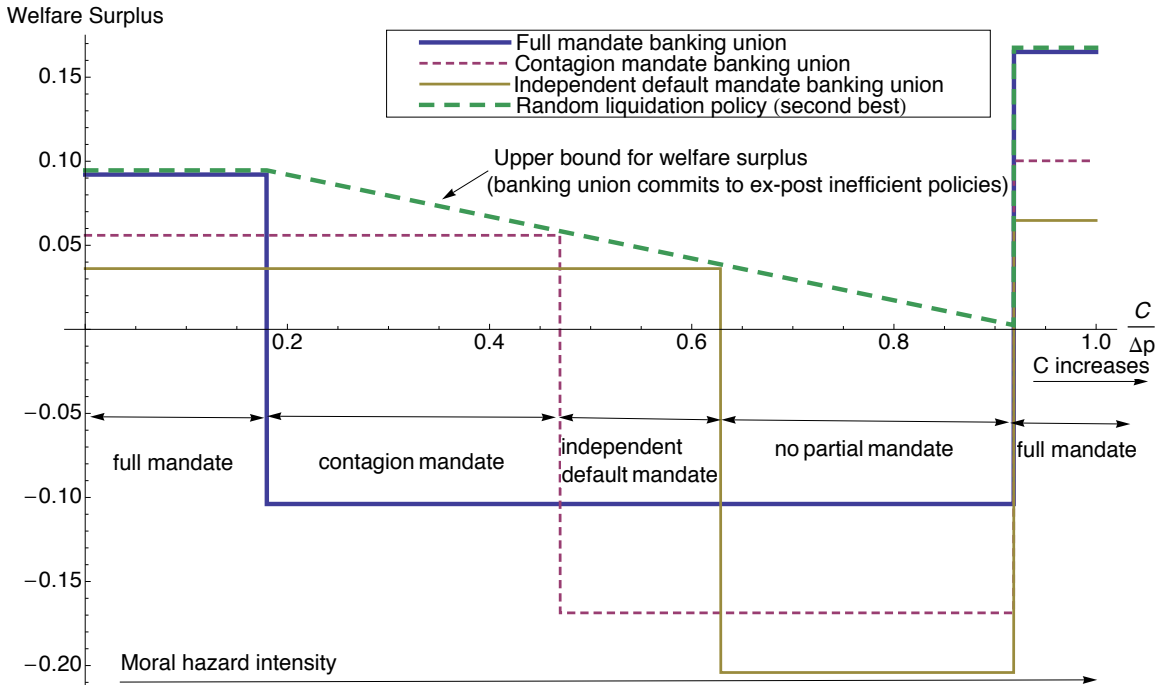
Corollary 1. (Limited mandate choice for $\Delta p \geq \overline{\Delta p}$) For relatively low moral hazard levels, $\frac{C}{\Delta p} \in (c_1, c_1 + \min\{p_L, 1 - p_L\}(c_2 - c_1))$, the limited mandate with the highest welfare surplus is selected, that is, the independent default mandate for $p_L < \frac{1}{2}$ 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.

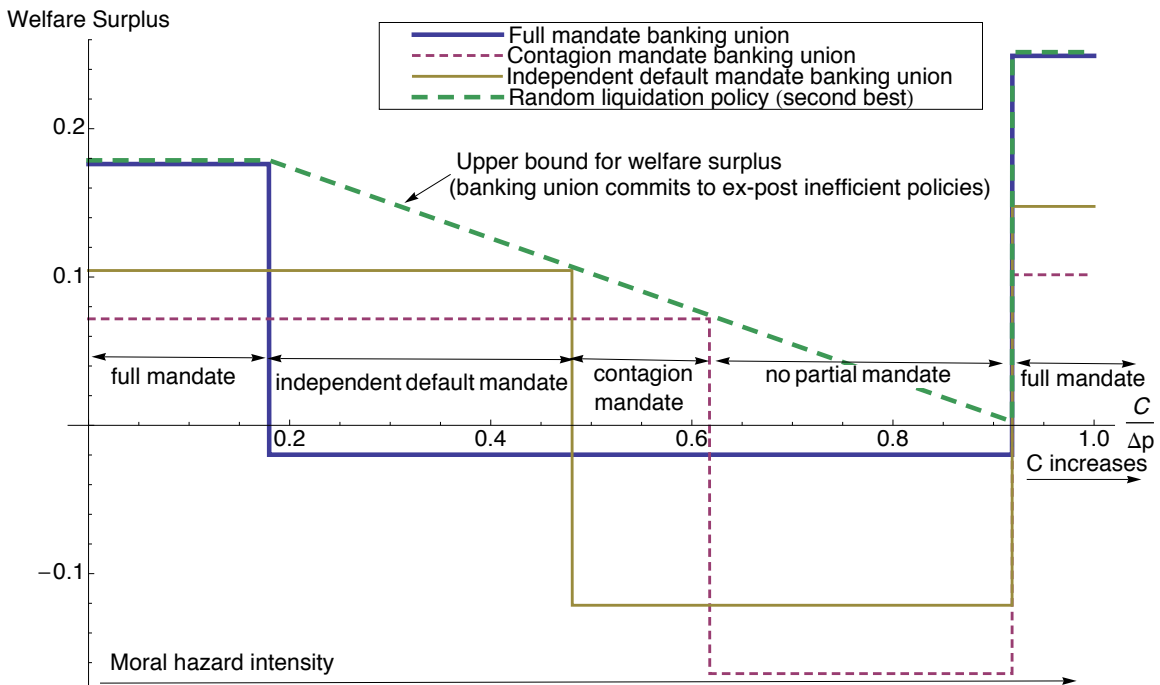


When the monitoring strategy has a large impact on the return distribution, that is, for more complex assets of BK_A 's, the banking union optimally intervenes after BK_B 's default only when creditor BK_A also defaults on its domestic portfolio. In this case, the systemic crisis is not mainly driven by the contagion effect. Otherwise, for a low impact of monitoring on the probability of success, 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.



(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.**

This 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 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).

5.1.3 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 a bargaining friction. 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. The international exposure of banks is difficult to measure, especially if complex instruments are involved. 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's (1960) theorem. A corollary of the analysis in this section 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 for 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 behavior amplified by a more lenient ex post resolution policy. There are several caveats to stronger supervision. First, Colliard (2013) argues agency frictions exist 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 upon the ex post outcome, thus reducing the need for particularly tough ex ante measures and further distortions.

5.2 Resolution fund contributions

In this section, 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 ℓ , country A will pay $\beta F \times \ell$ and country B will pay $(1 - \beta) F \times \ell$, where $F > 1$ is the marginal fiscal cost of providing funds.

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

$$\begin{aligned}\mathbb{E} \left[\text{Welfare}_{BU}^A - \text{Welfare}_{National}^A \right] &\geq 0 \\ \mathbb{E} \left[\text{Welfare}_{BU}^B - \text{Welfare}_{National}^B \right] &\geq 0.\end{aligned}\tag{18}$$

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 omitted, since the banking union is never optimal.

The banking union improves joint welfare when $\gamma > \gamma^*$ and $\Delta p < \overline{\Delta p}$. 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 decreases 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, as follows.*

- (i) **Low moral hazard.** *If $\frac{c}{\Delta p} \leq c_1$, then there exists $1 \geq \bar{\beta}_M > \underline{\beta}_M \geq \frac{1}{2}$, such that for any $\beta \in (\underline{\beta}_M, \bar{\beta}_M)$ the full mandate banking union is feasible.*
- (ii) **High moral hazard.** *If $\frac{c}{\Delta p} \geq c_2$, then there exist $\underline{\beta}_N$ and $\bar{\beta}_N$ such that $\bar{\beta}_M > \bar{\beta}_N > \underline{\beta}_N > \frac{1}{2}$ and for any $\beta \in (\underline{\beta}_N, \bar{\beta}_N)$ 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 $\underline{\beta}_D < \bar{\beta}_D$ such that $(\underline{\beta}_D, \bar{\beta}_D) \subset (\underline{\beta}_N, \bar{\beta}_N)$ and for any $\beta \in (\underline{\beta}_D, \bar{\beta}_D)$ the full mandate banking union is feasible.*

The maximum resolution fund share the creditor country is willing to pay satisfies equation 19:

$$\bar{\beta}_M \geq \bar{\beta}_N \geq \bar{\beta}_D.\tag{19}$$

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

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

The result that $\bar{\beta}_C = 1$ 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. The following lemma identifies the unique linear contract between the two countries in this case.

Lemma 4. (Banking union with zero welfare effect) *When $\gamma < \gamma^*$, β is unique and given by the following:*

(i) *If BK_B monitors its loans, $\beta = \beta_M^{ZS}$, where $\beta_M^{ZS} = \frac{(1-p_L)R_1^A}{2(1-p_H)\phi + \Delta p R_1^A} < \bar{\beta}_M$.*

(ii) *If BK_B does not monitor its loans, $\beta = \beta_N^{ZS}$, where $\beta_N^{ZS} = \frac{R_1^A}{2\phi} \in (0, \frac{1}{2})$.*

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

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, since the spillover frequency is lower. When moral hazard is high, the decision of RG_A to give up its resolution mechanism does not influence the probability of spillover.

Incentive shifting reduces the space of potential resolution fund contracts. Since $\bar{\beta}_D - \underline{\beta}_D < \bar{\beta}_N - \underline{\beta}_N$, 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. In compensation, 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

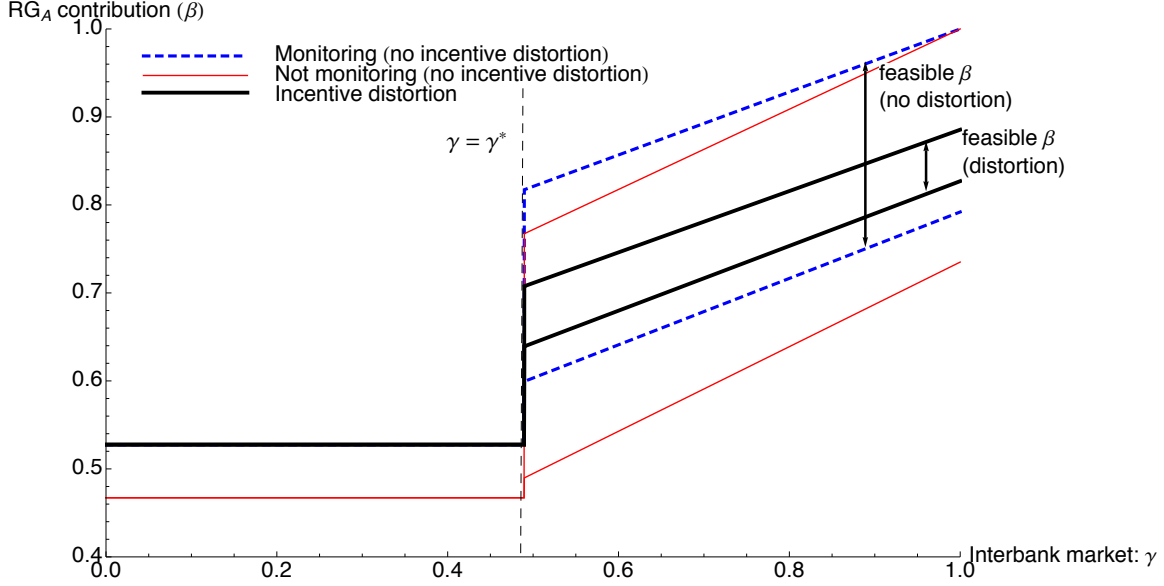


Figure 7: **Feasible cost sharing rules for the full mandate banking union**

This figure shows the feasible linear sharing rules of the fiscal cost of the form $\{\text{Country A:}\beta, \text{Country B:}1 - \beta\}$. For a small interbank market, the banking union does not improve welfare and there is a unique way to split the costs between countries. For situations in which there is a positive welfare surplus from the banking union (large γ), the country that benefits from resolving the externality also internalizes the largest part of the fiscal cost.

country A. Since $\beta_{-D} > \beta_{-N} > \beta_N^{ZS}$, the result is unaffected by incentive distortion effects. At the same time, RG_B also demands a lower share of the union costs, since its contributions 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 interbank market size and interest rate. The baseline model in Section 3 studies the case in which BK_A needs to lend on the interbank market to repay early depositors. The assumption guarantees an interbank transfer of γ and also fixes the interest rate at $r^I = \frac{\phi(1+\gamma) - R_1^A}{\gamma}$. 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 fulfill all claims at $t = 1$ without lending on the interbank market:

$$R_1^A + \gamma - \phi(1 + \gamma) > 0. \quad (20)$$

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^l at which it is willing to borrow funds. Given r^l , BK_A chooses the size of the loan γ^l 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 $r^l \geq 1$, the incentives to monitor weakly increase with γ^l for both BK_A and BK_B . Therefore, the probability of success at $t = 1$ increases with γ^l for both banks.*

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

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

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 $r^l > 1$. For BK_A , investing in the interbank market and investing in liquid assets are equivalent. It follows that BK_A accepts an interbank market rate as low as the return on liquidity ($r^l = 1$). 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 . Consequently, the expected profit for BK_A increases.

Lemma 7. *For $R_2 < \frac{F}{1-F(1-L)}$, an interbank market threshold $\underline{\gamma}_{National}^l < \gamma$ exists such that the national regulator RG_B liquidates BK_B for $\gamma^l > \underline{\gamma}_{National}^l$. 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. Otherwise, for $R_2 < \underline{R}_2 < \frac{F}{1-F(1-L)}$, an interbank market threshold $\underline{\gamma}_{Union}^l < \gamma$ exists such that the banking union liquidates BK_B for $\gamma^l > \underline{\gamma}_{Union}^l$. In addition, $\underline{\gamma}_{Union}^l > \underline{\gamma}_{National}^l$.*

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: 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 $R_2 \in (\underline{R}_2, \frac{F}{1-F(1-L)})$, 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 $\underline{\gamma}_{\text{Union}}^I$. 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 asset returns at $t = 1$ and $t = 2$.

Proposition 6. (Interbank market effect) *The equilibrium interbank market size and interest rate depend on the long term return R_2 and the short term return for BK_B , R_1^B . The possible equilibria are graphed in Figure 8, where $\underline{R}_1^B(R_2) < \overline{R}_1^B(R_2)$ are continuous functions of R_2 .*

For large returns and liquidation costs, that is, $R_2 > \frac{F}{1-F(1-L)}$, 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 implications on the effects of a banking union.

Banking union decreases incentives (A+B+C). The banking union decreases BK_B monitoring incentives for $R_1^B > \underline{R}_1^B(R_2)$, corresponding to the regions (A) to (C) in Figure 8.

Under national regulation, BK_B borrows the maximum available amount on the interbank market and pays a positive interest rate $r_{\text{National}}^I > 1$. 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. Creditor BK_A is compensated for the default risk through a positive net interest rate.

A banking union decreases monitoring incentives in three ways: through more bailouts, through higher interest rates, and 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 $\underline{\gamma}_{\text{Union}}^I < \gamma$. If it borrows γ , BK_B earns an additional return on the marginal investment $\gamma - \underline{\gamma}_{\text{Union}}^I$. On the other hand, it faces non-zero liquidation risk and has positive interest costs, since $r_{\text{Union}}^I > 1$. If BK_B borrows the lower amount $\underline{\gamma}_{\text{Union}}^I$, then it forgoes the additional return but is always bailed out and has zero interest costs.

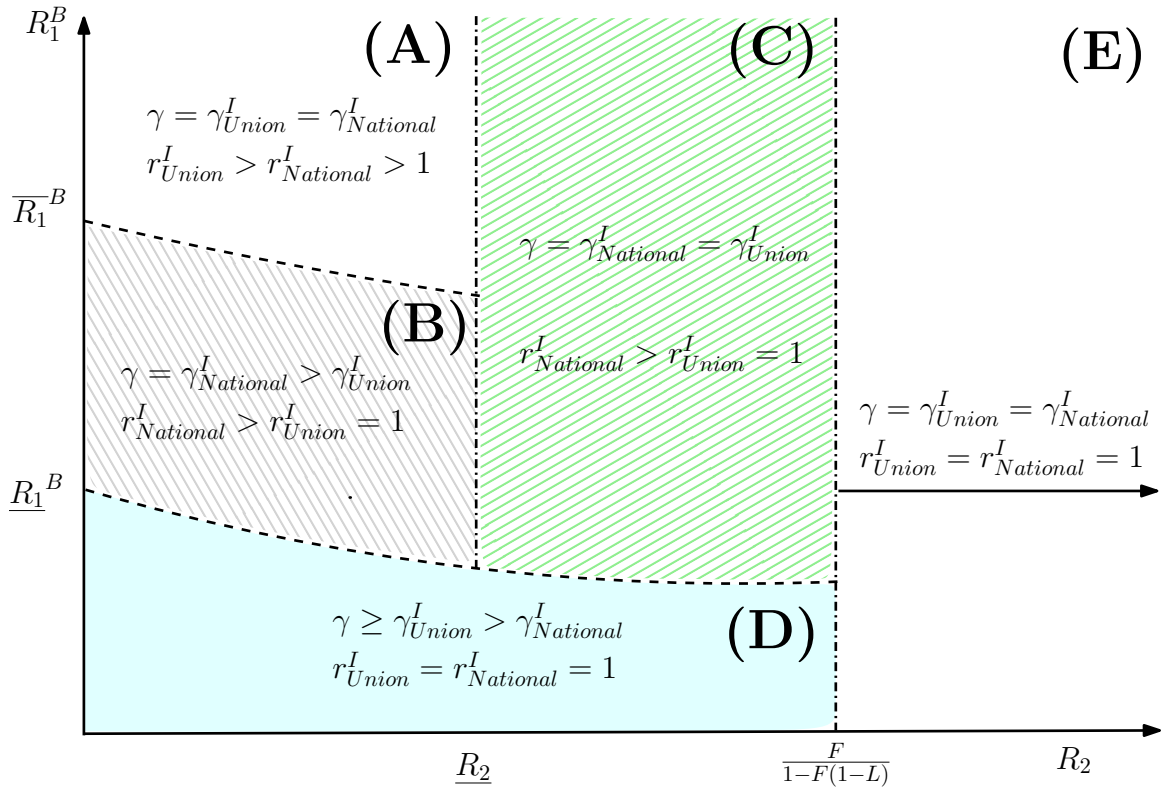


Figure 8: **Banking union impact on the interbank market**

This 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 banking union settings. Five regions are identified as a function of investment returns at $t = 1$, R_1^B and at $t = 2$, R_2 . The implicit functions $\underline{R}_1^B(R_2)$ and $\bar{R}_1^B(R_2)$ are convex for $p - (1 - \gamma + \gamma^*) > 0$ and concave otherwise. This figure only graphs the convex case.

In region (A), for high R_1^B , the additional investment return effect dominates. Bank 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 higher under a banking union than under the national resolution mechanism: $r_{\text{Union}}^I > r_{\text{National}}^I > 1$. Intuitively, a banking union bails out BK_B for higher foreign loan values than a national regulator does. It follows that the implicit insurance provided by a bailout is more valuable under a joint resolution mechanism, thus BK_A requires greater 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 . Bank BK_B borrows $\gamma_{\text{Union}}^I < \gamma$, 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 decrease since a banking union is more lenient.

Banking union improves incentives (D). If R_1^B is low enough, that is, $R_1^B < \underline{R}_1^B(R_2)$, 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 as well.

Summary In sum, a banking union intensifies moral hazard for systemically important banks in all cases in which 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, ceteris paribus, stimulates monitoring and increases the trade surplus, improving welfare.

7 Concluding remarks

This paper contributes to the recent European debate around the 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 toward 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 incentives for more interbank trading, increasing welfare.

Empirical implications. The model allows for a number of empirical predictions. Following the implementation of a single-resolution mechanism, banks with large European cross-border liabilities take on more risk. The effect is stronger for banks with larger European cross-border liabilities and moderate ex ante risk taking incentives. Such behavior could manifest, for example, as a shift in bank portfolios toward high-risk and high-return loans, or toward riskier asset classes (Rajan, 2006). Laeven and Levine (2009) propose several measures for bank risk taking behaviour: the distance to insolvency, the volatility of equity prices, and the volatility of earnings. In addition, the model implies systemically important banks are bailed out more often by a common regulator. The implication can be tested using deep out-of-the money put options to identify the behaviour of the systemic insurance premium (Kelly, Lustig, and Nieuwerburgh, 2011).

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, since they are the main beneficia-

ries from the elimination of contagion effects. However, when the banking union worsens market discipline, all countries seek to contribute lower shares to the joint intervention fund, since the welfare surplus of a single-resolution mechanism is reduced.

References

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

- 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.
- Holmstrom, Bengt, and Jean Tirole, 1997, Financial intermediation, loanable funds, and the real sector, *Quarterly Journal of Economics* 112, 663–691.
- International Monetary Fund, 2013, A banking union for the euro area, *Staff Discussion Notes No. 13/1*.
- Kara, Gazi I., 2012, International competition and coordination for the regulation of systemic risk, Manuscript.
- Kelly, Bryan T., Hanno Lustig, and Stijn Van Nieuwerburgh, 2011, Too-systemic-to-fail: What option markets imply about sector-wide government guarantees, *National Bureau of Economic Research Working Paper Series* No. 17149.
- Laeven, Luc, and Ross Levine, 2009, Bank governance, regulation and risk taking, *Journal of Financial Economics* 93, 259–275.
- 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.
- Rajan, Raghuram G., 2006, Has finance made the world riskier?, *European Financial Management* 12, 499–533.
- Rochet, Jean-Charles, and Jean Tirole, 1996, Interbank lending and systemic risk, *Journal of Money, Credit and Banking* 28, 733–762.
- Schoenmaker, Dirk, and Daniel Gros, 2012, A European deposit insurance and resolution fund – an update, *CEP* No. 283.
- Schoenmaker, Dirk, and Arjen Siegmans, 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.

Appendices

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.
\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 or 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 the global financial crisis. Initially, the response of European authorities to the destabilizing situation in the financial system was carried out within two funding programs: the European Financial Stability Facility and the European Financial Stabilization Mechanism, established on May 10, 2010. The two programs had the authority to raise up to EUR 500 billion, guaranteed by the European Commission and the EU member states. The mandate of the European Financial Stability Facility and the European Financial Stabilization Mechanism was to “safeguard financial stability in Europe by providing financial assistance” to Eurozone member countries.

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 program negotiated with the European Commission and the IMF.

In September 2012, the two programs were replaced by the European Stability Mechanism. The European Stability Mechanism support, again conditional on acceptance of a structural reform 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 (SSM) of national financial systems within the ECB. On September 12, 2012, in response to the Eurozone summit debate, the European Commission proposed that the ECB become 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 took shape. Two main pillars were proposed: the SSM (on March, 19) and the Single Resolution Mechanism (on June, 27).

SSM According to the proposals as of January 2014, participation in the SSM will be mandatory for all Eurozone countries, and optional only 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 that 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 intense cross-border activities.
5. The institution receives support from the EU bailout programs.

All other banks will remain under the 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 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 representatives from the ECB and the European Commission, and relevant national authorities. In case of 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: the sale of business, setting up a bridge institution with the purpose of asset sales in the future, separation of assets with the use of asset management vehicles, and bail-ins, in which 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 financed with contributions from financial institutions under the SSM. Use of the Single Bank Resolution Fund will be restricted to 5% of the total liabilities of the distressed institution and will be made conditional on the bail-in of at least 8% of total liabilities.

C Proofs

Proposition 1

Proof. **Resolution policy.** From (6), welfare following bailout is greater than welfare following liquidation for RG_B if:

$$\gamma \leq \frac{R_2(1 - F(1 - L)) + (F - 1)(1 - \phi)r}{Fr^I + (F - 1)(1 - \phi)r}. \quad (\text{C.1})$$

If BK_B has full bargaining power, $r^I = \frac{(1+\gamma)\phi - R_1^A}{\gamma}$. The bailout condition for RG_B is:

$$\gamma = \gamma^* \leq \frac{R_2(1 - F(1 - L)) + (F - 1)(1 - \phi)r + F(R_1^A - \phi)}{F\phi + (F - 1)(1 - \phi)r}. \quad (\text{C.2})$$

The equivalent bailout condition for RG_A is:

$$R_2(1 - F(1 - L)) \geq (1 - F)(1 + \gamma)(1 - \phi)r. \quad (\text{C.3})$$

Since $F < \frac{1}{1-L}$, the left-hand side of the equation is positive, whereas the right-hand side is negative. Therefore, regulator RG_A always bails out BK_A .

Monitoring decisions. If $\gamma \leq \gamma^*$, BK_B is always bailed out. The expected profit for BK_B , conditional on its monitoring decision, is:

$$\begin{aligned} \pi_B(\text{Monitor}) &= R_2 - (1 - \gamma)(1 - \phi)r + p_H(R_1^B + (1 - \gamma)\phi - r^I\gamma) + (1 - p_H) - C, \\ \pi_B(\text{Not Monitor}) &= R_2 - (1 - \gamma)(1 - \phi)r + p_L(R_1^B - (1 - \gamma)\phi - r^I\gamma). \end{aligned}$$

Bank BK_B only monitors its portfolio if:

$$\frac{C}{\Delta p} \leq R_1^B - (1 - \gamma)\phi - r^I\gamma = c_1^B. \quad (\text{C.4})$$

For $\gamma > \gamma^*$,

$$\begin{aligned} \pi_B(\text{Monitor}) &= p_H(R_1^B + R_2 - (1 - \gamma)\phi - (1 - \gamma)(1 - \phi)r - r^I\gamma), \\ \pi_B(\text{Not Monitor}) &= p_L(R_1^B + R_2 - (1 - \gamma)\phi - (1 - \gamma)(1 - \phi)r - r^I\gamma) - C. \end{aligned}$$

Bank BK_B monitors if:

$$\frac{C}{\Delta p} \leq R_1^B + R_2 - (1 - \gamma)\phi - (1 - \gamma)(1 - \phi)r - r^I\gamma = c_2^B < c_1^B. \quad (\text{C.5})$$

Bank BK_A does not monitor its loans: it is always bailed out and earns zero profit at $t = 0$ (since it has no bargaining power on the interbank market).

Interbank market. Bank BK_A always receives R_2 at $t = 2$. It is not able to pay demand depositors at $t = 1$ without the interbank market. The lowest interest rate it can accept corresponds to zero profits at $t = 1$:

$$\text{InterbankPayoff}_A = p(R_1^A - \phi(1 + \gamma) + \gamma r^I) \geq 0 \implies r^I \geq \frac{\phi(1 + \gamma) - R_1^A}{\gamma}. \quad (\text{C.6})$$

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

Bank BK_B gains from borrowing on the interbank market since it can leverage up its return but incurs a loss if it is no longer bailed out given default. The net payoff is

$$\text{InterbankPayoff}_B = \underbrace{p_H[(R_1^B + R_2)\gamma - r^I\gamma]}_{\text{leverage gains}} - \underbrace{(1 - p_H)(1 - \gamma)(R_2 - (1 - \phi)r)}_{\text{losses from extra liquidation}}. \quad (\text{C.7})$$

Bank BK_B is willing to pay a maximum rate of $\bar{r}_I = (R_1^B + R_2) - \frac{(1 - \gamma)(1 - p_H)}{\gamma p_H}(R_2 - (1 - \phi)r)$ If $\gamma + p_H \geq 1$, then $\bar{r}_I > \underline{r}_I$. \square

Proposition 2

Proof. Resolution policy. First, consider the case when BK_A receives zero and BK_B 's payoff is R_1^B at $t = 1$. The banking union's welfare after the bailout of BK_A is

$$\left[\text{Welfare}^A + \text{Welfare}^B \right]_{\text{Bailout}} = 2R_2 + R_1^B + (1 - F)R_1^A. \quad (\text{C.8})$$

The banking union welfare after liquidation of BK_A is

$$\left[\text{Welfare}^A + \text{Welfare}^B \right]_{\text{Liquidation}} = R_2 + R_1^B + R_1^A + (1 + \gamma)(1 - \phi)r(1 - F) - F(R_1^A - R_2(1 - L)). \quad (\text{C.9})$$

The bailout takes place if

$$R_2(1 - F(1 - L)) \geq (1 - F)(1 + \gamma)(1 - \phi)r, \quad (\text{C.10})$$

which is true since $F < \frac{1}{1-L}$.

Consider now the case when BK_A receives R_1^A and BK_B receives zero at $t = 1$. If BK_B is bailed out,

$$\left[\text{Welfare}^A + \text{Welfare}^B \right]_{\text{BailoutB}} = 2R_2 + 2\phi - F(2\phi - R_1^A). \quad (\text{C.11})$$

If BK_B is liquidated, BK_A always bails out BK_A if $F < \frac{1}{1-L}$. Welfare is

$$\left[\text{Welfare}^A + \text{Welfare}^B \right]_{\text{BailoutA}} = F \times R_1^A + R_2 + (2\phi + (1 - \gamma)(1 - \phi)r)(1 - F) + F((1 - L)R_2). \quad (\text{C.12})$$

For $1 < F < \frac{1}{1-L}$, the supranational regulator always bails out BK_B . The same outcome occurs when both BK_A and BK_B receive zero at $t = 1$.

Monitoring decisions. The monitoring condition for BK_A is the same as under national regulation and BK_B never monitors. Bank BK_B 's is always bailed out and it monitors if:

$$\frac{C}{\Delta p} \leq R_1^B - (1 - \gamma)\phi - r^J\gamma = c_1. \quad (\text{C.13})$$

Interbank market. The interbank market result is identical to that in the previous proof. \square

Lemma 1

Proof. The proof is shown through immediate mathematical calculation. \square

Proposition 3

Proof. If $\gamma > \gamma^*$ and $\frac{C}{\Delta p} \leq c_1$, the total welfare impact of a banking union is

$$(1 - p_H)[R_2(1 - F(1 - L)) + (F - 1)(1 - \gamma)(1 - \phi)r] \geq 0. \quad (\text{C.14})$$

The banking union is welfare-improving. It eliminates contagion and does not distort incentives for BK_B (BK_B always monitors).

If $\gamma > \gamma^*$ and $\frac{C}{\Delta p} > c_2$, the total welfare impact of a banking union is

$$(1 - p_L) [R_2 (1 - F (1 - L)) + (F - 1) (1 - \gamma) (1 - \phi) r] \geq 0. \quad (\text{C.15})$$

The banking union is again welfare improving. It eliminates contagion and does not distort incentives for BK_B (BK_B never monitors).

If $\gamma > \gamma^*$ and $c_1 < \frac{C}{\Delta p} \leq c_2$, BK_B only monitors under the national resolution mechanism. The welfare surplus under the banking union decreases, since the probability of default is larger for BK_B . The banking union is only welfare improving if

$$\Delta p \leq \Delta p^* = \frac{(1 - p_H) (R_2 (1 - F (1 - L)) + (1 - \gamma) (1 - \phi) (F - 1) r)}{F (2\phi - R_1^A) + (R_1^A + R_1^A - 2\phi)}. \quad (\text{C.16})$$

□

Lemma 2

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

Proposition 4

Proof. Consider the case where the full mandate banking union improves welfare. The full mandate welfare impact is

$$\text{Welfare}_{\text{FullMandate}}^{A+B} = (1 - p_H) \text{Spillover Effect} - \Delta p \times \text{Incentive Effect}. \quad (\text{C.17})$$

The *independent default mandate* banking union welfare impact is

$$\text{Welfare}_{\text{IndDef}}^{A+B} = (1 - p_H) (1 - p_L) \text{Spillover Effect}. \quad (\text{C.18})$$

The *independent default mandate* is optimal if

$$\Delta p > p_L \frac{(1 - p_H) \text{Spillover Effect}}{\text{Incentive Effect}} = p_L \overline{\Delta p}. \quad (\text{C.19})$$

The *contagion mandate* banking union welfare impact is

$$\text{Welfare}_{\text{Contagion}}^{A+B} = (1 - p_H) p_L \text{Spillover Effect}. \quad (\text{C.20})$$

The *contagion mandate* is optimal if

$$\Delta p > (1 - p_L) \frac{(1 - p_H) \text{Spillover Effect}}{\text{Incentive Effect}} = (1 - p_L) \overline{\Delta p}. \quad (\text{C.21})$$

For $\Delta p < \min\{p_L, 1 - p_L\} \overline{\Delta p}$, at least one limited mandate improves welfare relative to a full mandate banking union.

Consider the case in which the full mandate banking union reduces welfare. Under the *independent default mandate*, BK_B monitors if

$$\frac{C}{\Delta p} \leq \underbrace{R_1^A + R_1^B - 2\phi}_{=c_1} + p_L(R_2 - (1 - \gamma)(1 - \phi)r) = c_1 + p_L(c_2 - c_1) = c_2^s. \quad (\text{C.22})$$

For $\frac{C}{\Delta p} \in (c_1, c_2^s]$ BK_B monitors its loans. The independent mandate is optimal in this case, since:

$$\text{Welfare}_{\text{IndDef}}^{A+B} - \text{Welfare}_{\text{National}}^{A+B} = (1 - p_H)(1 - p_L)\text{Spillover Effect} > 0. \quad (\text{C.23})$$

Under the *contagion mandate*, BK_B monitors if

$$\frac{C}{\Delta p} \leq \underbrace{R_1^A + R_1^B - 2\phi}_{=c_1} + (1 - p_L)(R_2 - (1 - \gamma)(1 - \phi)r) = c_1 + (1 - p_L)(c_2 - c_1) = c_2^c. \quad (\text{C.24})$$

The banking union is welfare improving relative to national regulation whenever BK_B monitors the loans, for $\frac{C}{\Delta p} \in (c_1, c_2^c]$:

$$\text{Welfare}_{\text{Contagion}}^{A+B} - \text{Welfare}_{\text{National}}^{A+B} = (1 - p_H)p_L\text{Spillover Effect} > 0. \quad (\text{C.25})$$

□

Corollary 1

Proof. If $p_L < \frac{1}{2}$, then $c_2^c > c_2^s$. If $\frac{C}{\Delta p} \in (c_1, c_2^s]$, BK_B monitors under both limited mandates, but the welfare surplus is greater under the independent default mandate. For $\frac{C}{\Delta p} \in (c_1^s, c_2^c]$, BK_B monitors under the banking union with contagion mandate only. For $\frac{C}{\Delta p} \in (c_2^c, c_2)$, none of the partial mandate banking unions induces monitoring. Thus national regulation is optimal.

If $p_L > \frac{1}{2}$, then $c_2^c < c_2^s$. If $\frac{C}{\Delta p} \in (c_1, c_2^c]$, BK_B monitors under the two alternative banking unions considered but the banking union with a contagion mandate is preferred, since there are fewer liquidations. If $\frac{C}{\Delta p} \in (c_1^c, c_2^s]$ BK_B monitors under the banking union with an independent default mandate. If $\frac{C}{\Delta p} \in (c_2^s, c_2)$, national regulation is optimal.

If $p_L = \frac{1}{2}$, then $c_2^c = c_2^s$. Any limited mandate banking union is optimal if $\frac{C}{\Delta p} \in (c_1, c_2^s]$. □

Proposition 5

Proof. Consider first the case if $\gamma > \gamma^*$ and $\frac{C}{\Delta p} \leq c_1$ or $\frac{C}{\Delta p} > c_2$. Since there are no incentive distortions, the state world probabilities are unaffected by a banking union. The welfare surplus for RG_A is

$$\mathbb{P}(0, R_1^B)(1 - \beta)FR_1^A + \mathbb{P}(R_1^A, 0)(1 - \beta)F(2\phi - R_1^A) + \mathbb{P}(0, 0)(F\phi(1 + \gamma) - 2F\beta\phi) \geq 0, \quad (\text{C.26})$$

which is equivalent to

$$\beta \leq \frac{\mathbb{P}(0, R_1^B)FR_1^A + \mathbb{P}(R_1^A, 0)F(2\phi - R_1^A) + \mathbb{P}(0, 0)(F\phi(1 + \gamma))}{\mathbb{P}(0, R_1^B)FR_1^A + \mathbb{P}(R_1^A, 0)F(2\phi - R_1^A) + 2\mathbb{P}(0, 0)F\phi} \in (0, 1). \quad (\text{C.27})$$

Similarly, the condition for RG_B yields an upper bound for β :

$$\beta \geq \frac{\mathbb{P}(0, R_1^B) F R_1^A + \mathbb{P}(R_1^A, 0) F (2\phi - R_1^A) + \mathbb{P}(0, 0) (F\phi(1 + \gamma)) - \mathbb{E}\Delta\text{Welfare}_{BU}}{\mathbb{P}(0, R_1^B) F R_1^A + \mathbb{P}(R_1^A, 0) F (2\phi - R_1^A) + 2\mathbb{P}(0, 0) F \phi}. \quad (\text{C.28})$$

If $\frac{c}{\Delta p} \leq c_1$, then the bounds are

$$\beta \leq \frac{(1 - p_H)(1 - \Delta p + p_H(1 - \gamma) + \gamma(1 + \Delta p))\phi + \Delta p R_1^A}{2(1 - p_H)\phi + \Delta p R_1^A} = \bar{\beta}_M < 1, \quad (\text{C.29})$$

$$\beta \geq \bar{\beta}_M - \frac{\mathbb{E}\Delta\text{Welfare}_{BU}^M}{2F(1 - p_H)\phi + F\Delta p R_1^A} = \underline{\beta}_M. \quad (\text{C.30})$$

If $\frac{c}{\Delta p} \geq c_1$, then the bounds are:

$$\beta \leq \frac{1 + p_H(1 - \gamma) + \gamma(1 + \Delta p) - \Delta p}{2} = \bar{\beta}_N, \quad (\text{C.31})$$

$$\beta \geq \bar{\beta}_N - \frac{\mathbb{E}\Delta\text{W}_{BU}^N}{2F\phi(1 - p_L)} = \underline{\beta}_N. \quad (\text{C.32})$$

If $\gamma > \gamma^*$ and $c_1 < \frac{c}{\Delta p} \leq c_2$, introduction of the banking union reduces the monitoring incentives of BK_B . We focus on the case in which $\Delta p \leq \Delta p^*$, such that the banking union is still welfare improving. Let W_1^i , W_2^i , W_3^i and W_4^i denote the welfare of country i under national regulation in the four states of the world: (R_1^A, R_1^B) , $(0, R_1^B)$, $(R_1^A, 0)$, and $(0, 0)$. In addition, let S_i , $i \in \{1, 2, 3, 4\}$, denote welfare surplus for country A in all states of the world. The banking union feasibility condition for RG_A is

$$p_L^2 S_1 + (1 - p_L) p_L (S_2 + S_3) + (1 - p_L)^2 S_4 + \Delta p [p_L (W_3 - W_1) + (1 - p_L) (W_4 - W_2)] \geq 0. \quad (\text{C.33})$$

The upper limit for β is

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

A similar computation for RG_B yields the lower bound

$$\underline{\beta}_D = \underline{\beta}_N + \frac{\Delta p [W_1^B - W_3^B]}{2\phi(1 - p_L) F} > \underline{\beta}_N. \quad (\text{C.34})$$

To prove $\bar{\beta}_D > \underline{\beta}_D$, it is enough to show that

$$\bar{\beta}_N - \underline{\beta}_N - \frac{\Delta p (W^A [R_1^A, R_1^B] - W^A [R_1^A, 0])}{2F\phi(1 - p_L)} - \frac{\Delta p (W^B [R_1^A, R_1^B] - W^B [R_1^A, 0])}{2F\phi(1 - p_L)} \geq 0. \quad (\text{C.35})$$

From $\bar{\beta}_N - \beta_{-N} = \frac{\mathbb{E}\Delta W_{BU}^N}{2F\phi(1-p_L)}$ and the definitions of W^i ,

$$2\phi F - 2\phi > F\phi + F\phi\gamma + (F-1)\phi - (F-1)\gamma\phi \iff -2\phi > -2\phi - 2\phi\gamma, \quad (\text{C.36})$$

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

Lemma 3

Proof. The only interesting cases are for positive expected welfare surplus:

$$\Delta\text{Welfare} = (1 - p_H) \max\{p_L, 1 - p_L\} \text{Spillover} > 0. \quad (\text{C.37})$$

Independent default mandate There is no welfare surplus if BK_A succeeds in domestic projects. Otherwise, the following is obtained:

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

The incentive compatibility constraints for RG_A are

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

This gives the upper bound for β :

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

The incentive compatibility constraints for RG_B are

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

This gives the lower bound for β

$$\beta \geq \beta_{-I} = \bar{\beta}_I - \frac{(1 - p_H) \text{Spillover Effect}}{F(p_H \times R_1^A + 2(1 - p_H)\phi)} < \bar{\beta}_I.$$

Contagion mandate There is no welfare surplus relative to national regulation if either both banks fail or both banks succeed. Otherwise, the following is obtained:

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

The incentive compatibility constraints for RG_A are:

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

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

The incentive compatibility constraints for RG_B are:

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

This gives the lower bound for β :

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

□

Lemma 4

Proof. If the banking union does not affect welfare, it is only feasible if, as a zero-sum game between countries, $\text{Welfare}_{BU}^A - \text{Welfare}_{National}^A = 0$. From Proposition 2, the monitoring strategy of BK_B is unaffected by the banking union. If BK_B never monitors its loans, then the welfare condition is

$$(1-p_L)p_L(1-\beta)FR_1^A - p_L(1-p_L)\beta F(2\phi - R_1^A) + (1-p_L)^2(FR_1^A - 2\beta F\phi) = 0. \quad (\text{C.38})$$

The equilibrium fiscal cost share of country A is given by

$$\beta_N^{ZS} = \frac{R_1^A}{2\phi} \in \left(0, \frac{1}{2}\right). \quad (\text{C.39})$$

If BK_B is monitoring, the welfare condition is

$$(1-p_L)p_H(1-\beta)FR_1^A - p_L(1-p_H)\beta F(2\phi - R_1^A) + (1-p_L)(1-p_H)(FR_1^A - 2\beta F\phi) = 0 \quad (\text{C.40})$$

and the corresponding equilibrium fiscal cost share of country A is

$$\beta_M^{ZS} = \frac{(1-p_L)R_1^A}{2(1-p_H)\phi + \Delta p R_1^A} \in (0, 1). \quad (\text{C.41})$$

□

Lemma 5

Proof. If it is bailed out upon default, BK_B monitors its loans if the costs are low enough:

$$\frac{C}{\Delta p} \leq (1-\gamma + \gamma^I)R_1^B - \phi(1-\gamma) - \gamma^I r^I. \quad (\text{C.42})$$

If it not bailed out upon default, BK_B monitors its loans if

$$\frac{C}{\Delta p} \leq (1 - \gamma + \gamma^l)(R_1^B + R_2) - \phi(1 - \gamma) - (1 - \phi)(1 - \gamma)r - \gamma^l r^l. \quad (\text{C.43})$$

The monitoring thresholds for BK_B increase with γ^l .

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

$$\frac{C}{\Delta p} \leq R_1^A + \gamma - \phi(1 + \gamma) + \gamma^l r^l \text{Prob}(\text{interbank loan reimbursed}) - 1. \quad (\text{C.44})$$

□

Lemma 6

Proof. Let p_{IB} be the interbank loan reimbursement probability:

$$p_{\text{IB}} = \mathbb{P}(BK_B \text{ succeeds at } t = 1) + \mathbb{P}(BK_B \text{ succeeds at } t = 1) \times \mathbb{P}(BK_B \text{ is bailed out}). \quad (\text{C.45})$$

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

$$\pi_A^{t=1} = R_1^A + (\gamma - \gamma^l) - \phi(1 + \gamma) + \gamma^l r^l. \quad (\text{C.46})$$

For BK_A , investing in this market is equivalent to holding the surplus as liquidity, so it will accept the return on liquidity: $r^l = 1$.

If BK_B is not bailed out, then the payoff for BK_A is

$$\pi_A^{t=1} = \begin{cases} R_1^A + (\gamma - \gamma^l) - \phi(1 + \gamma) + \mathbb{P}(BK_B \text{ succeeds}) \gamma^l r^l, & \text{if } R_1^A + (\gamma - \gamma^l) - \phi(1 + \gamma) \geq 0, \\ \mathbb{P}(BK_B \text{ succeeds}) (R_1^A + (\gamma - \gamma^l) - \phi(1 + \gamma) + \gamma^l r^l), & \text{if } R_1^A + (\gamma - \gamma^l) - \phi(1 + \gamma) < 0 \end{cases}. \quad (\text{C.47})$$

The payoff piecewise increases in γ^l , since, from Lemma 5 the probability success of BK_B is non-decreasing in γ^l . Since the payoff function is continuous,⁴ it increases in γ^l on its full domain. Furthermore, the payoff of BK_B decreases with the interest rate paid to BK_A . □

Lemma 7

Proof. The welfare values for RG_B following bailout or liquidation are given by

$$\begin{aligned} \text{Welfare}_{B,\text{Bailout}} &= (1 - \gamma + \gamma^l)R_2 + (1 - F)(1 - \gamma)\phi - F r^l \gamma^l \\ \text{Welfare}_{B,\text{Liquidation}} &= (1 - \gamma + \gamma^l)R_2 (1 - L)F + (1 - F)[(1 - \gamma)\phi + (1 - \gamma)(1 - \phi)r]. \end{aligned} \quad (\text{C.48})$$

⁴It takes the value $\mathbb{P}(BK_B \text{ succeeds at } t = 1) \gamma^l r^l$ for $R_1^A + (\gamma - \gamma^l) - \phi(1 + \gamma) < 0$.

Regulator RG_B bails out BK_B only for $\gamma < \underline{\gamma}_{\text{National}}^I$, where:

$$\underline{\gamma}_{\text{National}}^I = \frac{(F-1)(1-\phi)(1-\gamma)r + (1-\gamma)R_2(1-F(1-L))}{Fr^I - R_2(1-F(1-L))}. \quad (\text{C.49})$$

A banking union always bails out bank A upon default and bank B in the situation where both banks fail independently. 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.

The bailout condition for BK_B is $\Delta\text{Welfare} = \text{Welfare}_{\text{Bailout}}^{\text{Joint}} - \text{Welfare}_{\text{Liquidation}}^{\text{Joint}} \geq 0$. Alternatively,

$$\Delta\text{Welfare} = \begin{cases} \overbrace{\gamma^I (R_2(1-F(1-L)) - (F-1)r^I) + \Theta(\gamma, \phi, r, F, L)}^{\Delta\text{Welfare}_{\text{Contagion}}^{\text{Joint}}}, & \text{if } R_1^A + \gamma - \gamma_I - \phi(1+\gamma) \geq 0, \\ \Delta\text{Welfare}_{\text{Contagion}}^{\text{Joint}} + (1-F)(R_1^A + \gamma - \gamma_I - \phi(1+\gamma)), & \text{if } R_1^A + \gamma - \gamma_I - \phi(1+\gamma) < 0, \end{cases} \quad (\text{C.50})$$

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

The function $\Delta\text{Welfare}$ is continuous and decreases with r^I . The maximum interbank market size is thus achieved for $r^I = 1$.

For $R_2(1-F(1-L)) - (F-1) > 0$, $\Delta\text{Welfare}$ increases in γ^I . 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 $\Delta\text{Welfare}$ 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:

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

then a banking union always bails out BK_B , since $\Delta\text{Welfare} > 0$ for $\gamma^I = \gamma$ and $r^I = 1$.

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

$$\gamma < \underline{\gamma}_{\text{Union}}^I = \frac{(F-1)(1-\phi)(1-\gamma)r + (1-\gamma)R_2(1-F(1-L))}{(F-1)r^I - R_2(1-F(1-L))} < \gamma_{\text{Contagion}} = R_1^A + \gamma - \phi(1+\gamma), \quad (\text{C.51})$$

and $R_2 < \underline{R}_2$, where \underline{R}_2 is defined as

$$\underline{R}_2 = \min \left\{ \frac{F-1}{1-F(1-L)}, \frac{F-1}{1-F(1-L)} (R_1^A + \gamma - (1+\gamma)\phi - (1-\phi)(1-\gamma)r) \right\}. \quad (\text{C.52})$$

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

Proposition 6

Proof. From Lemmas 6 and 7, BK_A chooses between two possible interbank market sizes. Bank 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 : (γ^I, r^I) . Only two interbank market equilibria are possible for each regulatory architecture. With national regulation, the equilibrium is either $(\underline{\gamma}_{\text{National}}^I, 1)$ or $(\gamma, r_{\text{National}}^I \geq 1)$. With a banking union, the equilibrium is either $(\underline{\gamma}_{\text{Union}}^I, 1)$ or $(\gamma, r_{\text{Union}}^I \geq 1)$.

Equilibrium interest rates The unique equilibrium interest rate solves equation (C.53) if BK_A can lend the whole amount to BK_B without being affected by contagion,

$$\gamma_{\text{National/Union}}^I (r^I) (r^I - 1) - \gamma r^I p^* + \gamma = 0, \text{ if } R_1^A - \phi(1 + \gamma) > 0, \quad (\text{C.53})$$

and equation (C.54) if BK_A defaults due to contagion,

$$\gamma_{\text{National/Union}}^I (r^I) (r^I - 1) - \gamma r^I p^* + \gamma + (1 - p^*) (R_1^A - \phi(1 + \gamma)) = 0, \text{ if } R_1^A - \phi(1 + \gamma) \leq 0. \quad (\text{C.54})$$

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

Bank BK_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

$$p^* (R_1^B + R_2 - \phi(1 - \gamma) - (1 - \phi)(1 - \gamma)r - \gamma r^I) \quad (\text{C.55})$$

and, from borrowing $\gamma_{\text{National/Union}}^I$ and being bailed out,

$$(1 - \gamma + \gamma^*) (p^* R_1^B + R_2) - p^* (\phi(1 - \gamma) - (1 - \phi)(1 - \gamma)r - \gamma^I). \quad (\text{C.56})$$

The difference between equations (C.55) and (C.56) is given by

$$p^* (\gamma - \gamma^I) R_1^B + p^* (\gamma^I - \gamma r^I) + (p - (1 - \gamma + \gamma^*)) R_2 \geq 0. \quad (\text{C.57})$$

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