BANCA D'ITALIA

EUROSISTEMA

Temi di discussione

(Working Papers)

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March 2019

Number 1212

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Number 1212 - March 2019

ISSN 1594-7939 (print)
ISSN 2281-3950 (online)

Printed by the Printing and Publishing Division of the Bank of Italy

BANK RESOLUTION AND PUBLIC BACKSTOP
IN AN ASYMMETRIC BANKING UNION

by Anatoli Segura[♦] and Sergio Vicente[*]

Abstract

This paper characterizes the optimal banking union with endogenous participation in a two-country economy in which domestic bank failures may be contemporaneous to sovereign crises, giving rise to risk-sharing motives to mutualize bail-out funding. Raising public funds to conduct bail-outs entails a deadweight loss. Bank bail-ins create disruption costs. The optimal resolution trades-off these costs. Truthfully eliciting information from domestic authorities imposes a domestic co-payment to fund bail-outs. When country asymmetry is large, ensuring the ex-ante participation of the fiscally stronger country requires a reduced contribution by this country, which increases the likelihood of bailing out its failing bank.

JEL Classification: G01, G21, G28.

Keywords: banking union, bail-in, bail-out, public backstop, mechanism design.

Contents

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1 Introduction[1]

During the global financial crisis, a large number of banks around the world were intervened by resolution authorities. In the U.S., a few states concentrated a large share of the bank resolutions, with Georgia facing 87 bank shutdowns amounting to 24.6% of its banking system, Florida experiencing 70 bank closures corresponding to 21.8% of its banking system, and Puerto Rico undergoing the closedown of 3 banks comprising 30% of its banking system. The resolution of all these banks, which were mostly operating within the confines of their jurisdictions, was carried out at the federal level, with an estimated cost of $72.5 billion to the Federal Deposit Insurance Corporation (FDIC).[2] Effectively, this injection of funds constituted a large source of redistribution of wealth from the most affluent territories to the states that experienced the largest shocks in their banking systems. In contrast, the public support programs for failing banks in the eurozone during the same period were funded at the national level. Several countries, chiefly Spain, Ireland, Greece, and Cyprus, had to inject massive amount of resources into their banking systems at a time at which their public finances were fragile, deepening their sovereign-debt crises. Although these countries obtained some financial assistance from other eurozone members to deal with the resolution of their failing banks, the degree of redistribution achieved through these programs was minimal, as most of the foreign support consisted of loans to the sovereigns with strong

[1]The views expressed in this paper are our own and do not necessarily coincide with those of Banca d'Italia. We would like to thank Thorsten Beck, Arnaud Boot (discussant), Elena Carletti, Guillermo Caruana, Jean-Eduard Colliard, Giovanni Dell'Ariccia, Xavier Freixas (discussant), Pedro Gete, Florian Heider, Luc Laeven, Agnese Leonello (discussant), Gerard Llobet, Gyöngyi Lóránth, Robert Marquez, David Martinez-Miera, Martin Oehmke, Fausto Panunzi, David Pothier (discussant), Rafael Repullo, Andrzej Stopczyński (discussant), Javier Suarez (discussant), Xavier Vives, Ansgar Walther (discussant), Lucy White and seminar audiences at the 8th Oxford Financial Intermediation Conference (OxFIT), the CEPR 1st Endless Summer Conference on Banking and Corporate Finance, the CEPR 28 European Summer Symposium in Financial Markets (Gerzensee, evening sessions), the EBA 7th Annual Research Workshop–Reaping the benefits of an integrated EU banking market, the 10th Baffi Carefin Banking Regulation Conference, the 10th Lisbon Meetings in Game Theory and Applications, the II MadBar Workshop at Universitat Pompeu Fabra, the 1st ESCB Financial Stability Workshop, the 25th Meeting of the Spanish Finance Association, and the 42nd Simposio of the Spanish Economic Association. Sergio is grateful to Fundación UCEIF, Banco de España, and Ministerio de Economía, Industria y Competitividad (ECO2017-82385-P).
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[2]This amount does not include the cost incurred by the Treasury, the Federal Reserve, and the FDIC itself in assisting Wachovia, Citigroup, and Bank of America under the systemic risk exception decided on these three institutions. For further details, see "Crisis and Response: An FDIC History, 2008–2013." FDIC. 2017. Washington, DC.

conditionality to ensure its repayment.[3]

The European sovereign-debt crisis motivated the creation of a eurozone banking union with the three-fold objective of providing a common supervision, a common resolution, and a common fiscal backstop for the banks in the area.[4] The first two objectives have been achieved with the establishment of the European Central Bank (ECB) and the Single Resolution Board (SRB) as central supervision and resolution authorities, respectively. The creation of the European Stability Mechanism (ESM) constitutes the first step towards the creation of a common fiscal backstop. However, the European Commission has issued a communication identifying "a last resort common fiscal backstop for the single resolution mechanism" as a critical missing element to complete the banking union.[5] The International Monetary Fund (IMF), in turn, has also warned that the banking union currently falls short of providing sufficient risk-sharing across countries.[6] However, several proposals to strengthen the common fiscal backstop have faced the opposition of the core countries of the eurozone under the concern that they may end up being net contributors to the common fiscal backstop.[7]

How should a common fiscal backstop be optimally designed? How much risk-sharing among countries can it provide? And how does the presence of a common fiscal backstop affect the resolution of banks? We address these questions in a model that takes into account two asymmetries that are prevalent in the context of the eurozone banking union. First, there exists a significant degree of heterogeneity on the fiscal strength of member states. Second, the newly created supranational resolution authority is required to operate in strict

[3]Financial support from the European Union was provided through the European Financial Stability Facility and the European Financial Stability Mechanism, two ad-hoc emergency programs that constituted the embryo of the current European Stability Mechanism.

[4]Euro Area Summit, 2012. Euro Area Summit Statement. Brussels, June 29.

[5]EC, 2017. Communication to the European Parliament, the Council, the European Central Bank, the European Economic and Social Committee and the Committee of the Regions on completing the banking union. European Commission 11/10/2017.

[6]IMF, 2016. 2016 article iv. consultation press release; Staff report; and statement by the executive director for the euro area. IMF Country Report No. 16/219.

[7]The following excerpt in the context of the establishment of a common fiscal capacity at the EU level provides an example: "The common fiscal capacity must not represent a disguised form of permanent transfers from one part of the union to another. Without effective safeguards in the design of the mechanism, which will ensure its fiscal neutrality amongst the Member States in the medium term, it could prove difficult to address the concerns of some Member States that they will become overall net contributors." (Interparliamentary conference on stability, economic coordination and governance in the European Union. Bratislava 16-18 October, 2016).

cooperation with more established domestic resolution authorities which, as put forward by Navaretti, Calzolari and Pozzolo (2015), may have informational advantages about the local banking sector.[8] Our stylized model shows how fiscal and informational asymmetries shape the way a banking union should provide risk-sharing across countries. This analysis highlights the need for imposing laxer conditions on countries with initially stronger fiscal positions to access the common fiscal backstop, which increases the probability of bailing out their banks.

The environment consists of a two-date and two-country economy with one bank and a resolution authority in each country. The bank funds its assets issuing debt from local investors. If its assets do not deliver the promised return to debtholders, the bank is resolved through either a bail-out or a bail-in. Raising public funds to conduct a bail-out entails a deadweight loss, which may be thought of as the monetary cost of raising funds through distortionary taxation. A bail-in, which imposes losses on debtholders, generates a costly disruption in the economy where the bank resides. The resolution policy trades off these costs. When a country undergoing a sovereign crisis faces a bank failure, the recourse to the foreign country's funds may reduce the overall cost of funding a bail-out, because the cost of public funds is exceptionally high during a crisis. This risk-sharing motive constitutes the rationale for the creation of a banking union.

Precisely, a banking union consists of a set of policies to resolve a failing bank that are contingent on both the ex-ante standpoint of the sovereigns (i.e., the relative likelihood that countries will undergo a crisis at a future date) and the ex-post state of the sovereigns at the time of resolving the bank (i.e., whether countries are fiscally stable or undergoing a crisis). The paper characterizes the resolution policies that minimize the ex-post aggregate resolution cost subject to the ex-ante participation constraints of both countries. A standard mechanism-design approach to elicit the private information about the bail-in disruption costs allows us to focus on resolution mechanisms that establish the home and the foreign country's contribution to fund a bail-out and delegate the resolution decision to the home

[8] The Single Resolution Mechanism (SRM), whose purpose is to "ensure an orderly resolution of failing banks," is composed by the Single Resolution Board and the National Resolution Authorities of participating Member States. The Regulation No 806/2014 of the European Parliament, which establishes the procedures for the resolution of banks in the framework of the SRM, states that "National Resolution Authorities should assist the Board in resolution planning and the preparation of resolution decisions." See Section 2.1 for a further discussion of the informational asymmetries between domestic and supranational authorities.

authority.

The paper first characterizes the *ex-post optimal banking union*, namely the set of resolution policies that minimizes the aggregate resolution cost without considering the countries' participation constraints. In the event in which the home country is undergoing a crisis and the foreign country is fiscally stable, the ex-post optimal resolution policy establishes a co-funding of bail-outs. The home country copayment is a consequence of the informational asymmetry between the supranational and the national authorities. Requiring the home country to partially finance the bail-out increases the overall resolution cost. However, it reduces the home authority's willingness to overstate the magnitude of the bail-in contagion cost to persuade the central authority of the need for a bail-out, which would be partially funded by the foreign country.[9] In the rest of contingencies (e.g., when both countries are simultaneously stable) there is no cost gain from co-funding bail-outs. Moreover, any foreign aid to fund bail-outs would increase the willingness of the sovereigns to bail out its failing banks. Consequently, the ex-post optimal resolution rules prescribe that the home sovereigns fully fund their own bail-outs in these contingencies.

The ex-post optimal banking union minimizes the aggregate resolution cost, but induces a positive expected net transfer from the stronger country to the weaker country, since the latter is more likely to experience a sovereign crisis. As a result, the ex-post optimal banking union is feasible only when countries' fiscal strength is not too dissimilar. When countries are sufficiently asymmetric, the *optimal (feasible) banking union* distorts the ex-post optimal resolution policy in two dimensions to ensure the voluntary participation of the fiscally stronger country.[10] First, in the contingencies in which the ex-post optimal mechanism prescribes a copayment of bail-outs, the stronger country both reduces its contribution to fund a bail-out of a foreign bank and receives a larger aid to fund a bail-out of its home bank. Second, the stronger country receives partial funding for its bail-outs in the contingencies in which there is no cost advantage from sharing the bail-out cost (e.g., when both countries are concurrently fiscally stable). These country-specific contributions to the funding of bail-outs

[9] The structure of this copayment scheme resembles the out-of-pocket deductible displayed by several insurance contracts to reduce moral hazard. In this framework, however, the role of the copayment is to elicit the private information that domestic authorities possess.

[10] A particular case in which countries are very asymmetric is the situation in which the strong country is always (expected to be) fiscally stable. We address this case in Section 4.3 (ii) and show that even in this case an optimal common fiscal backstop strictly improves upon autarky as long as the fiscally weak country is not always (expected to be) undergoing a fiscal crisis.

effectively imply laxer conditions for the stronger country to access the common fiscal backstop. The optimal resolution framework thus increases the likelihood that banks in fiscally stronger countries get bailed-out, which suggests that the minimization of the aggregate resolution cost may not be compatible with leveling the playing field among banks within a banking union with heterogeneous countries.[11] Notice that although these conditions seem to privilege the stronger country, the weaker country appropriates all the expected welfare gains that the banking union creates. Therefore, forming a banking union does not affect the expected aggregate welfare of the fiscally stronger country. However, since its banks are more likely to be bailed out, the banking union effectively leads to a redistribution of welfare from the taxpayers to the banks' owners.

One of the obstacles towards the completion of the eurozone banking union has been the core countries' concern that it may lead to net transfers of funds towards the periphery. On the contrary, the optimal banking union features a net expected transfer from the fiscally weaker country towards the fiscally stronger when the country asymmetry is large. In this case, while the stronger country benefits from an expected positive net transfer inflow, the weak country obtains the strong country's aid when it is most valuable, that is, when it concurrently experiences a sovereign crisis and a bank failure. This result highlights that imposing fiscal neutrality for each member country constitutes a suboptimal way of ensuring each country's legitimate demand that the creation of a banking union is not detrimental to its constituency.

The baseline model omits several relevant aspects of a banking union that we address as extensions of the basic framework. In the first one, the banking union includes the prerogative of the supranational authority to early intervene banks upon the observation of a signal of the quality of their assets. An intervention ahead of the potential deterioration of a bank's assets allows repaying the bank's creditors without resorting to public funds. When countries asymmetry is sufficiently large, the optimal early intervention policy features forbearance with the stronger country's bank, allowing the continuation of the bank under some contingencies in which it would be efficient to shut it down. The rationale for this ex-post suboptimal early intervention policy is that it softens the fiscally stronger country's

[11] Acharya (2003) also finds that creating a "leveled playing field" in capital requirements across countries may confer a competitive advantage to the banks in the countries with the most forbearing approach to bank resolution.

participation constraint by reducing its expected net transfer outflow in the resolution phase.

A second extension enlarges the set of bail-out funding tools to include the possibility of granting a bridge loan between sovereigns. Since loans are paid back at a future date, once the country undergoing a crisis may have regained its fiscal stability, they constitute a less costly form of copayment than contemporaneous home contributions. However, the optimal funding mix prescribes the use of direct transfers from a stable foreign country as well, as these funds constitute the least costly source of funding available within the banking union. This finding stands in contrast to the common fiscal backstop provided by the ESM, which considers direct transfers to be a last recourse option.[12]

A final extension introduces cross-border liabilities in our framework and shows that the cross-country ownership of banks' debt partially realigns the home and the foreign countries' objectives, enhancing the welfare gains induced by a banking union. The results are consistent with the view that an important driver for the creation of a banking union is the need to coordinate the supervision and the resolution actions for banks with significant cross-border liabilities.[13]

1.1 Related Literature

Our paper contributes to several strands of the literature. First, it belongs to an emerging literature on the architecture of banking unions that addresses the implications of the division of prerogatives between supranational and domestic authorities. In Foarta (2018), a supranational authority allocate resources to fund bail-outs, but domestic policymakers can divert political rents. As a result, there is an excessive expenditure in inefficient bail-outs, which may reduce welfare as compared with an autarky benchmark. Calzolari, Colliard, and Loranth (2017) highlight the unintended consequences of centralizing the supervision of multinational banks, which reduces the coordination problems among national agencies, but may inefficiently induce banks to adjust their international organizational structure to reduce supervisory monitoring. Carletti, Dell'Ariccia, and Marquez (2016) build a model of a "hub-and-spokes" banking union in which a central authority takes decisions based on

[12] Arts. 15-20 of the ESM Treaty.

[13] For instance, see van Claessens and van Horen (2013) for a survey on cross-border banking, Bolton and Oehmke (2018) on the resolution of cross-national banks, and Schoenmaker (2011) for a critical assessment of the impossibility of simultaneously achieving financial stability, financial integration, and national financial policies.

the information revealed by local supervisors. They find that a tough central authority may weaken the local authority's incentives to collect information, thereby increasing risk-taking by regulated banks. Similarly, in Colliard (2018) the central authority has an informational disadvantage relative to the local authority. The paper identifies a complementarity between the centralization of supervision and the degree of financial integration, which may lead to inefficient equilibria with local supervision and low financial integration. A common feature in these papers, which is also central in our analysis, is that the asymmetric information and the misalignment of preferences between domestic and supranational authorities leads to distortions of the resulting banking unions. Relative to these papers, our work is–to the best of our knowledge–the first one to analyze how the mutualization of a public backstop affects national authorities' incentives to reveal all their relevant information to the supranational resolution authority, and its implications for risk-sharing among the members of the banking union.

Several papers analyze how the heterogeneity across jurisdictions affects the feasibility and efficiency of supranational banking agreements. In Dell'Ariccia and Marquez (2006), competing domestic regulators do not internalize cross-border externalities, which leads to inefficiently low regulatory standards. Centralized regulation with common standards enhances overall welfare, but is only feasible when jurisdictions are sufficiently homogeneous. Similarly, in Beck and Wagner (2016) the establishment of centralized supervision with common standards reduces cross-border default externalities, but is not feasible when countries are very heterogeneous. Bolton and Oehmke (2017) analyze the choice of a single-point-of-entry (SPOE) versus a multiple-point-of-entry (MPOE) for the resolution of global banks. They find that although the SPOE resolution is more efficient, it is not implementable when the expected transfers across jurisdictions are too asymmetric. Our work departs from these papers in that we analyze the country-specific arrangements that are both feasible and maximize aggregate welfare when countries are largely asymmetric, finding that country heterogeneity must translate into an asymmetric treatment of countries. In this respect, we are closer to Stavrakeva (2018), who argues that capital requirements should be lower in countries with larger fiscal capacities because they are better equipped to conduct bail-outs in their banking systems.

Our work is also related to a broader literature that focuses on risk-sharing agreements among heterogeneous countries. Tirole (2015) analyzes how the optimal mutual insurance pact among countries that may experience a sovereign crisis depends on their degree of asymmetry. Similarly, Fahri and Werning (2017) address the problem of country risk-sharing within an optimal currency area and characterize the optimal transfers as a function of the countries' characteristics. In a similar vein to these papers, we establish the voluntary risk-sharing agreements that can be reached through a banking union in which fiscally strong countries demand an asymmetric treatment to avoid subsidizing weaker countries.

Finally, this paper is also related to a recent theoretical literature that assesses the effects of different approaches to bank resolution. Dell'Ariccia et al. (2018) examine the costs and benefits of bail-ins and bail-outs, hinging on the trade-off between the moral hazard costs associated with bail-outs and the potential spillovers arising from bail-ins. Colliard and Gromb (2018) show that the use of bail-in tools in bank resolution may reduce the bank stakeholders' incentives to restructure bank debt. Walther and White (2017) find that a commitment to impose bail-ins based on private information often lacks credibility, because regulators must avoid conveying bad news that may spread over to the financial system. Our paper differs from these in that our focus is the impact of the supranational-versus-domestic informational asymmetry and the country heterogeneity in the implementation of the resolution policy.

The rest of the paper is organized as follows. Section 2 presents the model set-up, including an additional subsection to discuss some of the assumptions of the model. Section 3 describes the resolution decisions in the absence of a banking union. Section 4, which constitutes the core of the paper, characterizes the optimal design of the banking union and shows how it depends on the degree of country asymmetry. Section 5 provides a discussion of some policy relevant features of the main results. Section 6 conducts the extensions of the baseline model. Section 7 concludes. The proofs of the formal results of the paper are contained in the Appendix.

2 The baseline model

In this section we describe the model setup. In Section 2.1 we discuss some of the main assumptions of the model. We consider a two-country–$i \in \{1,2\}$–and two-date–$t \in \{0,1\}$–economy where all agents are risk-neutral and have a zero discount rate. We refer to country

1 as the *strong* country and we label country 2 the *weak* country. As we formalize below, this distinction stands for the higher likelihood that the weak country undergoes a sovereign crisis. In each country there is a bank, a continuum of competitive investors, and a local bank resolution authority. We refer to the bank and the local authority in country i as bank i and authority i, respectively. We also say that authority i is the home authority of bank i and we use the notation $\bar{i}$ to refer to the other country, or to its agents.

Resolution authorities aim at maximizing the aggregate expected utility in their respective jurisdictions. They have resolution prerogatives over their country's bank and the capability to raise public funds to implement their initiatives. In addition, these domestic resolution authorities may agree at the initial date on the creation of a banking union to confer their prerogatives to a central resolution authority, as we specify below.

At $t = 0$, each bank has access to a project that requires an outlay of 1 unit. Banks raise these funds from local investors, issuing debt claims with face value D_i. The project's payoff at $t = 1$ is $R > 0$, if successful, and 0 otherwise. The probability that the project succeeds is p.

If a bank's project fails at $t = 1$, the bank cannot repay its debt and the competent resolution authority must resolve the bank. There are two types of resolution: A *bail-out* and a *bail-in.*

Bank bail-out A bank bail-out consists of the repayment of the unit of principal investment to the bank's debtholders.[14] Bail-outs are funded with public resources. We assume that the net social cost of public funds at $t = 1$ is λ_S if the country is fiscally *stable* (S) and λ_C if the country is undergoing a sovereign *crisis* (C), with $0 < \lambda_S < \lambda_C$. For each pair $\sigma \in \{SS, SC, CS, CC\}$ representing the state of the public finances in each of the countries at $t = 1$, we denote by q^σ the probability as of $t = 0$ that state σ realizes. We assume that the state of both countries public finances is common knowledge at $t = 1$. We denote q_i^S and $q_i^C \equiv 1 - q_i^S$ the probability that country i is stable and undergoing a crisis at $t = 1$, respectively. Hence, we have that $q_1^S = q^{SS} + q^{SC}$ and $q_2^S = q^{SS} + q^{CS}$. We assume

[14] We assume that debtholders only get the principal 1 for simplicity, as it renders the resolution decisions and the expected social costs of resolution independent of the promised repayment D_i. Alternatively, we could consider that a bail-out consists of the repayment of the debt face value D_i. This assumption would introduce a dependence of the cost of bail-outs on bail-out expectations, which would complicate the analysis without adding further insight.

that the strong country ($i = 1$) is more likely to be stable than the weak country ($i = 2$), that is:

Assumption 1 (Strong country more likely to be fiscally stable) $q_1^S > q_2^S$.

Notice that Assumption 1 implies both $q^{SS} + q^{CC} < 1$ and $q^{SC} > 0$, which implies that countries' public finances are not perfectly correlated.[15]

Bank bail-in A bank bail-in imposes the full burden of bank losses on debtholders. We assume that the loss suffered by bank debtholders may disrupt the rest of the financial sector, and therefore the economy at large, and generate a local deadweight contagion cost of k. As of $t = 0$, k is a random variable, which we assume to be uniformly distributed in the interval $[0, k_{\max}]$. For notational simplicity, we write its probability density function and cumulative distribution function as $g(k)$ and $G(k)$, respectively. The bail-in cost k is realized at $t = 1$, after the bank's project fails, but before the resolution decision is taken. We assume that its realization is only observed by the home authority. We make the following assumption:

Assumption 2 (Inefficient unconditional bail-outs) $k_{\max} > \lambda_C > \lambda_S > \int_0^{k_{\max}} kdG\left(k\right)$.

The assumption that $\lambda_S > \int_0^{k_{\max}} kdG\left(k\right)$ implies that unconditionally bailing out a bank is inefficient, even if the funding of the bail-out is entirely provided by a stable country. Put differently, this assumption asserts that in the absence of information on the realized value of k the optimal choice is to bail in a failing bank, regardless of the cost of public funds. This assumption is consistent with the Bank Recovery and Resolution Directive (BRRD) adopted by the EU, which attempts to make bail-ins the norm in bank resolutions, bail-outs being the exception.[16] The assumption that $k_{\max} > \lambda_C$ is inessential and only imposed to

[15] Observe that Assumption 1 does *not* rule out the particular case that the strong country is always stable, that is, $q_1^S = 1$. Indeed, we analyze this special case in Section 4.3.

[16] The Bank Recovery and Resolution Directive (BRRD)–Directive 2014/59/EU of the European Parliament and of the Council of 15 may 2014 establishing a framework for the recovery and resolution of credit institutions and investment firms–provides a common framework for the resolution of failing banks and confers authorities more powers to impose losses on private stakeholders, the so-called bail-in tools. Although the norm in the BRRD is to resolve banks through bail-ins, this directive allows public support to failing institutions when authorities consider that private burden sharing would endanger financial stability. However, the BRRD establishes strong conditions before resorting to public funds: The bank's shareholders and creditors must bear losses of at least 8% of all liabilities, and the privately funded Single Resolution Fund must contribute 5% of all liabilities to the resolution of the bank.

reduce the number of cases to consider.[17] It implies that bail-outs are preferable to the most disruptive bail-ins, even if the net social cost of public funds is high.

Banking Union A bank failure may occur when its home country is experiencing a crisis and the foreign country is stable. Consequently, domestic authorities may find it convenient to provide each other with some insurance by agreeing at the initial date to mutualize (to some extent) the funding of public support to failing banks. More precisely, we assume that at $t = 0$ local authorities may create a banking union conferring their prerogatives (both the decision on the resolution of failing banks and the capability to levy resources from sovereigns) to a central authority. This central authority operates without information on the realized bail-in contagion costs so that it must resort to the local authorities to elicit such information. The banking union agreement establishes a protocol of bank resolution decisions and sovereign contributions to bail-outs in each contingency that may arise.

Formally, a banking union is characterized by a resolution mechanism $\left\{b_{i,\sigma}(\hat{k}), x_{i,\sigma}(\hat{k})\right\}$, where the bank failure state (i, σ) represents the location $i \in \{1, 2\}$ of the failing bank and the state $\sigma \in \{SS, SC, CS, CC\}$ of the public finances in both countries at $t = 1$. For each disruption cost $\hat{k}$ reported by the failing bank's home authority, the resolution mechanism establishes whether the bank is bailed out ($b_{i,\sigma}(\hat{k}) = 1$) or bailed in ($b_{i,\sigma}(\hat{k}) = 0$), as well as the home country contribution $x_{i,\sigma}(\hat{k}) \in [0, 1]$ in case a bail-out is prescribed, the remaining funding needs $1 - x_{i,\sigma}(\hat{k})$ being contributed by the foreign country.

By the virtue of the revelation principle, we can focus on truth-telling resolution mechanisms for each bank failure state (i, σ). Using standard mechanism design arguments, we show in Appendix A that any relevant truth-telling mechanism that elicits the cost k and establishes a contingent bail-out/bail-in decision can be implemented as follows: The central authority sets the home contribution $x_{i,\sigma} \in [0, 1]$ to the funding of a bail-out and delegates the decision of whether to bail out or bail in the bank to the home authority. Consequently, we can characterize a banking union by a vector $\boldsymbol{x} = (x_{i,\sigma})_{i\in\{1,2\},\sigma\in\{SS,SC,CS,CC\}}$, establishing the home contribution to bail-outs in each of the eight bank failure states (i, σ). Note that the degenerate "banking union" described by the vector of home contributions $\mathbf{1} = (1, ..., 1)$ corresponds to the autarky case, in which each country resolves its bank failures on its own.

[17] It suffices to have $k_{\max} > \lambda_S$ so that bail-ins are not always preferable to bail-outs.

From now on, we will always refer to a banking union $\boldsymbol{x}$ as to a proper banking union, that is, one in which $\boldsymbol{x} \neq \mathbf{1}$.

Finally, we say that a banking union $\boldsymbol{x}$ is *feasible* if each country attains at least as much expected utility as in autarky. The banking union problem we address in the paper is that of analyzing the optimal banking union, that is, the aggregate welfare maximizing banking union that ensures the endogenous participation of the two countries.

2.1 Discussion of assumptions

In this section we discuss some of the assumptions made in the model.

Reduced form for bail-in disruption costs

The establishment of a new bank resolution framework within the eurozone, which includes the so-called bail-in tools, is paving the way towards minimizing the negative spillovers of bank bail-ins. However, several authors have warned that in some situations the use of bail-in tools may still cause severe disruptions in the rest of the economy (e.g., Dewatripont, 2014; Goodhart and Avgouleas, 2016). Systemic spillovers may manifest in different forms. For instance, bank bail-ins may undermine the investors' confidence, leading to roll-over freezes or deposit withdrawals, which may compromise financial stability (see Brown, Evangelou, and Stix, 2018, for evidence on this phenomenon following a bail-in event in Cyprus in 2013). Besides, as put forward by Dell'Ariccia et al. (2018), bail-in spillovers may be mechanically transmitted through the balance sheet of the bank, endangering the solvency of its debtholders and precipitating chains of bankruptcies. As evidenced by Beck, Da Rocha Lopes, and Silva (2017), which analyze the response of financial institutions to a bail-in in Portugal in 2014, the banks holding the bailed-in debt may tighten the access to credit to its borrowers, leading to further deterioration of the economic outlook. We model all such potential spillovers in reduced form, subsuming them in the parameter k. Finally, we assume for the sake of simplicity that the distribution of the bail-in disruption cost is independent of the state of the sovereigns. We could instead adopt the arguably more realistic assumption that the bail-in cost distribution is shifted to the right when the failing bank's home country is undergoing a crisis with no substantial changes in the qualitative results.

Informational advantage of national authorities

We assume that national authorities possess better information than the supranational authority about the potential consequences that a bank bail-in may inflict on the country's economy. This information advantage may arise from several sources. First, the SRB is a newly created authority, while national resolution authorities have been operating for a longer time and may have accumulated better knowledge about the domestic banking sector. Such expertise may allow them to better assess the relevant determinants of the bail-in spillovers. Second, and relatedly, the SRB is a resolution authority that is formally independent of the ECB, which is the supranational supervisory authority in the banking union.

The SRB can only gather information on banks through the ECB–or the relevant national supervisory authorities–through a memorandum of understanding between the two institutions. Instead, in several countries the resolution and the supervision authorities, although organically different, reside in the central bank, which has access to bank data to conduct its supervisory function. This privileged access to information on the entire domestic banking system might prove especially useful in the short time windows under which bank resolution processes are typically conducted. Third, in the similar context of the bank-supervisor relationship, several empirical analyses show that information acquisition is better the closer the geographical and cultural proximity between banks and their supervisors. Gopalan, Kalda, and Manela (2017) find that a larger geographical distance reduces the supervisor's effectiveness in reducing the bank's risk-taking behavior. Along these lines, Bian, Haselmann, Kick, and Vig (2015) state that "[...] proximity [between supervisors and banks] has the potential to improve the decision-making process, as it provides politicians with good information about banks that get into distress." Fourth, although the transposition into national law of the BRRD has constituted an important step towards the harmonization of the legal framework governing bank resolutions in the EU, "the divergence of national insolvency laws is a major obstacle towards a fully-fledged banking union", as recently acknowledged by the Chair of the SRB.[18] The particularities of national insolvency laws do in fact play a key role in determining the counterfactual of "no-creditor-worse-off" required for an application of the bail-in tools that is not exposed to potentially very costly litigation actions from affected bank stakeholders. In this respect, national authorities are likely to have a deeper knowledge of the intricacies of the domestic insolvency law due to the expertise of their human capital and the experience built throughout time operating under this legal framework. Finally, as argued by Ferrarini (2015), the institutional set-up of the eurozone banking union exhibits "semi-strong" centralization, consisting on supranational authorities with prerogatives on banks supervision and resolution, but sharing their tasks and operation in coordination with national authorities. This architecture may well constitute the optimal institutional response to the informational advantages of national authorities, at least in the current juncture.

Transfers across countries only for funding bail-outs

The paper restricts transfers across countries within the banking union to be used to fund

[18] Eurofit article by Elke König: "Real defragmentation of the Banking Union: the way forward," Thursday, 26 April 2018, https://srb.europa.eu/en/node/544

bail-outs of failing banks. We could allow unconditional transfers among countries, that is without any restriction on the use of these funds. With these type of transfers, fiscally strong countries could be compensated by weak countries at the inception of the banking union with independence of their banking sector needs. However, this sort of transfers have not been considered in the policy debate. Indeed, several voices have explicitly opposed integrating the banking union common fiscal backstop in the common EU budget, which would effectively delink the funding of bank bail-outs from the countries' contribution to the EU budget.[19] To better understand the mechanisms driving the main results of the paper, in Section 5.2 we address the implications of relaxing the assumption that transfers be only used to fund bail-outs.

National authorities' preferences

As noted by Navaretti, Calzolari and Pozzolo (2015), the assistance of national resolution authorities to the SRB on the preparation of resolution plans potentially creates a conflict of interest or coordination problems between national and central authorities, since their objectives are likely not entirely aligned. Along these lines, we assume that each domestic supervisor is concerned only with the welfare of the agents within its constituency, as in Colliard (2018), Carletti, Dell'Ariccia and Marquez (2016), and Calzolari, Colliard and Loranth (2018).[20] This view is consistent with the long-standing political economy view that national agents neglect the impact of their actions on foreign countries, recently put forward by Faia and Weder di Mauro (2015). Nonetheless, all of our qualitative results hold if we assume that national authorities also care for the well-being of the agents of the banking union at large, as long as they attribute a higher weight to their respective constituencies.

Cross-border liabilities

The main rationale for the creation of a banking union within the framework of this paper is risk-sharing across countries with independent banking systems. Many commentators have

[19] In fact, as evidenced by several agreements among eurozone countries, there exists a strong political opposition to build on financial capabilities to address uncertain episodes of financial distress. Common public funds to support a sovereign in distress are typically only mobilized once the dreadful event has already materialized and only employed to resolve the particular problem at hand. For further details, see "Strengthen stability: further development of the ESM in a deepened monetary union," by Klaus Regling, ESM Managing Director, at the Parliamentary evening of the association of German savings banks on 17 October 2018.

[20] The misalignment of objectives within the US banking system has been put forward by Agarwal *et al.* (2014), who find that federal regulatory supervisors are systematically tougher than their state counterparts.

argued that the banking union should also serve the purpose of providing a common space for an increasingly integrated banking system. We take on this issue in Section 6.3 and show that the main insights from the baseline analysis are reinforced in a set-up in which there are cross-border debt-holdings.

3 Bank resolution in autarky

In this section we characterize the optimal resolution policy of a country that addresses its bank failures on its own. The associated expected utility of its agents constitutes the outside option for the country when deciding whether or not to participate in a banking union.

Consider first the situation in which the failure of a bank at $t = 1$ occurs when the home country is stable. A bail-out amounts to a redistribution of one unit of funds within local agents at a (net) social cost of $\lambda_S \cdot 1$. Hence, the home authority bails out the bank when the bail-in contagion cost exceeds the social cost of the bail-out, that is, when $k \geq \lambda_S$. The expected social cost of a bank resolution when its home country is stable is thus given by:

$$\Pi^S = \underbrace{\int_0^{\lambda_S} k dG(k)}_{\textit{Bail-in cost}} + \underbrace{\lambda_S (1 - G(\lambda_S))}_{\textit{Bail-out cost}}. \tag{1}$$

If the bank's home country is undergoing a crisis the social cost of funds is $\lambda_C > \lambda_S$, which increases the cost of bail-outs and, consequently, elevates the bail-out region to $k \geq \lambda_C$. The expected social cost Π^C of a bank resolution when its home country is undergoing a crisis is then given by an expression analogous to (1) in which λ_S is replaced by λ_C. The expected cost difference of a bank resolution in these two states is therefore given by:

$$\Pi^C - \Pi^S = \underbrace{\int_{\lambda_S}^{\lambda_C} (k - \lambda_S) dG(k)}_{\textit{Bail-in versus bail-out}} + \underbrace{(\lambda_C - \lambda_S) [1 - G(\lambda_C)]}_{\textit{Cost-difference in bail-outs}} > 0. \tag{2}$$

Resolution costs in a country undergoing a sovereign crisis increase relative to a stable country because the higher cost of public funds leads to some bail-ins that are especially costly (i.e., for $\lambda_S \leq k < \lambda_C$, as captured by the first term of the latter expression) and makes more costly the funding of bail-outs whenever they are conducted (i.e., for $k \geq \lambda_C$, as captured by its second term).

Taking into account that banks' debt is priced competitively,[21] the expected utility as of $t = 0$ of the agents in country i, which we denote $\overline{U}_i$, is given by:

$$\overline{U}_i = \underbrace{pR - 1}_{Bank\ NPV} - \underbrace{(1-p)\left(q_i^S \Pi^S + q_i^C \Pi^C\right)}_{Resolution\ cost}. \tag{3}$$

The first term in this expression accounts for the expected value of the bank's project, while the second captures the expected resolution cost.

4 Optimal banking union

In this section we characterize the optimal banking union, that is, the aggregate welfare maximizing banking union within the class of agreements that ensure the participation of the two countries at $t = 0$. We first characterize the ex-post optimal resolution policies in a banking union. Then, we show that these are feasible if and only if the degree of asymmetry between the two countries is not too large. Finally, we analyze how resolution policies in the optimal banking union with large country asymmetry differ from ex-post optimal policies.

4.1 Ex-post optimal resolution policies

In this section, we describe the ex-post optimal resolution policies in a banking union for each state in which a bank may fail. The optimal resolution policies are defined as the aggregate welfare maximizing resolution policies that can be designed at $t = 1$ by a central authority with the prerogative of raising funds from the two countries, but without information on the realization of the bail-in contagion costs.

We start with the analysis of the case in which a bank fails at a country that is undergoing a sovereign crisis, while the other country is stable, which corresponds to the bank failure states $(1, CS)$ and $(2, SC)$. A resolution policy is characterized by the home contribution x to the funding of a bail-out. Observe that, by construction, the ex-post optimal resolution policy is independent of whether the home country is strong or weak.

[21] Notice that the equilibrium promised repayment D_i^* required by the competitive debtholders anticipates the probability of a bail-out, so that it satisfies:

$$pD_i^* + (1-p)\left[q_i^S\left(1 - G\left(\lambda_S\right)\right) + q_i^C\left(1 - G\left(\lambda_C\right)\right)\right] \cdot 1 = 1.$$

The particular value of such promised repayment does not have welfare implications. We henceforth omit it from our computations.

We first address the effect of the required bail-out funding home contribution x on the home authority decision to ask for either a bail-out or for a bail-in after observing that the bail-in disruption cost amounts to k. Bailing out the bank entails a utility for the agents in the home country of $1-(1+\lambda_C)x$. The first term corresponds to the transfer to the failing bank's debtholders associated with the bail-out. The second term stands for the gross social cost of the resources that the home country is required to contribute to the bail-out. Bailing in the bank, in turn, entails a utility of $-k$. Comparing the two, we have that the home authority prefers to ask for a bail-out whenever the bail-in disruption cost k is above a threshold $\overline{k}(x)$ given by:

$$\overline{k}(x)=\max\left\{(1+\lambda_C)x-1,0\right\}. \tag{4}$$

Note that the bail-out threshold $\overline{k}(x)$ is increasing in x because higher home contributions make bail-outs more costly for the home country. In addition, $\overline{k}(x)=0$ for all $x\leq\frac{1}{1+\lambda_C}$ and $\overline{k}(1)=\lambda_C$, since the home contribution to bail-outs $x=1$ corresponds to the autarky situation.

The expected aggregate resolution cost associated with a home contribution x to bail-outs is therefore given by:

$$\Pi(x)=\underbrace{\int_0^{\overline{k}(x)}kdG(k)}_{\textit{Bail-in cost}}+\underbrace{(\lambda_S+(\lambda_C-\lambda_S)x)(1-G(\overline{k}(x)))}_{\textit{Bail-out cost}}. \tag{5}$$

Notice that the term including the expected aggregate cost of the funding of bail-outs takes into account the social cost of the funds contributed by each of the countries.

The ex-post optimal resolution policy corresponds to the home contribution $x^*\in[0,1]$ that minimizes $\Pi(x)$. Notice that Assumption 2 implies that any home contribution leading to an unconditional bail-out (i.e., $x\leq\frac{1}{1+\lambda_C}$) is dominated by the autarky solution (i.e., $x=1$).[22] We can hence focus on the interval $x\in\left(\frac{1}{1+\lambda_C},1\right]$. In order to understand the drivers of the central authority decision, consider the marginal effect of an increase in the home contribution x on the expected aggregate cost of resolution $\Pi(x)$. Differentiating (5) yields:

$$\Pi'(x)=\underbrace{(\lambda_C-\lambda_S)\left[1-G\left(\overline{k}(x)\right)\right]}_{\textit{Cost effect (+)}}-\underbrace{(1+\lambda_S)(1-x)(1+\lambda_C)g(\overline{k}(x))}_{\textit{Overstatement effect (-)}}. \tag{6}$$

[22] The formal argument is contained in the proof of Proposition 1.

The first term in (6) is a *cost effect*, which accounts for the increase in the social cost of funding the bail-out by requiring the home country undergoing a crisis to contribute a higher share. This effect is positive due to the wedge in the cost of public funds between the home and the foreign country, thus pushing down the optimal home contribution to bail-outs. The second term is an *overstatement effect*, accounting for the diminished willingness of the home country to call for a bail-out when its contribution to bail-outs increases. This effect is negative, pushing up the optimal home contribution to the funding of bail-outs.

The overstatement effect appears because the home authority does not fully internalize the cost of a bail-out. In particular, the aggregate cost of funding a bail-out is given by $\lambda_S + (\lambda_C - \lambda_S)x$, while the home authority only faces a cost $\overline{k}(x)$–c.f. Expression (4) above. The wedge between the two, which is given by $(1 + \lambda_S)(1 - x)$, vanishes when the home country is required to fund bail-outs in its entirety (i.e., when $x = 1$). As a consequence, we have that $\Pi'(1) > 0$, which implies that $x^* < 1$. Hence, despite the informational frictions, the ex-post optimal resolution policy achieves some risk-sharing across countries that reduces the aggregate resolution cost when the home country is undergoing a crisis and the foreign country is fiscally stable.

For each of the other bank failure states the cost of public funds in the home country is not higher than in the foreign country so that there are no risk-sharing motives to mutualize the funding of bail-outs. An analogous analysis shows that in those states it is ex-post optimal that the home country of a failing bank funds its bail-out in its entirety.

The following proposition summarizes our discussion in this section. The formal proof is stated in the Appendix.

Proposition 1 (Ex-post optimal banking union) *The vector $\boldsymbol{x}^* = (x^*_{i,\sigma})$ of home contributions to bail-outs characterizing the ex-post optimal banking union satisfies:*

(i) When the failing bank is located in a country undergoing a crisis, and the foreign country is stable, that is, in the bank failure states $(i, \sigma) \in \{(1, CS), (2, SC)\}$, the home contribution is given by $x^*_{i,\sigma} = x^* \in \left(\frac{1}{1+\lambda_C}, 1\right)$, which is uniquely characterized by the following condition:

$$\Pi'(x^*) = 0. \tag{7}$$

(ii) In any other bank failure state, that is, for $(i,\sigma) \notin \{(1,CS),(2,SC)\}$, home countries fund bail-outs in their entirety, that is, $x^*_{i,\sigma} = 1$.

4.2 Feasibility of ex-post optimal resolution policies

In this section we ask whether the ex-post optimal banking union $\boldsymbol{x}^*$ characterized in Proposition 1 satisfies the participation constraint of the two countries at the initial date, in which case $\boldsymbol{x}^*$ is the optimal banking union.

We denote $U_i(\boldsymbol{x}^*)$ the expected utility, as of $t = 0$, of the agents in country i within the banking union $\boldsymbol{x}^*$. Considering that the ex-post optimal resolution policies differ from those in autarky only in the bank failure states $(1, CS)$ and $(2, SC)$, in which the home contribution to bail-outs is $x^* < 1$, it follows that the strong country's (positive or negative) net gain from joining the banking union $\boldsymbol{x}^*$ is given by:

$$U_1(\boldsymbol{x}^*) - \overline{U}_1 = \underbrace{(1-p)q^{CS}\left(\Pi^C - \Pi(x^*)\right)}_{\textit{Reduction of aggregate resolution cost}} - \underbrace{(1-p)\left(q^{SC} - q^{CS}\right)(1-x^*)(1+\lambda_S)\left(1 - G\left(\overline{k}(x^*)\right)\right)}_{\textit{Cost of net transfers from strong to weak country}}. \tag{8}$$

where $\overline{U}_1$ is as described in (3). The first term captures the gains attained by the creation of a banking union, which reduces the aggregate resolution cost when the strong country is undergoing a crisis and the weak country is stable (note that $\Pi(x^*) < \Pi(1) = \Pi^C$). The second term stands for the expected net transfers from the strong to the weak country implied by the foreign contribution to bail-outs $1 - x^*$ in states $(1, CS)$ and $(2, SC)$. Note that the term is proportional to the difference $q^{SC} - q^{CS}$ of the probabilities of these two states. Since $q^{SC} - q^{CS} = q_1^S - q_2^S > 0$, the expected net transfer is positive for country 1. Whenever the second term in (8) dominates the first one, the ex-post optimal banking union is not feasible, as the strong country prefers to remain in autarky.[23] The next proposition states that the ex-post optimal banking union is feasible if only if the degree of country asymmetry is not too large:

[23] The expression for the weak country's gain from joining the ex-post optimal banking union can be obtained by swapping the direction of the difference $q^{SC} - q^{CS}$ in (8), which shows that the weak country is a net receiver of funds and thus always finds it beneficial.

Proposition 2 (Feasibility of the ex-post optimal banking union) *There exists a degree of country asymmetry $a \in (0,1)$ such that the optimal banking union exhibits ex-post optimal resolution policies if and only if $q^{CS} \geq aq^{SC}$.*[24]

4.3 Optimal banking union with large country asymmetry

In this section we characterize the optimal banking union when country asymmetry is large enough so that the ex-post optimal banking union does not meet the participation constraint of the strong country. In order to formalize the problem, we generalize the notation and objects introduced in Section 4.1. For any given pair of public finances σ at $t = 1$, we denote by $\lambda_{1,\sigma}$ and $\lambda_{2,\sigma}$ the social cost of funds in countries 1 and 2, respectively.[25] In addition, for a resolution policy described by a home contribution to bail-outs x, we denote by $\overline{k}(x|i,\sigma)$ the bail-out threshold that it induces, and we let $\Pi(x|i,\sigma)$ denote its expected aggregate resolution cost. These functions, which are defined analogously to (4) and (5), respectively, are given by:

$$\overline{k}(x|i,\sigma) = \max\left\{(1+\lambda_{i,\sigma})x - 1, 0\right\}, \tag{9}$$

$$\Pi(x|i,\sigma) = \int_0^{\overline{k}(x|i,\sigma)} kdG(k) + (\lambda_{\bar{i},\sigma} + (\lambda_{i,\sigma} - \lambda_{\bar{i},\sigma})x)(1 - G(\overline{k}(x|i,\sigma))). \tag{10}$$

It is also convenient to introduce the function $t(x|i,\sigma)$, which accounts for the expected gross social cost incurred by the foreign country (country $\bar{i}$) in contributing to the funding of bail-outs in the bank failure state (i,σ). This function is given by:

$$t(x|i,\sigma) = (1-x)(1+\lambda_{\bar{i},\sigma})\left(1 - G\left(\overline{k}(x|i,\sigma)\right)\right). \tag{11}$$

Let $\boldsymbol{x} = (x_{i,\sigma})$ be a banking union. We can write the expected utility at $t = 0$ of agents in country i within the banking union $\boldsymbol{x}$ as follows:

$$U_i(\boldsymbol{x}) = \underbrace{pR - 1}_{NPV} \underbrace{- (1-p)\sum_\sigma q^\sigma \left(\underbrace{\Pi(x_{i,\sigma}|i,\sigma)}_{Aggregate\ resolution\ cost} - \underbrace{t(x_{i,\sigma}|i,\sigma)}_{Cost\ of\ transfers\ \text{from}\ foreign\ country}\right)}_{Home\ resolution\ cost}$$
$$- \underbrace{(1-p)\sum_\sigma q^\sigma t(x_{\bar{i},\sigma}|\bar{i},\sigma)}_{Cost\ of\ transfers\ \text{to}\ foreign\ country}. \tag{12}$$

[24] We show in the proof of the proposition that $a \equiv \frac{(1-x^*)(1+\lambda_S)\left(1-G\left(\overline{k}(x^*)\right)\right)}{\Pi^C - \Pi(x^*) + (1-x^*)(1+\lambda_S)\left(1-G\left(\overline{k}(x^*)\right)\right)}$.

[25] That is, $\lambda_{1,SC} = \lambda_{1,SS} = \lambda_{2,SS} = \lambda_{2,CS} = \lambda_S$ and $\lambda_{1,CS} = \lambda_{1,CC} = \lambda_{2,CC} = \lambda_{2,SC} = \lambda_C$.

The second term in (12) stands for the expected (net) cost incurred by country i in the resolution of its own bank. This expression is obtained by subtracting the expected cost of transfers incurred by the foreign country from the aggregate resolution cost. The third term in (12) takes into account the expected cost for country i of transfers to fund bail-outs at the foreign country.

Adding up the corresponding expressions of (12) for countries 1 and 2 we can write the aggregate welfare in the banking union as follows:

$$W(\boldsymbol{x}) \equiv U_1(\boldsymbol{x}) + U_2(\boldsymbol{x}) = 2(pR-1) - (1-p)\sum_{(i,\sigma)} q^{\sigma}\Pi(x_{i,\sigma}|i,\sigma). \tag{13}$$

This function captures the NPV of the two bank projects, as well as the expected aggregate resolution costs in each bank failure state. Note that $t(x_{i,\sigma}|i,\sigma)$ and $t(x_{\bar{i},\sigma}|\bar{i},\sigma)$ cancel out, as they constitute transfers among countries.

The optimal banking union is the solution to the following maximization problem:

$$\begin{array}{ll} \max_{\boldsymbol{x}} & W(\boldsymbol{x}) \\ \text{s.t.} & U_1(\boldsymbol{x}) \geq \overline{U}_1 \ \ (PC_1) \\ & U_2(\boldsymbol{x}) \geq \overline{U}_2 \ \ (PC_2) \end{array} . \tag{14}$$

It follows from (13) that solving the maximization problem in (14) is equivalent to minimizing the aggregate resolution costs, subject to the participation constraints of the two countries.

The following proposition provides necessary and sufficient conditions for a feasible banking union to exist when country asymmetry is large and provides the characterization of the optimal banking union in that case.

Proposition 3 (Optimal banking union with large country asymmetry) *Let the degree of country asymmetry a be as defined in Proposition 2 and assume that $q^{CS} < aq^{SC}$ so that the ex-post optimal banking union is not feasible. Then, there exists a banking union that strictly increases aggregate welfare relative to autarky if and only if $q^{SC} < 1$. In such case, the optimal banking union $\widehat{\boldsymbol{x}} \equiv (\widehat{x}_{i,\sigma})$ is unique and satisfies:*

(i) Only the participation constraint of the strong country binds, that is, $U_1(\widehat{\boldsymbol{x}}) = \overline{U}_1$ and $U_2(\widehat{\boldsymbol{x}}) > \overline{U}_2$.

(ii) If a bank fails in a country that is undergoing a crisis, and the other country is stable, then the home contribution to a bail-out is smaller (resp. larger) than ex-post optimal if

the failing bank is located in the strong (resp. weak) country, that is, $\widehat{x}_{1,CS} < x^* < \widehat{x}_{2,SC}$*. In addition, there is always foreign aid, even if the failing bank is located in the weak country, that is,* $\widehat{x}_{2,SC} < 1$*.*

(iii) *If a bank fails, and the state of the public finances of the two countries is the same, then there is foreign aid to fund a bail-out if and only if the failing bank is located in the strong country, that is,* $\widehat{x}_{1,SS} < \widehat{x}_{2,SS} = 1$ *and* $\widehat{x}_{1,CC} < \widehat{x}_{2,CC} = 1$*.*

(iv) *If a bank fails in a country that is stable, and the other country is undergoing a crisis, then there is no foreign aid to fund bail-outs, that is,* $\widehat{x}_{1,SC} = \widehat{x}_{2,CS} = 1$*.*

In order to shed light on the features of the optimal banking union characterized above, we discuss below a series of stylized economies in which, besides $\sigma = SC$, only one additional pair of public finances occurs with positive probability.

Optimal banking union in stylized economies with $q^{SC} \in (0, 1)$

(i) $q^{CS} > 0$ and $q^{SC} + q^{CS} = 1$ *(Countries' public finances perfectly negatively correlated).*

When the countries public finances are perfectly negatively correlated the strong country can obtain foreign aid in the bank failure state $(1, CS)$ and contribute to the funding of bail-outs at the weak country in the bank failure state $(2, SC)$. The proposition states that feasible risk-sharing across countries is optimally achieved by reducing the (more frequent) strong country foreign aid below the ex-post optimal level, and raising the (less frequent) weak country aid above the ex-post optimal level, that is:

$$0 < 1 - \widehat{x}_{2,SC} < 1 - x^* < 1 - \widehat{x}_{1,CS}. \tag{15}$$

The intuition is as follows. On the one hand, both distortions contribute to strictly softening the strong country's participation constraint. On the other hand, by construction the ex-post optimal policy minimizes the aggregate resolution cost–that is $\Pi'(x^*) = 0$–so that distortions around that level of mutualization of the funding of bail-outs have a negligible impact on the aggregate resolution cost. As a result, it is optimal to distort both resolution policies.

(ii) $q^{SS} > 0$ and $q^{SC} + q^{SS} = 1$ *(Strong country always stable).*

If the strong country is always stable and the two countries are stable contemporaneously with positive probability, the strong country can obtain foreign support to bail out its bank in the latter contingency. In order to see that a banking union is feasible in this economy, consider the derivative of the aggregate resolution costs function in the bank failure state $(1, SS)$, which is given by:

$$\begin{aligned}\Pi'(x_{1,SS}|1,SS) &= \underbrace{(\lambda_S - \lambda_S)\left[1 - G\left(\overline{k}(x_{1,SS}|1,SS)\right)\right]}_{\textit{Cost effect (=0)}} - \\ &\quad \underbrace{(1+\lambda_S)(1 - x_{1,SS})(1+\lambda_S)g(\overline{k}(x|1,SS))}_{\textit{Overstatement effect (-)}}.\end{aligned} \tag{16}$$

Observe that foreign aid in state $(1, SS)$ leads to an overall reduction of welfare, because the overstatement effect is at work and there is no cost gain. However, its impact on the overall welfare is small when the strong country home contribution $x_{1,SS}$ to a bail-out is large, that is, $\Pi'(x_{1,SS} = 1|1, SS) = 0$. The reason is that in this case the strong country internalizes to a large extent the cost of bailing out a home bank. Analogously, we can show that $U_1'(x_{1,SS} = 1|1, SS) > 0$, and thus a home contribution $\hat{x}_{1,SS} < x^*_{1,SS} = 1$ softens the strong country participation constraint with a negligible overall welfare effect. The strong country can thus be compensated for its contribution to the weak country bail-outs in state $(2, SC)$ through foreign aid in state $(1, SS)$. In addition, the optimal feasible risk-sharing requires that the support given by the strong country be below the ex-post optimal level, that is, $1-\widehat{x}_{2,SC} < 1-x^*$. As explained above, the reason is that the impact of small distortions from x^* on aggregate welfare is negligible, while strictly softening the participation constraint of the strong country.

(iii) $q^{CC} > 0$ and $q^{SC} + q^{CC} = 1$ *(Weak country always undergoing a crisis).*

Even when the weak country is always undergoing a crisis, the banking union can provide risk-sharing across countries, as long as the strong country may experience a crisis with positive probability. A welfare enhancing banking union is feasible because the aggregate resolution cost associated with the provision of foreign aid to the strong country in the bank failure state $(1, CC)$ is initially insignificant relative to the gains from the provision of foreign aid to the weak country in the bank failure state $(2, SC)$. The underlying reason is of the same nature as in the economy described in (ii).

The above examples describe the optimal banking union in the most simple economies with $q^{SC} < 1$. Observe that the main features of the resolution policies described in the stylized examples extend to the general case characterized in Proposition 3.

The proposition also states that when $q^{SC} = 1$ so that the strong country is always stable and the weak country is always undergoing a crisis, there is no possibility of creating a banking union. The reason is that in such an economy the only way of compensating the strong country for providing foreign aid in state $(2, SC)$ would be through support in the state $(1, SC)$. In this case, in addition to the distortion induced by the overstatement effect, there would be a cost loss in any transfer from the weak to the strong country. This is also the reason why in any optimal banking union countries undergoing crises never provide foreign aid to stable countries.

Gains and losses induced by the optimal banking union

In order to assess the gains and losses induced by the optimal banking union, we can write:

$$\begin{aligned} U_1(\widehat{\boldsymbol{x}}) + U_2(\widehat{\boldsymbol{x}}) - \left(\overline{U}_1 + \overline{U}_2\right) &= \underbrace{(1-p)\left[q^{CS}\underbrace{\left(\Pi^C - \Pi(\widehat{x}_{1,CS})\right)}_{>0} + q^{SC}\underbrace{\left(\Pi^C - \Pi(\widehat{x}_{2,SC})\right)}_{>0}\right]}_{\textit{Reduction in excess resolution cost from sovereign crises}} \\ &\quad \underbrace{-(1-p)\left[q^{SS}\underbrace{\left(\Pi(\widehat{x}_{1,SS}|1,SS) - \Pi^S\right)}_{>0} + q^{CC}\underbrace{\left(\Pi(\widehat{x}_{1,CC}|1,CC) - \Pi^C\right)}_{>0}\right]}_{\textit{Cost of excessive bail-outs at strong country}}. \end{aligned} \tag{17}$$

The first term includes the reduction of the aggregate resolution cost in the bank failure states in which there are risk-sharing motives to mutualize the funding of bail-outs. Since $\widehat{x}_{1,CS} < x^* < \widehat{x}_{2,SC}$, this reduction is smaller than in the ex-post optimal banking union. The second term in (17) captures the social cost of the excessive amount of bail-outs of the bank in the strong country in states in which there is no risk-sharing motive to provide foreign aid, but simply the need to compensate the strong country to form the banking union.

Also, observe that the participation constraint of the strong country binds, as stated in Proposition 3 (i). Hence, entering the banking union does not affect the expected aggregate welfare of the strong country's agents. However, forming a banking union leads to a redistribution of welfare in that country from the public to the bank owners, as the bank is bailed out more frequently within the banking union.

We conclude this section by highlighting a policy implication of our results: When country asymmetry is large, an aggregate welfare maximizing banking union requires the design of risk-sharing rules that are country-specific, explicitly recognizing the ex-ante differences among countries. Aiming at a symmetric banking union may render the project unfeasible. It is worth emphasizing that while the country-specific resolution policies in the optimal banking union may seem to privilege the strong country ex-post, it is indeed the weak country that appropriates the entire welfare gains associated with the creation of a banking union from an ex-ante perspective.

5 Discussion of the results

In this section we discuss the results along two additional dimensions. In Section 5.1 we analyze the sign of the expected net transfers across countries in the optimal banking union. In Section 5.2 we describe the role of initial-date unconditional transfer in restoring ex-post efficient resolution policies with large country asymmetry.

5.1 Net transfers across countries in an optimal banking union

As stated in the Introduction of the paper, a general principle governing the banking union negotiations is that it should not lead to permanent transfers across states. This position has been spearheaded by countries with strong economies in an attempt to prevent that the creation of common fiscal backstops becomes a hidden instrument to subsidize countries with weaker fiscal positions.

In this section, we argue that the optimal banking union among countries with a large degree of asymmetry characterized in Proposition 3 may lead to the weak country being a net contributor of funds. More generally, we illustrate how the degree of asymmetry and the correlation of public finances among countries shape transfers in the optimal banking union and determine which country is a net fiscal contributor.

Throughout this section we fix the value of the probability $q^{SC} > 0$. Moreover, for ease of exposition, and without any significant loss of insight, we let $q^{CC} = 0$. Notice that the assumption that $q^{CC} = 0$ implies that q^{CS} stands for the probability that the strong country undergoes a sovereign crisis. The distribution of public finances pairs at $t = 1$ is thus entirely described by the probability $q^{CS} \in \left[0, q^{SC}\right)$, where the upper bound of the latter interval stems from Assumption 1. The value $q^{CS} = 0$ represents the case of maximal asymmetry, whereby the strong country is always stable. On the other extreme, when q^{CS} gets arbitrarily close to q^{SC}, we have that countries are (almost) symmetric. For each $q^{CS} \in \left[0, q^{SC}\right)$, we denote by $T(q^{CS})$ the expected net contribution of funds from the strong country to the weak country in the optimal banking union.

Consider first the case in which the asymmetry among countries is not too large, that is, $q^{CS} > aq^{SC}$, where $a \in (0,1)$ corresponds to the value described in Proposition 2, and thus the ex-post optimal banking union is feasible. The expected net contribution of funds by the strong country is then given by:

$$T(q^{CS}) = (1-p)\left(q^{SC} - q^{CS}\right)(1-x^*)\left(1 - G\left(\overline{k}(x^*)\right)\right) > 0. \tag{18}$$

When countries are not too asymmetric, the strong country is a net contributor of funds. In addition, as q^{CS} decreases–so that the strong country becomes less likely to experience a fiscal crisis–, we have that $T(q^{CS})$ increases, that is the strong country's expected net transfer increases.

This is no longer the case when the ex-post optimal banking union is not feasible, that is, when $q^{CS} < aq^{SC}$. Ensuring the participation of the strong country requires distortions of the ex-post optimal resolution policies to reduce the net transfers from the strong country to the weak country in each state. These distortions may be as large as to revert the position of the strong country as a net contributor within the banking union.

In fact, the weak country is a net contributor when the strong country is always stable, as we show below. When $q^{CS} = 0$, there are only two states in which there are transfers of funds across countries: The strong country contributes in state $(2, SC)$ and receives a transfer in state $(1, SS)$. Since the strong country's participation constraint is binding, it follows that the net expected transfer from the strong country must equal the increase in the aggregate resolution cost in state $(1, SS)$ as compared to autarky, which stems from the overstatement effect that the foreign contribution to bail-outs induces without any associated cost gain. As a consequence, the strong country is a net expected receiver of funds.

The following proposition formalizes this result.

Proposition 4 (Net transfers across countries) *Suppose that the strong country is always (expected to be) stable, that is,* $q^{CS} = 0$*. Then, the weak country is a net expected contributor to the banking union, that is,* $T(q^{CS} = 0) < 0$*.*

Our analysis emphasizes that imposing zero net expected cross-country transfers is not the optimal way of ensuring each country's legitimate demand that the creation of a banking union is not detrimental to its constituency.

5.2 Initial date transfers

Recall from Proposition 2 that the ex-post optimal banking union is not feasible with large country heterogeneity, because it requires too large an expected net transfer from the strong to the weak country. Moreover, as shown in Proposition 3, the optimal banking union with large country heterogeneity exhibits ex-post inefficient transfers from the weak to the strong country in states in which there are no cost-of-funds gains. In this section, we explore the sources of this inefficiency by showing that the ex-post optimal banking union is achievable if we allow countries to issue unconditional transfers at the inception of the banking union.

Suppose that at $t = 0$ the cost of funds in the two countries is λ_S and that countries can issue transfers among them. Importantly, these funds can be employed by countries at their own will, that is, countries need not funnel these resources into the banking system. Let m denote the amount transferred *from* the weak *to* the strong country at $t = 0$ (i.e., $m < 0$ represents a case in which the strong country issues a transfer to the weak country). Then, for any given banking union $\boldsymbol{x}$ and initial transfer m, the utility in each of the countries is given by:

$$\begin{aligned} \widehat{U}_1(m, \boldsymbol{x}) &= U_1(\boldsymbol{x}) + (1 + \lambda_S)m \\ \widehat{U}_2(m, \boldsymbol{x}) &= U_2(\boldsymbol{x}) - (1 + \lambda_S)m. \end{aligned}$$

Notice that receiving a transfer reduces the country's need to raise an amount m through distortionary taxation or public debt issuance. Hence, the value of receiving an amount m increases the country's utility by $(1 + \lambda_S)m$. Moreover, observe that transfers do not affect aggregate welfare, since the shadow cost of raising an amount m of public funds to issue the transfer is precisely $(1 + \lambda_S)m$.

A banking union $\boldsymbol{x}$ with an associated initial transfer m is feasible if and only if no country is worse off than in autarky, that is $\widehat{U}_i(m, \boldsymbol{x}) \geq \overline{U}_i$, for $i = 1, 2$. The following proposition characterizes the optimal banking unions with initial date transfers.

Proposition 5 (Optimal banking union with initial date transfers) *Suppose that countries can make transfers across them at the initial date $t = 0$. Then, there exist $m^*_{\min} < m^*_{\max}$ such that a banking union described by an initial date transfer m and resolution policies $\boldsymbol{x}$ is optimal if and only if:*

$$m \in [m^*_{\min}, m^*_{\max}] \text{ and } \boldsymbol{x} = \boldsymbol{x}^*,$$

where $\boldsymbol{x}^*$ is the ex-post optimal banking union characterized in Proposition 1. Moreover, $m^*_{\min} > 0$ if and only if country asymmetry is large, in the sense of Proposition 2.

The proposition states that the possibility of issuing transfers across countries at the inception of the banking union ensures that the resulting agreement features ex-post optimal resolution policies. The reason for this result is that an initial-date transfer to the strong country relaxes its participation constraint, thus avoiding the distorted contributions to bail-out funding characterized in Proposition 3. The proposition also states that there is continuum of optimal banking unions that differ only in the initial-date transfer size. This result is reminiscent of the second welfare theorem in that countries can agree on the optimal risk-sharing agreement $\boldsymbol{x}^*$, which maximizes overall welfare, and independently issue transfers m to distribute the welfare gains from the agreement. Intuitively, when country asymmetry is large, these transfers must be directed to the stronger country as a compensation for its larger contribution to welfare, and thus $m^*_{\min} > 0$.

This arrangement can be interpreted as a coinsurance contract in which the weak country pays a premium m^* at the initial date to the strong country. There is coinsurance insofar as both countries commit to provide the (optimal coinsurance) amount x^* to fund bail-outs at the other country in the appropriate contingencies, as characterized in Proposition 1. The premium is paid by the weak country to compensate the strong country for its larger expected contribution, given the higher likelihood of the weak country to undergo a sovereign crisis.

Despite the benefits of allowing for unconditional transfers at the inception of the agreement, there are several reasons why this sort of arrangement may not be feasible. On the one hand, there may be domestic political economy constraints preventing fiscally weaker countries to transfer funds to strong countries in exchange for contingent help at a future date. Moreover, it may not even be feasible for countries with weaker public finances to raise a large amount of funds without compromising their fiscal positions at the beginning of the banking union.

6 Extensions

In this section we extend the model in three directions. In Section 6.1 we allow for early intervention by the central authority at an interim date and analyze how country asymmetry may lead to a differential treatment of banks across countries in these interventions. In Section 6.2 we analyze the optimal resolution policies when, in addition to direct transfers, the foreign country can issue a loan to the country undergoing a crisis. In Section 6.3 we introduce cross-border debt holdings and analyze the extent of risk-sharing in the presence of foreign ownership of debt claims.

6.1 Early intervention

So far we have circumscribed the authorities' decisions to the resolution of a bank when the realized value of its assets is not enough to repay debt investors. Authorities can in practice *early intervene* a bank to protect depositors and other senior debtholders when they believe that the bank is likely to fail at a future date. Early intervention ahead of a potential further deterioration of the bank assets allows authorities to ensure the repayment of all senior debtholders without the need to recourse to public funds.

In this section we extend the model to allow for both late resolution and early intervention actions. We analyze how these two are optimally set in a banking union. We introduce an interim date, which we refer to as $t = 1/2$, in which the relevant resolution authority observes a signal p_i, standing for the probability that bank i's project succeeds at $t = 1$. At $t = 0$, p_i is regarded as a random variable with support $[0, 1]$, cumulative distribution function $F(\cdot)$ and strictly positive probability density function $f(\cdot)$, with $\int_0^1 dF(p_i) = p$. We also assume that at $t = 1/2$ the pair of public finances $\sigma \in \{SS, SC, CS, CC\}$ at $t = 1$ is common knowledge. An early intervention of the bank at $t = 1/2$ leads to the liquidation of the bank assets, which yields a payoff of $L \geq 1$. The authority uses these proceeds to repay the unit principal owed to the bank debtholders and distributes the residual payoff among the bank's owners. Note that we assume that early intervention actions are based on a signal that is observed by both the central and domestic authorities. The rationale for this is that early intervention prevents the bail-in of debtholders, which makes the intervention process smoother and thus less reliant on information that can only be obtained by domestic authorities.

In this set-up a banking union consists of a pair of vectors $(\boldsymbol{x},\overline{\boldsymbol{p}})$. The vector $\boldsymbol{x} = (x_{i,\sigma})$ has the same meaning as in the baseline model. The vector $\overline{\boldsymbol{p}} = \left(\overline{p}_{i,\sigma}\right)$ consists of the early intervention thresholds for the interim signal, below which the relevant authority intervenes the bank.

We first analyze the ex-post optimal intervention thresholds $\overline{p}(x_{i,\sigma}|i,\sigma)$, which depend on the resolution home contributions to bail-outs $x_{i,\sigma}$ through its effect on the aggregate resolution cost. They are characterized by the following indifference condition:

$$\overline{p}(x_{i,\sigma}|i,\sigma)R - (1-\overline{p}(x_{i,\sigma}|i,\sigma))\Pi(x_{i,\sigma}|i,\sigma) = L. \tag{19}$$

The left hand side of (19) accounts for the aggregate expected utility associated with letting the bank continue until $t = 1$ conditional on the threshold signal. The first term captures the expected return of the bank assets. The second term includes the expected aggregate resolution cost, which takes into account both the probability that the bank fails and the resolution policies that will be adopted in that contingency. The right hand side of (19) accounts for the liquidation proceeds from the early intervention of the bank.

The ex-post optimal banking union is defined as that maximizing aggregate utility in the economy. It can be easily derived by backwards induction: It consists of the ex-post optimal late resolution policies $\boldsymbol{x}^*$ characterized in Proposition 1, and the associated ex-post optimal early intervention thresholds $\overline{\boldsymbol{p}}^* \equiv \left(\overline{p}(x^*_{i,\sigma}|i,\sigma)\right)$ given by Equation (19) evaluated in each ex-post optimal value $x^*_{i,\sigma}$ of home contributions. For the same reasons as in the baseline model, the ex-post optimal banking union $(\boldsymbol{x}^*, \overline{\boldsymbol{p}}^*)$ is feasible only when country asymmetry is not large.

Let us move to the analysis of the optimal banking union when country asymmetry is large. In this case, not only late resolution decisions, but also early intervention actions, might not be ex-post optimal. We say that a banking union $(\boldsymbol{x},\overline{\boldsymbol{p}})$ is *forbearing* in the early intervention of bank i in state σ if the intervention threshold $\overline{p}_{i,\sigma}$ lays below the optimal intervention threshold characterized by Equation (19), that is, if $\overline{p}_{i,\sigma} < \overline{p}(x_{i,\sigma}|i,\sigma)$. Similarly, we say that the banking union is *tight* in the early intervention of bank i in state σ if $\overline{p}_{i,\sigma} > \overline{p}(x_{i,\sigma}|i,\sigma)$.

In order to assess whether forbearance or tightness in early intervention are optimal we derive an analogous expression to (12) for the extended model:

$$
\begin{aligned}
U_i(\boldsymbol{x},\overline{\boldsymbol{p}}) \;=\; & \underbrace{\sum_{\sigma} q^{\sigma}\left(\left(\left(\int_{\overline{p}_{i,\sigma}}^{1} p\,dF(p)\right)R + F(\overline{p}_{i,\sigma})L\right) - 1\right.}_{\text{NPV}} \\
& \underbrace{-\sum_{\sigma}\left(\int_{\overline{p}_{i,\sigma}}^{1}(1-p)\,dF(p)\right) q^{\sigma}\left(\underbrace{\Pi(x_{i,\sigma}|i,\sigma)}_{\text{Aggregate resolution cost}} - \underbrace{t(x_{i,\sigma}|i,\sigma)}_{\text{Cost of transfers } from \text{ foreign country}}\right)}_{\text{Home resolution cost}} \\
& \underbrace{-\sum_{\sigma}\left(\int_{\overline{p}_{\bar{i},\sigma}}^{1}(1-p)\,dF(p)\right) q^{\sigma} t(x_{\bar{i},\sigma}|\bar{i},\sigma)}_{\text{Cost of transfers } to \text{ foreign country}}.
\end{aligned}
\tag{20}
$$

Observe that, unlike (12), (20) takes into account that the bank is liquidated whenever the (state-contingent) signal lays below the (state-contingent) early intervention threshold, yielding a value of L.

Suppose that for some bank failure state (i,σ) the banking union prescribes a resolution policy given by $x_{i,\sigma} < 1$, and thus country i receives foreign aid in that contingency. Using (19), we have that the derivative of the expected utility in country i with respect to the interim threshold $\overline{p}_{i,\sigma}$, evaluated at the ex-post optimal threshold $\overline{p}_{i,\sigma} = \overline{p}(x_{i,\sigma}|i,\sigma)$, is given by:

$$
\left.\frac{\partial U_i(\boldsymbol{x},\overline{p})}{\partial \overline{p}_{i,\sigma}}\right|_{\overline{p}_{i,\sigma}=\overline{p}(x_{i,\sigma}|i,\sigma)} = q^{\sigma}\left[\begin{array}{c} L\text{-}\overline{p}(x_{i,\sigma}|i,\sigma)R\text{-} \\ (1\text{-}\overline{p}(x_{i,\sigma}|i,\sigma))\left(\Pi(x_{i,\sigma}|i,\sigma)\text{-}t(x_{i,\sigma}|i,\sigma)\right) f(\overline{p}(x_{i,\sigma}|i,\sigma)) \end{array}\right], \tag{21}
$$

or:

$$
= -q^{\sigma} t(x_{i,\sigma}|i,\sigma) f(\overline{p}(x_{i,\sigma}|i,\sigma)) < 0. \tag{22}
$$

Hence, whenever a country receives foreign aid, early intervention forbearance increases the country's expected utility. The intuition is that foreign transfers make the bank continuation more profitable to the recipient country than to the entire economy. Moreover, the definition of the ex-post optimal intervention threshold implies that:

$$
\left.\frac{\partial W(\boldsymbol{x},\overline{p})}{\partial \overline{p}_{i,\sigma}}\right|_{\overline{p}_{i,\sigma}=\overline{p}(x_{i,\sigma}|i,\sigma)} = 0. \tag{23}
$$

Hence, the aggregate welfare effect of marginal changes of the early intervention threshold around its ex-post optimal value is negligible. As a result, the participation constraint of the strong country, which is binding when country asymmetry is large, can be relaxed with a negligible aggregate welfare impact by allowing some early intervention forbearance in the states in which the strong country receives foreign aid. Analogously, if the banking union prescribes some amount of foreign aid to the weak country in some state, then it is ex-ante optimal that the central authority be tight in the intervention of the weak country's bank to soften the participation constraint of the strong country. The next proposition characterizes the properties of early intervention policies in the optimal banking union:

Proposition 6 (Optimal early intervention with large country asymmetry) *There exists $a' \in (0,1)$ such that the optimal banking union is ex-post optimal if and only if $q^{CS} \geq a'q^{SC}$. If $q^{CS} < a'q^{SC}$ and $q^{SC} < 1$, then in an optimal banking union $(\widehat{\boldsymbol{x}},\widehat{\overline{p}})$ the central authority early intervention policy is forbearing with the strong country's bank in states $\{SS, CS, CC\}$, and is tight in the early intervention of the weak country in state SC.*

The proposition states that when country asymmetry is large the bank in the strong country will benefit from some early intervention forbearance. In contrast, the bank in the weak country will experience some tight early interventions. These two early intervention distortions complement the late resolution distortions in softening the strong country participation constraint. The preferential treatment of the bank in the strong country suggests that there could be a tension when countries differ substantially between the objective of minimizing resolution costs within a banking union and that of ensuring a level-playing field across banks.

6.2 Direct versus indirect aid

In the baseline model we have considered financial aid from the foreign country in the form of a transfer to the debtholders of the failing bank. This form of external support, which resembles the Direct Recapitalization Instrument (DRI) established by the European Stability Mechanism (ESM) in 2014, differs from the indirect recapitalization instrument (IRI), in which the ESM grants a loan to a fragile sovereign to support the resolution of domestic failing banks. The current agreements among EU members establish a pecking order in the use of these instruments: Access to the Direct Recapitalization Instrument can only be granted "if indirect recapitalization is not possible," and its use requires some contribution by the sovereign in distress.

In this section we extend the model to allow for both direct transfers and loans issued by the foreign country, and inquire about the optimality of prioritizing indirect foreign aid. We introduce an additional date, $t = 2$, at which the sovereigns may also raise public funds. Countries may be stable or undergo a crisis at $t = 2$. To keep the setup as simple as possible, we assume that a country undergoing a crisis becomes stable at $t = 2$ with probability $\rho_C \in (0, 1)$ and that a stable country continues to be stable with probability $\rho_S \in (0, 1]$. We denote the expected cost of public funds at $t = 2$ given the sovereign state $h \in \{S, C\}$ at $t = 1$ as $\tilde{\lambda}_h \equiv \rho_h \lambda_S + (1 - \rho_h)\lambda_C$. We restrict loans to be fiscally neutral (in expectation) for the lending country so that any subsidy among countries is channeled through direct transfers. Hence, the gross interest rate on a loan granted by a country in state $h \in \{S, C\}$ is given by $R_h = \frac{1+\lambda_h}{1+\tilde{\lambda}_h}$.

Formally, and similarly to the baseline model, we can describe a banking union by a pair $(x_{i,\sigma}, y_{i,\sigma})$, establishing for each of the bank failure states (i, σ) the home country contribution $x_{i,\sigma}$ and the amount $y_{i,\sigma}$ borrowed as indirect aid to fund bail-outs. The remaining amount $1 - x_{i,\sigma} - y_{i,\sigma}$ is provided by the foreign country in the form of direct foreign aid. As in the baseline model, a standard mechanism-design approach allows us to focus on resolution mechanisms in which the decision of whether to bail out or to bail in the failing bank is delegated to the home resolution authority.

In order to illustrate the role for loans in this setup, consider a bank failure while the home country is undergoing a crisis and the foreign country is stable. Partially funding a bail-out through a foreign country loan plays the same role as home contributions in reducing the willingness of the domestic authority to overstate the need for foreign support, as the loan has to be paid back at $t = 2$. Moreover, since the country undergoing the crisis pays back the loan at a time at which it is stable with positive probability, substituting home contributions with a loan from the foreign country reduces the expected cost of funds for the borrowing country, since $\left(1 + \tilde{\lambda}_C\right) R_S < 1 + \lambda_C$. Moreover, by construction of R_S, the loan is fiscally neutral for the lending country. Therefore, indirect foreign aid dominates home contributions. Nonetheless, since $\tilde{\lambda}_C > \lambda_S$, direct foreign aid constitutes a less costly source of public funds from an aggregate perspective. Hence, as in the baseline model, there is an aggregate cost advantage of using direct foreign aid to fund banks' bail-outs. Consequently, the optimal funding mix consists of a combination of a direct transfer and a loan from the foreign country, thereby eliminating home contributions in the resolution of banks.

When both countries are either concurrently stable, or simultaneously undergoing a crisis, there is no gain from using loans. Hence, any loan could be substituted out by a contemporaneous home contribution with no payoff consequence for any of the countries. In order to simplify the exposition, in the following proposition we focus on the set of mechanisms in which the use of loans strictly improves welfare. A similar analysis to that conducted in Section 4 leads to the following result:

Proposition 7 (Banking union with direct and indirect foreign aid) *Assume that* $q^{SC} < 1$. *The optimal banking union* $(\widehat{\boldsymbol{x}}, \widehat{\boldsymbol{y}})$ *is such that:*

(i) In states $(i, \sigma) \in \{(1, CS), (2, SC)\}$ *bail-outs are funded with a combination of strictly positive amounts of direct (transfer) and indirect (loan) foreign aid–and no contemporaneous home contributions–,that is,* $\widehat{x}_{i,\sigma} = 0$ *and* $\widehat{y}_{i,\sigma} \in (0, 1)$ *(and thus* $1 - \widehat{x}_{i,\sigma} - \widehat{y}_{i,\sigma} \in (0, 1)$*).*

(ii) In states $(i, \sigma) \notin \{(1, CS), (2, SC)\}$*, indirect (loan) foreign aid is not issued, that is,* $\widehat{y}_{i,\sigma} = 0$*, and thus any source of foreign aid is channeled through direct transfers.*

The proposition states that in every contingency in which it is optimal to issue loans, these must be combined with a direct transfer from the issuing country to reduce the aggregate cost of bail-outs. In addition, in those states, it is also optimal not to require home contributions, as the loans provide incentives for local authorities not to overstate the need for bail-outs.

Unlike the ESM design of the DRI as a last resort instrument, this result suggests that the DRI should be considered as an integral part of optimal resolution schemes, which should be systematically used in combination with the IRI. Moreover, the access to the DRI should be granted without requiring the home sovereign undergoing a crisis to contribute to the funding of a bail-out contemporaneously.

6.3 Cross-border debt holdings

In this section we show that the presence of cross-border liabilities provides an additional motive for countries to form a banking union and increases the welfare gains generated by such an agreement. Formally, we assume that a fraction β of each bank's debt is held by agents of the foreign country. The case $\beta = 0$ thus corresponds to the baseline model. We keep the assumption that bail-ins originate a disruption cost of k at the home country that is privately observed by the home authority. This assumption is particularly plausible for banks whose core lending activities are domestic, in which case the potential contagion to other banks will be presumably confined to domestic institutions whose assets are more correlated with those of the failing bank.[26]

Consider the resolution of a bank at a country undergoing a crisis when the foreign country is stable. Let x denote the home contribution to a bail-out in the baseline economy and x' a home contribution in the economy with cross-border liabilities. The following comparison ensues:

Utility following bail-out	Cross-border	Baseline
Home	$1-\beta-(1+\lambda_C)x'$	$1-(1+\lambda_C)x$
Foreign	$\beta-(1+\lambda_S)(1-x')$	$-(1+\lambda_S)(1-x)$

Setting $x' \equiv x - \frac{\beta}{1+\lambda_C}$, it follows that the utility-upon-bail-out difference between the cross-border and the baseline economy is given by:

Home	$1-\beta-(1+\lambda_C)x'-(1-(1+\lambda_C)x)=0$
Foreign	$\beta-(1+\lambda_S)(1-x')-(-(1+\lambda_S)(1-x))=\frac{\lambda_C-\lambda_S}{1+\lambda_C}>0$

These expressions show that starting with any home contribution x to bail-outs in the baseline model, we can reduce the home contribution to x' in the case in which there are cross-border debt holdings, maintaining the home country's utility unaltered and strictly increasing the foreign country's utility. The reason is that when a fraction of the bank's debt is held abroad, the foreign country's contribution to a bail-out constitutes a partial transfer to its own agents.

These arguments can be generalized to the remaining bank-failure states, as we state in the following proposition.

Proposition 8 (Banking union with cross-border liabilities) *Suppose that a fraction $\beta > 0$ of each bank's debt is held by agents from the foreign country. Then the welfare*

[26] Under the assumption that a bail-in generates contagion costs also in the foreign country, and that its magnitude is privately observed by the foreign authority, the mechanism design problem would be such that the principal (the central authority) has to provide incentives to reveal their private information to two agents–both the home and the foreign authority. The formal analysis in this case becomes much more complex and is beyond the scope of this paper.

gains relative to autarky induced by the optimal banking union are strictly larger than in the baseline model.

The presence of cross-border liabilities provides an additional motive for countries to be willing to share the costs of bailing out banks. The proposition shows that such motive adds to the risk-sharing motive highlighted in the baseline model and increases the welfare gains that the optimal banking union attains.

7 Conclusion

In this paper, we analyze the optimal bank resolution and the design of a fiscal backstop in a banking union. The rationale for a banking union is to provide a risk-sharing agreement across countries when one of the sovereigns may be in financial distress at the time of having to resolve a failing domestic bank. We address the potential for risk-sharing in a banking union in a setup that takes into consideration two features that are prevalent in the eurozone banking union project: Supranational resolution authorities must rely on the information provided by domestic resolution authorities and countries differ on the strength of their public finances.

The informational friction limits the extent of risk-sharing because countries face an incentive to overstate the bail-in cost to obtain funding from the neighboring country to bail out home troubled banks. The ex-post aggregate welfare resolution policies in a banking union entail co-funding of bail-outs if and only if banks are located in countries undergoing a crisis and the foreign country is stable. In addition, ex-post optimal decisions have to be distorted when country asymmetry is large to ensure the participation of the strong country in the banking union. In particular, we find that the required distortions reduce the amount of foreign aid to the weak country and increase the transfers to the strong country, thereby increasing the probability of bail-outs in the strong country and decreasing it in the weak country.

The findings in the paper highlight the importance of establishing country-specific resolution policies for heterogenous countries to benefit from a banking union. However, even though asymmetric resolution policies privilege the strong country's bank, it is the weak country's agents that appropriate the surplus created by the banking union. Indeed, the optimal banking union when country asymmetry is large leads to a net welfare gain of the weak country's agents, and to a redistribution of welfare from the taxpayer to the bank owners within the strong country.

The paper also highlights that requiring expected transfers to net out across countries is suboptimal. In particular, we find that strong countries should be the net receiver of funds when their public finances are always stable.

The need for country-specific policies to ensure the participation of the strong countries in the union extends to the case in which authorities can early intervene a bank at a time in which the liquidation of the bank assets yields sufficient proceeds to repay debtholders in full. We find that the optimal banking union exhibits forbearance in the early intervention decisions of the bank in the strong country and is tight in intervening the weak country's bank.

Our results also have implications for the design of the European Stability Mechanism assistance programs. We find that the current "pecking order", which envisions the direct recapitalization instrument as a last recourse option, is suboptimal: Combining loans with direct transfers can improve upon the existing regulation.

Finally, the paper highlights a risk-sharing rationale for a banking union. Nonetheless, the presence of cross-country debt exposures among banking sectors facilitates risk-sharing agreements and enhances the welfare that countries can attain through a banking union.

Appendix

A Truth-telling bank resolution mechanisms

In this appendix we first characterize the different types of truth-telling resolution mechanisms and then select the only type that is relevant for the analysis of an optimal banking union. We show, as stated in Section 2, that the relevant truth-telling mechanisms can be described by the required home contribution to bail-outs x, and can be implemented by delegating the resolution decision (bail-out or bail-in) to the home authority.

We first adopt without loss of generality the following convention: for the knife-edge cases in which under a particular resolution mechanism the home authority is indifferent between reporting a value of k that leads to a bail-out and another one leading to a bail-in, we assume that it chooses to report the former.[27]

Let $\left\{b_{i,\sigma}(\hat{k}), x_{i,\sigma}(\hat{k})\right\}$ be a resolution mechanism in bank failure state (i, σ). Suppose that the bail-in cost observed by the home authority is k. The expected utility of agents in country i if the home authority reports $\widehat{k}$ is given by:

$$V(\widehat{k}, k) = \underbrace{b_{i,\sigma}(\widehat{k})}_{\text{Debtholders' payoff}} - \underbrace{(1 - b_{i,\sigma}\left(\widehat{k}\right))k}_{\text{Bail-in Cost}} - \underbrace{(1 + \lambda_{i,\sigma})\, x_{i,\sigma}(\widehat{k})}_{\text{Cost Public Funds}}, \tag{A1}$$

where $\lambda_{i,\sigma}$ denotes the deadweight cost associated with raising public funds in country i in the state of public finances σ. The first term in (A1) corresponds to the transfer that the bank's debtholders receive through a bail-out. The second term stands for the bail-in costs. The last term includes the expected gross social cost of the funds country i has to provide for the resolution of its bank. The truth-telling property of the resolution mechanism can then be written as:

$$V(k, k) \geq V(\widehat{k}, k) \text{ for all } k \text{ and } \widehat{k} \in [0, k_{\max}]. \tag{A2}$$

The next lemma characterizes the set of incentive compatible resolution mechanisms.

Lemma 1 *A resolution mechanism for a failing bank in a country is truth-telling if and only if it belongs to one of the three following classes:*

1. *(Unconditional bail-in)* $b_{i,\sigma}(k) = 0$ *for all* $k \in [0, k_{\max}]$.
2. *(Unconditional bail-out) There exists* $\bar{x} \in [0, 1]$ *such that* $b_{i,\sigma}(k) = 1$ *and* $x_{i,\sigma}(k) = \overline{x}$ *for all* $k \in [0, k_{\max}]$.

[27] Without this convention, there could be other truth-telling schemes on top of those described in the ensuing Lemma 1 in which the close interval is open on its left boundary. Nonetheless, these other mechanisms are ex-ante payoff equivalent to those described in Lemma 1.

3. *(Threshold) There exists* $x \in (\underline{x}, 1]$ *and* $\overline{k}_{i,\sigma}(x) \in (0, k_{\max})$ *such that* $b_{i,\sigma}(k) = 1$ *if and only if* $k \geq \overline{k}_{i,\sigma}(x)$*, in which case* $x_{i,\sigma}(k) = x$*. Moreover, we have that*

$$\overline{k}_{i,\sigma}(x) = (1 + \lambda_{i,\sigma})x - 1, \tag{A3}$$

where $\underline{x} \in (0, 1)$ *is uniquely determined by the condition* $\overline{k}_{i,\sigma}(\underline{x}) = 0$*.*

Proof *Necessity* Suppose that $\left\{b_{i,\sigma}\left(\widehat{k}\right), x_{i,\sigma}\left(\widehat{k}\right)\right\}$ is an incentive compatible (truth-revealing) mechanism. Let us define the set $\Gamma^1 = \{k \in [0, k_{\max}] \text{ s.t. } b_{i,\sigma}(k) = 1\}$. If Γ^1 is empty then case 1 in the lemma is satisfied. Let us suppose that Γ^1 is non empty. Taking into account that $(1 + \lambda_{i,\sigma})\, x$ is strictly increasing in x, it is immediate to show that truth-telling implies that there exists a constant $\overline{x}$ such that $x_{i,\sigma}(k) = \overline{x}$ for all $k \in \Gamma^1$.

Let us now prove that if $k' \geq k$ for some $k \in \Gamma^1$ then $k' \in \Gamma^1$. In fact, incentive compatibility implies

$$\begin{aligned} V(k', k') \geq V(k, k') \Leftrightarrow \quad & b_{i,\sigma}(k') - (1 - b_{i,\sigma}(k'))k' - (1 + \lambda_{i,\sigma})\, x_{i,\sigma}(k') \geq \\ & \geq 1 - (1 + \lambda_{i,\sigma})\, \overline{x}, \\ V(k, k) \geq V(k', k) \Leftrightarrow \quad & 1 - (1 + \lambda_{i,\sigma})\, \overline{x} \geq \\ & \geq b_{i,\sigma}(k') - (1 - b_{i,\sigma}(k'))k - (1 + \lambda_{i,\sigma})\, x_{i,\sigma}(k'), \end{aligned}$$

and combining the two inequalities we have

$$-(1 - b_{i,\sigma}(k'))k' \geq -(1 - b_{i,\sigma}(k'))k,$$

which can only be satisfied if $b_{i,\sigma}(k') = 1$.

Let $\overline{k} = \inf(\Gamma^1)$. We must have $\overline{k} \in \Gamma^1$. In fact, if that is not the case then $b_{i,\sigma}(\overline{k}) = 0$. By definition of $\overline{k}$, for any $\varepsilon > 0$ there exists $k' \in \Gamma^1$ and such that $0 < k' - \overline{k} < \varepsilon$. Incentive compatibility implies:

$$\begin{aligned} V(\overline{k}, \overline{k}) \quad &\geq \quad V(k', \overline{k}) \Leftrightarrow -\overline{k} \geq 1 - (1 + \lambda_{i,\sigma})\, \overline{x} \\ V(k', k') \quad &\geq \quad V(\overline{k}, k') \Leftrightarrow 1 - (1 + \lambda_{i,\sigma})\, \overline{x} \geq -k'. \end{aligned}$$

Combining the two inequalities and taking limits $\varepsilon \to 0$ we conclude that

$$-\overline{k} = 1 - (1 + \lambda_{i,\sigma})\, \overline{x}.$$

But then when the local authority observes $\overline{k}$ it is indifferent between reporting $\overline{k}$, which leads to a bail-in, and reporting any $k \in \Gamma^1$, which leads to a bail-out. Our convention established at the beginning of this Appendix then states that the local authority would report $k \in \Gamma^1$ and the mechanism would not be truth-revealing. Hence we must have $\overline{k} \in \Gamma^1$ and the fact that for all $k \geq \overline{k}$ we have $k \in \Gamma^1$ then implies that $\Gamma^1 = [\overline{k}, 1]$. If $\overline{k} = 0$ then case 2 in the lemma is satisfied. If $\overline{k} > 0$ then for any $k < \overline{k}$ it has to be the case that $b_{i,\sigma}(k) = 0$ and incentive compatibility implies

$$\begin{aligned} V(\overline{k},\overline{k}) &\geq V(k,\overline{k}) \Leftrightarrow 1-(1+\lambda_{i,\sigma})\,\overline{x} \geq -\overline{k} \\ V(k,k) &\geq V(\overline{k},k) \Leftrightarrow -k \geq 1-(1+\lambda_{i,\sigma})\,\overline{x}. \end{aligned}$$

Taking limits $k \rightarrow \overline{k}$ and combining the two inequalities we have that

$$1-(1+\lambda_{i,\sigma})\,\overline{x} = -\overline{k},$$

and then case 3 in the lemma is satisfied.

Sufficiency It is straightforward to check that the mechanisms in the 3 cases in the lemma satisfy incentive compatibility.■

Some of the truth telling mechanisms characterized in the previous lemma cannot be part of an optimal banking union because they are Pareto dominated. We have:

Lemma 2 *The following truth-telling mechanisms are Pareto dominated and can be discarded for the analysis of the ex-post optimal resolution policies and of the optimal banking union:*

1. *The unconditional bail-in mechanism is Pareto dominated by a threshold mechanism with home contribution to bail-outs $x = 1$.*
2. *The unconditional bail-out mechanism characterized by a home contribution $\bar{x} > \underline{x}$ to bail-outs is Pareto dominated by a threshold mechanism with home contribution to bail-outs $x = \bar{x}$.*

Proof The first statement is an immediate consequence of the assumption $c_{\max} > \lambda_C$ and the fact that the foreign country is indifferent between an unconditional bail-in policy and a threshold mechanism in which bail-outs are entirely locally funded (i.e., such that $x = 1$).

Second, by construction the home country prefers a threshold mechanism with home contribution to bail-outs $x = \bar{x}$ to an unconditional bail-out mechanism with the same home contribution. The foreign country also prefers the former because it strictly reduces the probability that it has to contribute to fund a bail-out.■

We conclude that it suffices to restrict our attention to the threshold mechanisms, which are described by a home contribution to bail-outs $x > \underline{x}$, and the unconditional bail-out mechanisms with home contribution to bail-outs $\bar{x} \leq \underline{x}$, which can be also thought as a family of threshold mechanisms where the induced bail-out threshold is $\overline{k} = 0$. This justifies our restriction in the entire paper to resolution mechanisms that are described by the required home contribution to bail-outs x in the entire interval $x \in [0, 1]$, and in which the decision on whether to conduct a bail-out or a bail-in is delegated to the home authority.

B Proofs

Proof of Proposition 1 We have proved all the statements of the proposition in the text preceding the proposition, except for:

i) No $x \leq \frac{1}{1+\lambda_C}$ is optimal.

In fact, we have that:

$$\Pi(1) = \int_0^{\lambda_C} kdG(k) + \lambda_C(1 - G(\lambda_C)) < \int_0^{k_{\max}} kdG(k) < \lambda_S = \Pi(0),$$

where the inequality follows from Assumption 2. Since $\Pi'(x) > 0$ for all $x < \frac{1}{1+\lambda_C}$, the inequality above implies that $\Pi(x) \geq \Pi(0) > \Pi(1)$ for all $x \leq \frac{1}{1+\lambda_C}$.

ii) The function $\Pi(x)$ is convex in the interval $x \in \left[\frac{1}{1+\lambda_C}, 1\right]$ and thus has a unique minimum in this interval.

Plugging the expression for the p.d.f. and the c.d.f. of a uniform distribution in the expression for $\Pi'(x)$ in (6) we have that:

$$\Pi'(x) = (\lambda_C - \lambda_S)\frac{k_{\max} - \overline{k}(x)}{k_{\max}} - (1 + \lambda_S)(1 - x)(1 + \lambda_C)\frac{1}{k_{\max}}.$$

Differentiating the latter expression with respect to x we obtain:

$$\Pi''(x) = \frac{1 + \lambda_C}{k_{\max}}\left[-(\lambda_C - \lambda_S) + (1 + \lambda_S)\right] = \frac{1 + \lambda_C}{k_{\max}}(1 + 2\lambda_S - \lambda_C) > 0,$$

where in the last inequality we have used that Assumption 2 implies that $2\lambda_S > k_{\max} > \lambda_C$.■

Proof of Proposition 2 The expression for the gains from entering the ex-post optimal banking union in (8) can be easily obtained from the general expression for the utility of agents in a country within any banking union in (12).

From (8) we have that $U_1(\boldsymbol{x}^*) - \overline{U}_1 \geq 0$ if and only if:

$$\begin{aligned} q^{CS}\left(\Pi^C - \Pi(x^*)\right) &\geq \left(q^{SC} - q^{CS}\right)(1 - x^*)(1 + \lambda_S)\left(1 - G\left(\overline{k}(x^*)\right)\right) \\ &\Leftrightarrow \\ q^{CS} &\geq aq^{SC}, \end{aligned} \tag{B1}$$

where:

$$a \equiv \frac{(1 - x^*)(1 + \lambda_S)\left(1 - G\left(\overline{k}(x^*)\right)\right)}{\Pi^C - \Pi(x^*) + (1 - x^*)(1 + \lambda_S)\left(1 - G\left(\overline{k}(x^*)\right)\right)} \in (0, 1).$$

Finally, from Assumption 1, and using the fact that $q^{SC} > q^{CS}$, we have that if the participation constraint of country 1 is satisfied then the participation constraint of country 2 is also satisfied. We conclude that a banking union with ex-post optimal resolution policies satisfies the participation constraint of the two countries if and only if (B1) is satisfied.■

Proof of Proposition 3 We refer to a general banking union as $\boldsymbol{x}$. Let us first state some properties of the partial derivatives of the aggregate welfare function and the expected utility in each country that have either been discussed in Section 4.3 or that can be easily derived from the expressions introduced in that section.

- For any (i, σ):
$$\frac{\partial W(\boldsymbol{x})}{\partial x_{i,\sigma}} = -(1-p)q^{\sigma}\frac{\partial \Pi(x_{i,\sigma}|i,\sigma)}{\partial x_{i,\sigma}}.$$

- For any i and $\sigma \in \{SS, CC\}$, if $q^{\sigma} > 0$:
$$\frac{\partial W(\boldsymbol{x})}{\partial x_{i,\sigma}} > 0 \text{ if } x_{i,\sigma} < 1, \text{ and } \frac{\partial W(\boldsymbol{x})}{\partial x_{i,\sigma}} = 0 \text{ if } x_{i,\sigma} = 1.$$

- For $(i, \sigma) \in \{(1, SC), (2, CS)\}$, if $q^{\sigma} > 0$:
$$\frac{\partial W(\boldsymbol{x})}{\partial x_{i,\sigma}} > 0.$$

- For $(i, \sigma) \in \{(1, CS, (2, SC)\}$, if $q^{\sigma} > 0$:
$$\frac{\partial W(\boldsymbol{x})}{\partial x_{i,\sigma}} > 0 \text{ if } \frac{1}{1+\lambda_{i,\sigma}} < x_{i,\sigma} < x^*, \ \frac{\partial W(\boldsymbol{x})}{\partial x_{i,\sigma}} = 0 \text{ if } x_{i,\sigma} = x^*, \text{ and } \frac{\partial W(\boldsymbol{x})}{\partial x_{i,\sigma}} < 0 \ \text{ otherwise.}$$

- For any (i, σ), if $q^{\sigma} > 0$:
$$\frac{\partial U_i(\boldsymbol{x})}{\partial x_{i,\sigma}} < 0, \text{ and } \frac{\partial U_i(\boldsymbol{x})}{\partial x_{\bar{i},\sigma}} > 0.$$

Let $\widehat{\boldsymbol{x}} \equiv (\widehat{x}_{i,\sigma})$ be an optimal banking union. Let us denote PC_i the participation constraint of country i. We first prove the existence of a feasible banking union when $q^{SC} < 1$ and the properties of the optimal one. We then prove that there is no proper feasible banking union when $q^{SC} = 1$.

Optimal banking union when $q^{SC} < 1$

We conduct the proof of the statements in the proposition in a sequence of steps.

i) Any optimal banking union strictly increases aggregate welfare relative to autarky.

It suffices to find a banking union that strictly increases aggregate welfare relative to autarky. Since $q^{SC} < 1$, at least one of the three following inequalities is satisfied:

a) $q^{CS} > 0$.

From (12) we have that

$$\begin{aligned}
\frac{1}{q^{CS}}\frac{\partial U_1(\mathbf{1})}{\partial x_{1,CS}} &= \frac{1}{q^{SC}}\frac{\partial U_2(\mathbf{1})}{\partial x_{2,SC}} = -(1-p)(1+\lambda_C)\left(1-G\left(\lambda_C\right)\right), \\
\frac{1}{q^{CS}}\frac{\partial U_2(\mathbf{1})}{\partial x_{1,CS}} &= \frac{1}{q^{SC}}\frac{\partial U_1(\mathbf{1})}{\partial x_{2,SC}} = (1-p)(1+\lambda_S)\left(1-G\left(\lambda_C\right)\right),
\end{aligned} \quad \text{(B2)}$$

where $\mathbf{1}$ denotes the autarky banking union. Let us consider the family of banking unions $\boldsymbol{x}(y)$, indexed by the parameter $y \geq 0$, which is characterized by: $x_{1,CS}(y) = 1-y, x_{2,SC}(y) = 1 - \gamma y$ with $\gamma \equiv \frac{q^{CS}(1+\lambda_C)}{q^{SC}(1+\lambda_S)} - \varepsilon$ and $\varepsilon > 0$, and $x_{i,\sigma}(y) = 1$ for any other (i, σ). Using (B2), we have that

$$
\begin{aligned}
\left.\frac{d\widehat{U}_1(\boldsymbol{x}(y))}{dy}\right|_{y=0} &= -\frac{\partial U_1(\mathbf{1})}{\partial x_{1,CS}} - \gamma \frac{\partial U_1(\mathbf{1})}{\partial x_{2,SC}} = \\
&= \varepsilon(1-p)q^{SC}(1+\lambda_S)\left(1 - G\left(\lambda_C\right)\right), \text{ and} \\
\left.\frac{d\widehat{U}_2(\boldsymbol{x}(y))}{dy}\right|_{y=0} &= -\frac{\partial U_2(\mathbf{1})}{\partial x_{1,CS}} - \gamma \frac{\partial U_2(\mathbf{1})}{\partial x_{2,SC}} = \\
&= (1-p)\left(1 - G\left(\lambda_C\right)\right)\left[\frac{(1+\lambda_C)^2 - (1+\lambda_S)^2}{1+\lambda_S} q^{CS} - \varepsilon q^{SC}\left(1+\lambda_C\right)\right].
\end{aligned}
$$

We have that since $q^{CS} > 0$, then for ε sufficiently small $\left.\frac{d\widehat{U}_1(\boldsymbol{x}(y))}{dy}\right|_{y=0} > 0$ and $\left.\frac{d\widehat{U}_1(\boldsymbol{x}(y))}{dy}\right|_{y=0} > 0$. Then, there exists $y > 0$ such that in the banking union $\boldsymbol{x}(y)$ both countries are strictly better off than in autarky.

b) $q^{SS} > 0$.

From (12) we have that

$$
\frac{\partial U_1(\mathbf{1})}{\partial x_{1,SS}} = -\frac{\partial U_2(\mathbf{1})}{\partial x_{1,SS}} = -(1-p)q^{SS}(1+\lambda_S)\left(1 - G\left(\lambda_S\right)\right). \tag{B3}
$$

Let us consider the family of banking unions $\boldsymbol{x}(y)$ indexed by the parameter $y \geq 0$ characterized by: $x_{1,SS}(y) = 1 - y, x_{2,SC}(y) = 1 - \gamma y$ with $\gamma \equiv \frac{q^{SS}(1-G(\lambda_S))}{q^{SC}(1-G(\lambda_C))} - \varepsilon$ and $\varepsilon > 0$, and $x_{i,\sigma}(y) = 1$ for any other (i, σ). Using (B2) and (B3), the arguments of the previous case can be reproduced in an analogous manner and show that there exists $y > 0$ such that in the banking union $\boldsymbol{x}(y)$ both countries are strictly better off than in autarky.

c) $q^{CC} > 0$.

Analogous to case b.

Notice that if $q^{\sigma} = 0$ for some σ, the specific resolution policies in the bank failure states (i, σ) are irrelevant. For the sake of shortening our arguments we will assume throughout the rest of the proof of the case $q^{SC} < 1$ that $q^{\sigma} > 0$ for *all* $\sigma \in \{SS, CC, CS\}$. The reader can easily check that our arguments are valid if $q^{\sigma} > 0$ for *some* $\sigma \in \{SS, CC, CS\}$, which has to be the case since $q^{SC} < 1$.

ii) Exactly one of the participation constraints is binding.

Suppose none of the participation constraints is binding. Then $\widehat{\boldsymbol{x}} = \boldsymbol{x}^*$. But we have $q^{CS} < aq^{SC}$, and Proposition 2 implies $\boldsymbol{x}^*$ is not feasible.

Suppose PC_i is binding. Then $PC_{\bar{i}}$ is not binding because otherwise *i)* would imply that $\widehat{\boldsymbol{x}}$ is not optimal.

iii) If PC_1 *is binding then* $\widehat{\boldsymbol{x}}$ satisfies $\widehat{x}_{1,SS} < \widehat{x}_{2,SS} = 1, \widehat{x}_{1,CC} < \widehat{x}_{2,CC} = 1, \widehat{x}_{2,CS} = 1, \widehat{x}_{1,CS} < x^*$.

If PC_1 is binding then *ii)* implies that PC_2 is not binding.

For $\sigma \neq SC$, the properties of the derivatives of $W(\boldsymbol{x})$ and $U_1(\boldsymbol{x})$ with respect to $x_{2,\sigma}$ when $x_{2,\sigma} < 1$ and the optimality of $\widehat{\boldsymbol{x}}$, immediately imply that $\widehat{x}_{2,SS} = \widehat{x}_{2,CC} = \widehat{x}_{2,CS} = 1$.

For $\sigma \in \{SS, CC\}$, the properties of the derivatives of $W(\boldsymbol{x})$ and $U_1(\boldsymbol{x})$ with respect to $x_{1,\sigma}$ when $x_{1,\sigma} = 1$ and the optimality of $\widehat{\boldsymbol{x}}$, immediately imply that $\widehat{x}_{1,SS} < 1$ and $\widehat{x}_{1,CC} < 1$.

The properties of the derivatives of $W(\boldsymbol{x})$ and $U_1(\boldsymbol{x})$ with respect to $x_{1,CS}$ when $x_{1,CS} \geq x^*$ and the optimality of $\widehat{\boldsymbol{x}}$, immediately imply that $\widehat{x}_{1,CS} < x^*$.

iv) If PC_1 *is binding then* $\widehat{\boldsymbol{x}}$ satisfies $x^* < \widehat{x}_{2,SC} < 1$.

If PC_1 is binding then *ii)* implies that PC_2 is not binding and the properties of $\widehat{\boldsymbol{x}}$ in *iii)* are satisfied.

The properties of the derivatives of $W(\boldsymbol{x})$ and $U_1(\boldsymbol{x})$ with respect to $x_{2,SC}$ when $x_{2,SC} \in \left[\frac{1}{1+\lambda_C}, x^*\right]$ and the optimality of $\widehat{\boldsymbol{x}}$, imply that $\widehat{x}_{2,SC} \notin \left[\frac{1}{1+\lambda_C}, x^*\right]$.

Suppose that $\widehat{x}_{2,SC} < \frac{1}{1+\lambda_C}$ and thus $\overline{k}(\widehat{x}_{2,SC}|2, SC) = 0$. We thus have that:

$$\Pi(\widehat{x}_{2,SC}|2, SC) \geq \Pi(0|2, SC) > \Pi(1|2, SC), \tag{B4}$$

where the last inequality follows from Assumption 2.

Let us now prove that the following inequality holds:

$$\Pi(\widehat{x}_{1,CS}|1, CS) > \Pi(1|1, CS). \tag{B5}$$

We have from *iii)* that $\widehat{x}_{1,CS} < x^*$. If $\widehat{x}_{1,CS} \leq \frac{1}{1+\lambda_C}$ the same arguments as for the bank failure state $(2, SC)$ imply the inequality. Suppose that $\widehat{x}_{1,CS} > \frac{1}{1+\lambda_C}$ so that $\overline{k}(\widehat{x}_{1,CS}|1, CS) > 0$. Let us denote $\mu > 0$ the Lagrange multiplier of the participation constraint of country 1 at the banking union $\widehat{\boldsymbol{x}}$. Optimality of $\widehat{\boldsymbol{x}}$ implies that

$$\left.\frac{\partial W}{\partial x_{2,SC}}\right|_{x_{2,SC}=\widehat{x}_{2,SC}} \geq -\mu \left.\frac{\partial U_1}{\partial x_{2,SC}}\right|_{x_{2,SC}=\widehat{x}_{2,SC}}, \text{ with equality iff } \widehat{x}_{2,SC} > 0. \tag{B6}$$

Using that $\overline{k}(x_{2,SC}|2, SC) = 0$ for all $x_{2,SC} < \frac{1}{1+\lambda_C}$, we can compute the marginal derivatives in the inequality above and obtain after some algebra

$$\mu \geq \frac{\lambda_C - \lambda_S}{1 + \lambda_S}. \tag{B7}$$

In addition, using that $\widehat{x}_{1,CS} \in \left(\frac{1}{1+\lambda_C}, x^*\right)$ the optimality of $\widehat{\boldsymbol{x}}$ implies that:

$$\left.\frac{\partial W}{\partial x_{1,CS}}\right|_{x_{1,CS}=\widehat{x}_{1,CS}} = -\mu \left.\frac{\partial U_1}{\partial x_{1,CS}}\right|_{x_{1,CS}=\widehat{x}_{1,CS}}, \tag{B8}$$

which after some algebra can be written as:

$$[\mu\,(1+\lambda_C)+\lambda_C-\lambda_S]=\frac{(1+\lambda_S)\,(1-\widehat{x}_{1,CS})\,(1+\lambda_C)}{k_{\max}-((1+\lambda_C)\widehat{x}_{1,CS}-1)}. \tag{B9}$$

Notice that x^* is defined as the solution of (B8) for $\mu=0$, and thus from the equality above the following equality follows:

$$\lambda_C-\lambda_S=\frac{(1+\lambda_S)\,(1-x^*)\,(1+\lambda_C)}{(k_{\max}-((1+\lambda_C)x^*-1))}. \tag{B10}$$

Dividing (B9) by (B10) we obtain:

$$\frac{1+\lambda_C}{\lambda_C-\lambda_S}\mu+1=\frac{1-\widehat{x}_{1,CS}}{1-x^*}\frac{k_{\max}-((1+\lambda_C)x^*-1)}{k_{\max}-((1+\lambda_C)\widehat{x}_{1,CS}-1)}.$$

Using (B7) an recognizing that $\widehat{x}_{1,CS}<x^*$, it follows from the latter expression that:

$$\begin{aligned} 2 &< \frac{1+\lambda_C}{1+\lambda_S}+1\le\frac{1+\lambda_C}{\lambda_C-\lambda_S}\mu+1= \\ &= \frac{1-\widehat{x}_{1,CS}}{1-x^*}\frac{k_{\max}-((1+\lambda_C)x^*-1)}{k_{\max}-((1+\lambda_C)\widehat{x}_{1,CS}-1)}<\frac{1-\widehat{x}_{1,CS}}{1-x^*}, \end{aligned}$$

and thus:

$$1-x^*<x^*-\widehat{x}_{1,CS}.$$

Finally, since the function $\Pi(x_{1,CS}|1,CS)$ achieves a minimum at $x_{1,CS}=x^*$, the inequality above implies (B5).

For any other $(i,\sigma)\notin\{(1,CS),(2,SC)\}$, it follows from *iii)* and the properties of the derivatives of $W(\boldsymbol{x})$ with respect to $x_{i,\sigma}$ that:

$$\Pi(\widehat{x}_{i,\sigma}|i,\sigma)\ge\Pi(1|i,\sigma). \tag{B11}$$

Taking (B4), (B5) and (B11) together we have that $W(\widehat{\boldsymbol{x}})<W(1)$, which contradicts the optimality of $\widehat{\boldsymbol{x}}$. We conclude that it cannot be the case that $\widehat{x}_{2,SC}<\frac{1}{1+\lambda_C}$, and thus we must have $\widehat{x}_{2,SC}>x^*$.

Finally, taking *iii)* into consideration, if $\widehat{x}_{2,SC}=1$ it would follow that all the home contributions of country 2 are equal to 1. Moreover, since $q^{SC}<1$, there would be at least one home contribution of country 1 that occurs with positive probability and is different from 1. As a result, PC_2 would not be satisfied.

v) If PC_1 is binding then $\widehat{\boldsymbol{x}}$ satisfies $\widehat{x}_{1,SC}=1$.

Suppose that PC_1. Let $\mu>0$ denote again the Lagrange multiplier of the participation constraint of country 1 at $\widehat{\boldsymbol{x}}$. Using *iv),* we have that (B6) is satisfied with equality. Some algebra rearrangements lead to:

$$\frac{\lambda_C-\lambda_S-\mu(1+\lambda_S)}{1+\mu}=\frac{(1+\lambda_S)\,(1-\widehat{x}_{2,SC})\,(1+\lambda_C)}{k_{\max}-\overline{k}(\widehat{x}_{2,SC}|2,SC)}>0, \tag{B12}$$

and thus the Lagrangian multiplier μ satisfies:

$$\mu < \frac{\lambda_C - \lambda_S}{1 + \lambda_S}. \tag{B13}$$

Suppose that $\widehat{x}_{1,SC} < 1$. The optimality of $\widehat{\boldsymbol{x}}$ implies that:

$$\left.\frac{\partial W}{\partial x_{1,SC}}\right|_{x_{1,SC}=\widehat{x}_{1,SC}} \geq -\mu \left.\frac{\partial U_1}{\partial x_{1,SC}}\right|_{x_{1,SC}=\widehat{x}_{1,SC}} \quad \text{with equality iff } \widehat{x}_{1,SC} > 0. \tag{B14}$$

Let us first consider the case that $\widehat{x}_{1,SC} > \frac{1}{1+\lambda_S}$ so that (B14) is satisfied with equality and $\overline{k}(\widehat{x}_{1,SC}|1, SC) > 0$. Some algebra rearrangements lead to:

$$\mu(1 + \lambda_S) - (\lambda_C - \lambda_S) = \frac{(1 + \lambda_C)\,(1 - \widehat{x}_{1,SC})\,(1 + \lambda_S)}{k_{\max} - \overline{k}(\widehat{x}_{1,SC}|1, SC)} > 0,$$

which implies that (B13) cannot be satisfied. Suppose, on the contrary, that $\widehat{x}_{1,SC} \leq \frac{1}{1+\lambda_S}$, and thus $\overline{k}(\widehat{x}_{1,SC}|1, SC) = 0$. We have that (B14) can be written as:

$$\mu \leq \frac{\lambda_C - \lambda_S}{1 + \lambda_S} \text{ with equality iff } \widehat{x}_{1,SC} > 0,$$

which, taking into consideration (B13), implies that $\widehat{x}_{1,SC} = 0$. Let us now show that we would have $U_1(\widehat{\boldsymbol{x}}) > U_1(\mathbf{1})$, thereby contradicting the fact that PC_1 is binding. In fact, taking into account *iii)* we have that an optimal banking union with PC_1 binding strictly increases the utility in country 1 conditional on the pair of public finances at $t = 1$ being $\sigma \neq SC$. Moreover, taking into account that $\widehat{x}_{1,SC} = 0$, the utility in country 1 conditional on the pair of public finances at $t = 1$ being $\sigma = SC$ is given by:

$$U_1(\widehat{\boldsymbol{x}}|\sigma = SC) = pR + (1-p)\cdot 1 - (1-p)(1-\widehat{x}_{2,SC})(1+\lambda_S)\left(1 - G\left(\overline{k}(\widehat{x}_{2,SC}|2, SC)\right)\right), \tag{B15}$$

where the first term captures the expected payoff of the bank project, the second term includes the transfers to country 1 induced by the bail-outs entirely funded by country 2 whenever bank 1 fails, and the last term captures the transfers country 1 does to country 2 to contribute to the funding of bail-outs in the latter country. In contrast, under autarky the utility in country 1 conditional on the pair of public finances at $t = 1$ being $\sigma = SC$ is given by:

$$U_1(\mathbf{1}|\sigma = SC) = pR - (1 - p)\left[\int_0^{\lambda_S} k dG(k) + \lambda_S(1 - G(\lambda_S))\right]. \tag{B16}$$

Using that $\widehat{x}_{2,SC} > x^*$ and the fact that $\overline{k}(x^*|2, SC) > \lambda_S$, which follows from Proposition 1, it follows that $\overline{k}(\widehat{x}_{2,SC}|2, SC) > \lambda_S$. Using this inequality, (B15) and (B16), the inequality $U_1(\widehat{\boldsymbol{x}}|\sigma = SC) > U_1(\mathbf{1}|\sigma = SC)$ can be written after some algebraic manipulation as:

$$\int_0^{\lambda_S} (1 + k)\, dG(k) + \int_{\lambda_S}^{\overline{k}(\widehat{x}_{2,SC}|2,SC)} (1 + \lambda_S) dG(k) + \int_{\overline{k}(\widehat{x}_{2,SC}|2,SC)}^{1} \widehat{x}_{2,SC}(1 + \lambda_S) dG(k) > 0,$$

and is thus satisfied. This concludes the proof that when $\widehat{x}_{1,SC} = 0$ we have that $U_1(\widehat{\boldsymbol{x}}) > U_1(\mathbf{1})$, contradicting the assumption that PC_1 is binding.

vi) If PC_2 is binding then $\widehat{\boldsymbol{x}}$ satisfies: $\widehat{x}_{2,SC} < x^* < \widehat{x}_{1,CS} < 1, \widehat{x}_{2,SS} < \widehat{x}_{1,SS} = 1, \widehat{x}_{2,CC} < \widehat{x}_{1,CC} = 1, \widehat{x}_{1,SC} = \widehat{x}_{2,CS} = 1$.

The statements in this item extend those in *iii)-v)* and its proof is identical.

vii) PC_2 is not binding.

Suppose that PC_2 is binding. Taking *vi)* into consideration, considering the characterization in Proposition 1 of the ex-post optimal banking union $\boldsymbol{x}^*$, and given the inequalities $\frac{\partial U_1(\boldsymbol{x})}{\partial x_{1,\sigma}} < 0$ and $\frac{\partial U_1(\boldsymbol{x})}{\partial x_{2,\sigma}} > 0$, it follows that:

$$U_1\left(\widehat{\boldsymbol{x}}\right) < U_1\left(\boldsymbol{x}^*\right).$$

From this inequality, and using the fact that $q^{CS} < aq^{SC}$, Proposition 2 implies $U_1\left(\widehat{\boldsymbol{x}}\right) < \overline{U}_1$, which means that PC_1 is not binding.

To conclude the proof it suffices to notice that *ii)* and *vi)* imply that PC_1 is binding. Then, the statements in the proposition result from *iii)-v).*

viii) There exists a unique optimal banking union

Let $\widehat{\boldsymbol{x}}$ and $\widehat{\boldsymbol{x}}'$ denote two optimal banking unions. Then, they satisfy Properties *iii)-v).* Let μ and μ' be the Lagrange multiplier of the participation constraint of country 1 at $\widehat{\boldsymbol{x}}$ and $\widehat{\boldsymbol{x}}'$, respectively. Using (B12), we have that:

$$\widehat{x}_{2,SC} \leq \widehat{x}'_{2,SC} \text{ iff } \mu \leq \mu' \text{ with equality iff } \mu = \mu'. \tag{B17}$$

We can conduct similar arguments in the other bank failure states in which there is positive foreign aid, namely in the states $(1, \sigma)$, with $\sigma \in \{SS, CC, SC\}$, and find that:

$$\widehat{x}'_{1,\sigma} \leq \widehat{x}_{1,\sigma} \text{ iff } \mu \leq \mu' \text{ with equality iff } \mu = \mu'. \tag{B18}$$

We have that $U_1\left(\widehat{\boldsymbol{x}}'\right) = U_1\left(\widehat{\boldsymbol{x}}\right) = \overline{U}_1$. Now, (B17) and (B18) imply that $U_1\left(\widehat{\boldsymbol{x}}'\right) \geq U_1\left(\widehat{\boldsymbol{x}}\right)$ iff $\mu \leq \mu'$, with equality iff $\mu = \mu'$. It follows that $\mu = \mu'$ which, in turn, from (B17) and (B18) implies that $\widehat{\boldsymbol{x}} = \widehat{\boldsymbol{x}}'$.

Infeasibility of a banking union $\boldsymbol{x}$ with $W(\boldsymbol{x}) > W(1)$ when $q^{SC} = 1$

Suppose that $q^{SC} = 1$ and that there exists a banking union $\boldsymbol{x}$ with $W(\boldsymbol{x}) > W(1)$. Let $\widehat{\boldsymbol{x}}$ denote the optimal banking union which, a fortiori, satisfies $W(\widehat{\boldsymbol{x}}) > W(1)$. Since country asymmetry is maximal, we have from Proposition 2 that $\widehat{\boldsymbol{x}} \neq \boldsymbol{x}^*$, and at least one of the participation constraints is binding. If PC_2 is binding, then the properties of the derivatives of $W\left(\boldsymbol{x}\right)$ and $U_2\left(\boldsymbol{x}\right)$ with respect to $x_{1,SC}$, and the optimality of $\widehat{\boldsymbol{x}}$, immediately imply that $\widehat{x}_{1,SC} = 1$. Moreover, $W(\widehat{\boldsymbol{x}}) > W(1)$ implies that $\widehat{x}_{2,SC} < 1$. But then, it immediately follows that $U_1(\widehat{\boldsymbol{x}}) < U_1(1)$.

We thus have that PC_1 is binding. The fact that $W(\widehat{\boldsymbol{x}}) > W(1)$ implies that $\widehat{x}_{2,SC} \in (x^*, 1)$. From here the arguments in step *v)* of the proof of the case $q^{SC} < 1$ conducted above could be reproduced, which implies that $\widehat{x}_{1,SC} = 1$. But this, again, would imply that $U_1(\widehat{\boldsymbol{x}}) < U_1(1)$.■

Proof of Proposition 4 Using the characterization of the optimal banking union $\widehat{\boldsymbol{x}} \equiv (\widehat{x}_{i,\sigma})$ in Proposition 3, we have that:

$$\begin{aligned} T(q^{CS} &= 0) = (1-p)q^{SC}(1-\widehat{x}_{2,SC})\left(1-G\left(\overline{k}(\widehat{x}_{2,SC}|SC)\right)\right) - \\ &-(1-p)q^{SS}(1-\widehat{x}_{1,SS})\left(1-G\left(\overline{k}(\widehat{x}_{1,SS}|SS)\right)\right). \end{aligned} \tag{25}$$

Moreover, we can use the fact that the strong country's participation constraint is binding and write (12) as:

$$\underbrace{-(1+\lambda_S)T(q^{CS}=0)}_{\text{Net cost of cross-country transfers to strong country}} = \underbrace{(1-p)q^{SS}\left(\Pi(\widehat{x}_{1,SS}|1,SS) - \Pi^S\right)}_{\text{Increase in agg. res. cost in state (1,SS)}} > 0, \tag{26}$$

where we have used that $\widehat{x}_{1,SS} < 1$, and the fact that $\Pi(x|1, SS)$ is strictly decreasing in x for $x < 1$. The latter inequality implies that the strong country is a net receiver of funds, that is $T(q^{CS} = 0) < 0$.

Proof of Proposition 5 The proof of this result is constructive. Consider a transfer m^* such that:

$$\begin{aligned} U_1(\boldsymbol{x}^*) + (1+\lambda_S)m^* &\geq \overline{U}_1 \\ U_2(\boldsymbol{x}^*) - (1+\lambda_S)m^* &\geq \overline{U}_2. \end{aligned} \tag{27}$$

Define the expected contribution of the strong country through this agreement as:

$$T(m^*) \equiv (1-p)\left(q^{SC} - q^{CS}\right)(1-x^*)\left(1-G\left(\overline{k}(x^*)\right)\right) - m^*.$$

Then, we can write the inequalities in (27) as follows:

$$\begin{aligned} (1-p)q^{CS}\left(\Pi^C - \Pi(x^*)\right) - (1+\lambda_S)T(m^*) &\geq 0 \\ (1-p)q^{SC}\left(\Pi^C - \Pi(x^*)\right) + (1+\lambda_S)T(m^*) &\geq 0. \end{aligned}$$

We can therefore write the inequalities in (27) as:

$$-(1-p)q^{SC}\left(\Pi^C - \Pi(x^*)\right) \leq (1+\lambda_S)T(m^*) \leq (1-p)q^{CS}\left(\Pi^C - \Pi(x^*)\right).$$

Recognizing that $q^{SC} > q^{CS}$, the latter inequality defines a non-empty interval $[m^*_{\min}, m^*_{\max}]$.

We now show that $m^*_{\min} > 0$ if and only if the ex-post optimal banking union is not feasible without initial transfers.

For the "if" part, assume that the ex-post optimal banking union is not feasible without initial transfers. Then, we know from the proof of Proposition 2 that $U_1(\boldsymbol{x}^*) < \overline{U}_1$. Hence, for the inequality $U_1(\boldsymbol{x}^*) + (1+\lambda_S)m^* \geq \overline{U}_1$ to hold, we necessarily need $m^* > 0$.

For the "only if" part, assume for the sake of contradiction that both $U_1(\boldsymbol{x}^*) \geq \overline{U}_1$ and $U_2(\boldsymbol{x}^*) \geq \overline{U}_2$. If $U_1(\boldsymbol{x}^*) = \overline{U}_1$, then $U_1(\boldsymbol{x}^*) \geq \overline{U}_1$ is trivially satisfied for $m^* = 0$. If $U_1(\boldsymbol{x}^*) > \overline{U}_1$, then we also have that $U_2(\boldsymbol{x}^*) > \overline{U}_2$, since $q^{SC} > q^{CS}$. In this case, we can always find a sufficiently small $m^* < 0$ so that both $U_1(\boldsymbol{x}^*) \geq \overline{U}_1$ and $U_2(\boldsymbol{x}^*) \geq \overline{U}_2$ hold.

Proof of Proposition 6 The ex-post optimal banking union is feasible if and only if:

$$U_1(\boldsymbol{x}^*, \overline{\boldsymbol{p}}^*) - \overline{U}_1 \geq 0. \tag{28}$$

Denote the early intervention thresholds in autarky by $\overline{\boldsymbol{p}}^{Aut} = \overline{p}(1|1,CS) = \overline{p}(1|2,SC)$. From (19), we have that $\overline{\boldsymbol{p}}^{Aut} > \overline{p}(x^*|1,CS)$. Using the utility so that in (20), we can write the feasibility condition (28) as:

$$\begin{array}{c}\left(\int_{\overline{p}^{Aut}}^{1}(1\text{-}p_i)dF(p_i)\right) q^{CS}\left(\Pi^C - \Pi(x^*)\right) + \left(\int_{\overline{p}(x^*|1,CS)}^{\overline{p}^{Aut}}\left[pR-(1-p)\Pi(x^*)-L\right]dF(p)\right) q^{CS} \\ -\left(\int_{\overline{p}(x^*|1,CS)}^{1}(1\text{-}p_i)dF(p_i)\right)\left(q^{SC}-q^{CS}\right)(1-x^*)(1+\lambda_S)\left(1-G\left(\overline{k}(x^*)\right)\right)\end{array} \geq 0. \tag{29}$$

Notice the similarities with the analogous condition for the baseline model in (8). As in the proof of Proposition 2, it can be shown from the latter expression that there exist $a' \in (0,1)$ such that $a' \in (0,1)$ such that $(\boldsymbol{x}^*, \overline{\boldsymbol{p}}^*)$ is feasible if and only if $q^{CS} \geq a' q^{SC}$.

Suppose for the rest of the proof that $q^{CS} < a' q^{SC}$ and $q^{SC} < 1$.

Let $(\boldsymbol{x},\overline{\boldsymbol{p}})$ be a feasible banking union and let $W(\boldsymbol{x},\overline{\boldsymbol{p}})$ and $Ui(\boldsymbol{x},\overline{\boldsymbol{p}})$denote the aggregate welfare function and the expected utility in country i, respectively. It is easy to check that the partial derivatives of these functions with respect to the $x_{i,\sigma}$ have the same properties as those of their baseline model analogous described at the beginning of the proof of Proposition 3. In addition, we have that, if $\frac{\partial U_i(\boldsymbol{x},\overline{\boldsymbol{p}})}{\partial x_{i,\sigma}} \neq 0$, then the quotient $\frac{\frac{\partial W(\boldsymbol{x},\overline{\boldsymbol{p}})}{\partial x_{i,\sigma}}}{\frac{\partial U_i(\boldsymbol{x},\overline{\boldsymbol{p}})}{\partial x_{i,\sigma}}}$ is independent of $\overline{\boldsymbol{p}}$.Taking this into account, the statements *i)-vi)* in the proof of Proposition 3 can be proved with no changes in this extended set-up.

The following properties will be used frequently in the rest of the proof and can be easily checked:

$$\left.\frac{\partial W(\boldsymbol{x},\overline{\boldsymbol{p}})}{\partial \overline{p}_{i,\sigma}}\right|_{\overline{p}_{i,\sigma}=\overline{p}(x_{i,\sigma}|i,\sigma)} = 0, \text{ and } \frac{\partial W(\boldsymbol{x},\overline{\boldsymbol{p}})}{\partial \overline{p}_{i,\sigma}} < 0 \text{ iff } \overline{p}_{i,\sigma} > \overline{p}(x_{i,\sigma}|i,\sigma) \tag{B19}$$

$$\frac{\partial U_i(\boldsymbol{x},\overline{\boldsymbol{p}})}{\partial \overline{p}_{i,\sigma}} < 0 \text{ if } \overline{p}_{i,\sigma} > \overline{p}(x_{i,\sigma}|i,\sigma) \text{ or if } \overline{p}_{i,\sigma} = \overline{p}(x_{i,\sigma}|i,\sigma) \text{ and } x_{i,\sigma} < 1 \tag{30}$$

$$\frac{\partial U_i(\boldsymbol{x},\overline{\boldsymbol{p}})}{\partial \overline{p}_{\overline{i},\sigma}} > 0 \text{ if } x_{\overline{i},\sigma} < 1, \text{ and } \frac{\partial U_i(\boldsymbol{x},\overline{p})}{\partial \overline{p}_{\overline{i},\sigma}} = 0 \text{ if } x_{\overline{i},\sigma} = 1.$$

Let us now prove that statement *vii)* in the proof of Proposition 3 remains valid, namely, PC_2 cannot be binding in the optimal banking union. Suppose, on the contrary, that PC_2 is binding. We argue that this leads to distortions relative to the policies in the ex-post optimal banking union $(\boldsymbol{x}^*, \boldsymbol{p}^*)$ that imply $U_1\left(\widehat{\boldsymbol{x}}, \widehat{\overline{\boldsymbol{p}}}\right) < U_1(\boldsymbol{x}^*, \boldsymbol{p}^*)$ and, since by assumption the country asymmetry is large enough so that the banking union $(\boldsymbol{x}^*, \boldsymbol{p}^*)$ does not satisfy PC_1, we would have a contradiction.

Since PC_2 is binding, we must have that $\widehat{x}_{1,CS} > x^*$ and the ex-post optimal intervention threshold $\overline{p}(\widehat{x}_{1,CS}|1,CS)$, conditional on $\widehat{x}_{1,CS}$, satisfies $\overline{p}(\widehat{x}_{1,CS}|1,CS) > p^*$. In addition, since PC_2 is binding, the properties in (B19) and the optimality of $(\widehat{\boldsymbol{x}},\widehat{\overline{\boldsymbol{p}}})$ imply that:

$$\widehat{\overline{p}}_{1,CS} > \overline{p}(\widehat{x}_{1,CS}|1,CS) > p^*. \tag{B20}$$

Similarly, for $\sigma = SS, CC, SC$, we have that $\widehat{x}_{1,\sigma} = x^*_{1,\sigma} = 1$ and:

$$\widehat{\overline{p}}_{1,\sigma} > \overline{p}(\widehat{x}_{1,\sigma}|1,\sigma) = \overline{p}(1|1,\sigma). \tag{B21}$$

It follows that the distortions in the resolution and early intervention policies of $(\widehat{\boldsymbol{x}},\widehat{\overline{\boldsymbol{p}}})$, relative to $(\boldsymbol{x}^*, \boldsymbol{p}^*)$, in the bank failure states that involve the bank in country 1 strictly decrease the utility in that country.

Let us now consider the resolution and early intervention decisions of bank 2 in state $\sigma = SC$, that is $\widehat{x}_{2,SC}$ and $\widehat{\overline{p}}_{2,SC}$. In order to prove that the distortions induced by the fact that PC_2 is binding reduce the utility in country 1 it suffices to show that:

$$\left(\int_{\widehat{\overline{p}}_{2,SC}}^{1}(1-p_2)dF(p_2)\right) q^\sigma t(\widehat{x}_{2,SC}|2,SC) \geq \left(\int_{\overline{p}^*}^{1}(1-p_2)dF(p_2)\right) q^\sigma t(x^*|2,SC), \tag{B22}$$

where the left hand side and the right hand side account for the social gross cost of the transfers from country 1 to country 2 under $\left(\widehat{x}_{2,SC}, \widehat{\overline{p}}_{2,SC}\right)$ and $(x^*, \overline{p}^*)$, respectively. Suppose, on the contrary, that (B22) is not satisfied. Since we have that $\widehat{x}_{2,SC} < x^*$, it has to be the case that $\widehat{\overline{p}}_{2,SC} > \overline{p}^*$. Let $(\widehat{\boldsymbol{x}}', \widehat{\overline{\boldsymbol{p}}}')$ be the banking union that differs from $(\widehat{\boldsymbol{x}}, \widehat{\overline{\boldsymbol{p}}})$ only in the policies for bank 2 in the state $\sigma = SC$, which are defined to be $\widehat{x}'_{2,SC} = x^*$ and $\widehat{\overline{p}}'_{2,SC} = \overline{p}^*$.

The increase in $x_{2,SC}$ from $\widehat{x}_{2,SC}$ to $\widehat{x}'_{2,SC} = x^*$ is aggregate welfare increasing and, conditional on $\widehat{x}'_{2,SC} = x^*$, the reduction in $\overline{p}_{2,SC}$ from $\widehat{\overline{p}}_{2,SC}$ to $\widehat{\overline{p}}'_{2,SC} = \overline{p}^*$ is also aggregate welfare increasing, which implies that $W(\widehat{\boldsymbol{x}}', \widehat{\overline{\boldsymbol{p}}}') > W(\widehat{\boldsymbol{x}}, \widehat{\overline{\boldsymbol{p}}})$. Moreover, the fact that (B22) is not satisfied means, by construction, that $U_2(\widehat{\boldsymbol{x}}', \widehat{\overline{\boldsymbol{p}}}') > U_2(\widehat{\boldsymbol{x}}, \widehat{\overline{\boldsymbol{p}}})$. The optimality of $(\widehat{\boldsymbol{x}}, \widehat{\overline{\boldsymbol{p}}})$ then implies that:

$$U_1(\widehat{\boldsymbol{x}}', \widehat{\overline{\boldsymbol{p}}}') < \overline{U}_1 < U_1(\widehat{\boldsymbol{x}}, \widehat{\overline{\boldsymbol{p}}}).$$

Notice that the increase in $x_{2,SC}$ from $\widehat{x}_{2,SC}$ to $\widehat{x}'_{2,SC} = x^*$ increases the utility in country 1, while the reduction in $\overline{p}_{2,SC}$ from $\widehat{\overline{p}}_{2,SC}$ to $\widehat{\overline{p}}'_{2,SC} = \overline{p}^*$ decreases it. As a result, the inequality above implies that there exists a banking union $(\widehat{x}'', \widehat{\overline{\boldsymbol{p}}}'')$ that differs from $(\widehat{x}, \widehat{\overline{\boldsymbol{p}}})$ only in the policies for bank 2 in state $\sigma = SC$, which are given by $\widehat{x}'_{2,SC} = x^*$, $\widehat{\overline{p}}'_{2,SC} \in (\overline{p}^*, \widehat{\overline{p}}_{2,SC})$, and satisfy:

$$U_1(\widehat{\boldsymbol{x}}'', \widehat{\overline{\boldsymbol{p}}}'') = U_1(\widehat{\boldsymbol{x}}, \widehat{\overline{\boldsymbol{p}}}) \text{ and } W(\widehat{\boldsymbol{x}}'', \widehat{\overline{\boldsymbol{p}}}'') > W(\widehat{\boldsymbol{x}}, \widehat{\overline{\boldsymbol{p}}}).$$

The equality and inequality above in turn imply that $U_2(\widehat{\boldsymbol{x}}'', \widehat{\overline{\boldsymbol{p}}}'') > U_2(\widehat{\boldsymbol{x}}, \widehat{\overline{\boldsymbol{p}}}) = \overline{U}_2$. But then the banking union $(\widehat{\boldsymbol{x}}'', \widehat{\overline{\boldsymbol{p}}}'')$ would be feasible and thus optimal.

Analogous arguments show that the distortions in the policies for bank 2 in states $\sigma = SS, CC, CS$ induced by the fact that PC_2 is binding reduce the utility in country 1 relative to that under the ex-post optimal banking union. This concludes the proof that PC_2 cannot be binding.

We must thus have that PC_1 is binding. The statements in the proposition regarding the forbearance in early interventions of bank 1 and tightness in those of bank 2 are then an immediate consequence of the properties in (B19) and the optimality of $(\widehat{\boldsymbol{x}}, \widehat{\overline{\boldsymbol{p}}})$.■

Proof of Proposition 7 An arbitrary funding mix $(x_{i,\sigma}, y_{i,\sigma})$ for bail-outs at country i in state σ consists of: the home contribution $x_{i,\sigma}$ at $t = 1$, the foreign loan $y_{i,\sigma}$ repaid by the home country at $t = 2$, and the foreign contribution $1 - x_{i,\sigma} - y_{i,\sigma}$ at $t = 1$. Notice that both home contributions and foreign loans provide incentives to the home authority not to overstate the need for bail-outs. In addition, by construction of the interest rate charged by the foreign country on loans, the expected utility of this country only depends on is direct foreign contribution.

Let $(\widehat{\boldsymbol{x}}, \widehat{\boldsymbol{y}})$ be an optimal banking union. In order to prove the proposition we will argue that for any bank failure state (i, σ) we have that either $\widehat{x}_{i,\sigma} = 0$ or $\widehat{y}_{i,\sigma} = 0$and thus the optimal funding mix is characterized by a single variable ($\widehat{y}_{i,\sigma}$ in states for which $\widehat{x}_{i,\sigma} = 0$, and $\widehat{x}_{i,\sigma}$ in states for which $\widehat{y}_{i,\sigma} = 0$). The results in the proposition then can be obtained by reproducing the arguments in the proofs of Propositions 1, 2 and 3.

i) If $(i, \sigma) \in \{(1, CS), (2, SC)\}$, then $\widehat{x}_{i,\sigma} = 0$.

Suppose that $\widehat{x}_{i,\sigma} > 0$. Since $\lambda_C > \tilde{\lambda}_C$ and $R_S \leq 1$ (because $\tilde{\lambda}_S \geq \lambda_S$), we have that $1+\lambda_C > \left(1+\tilde{\lambda}_C\right) R_S$. This implies that the cost for the home country of home contributions is strictly higher than repaying foreign loans. Hence, the funding mix $(0, y'_{i,\sigma})$ such that $y'_{i,\sigma} = \widehat{x}_{i,\sigma}+\widehat{y}_{i,\sigma}$ strictly increases the home country's welfare relative to $(\widehat{x}_{i,\sigma}, \widehat{y}_{i,\sigma})$, without changing the foreign country's welfare. A banking union that only differs from $(\widehat{\boldsymbol{x}}, \widehat{\boldsymbol{y}})$ in the funding mix in the state (i, σ), which is defined to be $(0, y'_{i,\sigma})$, would thus be feasible and increase aggregate welfare.

ii) If $(i, \sigma) \in \{(1, SC), (2, CS)\}$, then $\widehat{y}_{i,\sigma} = 0$.

Suppose that $\widehat{y}_{i,\sigma} > 0$. Since $\tilde{\lambda}_S \geq \lambda_S$ and $R_C > 1$ (because $\lambda_C > \tilde{\lambda}_C$), we have that $1 + \lambda_S < \left(1+\tilde{\lambda}_S\right) R_C$. This implies that the cost for the home country of repaying foreign loans is strictly higher than that of home contributions. Hence, the funding mix $(x'_{i,\sigma}, 0)$ such that $x'_{i,\sigma} = \widehat{x}_{i,\sigma}+\widehat{y}_{i,\sigma}$ strictly increases the home country's welfare relative to $(\widehat{x}_{i,\sigma}, \widehat{y}_{i,\sigma})$, without changing the foreign country's welfare. A banking union that only differs from $(\widehat{\boldsymbol{x}}, \widehat{\boldsymbol{y}})$ in the funding mix in the state (i, σ), which is defined to be $(x'_{i,\sigma}, 0)$, would thus be feasible and increase aggregate welfare.

iii) If $(i, \sigma) \in \{(1, SS), (1, CC), (2, SS), (2, CC)\}$, then $\widehat{y}_{i,\sigma} = 0$.

Suppose that $\widehat{y}_{i,\sigma} > 0$. We have that $1 + \lambda_S = \left(1+\tilde{\lambda}_S\right) R_S$ and that $1 + \lambda_C = \left(1+\tilde{\lambda}_C\right) R_C$. This implies that the cost for the home country of repaying foreign loans equals that of home contributions. Hence, the funding mix $(x'_{i,\sigma}, 0)$ such that $x'_{i,\sigma} = \widehat{x}_{i,\sigma}+\widehat{y}_{i,\sigma}$ provides the same welfare as $(\widehat{x}_{i,\sigma}, \widehat{y}_{i,\sigma})$ for the two countries. A banking union that only differs from $(\widehat{\boldsymbol{x}}, \widehat{\boldsymbol{y}})$ in the funding mix in the state (i, σ), which is defined to be $(x'_{i,\sigma}, 0)$, is thus pay-off equivalent to $(\widehat{\boldsymbol{x}}, \widehat{\boldsymbol{y}})$.■

Proof of Proposition 8 We introduce some notation. For a given bank failure state (i, σ) and home contribution x we denote $\overline{k}^{\beta}(x|i, \sigma)$ the bail-out threshold in the economy with cross-border liabilities. We have that:

$$\overline{k}^{\beta}(x|i, \sigma) = \max\left\{(1+\lambda_{i,\sigma})\, x - (1-\beta)\,, 0\right\}.$$

Consider (9), which is the characterization of the analogous threshold $\overline{k}(x|i, \sigma)$ in the baseline model. Then, for $x \geq \frac{\beta}{1+\lambda_{i,\sigma}}$ we have that:

$$\overline{k}^{\beta}(x - \frac{\beta}{1+\lambda_{i,\sigma}}|i, \sigma) = \overline{k}^{0}(x|i, \sigma) = \overline{k}(x|i, \sigma).$$

Notice that for $x < \frac{\beta}{1+\lambda_{i,\sigma}}$ the equality also holds if we replace $x - \frac{\beta}{1+\lambda_{i,\sigma}}$ by $\max\left\{x - \frac{\beta}{1+\lambda_{i,\sigma}}, 0\right\}$.

For any country $j \in \{1, 2\}$, bank-failure tuple (i, σ), and home contribution x, we denote the overall utility at $t = 1$ of agents in country i when there are cross-border liabilities β as $U_i^{\beta}(x|i, \sigma)$. In addition, we denote $U_j(x|i, \sigma) = U_j^0(x|i, \sigma)$.

Finally, we have that the overall utility as of $t = 0$ in country j associated with a banking union $\boldsymbol{x}$ when there are cross-border liabilities β, which we denote by $U_j^{\beta}(\boldsymbol{x})$, satisfies:

$$U_j^{\beta}(\boldsymbol{x}) = \sum_{i,\sigma} q^{\sigma} U_j(x_{i,\sigma}|i,\sigma). \tag{31}$$

We can now proceed with the proof. Consider the optimal banking union $\boldsymbol{x}^*$ of the baseline economy. We are going to construct a new banking union $\boldsymbol{x}' = (x'_{i,\sigma})$ satisfying for every j and (i,σ) the following inequality:

$$U_j^{\beta}(x'_{i,\sigma}|i,\sigma) - U_j^{\beta}(1|i,\sigma) \geq U_j(x^*_{i,\sigma}|i,\sigma) - U_j(1|i,\sigma), \tag{32}$$

with strict inequality for some i and (j,σ). This will in particular imply that the banking union $\boldsymbol{x}'$ is feasible in the economy with cross-border liabilities and that the welfare gains relative to autarky induced by $\boldsymbol{x}'$ are strictly larger than those induced by $\boldsymbol{x}$ in the baseline economy.

To streamline the expressions and exposition to follow, we make two simplifying assumptions. First, for all (i,σ) we have $\overline{k}^{\beta}(1|i,\sigma) > k_{\max}$and thus there are no bail-outs in autarky in the cross-border economy. A necessary and sufficient condition for the assumption to be satisfied is that $\lambda_S + \beta > k_{\max}$. Second for all σ, we have $q^{\sigma} > 0$.

Consider the bank failure state (i,σ). Suppose $\lambda_{i,\sigma} \geq \lambda_{\bar{i},\sigma}$. Let:

$$x'_{i,\sigma} = \max\left\{x^*_{i,\sigma} - \frac{\beta}{1+\lambda_{i,\sigma}}, 0\right\}. \tag{33}$$

We have by construction that:

$$\overline{k}^{\beta}(x'_{i,\sigma}|i,\sigma) = \overline{k}(x^*_{i,\sigma}|i,\sigma), \tag{34}$$

and that:

$$x^*_{i,\sigma} - x'_{i,\sigma} \leq \frac{\beta}{1+\lambda_{i,\sigma}}. \tag{35}$$

We have the following utility gains for the home country in the baseline and cross-border economies:

$$\begin{aligned} U_i(x^*_{i,\sigma}|i,\sigma) - U_i(1|i,\sigma) &= \int_{\overline{k}(x^*_{i,\sigma}|i,\sigma)}^{\lambda_{i,\sigma}} \left(k - \overline{k}(x^*_{i,\sigma}|i,\sigma)\right) dG(k) + (1 - G(\lambda_{i,\sigma}))\left(\lambda_{i,\sigma} - \overline{k}(x^*_{i,\sigma}|i,\sigma)\right), \\ U_i^{\beta}(x'_{i,\sigma}|i,\sigma) - U_i^{\beta}(1|i,\sigma) &= \int_{\overline{k}^{\beta}(x'_{i,\sigma}|i,\sigma)}^{k_{\max}} \left(k - \overline{k}^{\beta}(x'_{i,\sigma}|i,\sigma)\right) dG(k), \end{aligned}$$

where we have used that $\overline{k}^{\beta}(1|i,\sigma) > k_{\max}$ and that $\overline{k}(1|i,\sigma) = \lambda_{i,\sigma}$. Using (34) it follows from the latter two expressions that:

$$U_i^{\beta}(x'_{i,\sigma}|i,\sigma) - U_i^{\beta}(1|i,\sigma) > U_i(x^*_{i,\sigma}|i,\sigma) - U_i(1|i,\sigma),$$

and (32) is strictly satisfied for $j = i$.

We have the following utility gains for the foreign country:

$$\begin{aligned} U_{\bar{i}}(x^*_{i,\sigma}|i,\sigma) - U_{\bar{i}}(1|i,\sigma) &= -\left(1-\overline{k}(x_{i,\sigma}|i,\sigma)\right)\left(1+\lambda_{\bar{i},\sigma}\right)\left(1-x^*_{i,\sigma}\right), \\ U^{\beta}_{\bar{i}}(x'_{i,\sigma}|i,\sigma) - U^{\beta}_{\bar{i}}(1|i,\sigma) &= -\left(1-\overline{k}^{\beta}(x'_{i,\sigma}|i,\sigma)\right)\left[\left(1+\lambda_{\bar{i},\sigma}\right)\left(1-x'_{i,\sigma}\right)-\beta\right], \end{aligned}$$

where in the second expression we have used that when in any bail-out of bank i the measure β of debtholders in country $\bar{i}$ are repaid and that in autarky there are no bail-outs. Taking into account (33), (34), (35), and the assumption that $\lambda_{i,\sigma} \geq \lambda_{\bar{i},\sigma}$, we have from the latter two expressions that:

$$\begin{aligned} U^{\beta}_{\bar{i}}(x'_{i,\sigma}|i,\sigma) - U^{\beta}_{\bar{i}}(1|i,\sigma) &= -\left(1-\overline{k}(x^*_{i,\sigma}|i,\sigma)\right)\left[\left(1+\lambda_{\bar{i},\sigma}\right)\left(1-x^*_{i,\sigma}\right)-\beta\left(1-\left(1+\lambda_{\bar{i},\sigma}\right)\left(x^*_{i,\sigma}-x'_{i,\sigma}\right)\right)\right] \\ &\geq U_{\bar{i}}(x^*_{i,\sigma}|i,\sigma) - U_{\bar{i}}(1|i,\sigma) + \left(1-\overline{k}(x^*_{i,\sigma}|i,\sigma)\right)\beta\frac{\lambda_{i,\sigma}-\lambda_{\bar{i},\sigma}}{1+\lambda_{i,\sigma}} \geq \\ &\geq U_{\bar{i}}(x^*_{i,\sigma}|i,\sigma) - U_{\bar{i}}(1|i,\sigma), \end{aligned}$$

and (32) is satisfied for $j = \bar{i}$.

Suppose $\lambda_{i,\sigma} < \lambda_{\bar{i},\sigma}$, then Proposition 1 and 3 imply that the optimal banking union satisfies $x^*_{i,\sigma} = 1$. Let $x'_{i,\sigma} = 1$. Then we trivially have for any $j = 1,2$ that:

$$U^{\beta}_{j}(x'_{i,\sigma}|i,\sigma) - U^{\beta}_{j}(1|i,\sigma) = U_j(x^*_{i,\sigma}|i,\sigma) - U_j(1|i,\sigma) = 0,$$

and (32) is satisfied for any j.■

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