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**CROSS-BORDER RESOLUTION OF  
GLOBAL BANKS: BAIL IN UNDER  
SINGLE POINT OF ENTRY VERSUS  
MULTIPLE POINTS OF ENTRY**

Ester Faia and Beatrice Weder Di Mauro

***FINANCIAL ECONOMICS and  
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## Abstract

Cross-border resolution regimes are at the frontier of the international financial architecture reform. Bail-in resolution for global groups is now designed under two distinct regimes, SPE (Single Point of Entry) and MPE (Multiple Points of Entry). No model rationalized their welfare consequences. We examine cooperation versus non-cooperation in a model with strategically optimizing authorities and banks. Welfare losses in each regime depend on the degree of banks' liabilities home bias. SPE cooperative generally minimizes losses since authorities internalize cross-country spillovers, unless groups are highly decentralized. SPE may have unintended consequences: under cooperation it increases financial re-trenchment in previously segmented markets (by the same token it stimulates integration in well integrated markets). Under noncooperation subsidiarization emerges as an endogenous outcome. High capital requirements by acting as discipline device reduce losses and blur the difference between regimes.

JEL Classification: G18, F3

Keywords: global financial architecture, recovery and resolution planning, single point of entry, strategic regulatory interaction, financial spillover, financial retrenchment

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# Cross-Border Resolution of Global Banks\*

## Bail in under Single Point of Entry versus Multiple Points of Entry

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### Abstract

Cross-border resolution regimes are at the frontier of the international financial architecture reform. Bail-in resolution for global groups is now designed under two distinct regimes, SPE (Single Point of Entry) and MPE (Multiple Points of Entry). No model rationalized their welfare consequences. We examine cooperation versus non-cooperation in a model with strategically optimizing authorities and banks. Welfare losses in each regime depend on the degree of banks' liabilities home bias. SPE cooperative generally minimizes losses since authorities internalize cross-country spillovers, unless groups are highly decentralized. SPE may have unintended consequences: under cooperation it increases financial re-trenchment in previously segmented markets (by the same token it stimulates integration in well integrated markets). Under non-cooperation subsidiarization emerges as an endogenous outcome. High capital requirements by acting as discipline device reduce losses and blur the difference between regimes.

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## 1 Introduction

Following the disorderly collapse of Lehmann Brothers and a wave of banking crisis, G20 policy-makers gave top priority to the design the international financial architecture with specific focus

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on an effective regime for orderly resolution of global systemically important banks (GSIBs). In 2013 the Financial Stability Board [19] established bail-in (instead of bail-out) as the new paradigm for resolutions and stated that global groups could implement bail-in under two different regimes: SPE, (Single Point of Entry) and MPE, (Multiple Points of Entry). In the first case the authority in charge of the resolution is the one in the country of the parent holding; in the second case local resolution authorities have intervention powers. Policy-makers have stressed that it is hard to overestimate the significance of these regulatory innovations since they are transforming global bank structures as well as shaping international regulatory interaction (see e.g. Tucker [36]). In addition, the reform may have profound consequences for cross-border financial integration/retrenchment. Yet, there has been little analysis of the consequences of SPE versus MPE resolution beyond the circle of policy-makers and regulators. The purpose of this paper is to provide such analysis.

Bail-in resolutions require to put losses that exceed equity onto bondholders while preserving systemically important liabilities, a nontrivial task in the case of a systemically important institution.<sup>1</sup> For a globally systemic bank these procedures present additional complications. GSIBs have large subsidiaries and branches in many countries and thus confront multiple regulators and national resolution authorities. In crisis these may be tempted to act in their own interests to protect local bond-holders rather than cooperate with the authority of the parent holding country, the central premise of the SPE regime. SPE requires that local authorities remain passive while the authority of the parent holding country takes responsibility for stabilizing the banking group and recapitalizing the parent as well as subsidiaries/branches worldwide. Note that MPE requires no such cooperation since the local authority intervenes at the level of the subsidiary without recourse to the parent bank and therefore ring-fences the local entity. Certainly, the most effective way to address possible coordination failures under SPE is by relinquishing national powers and establishing a centralized authority. This is the path on which the Eurozone has embarked with the newly created European Single Resolution Authority. However, globally this is not a viable option and therefore coordination failures may well result under SPE. This concern has also been voiced

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<sup>1</sup>This is a very different approach than the one typically adopted for smaller, non-systemic banks. Small banks can be resolved through purchase and assumption, i.e. in a crisis they are split into parts: those parts considered critical are then transferred to another bank or a bridge bank and the rest is sent into receivership. For systemically important institutions this method is not advisable since it will be extremely difficult to fully isolate the critical parts in a crisis and prevent contagion to the rest of the group and other intermediaries.

by regulators (see for instance Huertas [26]) and has to be taken seriously since SPE is emerging as the dominant model for global banks as expressed in their resolutions plans (living wills) and shown below.

We take a possible coordination failure into account by analyzing three outcomes (for simplicity all called regimes henceforth): SPE cooperative (the regime as intended), SPE non-cooperative (the failure to cooperate under SPE) and MPE (an uncoordinated regime by design) We study these different regimes focusing on two questions. First, we explore the efficiency consequences (in terms of overall investors' welfare). Second, we ask which regime fosters financial integration better.

We examine these questions using a game-theoretic model that embeds strategic interaction among national authorities (and between banks and regulators) for an environment in which supervisors, investors and banks form optimal decisions. In our two countries model banks optimize profits, invest and raise liabilities domestically and abroad and face equity requirements. Regulatory authorities determine optimal bail-in losses, for a given regime, by maximizing investors' welfare and by taking into account banks' behavior. Depending on the expected resolution regime, banks react endogenously by choosing the level of foreign exposure or the global business structure (branch versus subsidiary). The pre-conditions for the emergence of strategic interactions in our model are two. First, there is a shared liability effect since banks have local and foreign funding and the fraction of foreign bail-inable bonds enters groups' equity requirements. Second, there is an asset internationalization effect from banks holdings of foreign assets<sup>2</sup>. Such spillovers are not internalized under uncoordinated regimes (MPE and SPE non-cooperative) since national authorities do not weight the interest of foreign investors.

We find that the welfare losses (which includes both bond-holders and equity-holders welfare) under the non-cooperative SPE or MPE regimes are higher than under the cooperative SPE, albeit their relative size depends upon the share of bank's foreign liabilities (home bias). The economic rationale is based on the failure of authorities, acting in an uncoordinated Nash equilibrium, to internalize cross-country spill-overs. As each national authority attempts to protect its bondholders, it fails to visualize the impairment of the group ability to fulfill the regulatory

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<sup>2</sup>Similar externalities have been highlighted, albeit in a different context, by Calzolari et. al. [6] who study coordination of prudential policy.

requirements. In equilibrium this results in larger losses. The overall result is confirmed also when considering alternative banks' business models (branches versus subsidiaries). Second, we find that ex ante prudential regulation (equity requirements) blurs the difference between cooperative and non-cooperative regimes. Equity requirements act as a preemptive discipline device, which reduce ex post welfare losses under any resolution regime. Third, the comparison between MPE versus SPE reveals another interesting aspect. Bond-holders losses are higher under the MPE, except for a low degree of home bias which characterizes a highly decentralized banking group. In this last case indeed cross-countries strategic externalities are limited and the decentralized resolution plan becomes more efficient. The results are in line with data from the living wills of systemically important financial institutions, which show the regimes that are deemed optimal in a jointly agreed declaration of banks and regulators. The choice of resolution regime also bears consequences for financial integration, as banks react to the expected regime. In principle more financial integration is superior due to improved risk-sharing possibilities. Our model shows that SPE might favour financial re-trenchment, particularly so when markets are already very segmented from the start. Under SPE the parent holding remains fully liable for foreign subsidiaries' losses, hence incentives to venture into foreign markets are mitigated. By the same token, SPE cooperative will further foster banks' internationalization if markets are already fairly integrated. This finding supports the choice of Eurozone policy-makers to opt for SPE under a Single Resolution Mechanism.

Finally, we show that for fairly decentralized groups (with higher than half foreign liabilities) it is preferable to decentralize through a subsidiary structure. Indeed, under the assumption that the parent holding has pre-positioned enough equity capital to absorb subsidiaries' losses, this business model protects the parent holding from severe downstreaming.

The rest of the paper is divided as follows. The next section presents a literature review and examines data on banks' living wills. Section 3 presents the model and its results. Section 4 concludes. An appendix follows.

## **2 Review of literature and evidence on regime choices**

Policy coordination in all its aspects is a major building block of the international finance literature. Resolution regimes for G-SIBs pertain to the newly emerging literature on the global financial reg-

ulatory architecture. Despite the importance of this topic the literature is so far unequipped with a model that analyzes international coordination in resolution regimes. The closest contribution in the spirit to our paper is Calzolari et. al. [6] who study international coordination of prudential policy using a game-theoretic approach.<sup>3</sup> They find that centralized supervision, albeit more efficient, favours financial re-trenchment a finding we also have in some constellations. A number of features however differentiate our work from their: we assume that policy makers minimize micro-founded loss functions that trade-offs the interests of all banks' investors (bondholders and equity-holders); our banking groups can invest assets in foreign assets and are subject to ex ante regulatory requirements. Also in Calzolari et. al. [6] the policy maker chooses a binary actions (whether to supervise or not), while in our model resolution authorities' actions are continuous (namely they chose the size of the bond-holders' losses).

Recently a number of contributions have emerged on resolution regimes. Diemer [13] studies coordination in bail-out regimes for multinationals, while we focus on bail-in regimes. Benczur et. al. [4] use micro-simulations to quantify the beneficial effects of bail-in on public finance costs. They however do not discuss different international regimes. To our knowledge ours is the first paper to study the welfare implications of different cooperation levels in cross border resolutions regimes from a macro general equilibrium perspective. Bolton and Oehmke (2016) discusses multiple versus single point of entry and derive implications mainly for bank structure. Their set up, however, does not allow for a meaningful trade-off between creditors: increasing bond-holders' losses reduces equity holders' losses. At last the role of a single point of entry business model is also studied in Kupiec and Wallison[30] but with a focus on banks' recapitalization.

Direct empirical evidence on the effects of bail-in is very limited because so far there have been almost no pure bail-in events. Past cases of bank resolution have been mostly through bail-out or, more rarely, through hybrid bail-in/bail-out (see Faia and Weder di Mauro [17] for a discussion of such hybrid cases). Schaefer et. al [35] use some of these hybrid events to estimate their effect on reducing bail-out expectations of bank creditors across Europe. Also on the empirical side Ignatowski and Korte[27] test the impact of resolution regimes on risk-taking use a quasi-

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<sup>3</sup>Further papers on supervision and regulatory coordination include Dell'Ariccia and Marquez [11], Freixas [21], Niepmann and Schmidt-Eisenlohr [31]. Finally Beck and Wagner [3] using data and theory show how supervisors intervened depending on the distribution of asset, liabilities and equity claims across markets.

experiment approach. They show that resolution regimes matter for small banks but not for large ones: our paper fills the gaps on G-SIB and focus on a theoretical model.

Our model is also related to the general literature on the role of international capital flows, for instance Passari and Rey [33] discuss the elusive welfare gains from cross-border flows. In line with this there is recent evidence on sudden financial re-trenchment. Bremus and Fratzscher [5], De Haas and Van Lelyveld [12] and Van Rijckeghem and Weder di Mauro [37] all document a retreat from cross border lending after the global financial crisis. Claessens and van Horen [10] highlight a sharp reduction in cross-border lending, particularly so for advanced countries hit by systemic crisis. Giannetti and Laeven [22],[23] find that banks increased home bias when confronting a banking crisis. The IMF [28] shows that the tightening of regulations, worldwide and in response to the crisis, explains a large share of the overall reduction of cross border claims. All of the above-mentioned literature explored the link between the crisis and financial dis-integration, however they cannot examine the link with the newly implemented regimes for global banks' resolution.

Finally our paper also draws conclusions about Total Loss Absorbing Capacity regulation showing that they can blur the difference between coordinated and uncoordinated bail-in regimes. A recent paper that studies the impact of TLAC for G-SIB is Kupiec[29].

## 2.1 Living Wills of GSIB

Before presenting the model it is instructive to examine the emerging landscape of cross-border resolution. This is now possible because regulators worldwide require that global banks submit a plan that explains how the recovery or resolution plan (RRP hereafter) would take place in the event of severe financial distress or failure of the bank. Those plans have to be deemed feasible and efficient jointly by regulators and banks. The cornerstone of all plans is the designation of the group as operating under SPE or MPE.<sup>4</sup> The Dodd-Frank Act was helpful in providing transparency about the plans since it requires their regular publication. All bank holding companies with consolidated assets of more than \$50 billion submit yearly resolution plans to the Federal Reserve and it publishes summaries (up to 100 pages long) on its website.<sup>5</sup> Other regulators do not publish the RRP and full global resolutions plans remain confidential, however they are referenced in the summaries

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<sup>4</sup>Recall that SPE un-coordinated is not an official regime but the failure for SPE to work as intended.

<sup>5</sup><http://www.federalreserve.gov/bankinforeg/resolution-plans.htm>

published by the US. We read the living wills of global banks with more than 100bn in assets that submitted to the FED in 2015 to extract the choice of global resolution regime.<sup>6</sup>

Table 1 shows that the majority of global banks are to operate under SPE. Only HSBC and BBVA are designated as MPE groups. The list also shows that the choice of MPE or SPE is not correlated with the size of the bank. HSBC and BBVA are, respectively, the largest and the smallest among those banks in terms of total assets. Instead, the choice of MPE appears to be related to the highly decentralized, retail based business models of the two banks. For instance, BBVA has expanded internationally (mainly in Latin America) through the acquisition of local retail banks, which continue to operate with local funding and quite independently from headquarters<sup>7</sup>. For such a bank an MPE strategy seems a better fit since the scope of strategic interaction is limited. This observation is well in line with results of our model in section 3, which show that under a low degree of home bias in liabilities (ex ante highly decentralized business models) MPE dominates.

**Table 1. Recovery and Resolutions Plans of Global Banks<sup>8</sup>**

Bank	Currency	Total Assets	Preferred Resolution	Source
HSBC	USD bn	2634	MPE	RRP, 12-31-2015
JP Morgan	USD bn	2573	SPE	RRP, 7-1-2015
BNP Paribas	Euro bn	2077	SPE	RRP, 12-31-2015
Bank of America	USD bn	2104	SPE	RRP, 7-1-2015
Citigroup	USD bn	1832	SPE	RRP, 7-1-2015
Deutsche Bank	USD bn	1709	SPE	RRP, 7-1-2015
Barclays	BP bn	1358	SPE	RRP, 7-1-2015
UBS	CHF bn	1062	SPE	RRP, 7-1-2015
RBS	BP bn	1050	SPE	RRP, 12-31-2015
Credit Suisse	CHF bn	921	SPE	RRP, 7-1-2015
Goldman Sachs	USD bn	856	SPE	RRP, 7-1-2015
Morgan Stanley	USD bn	829	SPE	RRP, 7-1-2015
BBVA	Euro bn	651	MPE	See [14]

<sup>6</sup>We added BBVA, which has made the chosen regime public.

<sup>7</sup>The other systemically important global Spanish bank, Banco Santander, has a similar business model and should also prefer a MPE approach. (see Alvarez and Fernandez [1]).

<sup>8</sup>Notes: Summaries published by NY FED <http://www.federalreserve.gov/bankinforeg/resolution-plans.htm>. Included: banks holding companies above 100bn assets that submitted RRP to the NY FED in 2015. Not included: financial groups (AIG, Prudential Financial, GECC); Wells Fargo and Bank of NY Mellon (bridge bank). Assets as in RRP (and Annual Report 2014 for DB and BBVA). Comparability restricted due to different accounting.

A reading of the recovery and resolutions plans also informs about the banks' reasons for an SPE choice. Centralized groups report that SPE coordinated regime would help a more efficient allocation of losses since a central authority with vision on the entire consolidated balance sheet can maximize the value of the Group for the benefit of its stakeholders, preserve critical operations and otherwise minimize financial instability.<sup>9</sup>

Moreover some SPE groups plans state explicitly that this strategy will require globally coordinated action among regulators. Table 1 shows that there are 5 different the home country authorities are in charge of their respective parent bank under SPE (US,UK, Germany, France and Switzerland). As noted, this means that the national authorities cooperate by not intervening themselves. The idea is that such cooperation should be ensured through the several layers of crisis management groups that have been installed at the regional and international level and that encompass the most important supervisors of every global bank.<sup>10</sup> However, the living will of Credit Suisse gives a flavor of the size of the challenge to maintain cooperation among multiple authorities at home and abroad: it notes that the number of important (material) supervisory authorities that have intervention powers for the group amounts to 19 (out of which. five are in the United States alone).<sup>11</sup> This seems to give grounds for the fear that coordination may be rather difficult to achieve in crisis and motivates the discussion of the SPE non-cooperative outcome in the model below.

At last, living wills give indications on banks' de-globalization under SPE regimes. In particular, regulators have required GSIBs to re-organize their business models and reduce intra-group dependencies<sup>12</sup>. Equally our model below shows that GSIBs under SPE regimes tend to reduce exposure to foreign assets and to change business models towards subsidiarization.

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<sup>9</sup><http://www.federalreserve.gov/bankinfo/reg/resolution-plans.htm>

<sup>10</sup>At the international level, there are supervisory colleges, which are responsible for coordinating when the bank is operating as a going concern, there are crisis management groups, which are supposed to take over when conditions have deteriorated to the point where they may reach non-viability (BIS 2014). At the regional level, supervisors of European banks are organized in resolution colleges (EBA 2014) and finally there are multiple supervisory authorities at the national level.

<sup>11</sup>see RRP Credit Suisse <http://www.federalreserve.gov/bankinfo/reg/resolution-plans/credit-suisse-1g-20150701.pdf> p. 18

<sup>12</sup>For instance, UBS has completely changed its legal structure to improve resolvability (See UBS Quarterly Report Q32015 p. 12, [https://www.ubs.com/global/en/about\\_ubs/investor\\_relations/quarterly\\_reporting/2015.html](https://www.ubs.com/global/en/about_ubs/investor_relations/quarterly_reporting/2015.html))

### 3 The Model

We address the coordination failures highlighted so far using a game-theoretic approach. All agents in our economy form decisions by solving optimization problems under full information. Strategic interactions take place between authorities in different jurisdictions and between banks and regulators. The game develops in two periods. The time-line is as follows. At time  $t = 0$  nature assigns the policy regime (SPE or MPE), banks' foreign exposure and their regulatory requirements are given. At time  $t = 1$  the optimal fraction of bail-inable bonds is optimally chosen by a single resolution authority, if the SPE regime is in place, or by policy makers in the two countries (simultaneously) if the MPE or the uncoordinated SPE regimes are in place (Nash equilibrium). Resolution authorities in each country minimize a loss function, which results from aggregating banks' stakeholders (bondholders and equity holders) welfare. At time  $t = 2$  banks react to the policy regime by choosing the extent to which they wish to invest in foreign assets and also their business model (branches versus subsidiaries).

Our model is comprised of two countries which we label  $i$  and  $j$ . In each country there is a banking group which optimally chooses domestic and foreign assets,  $A^i$  and  $A^{i,*}$  respectively, domestic and foreign liabilities short term liabilities,  $(1 - \mu)D^i$  and  $\mu D^i$  respectively, and must fulfil equity requirements. Assets' returns,  $R^{A,i}$  and  $R^{A*,i}$ , are random and follow distributions  $f(R^{A,i})$  and  $f(R^{A*,i})$  and are un-correlated. Due to arbitrage the return on short term liabilities,  $R^D$ , is equalized across countries.

Cross-country spillovers emerge in our model through two channels. The first is a *shared liabilities* channel. Global groups raise liabilities across countries, hence foreign liabilities impact their equity requirements as well as their optimization problem. Foreign (domestic) authorities that attempt to protect their bondholders from losses end up affecting domestic (foreign) banks' decisions. The second is an *asset globalization* channel. Banks invest in assets cross-countries, hence foreign assets enter the decisional problem of the parent holding through the equity requirement. Authorities' decisions on the cross-country share of bondholders losses affects banks' shortfalls in equity, which in turn affects their cross-country allocation of assets. In a context with cross-country spillovers *beggar-thy-neighbour* effects emerge as national regulators, while tempted to protect national bond-holders, end up increasing overall losses for the entire global group.

Next we present agents' optimization problems and the analytical solution in each regime (SPE, coordinated and uncoordinated, and MPE). We compare regimes by comparing welfare costs.

### 3.1 Banks' Optimization

Banks are optimizing agents who choose how to allocate assets across borders and how to fund their portfolio by maximizing expected profits subject to regulatory constraints. The supply of short term liability is given locally:  $\mu D^i$  is the fraction of domestic short term liability and  $(1 - \mu)D^i$  is the fraction of foreign owned liabilities. Hence  $\mu$  represents the degree of home bias (taken as given by banks) and represents the cross-country liability structure. Ex ante banks choose  $A^i$ ,  $A^{i,*}$  and  $D^i$  to maximize at every period  $t$ :

$$E(\pi) = E(R^{A,i})A^i + E(R^{A^*,i})A^{i,*} - R^D D^i \quad (1)$$

Banks shall also fulfill an equity regulatory requirements or a VaR constraint. Under the SPE regime banks face a single equity requirement constraint defined on the group-wise consolidated balance sheet and imputed upon the parent holding. For the time being we assume that the foreign unity is a branch<sup>13</sup>. Under SPE this implies that the parent holding is responsible for the branch capital short-fall. Under the MPE regime the parent holding (the domestic bank) and the foreign branch face two different equity requirements, each referring to the balance sheet of the local entity. Under SPE the equity requirement reads as follows:

$$CR = \frac{A^i + A^{i,*} - (\mu D^i + (1 - \mu)D^i)}{A^i + A^{i,*}} \geq \beta \quad (2)$$

In need of liquidity banks start to sell assets, however they can do it only until the capital requirements is satisfied. If this happens, banks go technically on default. The solution to the banks' maximization problem is laid down in Appendix A. Given the linear optimization problem the total amount of assets is determined by equation 2, the share between  $A^i$  and  $A^{i,*}$  is determined by the ratio between the asset returns and the ratio between liabilities and assets is determined by the cost of deposits (relatively to asset returns)<sup>14</sup>.

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<sup>13</sup>This means that the local unit is not a separate legal entity.

<sup>14</sup>Since the supply of deposits is exogenously given, the banks' first order conditions imply that their returns adjust so as to balance demand and supply.

Under MPE the local regulatory constraints read as follows<sup>15</sup>:

$$CR^i = \frac{A^i - \mu D^i}{A^i} \geq \beta^i \quad (3)$$

$$CR^j = \frac{A^{i,*} - (1 - \mu)D^i}{A^{i,*}} - \Psi \geq \beta^j \quad (4)$$

We have assumed that raising capital in the foreign country entails some sunk cost,  $\Psi$ . This cost captures several aspects of the lumpiness associated with opening activities in foreign markets. First, it contains the bare costs of installing the branch or the subsidiary facilities abroad. Second, it includes banks' advance payment to the local insurance fund. Third, it entails the resource costs associated with the fact that peripheral equity capital might be of lower quality. At last, the cost captures the negative reputation effects associated with the possibility of closing down operations in a periphery country. Theoretically its main role is to rule out the equilibrium in which the bank exits the foreign market in the face of temporary losses. Notice however that, as we verify later, this costs does not affect the results of the model in terms of regimes' comparison.

### 3.2 The Optimization Problem of the Resolution Authority

If the possibility of banks' default materializes the resolution authority intervenes through bail in procedures. Resolution authorities can intervene in a coordinated or in an uncoordinated fashion: more details on this point are given in the next section. Bail-ins are usually implemented through some complex procedures which involve pecking order of loss bearing investors and transfer of short term liabilities into equities. Overall resolution authorities decide the optimal fraction  $\xi$  of bail-inable short term liabilities, which will either bear direct losses or be transformed into equities (valued at lower prices). In the non cooperative solution (which from now on we label the multiple point of entry) the regulatory authority of each country chooses a fraction  $\xi$  out of short term liabilities held domestically, namely a fraction of  $\mu D^i$  for country  $i$  and a fraction out of  $(1 - \mu)D^i$  for the foreign country. In the cooperative solution (which from now we will label the SPE-cooperative) the resolution authority chooses a fraction  $\xi$  of the total  $(\mu D^i + (1 - \mu)D^i)$ . In other words under the cooperative regime there is one single authority (that of the parent holding's country) and the resolution is applied at the level of the parent's holding, hence both the capital requirements as well

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<sup>15</sup>Notice that in this case the distinction between subsidiaries and branches is immaterial since the national resolution authorities only examine the local offices liability structure.

as the bail-inable assets are computed by considering the full consolidated group balance sheet. We shall stress once more that we consider also a second non-cooperative regime, namely the failure of the single point of entry (which since now on we label the non-cooperative-SPE). In this case the banks' capital requirement is defined upon the consolidated balance sheet (hence considering the parent holding as the point of entry), however authorities fail to coordinate and end up maximizing domestic welfare taking as given the optimal choice of the other country. For this case the optimal fraction of bail-inable liabilities in each country is obtained through a Nash equilibrium solution.

Resolution authorities choose  $\xi$  to maximize investors' welfare (investors in our economy include both bond-holders and equity-holders). We rely on a micro-founded concept of welfare, in that we assume that the regulators shall maximize the sum of the economy's investors utilities (bond-holders and equity-holders). Assuming risk-averse investors implies that the relevant objective for the policy maker is that of minimizing losses for investors' of banks' liabilities. More specifically it can be shown that under a quadratic utility the relevant objective becomes a quadratic loss minimization, in which each investor's loss is aggregated through Pareto-Negishi weights. Notice that bond-holders and equity-holders have diverging interests in relation to the optimal choice of the bail-inable assets. In that respect a typical trade-off materializes for the resolution authority. When the bank is hit by shocks to assets losses can indeed be covered in two ways. Either by imposing hair cuts to bondholders (or equivalently by transforming bonds into equities at lower market values) or by raising new capital through equity holders. In the uncoordinated regime the resolution authority is concerned solely with residents' losses, the opposite is true in the coordinated regime. Losses to bondholders can be quantified as  $\xi\mu\frac{D^i}{A^i+A^{i,*}}$  in the uncoordinated regime and as  $\xi\frac{(\mu D^i+(1-\mu)D^i)}{A^i+A^{i,*}}$  in the coordinated regime. Since bondholders are assumed to have quadratic utilities the regulators shall minimize their quadratic welfare loss. The second possible manoeuvre to cover banks' losses is a capital action that implicitly dilutes the value of equities. The cost to equity-holders can be quantified through the capital short-fall needed to recapitalize the bank,  $CR - \beta$ . Since equity holders are also assumed to have quadratic utilities the regulator wishes to minimize their quadratic losses,  $(CR - \beta)^2$ . An increase in  $\xi$  increases the cost to bondholders, but reduces the capital short-fall, hence the cost to equity-holders. The regulator solves the maximization problem subject to the bank's behavioral constraints, which can be summarized by the equity

requirements (spelled out in the previous section for each regime)<sup>16</sup>. The focus on welfare, optimal regimes and trade-offs is one of the main novelties of our paper.

### 3.3 Cooperative versus non cooperative SPE regimes

Notice that a necessary condition for strategic externalities to materialize also in the SPE regimes is that the foreign resolution decisions,  $\xi^*$ , affect the domestic parent holding equity requirement to the extent that foreign liabilities enter a consolidated balance sheet. Those types of cross-country spillovers might induce temptation to deviate from full cooperation. In other words, the attempt of the foreign resolution authority to protect resident bond-holders (by reducing  $\xi^*$ ) produces negative externalities on the parent holding. Also notice that in our set-up domestic and foreign resolution authorities have symmetric objectives, implying that the scope for coordination failure is not due to ad hoc pre-imposed differences in preferences.

We start by examining the regulator's optimization problem in the *SPE cooperative regime* a single resolution authority chooses  $\xi$  to minimize:

$$L_{bailin}^i = \left( \xi \frac{(\mu D^i + (1 - \mu) D^i)}{A^i + A^{i,*}} \right)^2 + (CR - \beta)^2 \quad (5)$$

subject to the constraint subject to:

$$CR = \frac{A^i + A^{i,*} - (\mu(1 - \xi) D^i + (1 - \mu)(1 - \xi^*) D^i)}{A^i + A^{i,*}} \leq \beta \quad (6)$$

The first order condition reads as follows:

$$\xi \left[ \frac{(\mu D^i + (1 - \mu) D^i)}{A^i + A^{i,*}} \right]^2 + (CR - \beta) \left[ \frac{(\mu D^i + (1 - \mu) D^i)}{A^i + A^{i,*}} \right] = 0 \quad (7)$$

Rearranging one gets the optimal level of bail-inable deposits which is given by:

$$\xi^C = \frac{(\beta - 1)(A^i + A^{i,*})}{2D^i} + \frac{1}{2} \quad (8)$$

Next we examine the regulators' optimization in the *non cooperative* SPE regime. Recall that in this case the capital regulation is applied based on the single point of entry, but national authorities fail to coordinate. Here each national regulator decides the fraction of domestic short

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<sup>16</sup>In Appendix A it is shown that given banks' risk neutrality the equity requirement is sufficient to determine overall banks' asset exposure.

term liabilities,  $\xi$ , by taking as given the fraction chosen by the other national regulator,  $\xi^*$ . The resulting equilibrium would be a standard Nash prisoner's dilemma. The regulator of country  $i$  chooses  $\xi$  to minimize:

$$L_{bailin}^i = \left(\xi\mu\frac{D^i}{A^i + A^{i,*}}\right)^2 + (CR - \beta)^2 \quad (9)$$

subject to the 6 constraint.

The optimization problem can be written as follows:

$$\text{Min}_\xi \left(\xi\mu\frac{D^i}{A^i + A^{i,*}}\right)^2 + \left(\frac{A^i + A^{i,*} - (\mu(1 - \xi)D^i + (1 - \mu)(1 - \xi^*)D^i)}{A^i + A^{i,*}} - \beta\right)^2 \quad (10)$$

The first order conditions with respect to  $\xi$  delivers the following solution:

$$\xi = \frac{(\beta - 1)(A^i + A^{i,*})}{2\mu D^i} + \frac{1}{2} + \frac{(1 - \mu)}{2\mu}(1 - \xi^*) \quad (11)$$

The optimization problem of the foreign resolution authority leads to a symmetric reaction function<sup>17</sup>. To obtain the Nash equilibrium we substitute the foreign authority reaction function into equation 11 (derivations are shown in Appendix B). This leads to:

$$\xi^{NC} = \frac{(\beta - 1)(A^i + A^{i,*})}{D^i(2\mu - 1)} + \frac{1}{1 + \mu} \quad (12)$$

It is interesting to note that the optimal  $\xi^C$  in the cooperative regime is independent from the degree of home bias in bond holding. In this case the regulator internalizes the cross-country spillovers in liabilities, hence he is indifferent between domestic and foreign bondholders. On the contrary under the non-cooperative regime the fraction of domestic bondholders (relatively to the fraction of foreign bondholders) matters for the optimal  $\xi^{NC}$ , since it affects the regulators' incentives toward protecting domestic investors at the expenses of foreign ones. In fact a comparison between  $\xi^{NC}$  and  $\xi^C$  reveals that (for given asset allocation) the structure of liabilities, as exemplified by the degree of home bias  $\mu$ , plays a crucial role. As  $\mu \rightarrow 1$ , bond-holders losses under the non-cooperative regime become  $\xi^{NC} = \frac{(\beta-1)(A^i+A^{i,*})}{2D^i} + \frac{1}{2}$  which are equal to  $\xi^C = \frac{(\beta-1)(A^i+A^{i,*})}{2D^i} + \frac{1}{2}$ . When liabilities are raised only locally the regulator does not face any trade-off between domestic and foreign bondholders, hence the two solutions tend to coincide. Under  $\mu = \frac{1}{2}$  bond-holders losses under the non-cooperative regime are  $\xi^{NC} = \frac{(\beta-1)(A^i+A^{i,*})}{D^i} \frac{2}{3} + \frac{2}{3}$ , hence certainly larger than

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<sup>17</sup>We are assuming an equivalent degree of home bias,  $\mu = \mu^*$ . We are focusing on global SIFI this is realistic assumption, since their liability structure is mostly symmetric across developed markets.

$\xi^C$ . This case corresponds to a perfect beggar-thy-neighbour effect. Each authority attempts to ring fence domestic bondholders, but as both authorities fail to internalize international spillovers the resulting Nash equilibrium features higher losses than the coordinated solution. Intuitively the domestic authority sets a lower  $\xi$  in an attempt to protect domestic bond-holders, but this action produces sequential capital short-falls, which eventually require further bail-in actions. A full assessment of this comparison is simulated numerically (for different levels of  $\mu$  and  $\beta$ ) in Figure 1 which plots the regions in which  $\xi^{NC} \geq \xi^C$ <sup>18</sup>.

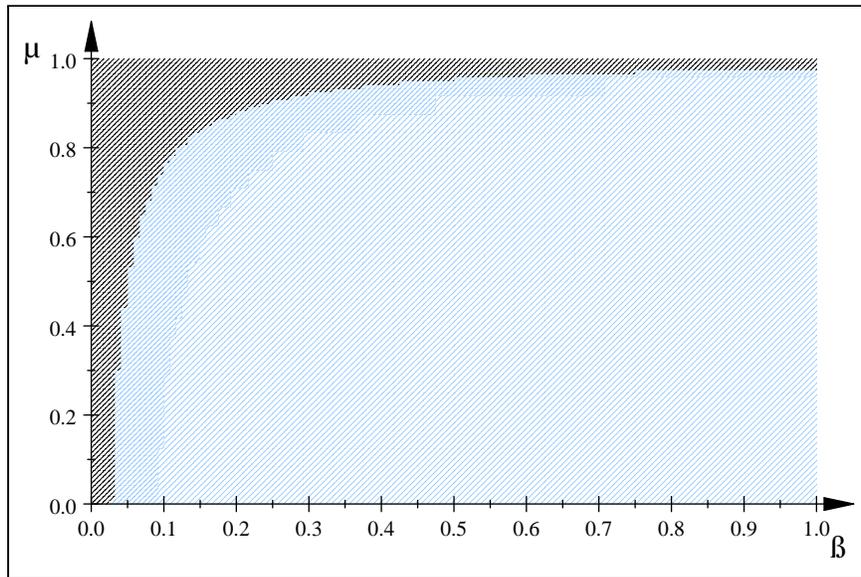


Figure1. Regions in which  $\xi^{NC} \geq \xi^C$  for different values of  $\beta$  and  $\mu$ .

The figure shows that bond-holders losses are generally higher in the non-cooperative regime than in the cooperative one, unless liabilities' home bias is very high. The result holds generally for almost any level of the regulatory equity requirement. The rationale for this result is as follows. Under the non-cooperative solution the resolution authority does not internalize the spillovers that

<sup>18</sup>For this numerical comparison we fix assets to notional values of  $A^i = A^{i,*}$  and  $D^i = 200$ . Notice that asset allocations shall be the same across the two countries since we are assuming equal returns. Also notice that the value of deposits which would guarantee that the regulatory capital requirement holds is equal to 175. Hence any value above that is compatible with the optimal solution.

its own actions have on the parent holding equity requirements and eventually on the foreign bondholders. This results in a prisoner's dilemma equilibrium in which ex post bondholders' costs turn out to be higher than under cooperation. Those mis-incentives are higher, the larger the spillover effects (due to the shared liability) are. The latter in turn increase when  $\mu$  falls. Importantly for high levels of the equity requirements the cooperative regime ceases to be superior. In this case indeed for both regulators the costs of deviating from the banks' equity target becomes predominant, hence they lose any incentive to ring fence domestic bond-holders. Intuitively high equity requirements, by acting as discipline devices, reduce the welfare cost under any regime and blur the difference between them. The analytical expression for the equilibrium policy actions,  $\xi$ , of the two authorities under the SPE regime is summarized in Appendix C.

To compare the efficiency of the two regimes we shall now compute their welfare costs. We can do so by substituting the optimal  $\xi$  under the two regimes in the aggregate welfare, given by the regulator's objectives.

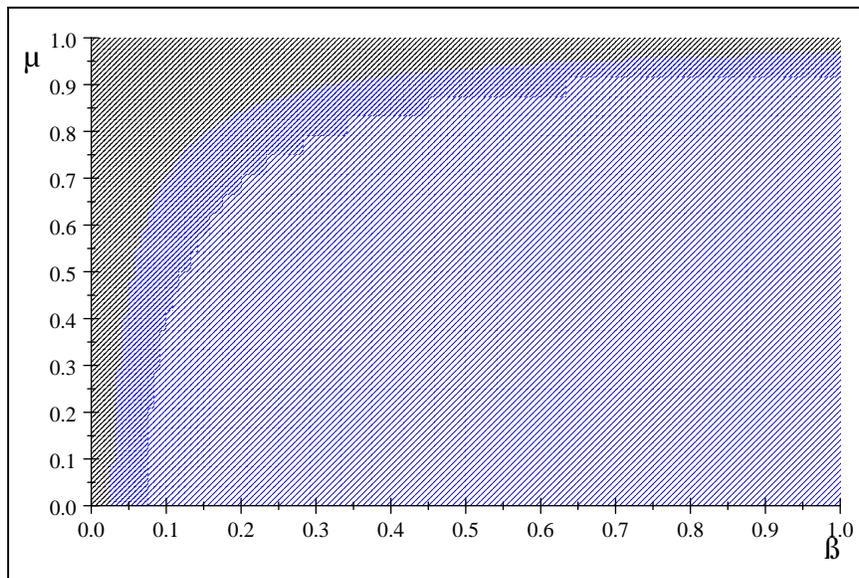


Figure 2. Regions in which welfare losses under non-cooperative SPE is larger than welfare under cooperative SPE for different values of  $\mu$  and  $\beta$ .

Figure 2 shows that the welfare costs under the non-cooperative regime is higher than the one under cooperative regime (shaded area in blue) except for high levels of home bias. Cooperative actions are generally more efficient since, as explained above, the authority internalizes all spillovers. Again we observe that high capital requirements blur the difference between regimes. Analytically the result is clear. When  $\beta$  increases the welfare costs associated with the capital short-fall,  $(CR - \beta)^2$ , become predominant compared to the incentives to reduce bond-holders' losses. Economically it is intuitive. Ex ante prudential regulations have a preemptive role, which by reducing the likelihood of crises, also reduces welfare losses under any regime. This result effectively rationalizes the preemptive role of the TLAC (Total Loss Absorbing Capacity) policy. The latter in fact requires global groups to preposition a sufficient level of equity capital<sup>19</sup> so as to absorb most losses emerging during the resolution procedure<sup>20</sup>. At last, notice that the pattern for the comparison of overall welfare losses (for the two extreme Nash equilibria, coordination versus non-coordination) is very similar to the pattern for the optimal fraction of bond-holders' losses. This signals that, albeit the trade-of embedded in the loss function, investors' losses end up being rather complementary in equilibrium.

### 3.3.1 SPE non-cooperative: subsidiaries versus branches

In reality banks who engage into foreign markets might do so under different business models. Some might decide to open foreign subsidiaries and some might decide to open foreign branches. A branch office is not a separate legal entity of the parent corporation, while a subsidiary is. Under the fully cooperative regime this difference is immaterial since the resolution is conducted at the center and since the single resolution authority takes into account the fully consolidated balance sheet of the group, independently from potentially different business models<sup>21</sup>. The same is true under the multiple points of entry regimes (discussed in the next section) since in this case resolution takes place locally and each national resolution authority only examines the balance sheet of the local offices. The difference instead becomes salient under an SPE regime in which resolution authorities

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<sup>19</sup>This actually holds for both branches and subsidiaries.

<sup>20</sup>It is also worth noticing that current regulation allows for downstreaming, namely transfer of equities from the parent holding to the branch, but not for upstreaming.

<sup>21</sup>Even in this case global groups might choose to hold subsidiaries or branches for tax purposes. However from the point of view of the resolution regime this difference is immaterial.

fail to coordinate. While the previous section examined this regime under the branch case, we now examine the same regime under the subsidiary case.

The resolution procedure is still implemented at the center<sup>22</sup>, but liabilities are not shared across group offices. Hence contrary to before the parent holding equity requirement shall not include foreign liabilities, hence the shared liability effect is missing. On the other side, current regulations force the parent holding to pre-position equity capital onto the subsidiary<sup>23</sup>, thereby making the parent holding directly liable for subsidiaries capital short-falls (downstreaming). Hence the parent holding constraints include a second separate equity requirement. Overall parent holding equity requirements are:

$$CR^N = \frac{A^i - (\mu(1 - \xi)D^i)}{A^i} \geq \beta \quad (13)$$

$$CR^S = \frac{A^{i,*} - ((1 - \mu)(1 - \xi)D^i)}{A^{i,*}} \geq \beta \quad (14)$$

Notice that in the above constraints we did not distinguish between domestic and foreign bondholders' losses. Under an SPE regime the choice of  $\xi$  is undertaken by the domestic resolution authority and is applied to both domestic and foreign liabilities. In this case strategic interactions emerge primarily between the global banking group and the resolution authority of the parent holding<sup>24</sup>. Notice that based on current regulations the equity requirement,  $\beta$ , holds equally for both parts of the group. The optimization problem for the domestic resolution authority reads as follows:

$$Min_{\xi} \left( \xi \mu \frac{D^i}{A^i} \right)^2 + (CR^N - \beta)^2 + (CR^S - \beta)^2 \quad (15)$$

subject to equations 13 and 14. The optimality condition delivers the following optimal fraction:

$$\xi^S = \frac{\Theta}{\Omega} - \frac{(1 - \beta)}{\Omega} \frac{1}{\mu} \frac{A^i}{D^i} \quad (16)$$

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<sup>22</sup>In the event of resolution the central regulatory authority has statutory power over to all liabilities of the ailing bank, including liabilities held abroad and claims governed by foreign laws (see Zhou et. al.[38]).

<sup>23</sup>The Financial Stability Board issued new guidelines suggesting that any G-SIB should pre-position a sufficient amount of capital (possibly larger than the one required by the SSM and reaching also 20%) in each subsidiary. Those guidelines have been already implemented in several countries' legal frameworks. See also Gracie [25].

<sup>24</sup>Notice that the local resolution authority might be called into action for insolvency of the subsidiary alone. However the fraction of foreign bailinable bonds chosen for this specific case does not enter any of the objectives or constraints faced by the host regulator. For this reason we neglect to spell out the optimization problem of the local resolution authority.

where  $\Omega = 2\mu + \frac{(1-\mu)^2}{\mu}$  and where  $\Theta = \mu + \frac{(1-\mu)^2}{\mu}$ <sup>25</sup>. It is instructive to compare  $\xi^S$  to the optimal value derived for the branch case (with uncoordinated SPE) and with the value derived under coordinated SPE. Given the presence of polynomial expressions with respect to the value of  $\mu$ , the numerical comparison of the optimal fractions is not feasible<sup>26</sup>. We therefore proceed to the comparison for limiting values of  $\mu$ . The following ranking emerges.

**Lemma 1.** *For given values of  $\mu$  the following ranking holds:*

For $\mu = 1$	$\xi^S = \frac{(\beta-1)A^i}{2D^i} + \frac{1}{2} \geq \xi^C = \frac{(\beta-1)(A^i+A^{i,*})}{2D^i} + \frac{1}{2}$ also $\xi^S \geq \xi^{NC}$ since $\xi^{NC} = \xi^C$
For $\mu = \frac{1}{2}$	$\xi^S \geq \xi^C$ when $\left[ \frac{2A^i}{D^i} - \frac{(A^i+A^{i,*})}{2D^i} \right] \leq \frac{7}{(1-\beta)22}$ ; $\xi^S \leq \xi^{NC}$ when $\left[ \frac{2A^i}{D^i} - \frac{(A^i+A^{i,*})}{D^i} \right] \frac{2}{3} \leq \frac{16}{(1-\beta)33}$
For $\mu = 0$	$\xi^S = 1 + \frac{(\beta-1)A^i}{D^i} > \xi^C = \frac{(\beta-1)(A^i+A^{i,*})}{2D^i} + \frac{1}{2}$ ; $\xi^S = 1 + \frac{(\beta-1)A^i}{D^i} \leq \xi^{NC} = \frac{(\beta-1)(A^i+A^{i,*})}{D^i} + 1$

Table 2. Comparison between bond-holders' losses (subsidiary versus branch)

The ranking in Lemma 1 can be rationalized as follows. The  $\xi$  in an uncoordinated SPE-regime remains higher than the one under coordinated SPE also when considering the branch case. The above discussion related to the failure to internalize the costs of foreign bond-holders remains valid. The relative comparison between the  $\xi^S$  and  $\xi^{NC}$  is more complex. In both cases regulators fail to internalize cross-country spillovers, however their objectives and constraints are different in the two cases. For highly centralized groups ( $\mu \rightarrow 1$ , liabilities raised primarily in the home country)  $\xi^S \geq \xi^{NC}$ , while for highly decentralized groups the opposite is true. When most liabilities are raised at the center the resolution authority, which is primarily concerned with the costs for domestic bondholders, is tempted to keep  $\xi^S$  as low as possible. The capital pre-positioning however works as discipline device: since  $(1-\mu)$  approaches zero,  $\xi^S$  should be high enough to avoid a subsidiary capital short-fall. Ultimately the need to satisfy two independent capital requirements tilts the regulator's objectives toward assigning more weights to equity holders costs (as proxied by the equity short-fall). As a result the authority sets  $\xi^S \geq \xi^{NC}$ . The opposite reasoning holds for highly decentralized groups (low degree of home bias).

<sup>25</sup>We derived this symmetric under the assumption that the asset exposure across countries is the same, hence  $A^i = A^{i,*}$ . This maintains symmetry with the other cases considered. The general expression for  $\xi$  reads as follows:  $\xi^S = \frac{\Theta}{\Omega} - \frac{(1-\beta)}{\Omega} \left[ 1 + \frac{(1-\mu)}{\mu} \frac{A^i}{A^{i,*}} \right]$  where  $\Omega = 2\mu \frac{D^i}{A^i} + \frac{(1-\mu)^2}{\mu} \frac{D^i}{A^{i,*}} \frac{A^i}{A^{i,*}}$  and where  $\Theta = \mu \frac{D^i}{A^i} + \frac{(1-\mu)^2}{\mu} \frac{D^i}{A^{i,*}} \frac{A^i}{A^{i,*}}$ .

<sup>26</sup>For each value of  $\beta$  there are always two value of  $\mu$  that solve the inequalities  $\xi^S \geq \xi^C$  or  $\xi^S \geq \xi^{NC}$ .

Overall bond-holders losses with subsidiaries are higher compared to cooperative regimes and to non-cooperative regimes with branches. With subsidiaries there is no shared liability effect and cross-country spillovers are solely due to the asset internationalization effect. The latter materializes due to the capital pre-positioning. The addition of the capital pre-positioning requirement induces the regulator to weight more the costs from the equity short-falls. As a result bond-holders are assigned higher losses compared to most other regimes.

### 3.4 The Model under Multiple Points of Entry

Under the multiple points of entry regime the resolution authority of each country is delegated to resolve the local bank branch in a non cooperative fashion. In country  $i$  the resolution authority chooses  $\xi$  to minimize:

$$MinL_{bailin,MPE}^i = \left(\xi\mu\frac{D^i}{A^i}\right)^2 + (CR - \beta^i)^2 \quad (17)$$

subject to:

$$CR^i = \frac{A^i - \mu(1 - \xi)D^i}{A^i} \geq \beta^i \quad (18)$$

The first order condition in this case reads as follows:

$$\xi^{i,MPE} = \frac{(\beta - 1)(A^i)}{2\mu D^i} + \frac{1}{2} \quad (19)$$

Notice that ex ante the fraction of foreign bond-holders' losses,  $\xi^*$ , does not enter the parent holding behavioral constraint, nor the domestic regulator optimization problem. It will do so only in the Nash equilibrium due to cross-substitution of the reaction functions. The authority of the foreign country chooses  $\xi^*$  to:

$$MinL_{bailin,MPE}^j = \left(\xi^*(1 - \mu)\frac{D^i}{A^i}\right)^2 + (CR - \beta^j)^2 \quad (20)$$

s. to:

$$CR^j = \frac{A^{i,*} - (1 - \mu)(1 - \xi^*)D^i}{A^{i,*}} - \Psi \geq \beta^j \quad (21)$$

The first order conditions in this case reads as follows:

$$\xi^{j,MPE} = (\beta - 1 + \Psi)\frac{A^{i,*}}{2(1 - \mu)D^i} + \frac{1}{2} \quad (22)$$

Notice that the cost of raising capital does not affect the comparison between the MPE and the SPE regimes. When  $\Psi = 0$  it follows that  $\xi^{i,MPE} = \xi^{j,MPE}$ . When  $\Psi \geq 0$ ,  $\xi^{j,MPE}$  is higher than  $\xi^{i,MPE}$ . For this reason we will compare  $\xi^{i,MPE}$  to  $\xi^C$ , so that any qualitative result emerging from the comparison will apply to  $\xi^{j,MPE}$  as well.

We compare MPE and coordinated SPE regimes first for limiting cases (Table 3) and then numerically for all values of  $\mu$  and  $\beta$ .

$\xi^{i,MPE} = \xi^C$	$A^{i,*} = 0$ and $\mu = 1$
$\xi^{i,MPE} \geq \xi^C$	$(1 - \mu) \geq \frac{A^{i,*}}{A^i}$
$\xi^{j,MPE} \geq \xi^C$	$(1 - \mu) \leq \frac{(\beta-1+\Psi)A^{i,*}}{(\beta-1)(A^{i,*}+A^i)}$
$\xi^{j,MPE} = \xi^C$	$(1 - \mu) \rightarrow 1$ and $\Psi = 0$
$\xi^{i,MPE} \rightarrow \infty$	$\mu \rightarrow 1$

Table 3. Comparison of losses for both countries under MPE and SPE-cooperative

Several considerations stand out from Table 3. First, when the degree of home bias in country  $i$ , approaches 1, we have that  $\xi^{i,MPE} = \xi$ . This is effectively the limiting case of a closed economy for which cross-country spillovers are not relevant for the national regulators. Second,  $\xi^{i,MPE} \geq \xi^C$  whenever the degree of home bias of country  $i$  is smaller than  $\frac{A^{i,*}}{A^i} - 1$ . Intuitively if banks are globally more exposed on the asset side than on the liabilities' side, the impact of changes in foreign assets on the capital shortfall out-weights the loss to domestic investors. Because of this the resolution authority will convert a larger fraction of short term liabilities in order to cover for the capital shortfall.

Let's now examine the same comparison but for country  $j$ . Intuitively the resolution authority of country  $j$  will generally be forced to bail-in a higher fraction than the resolution authority of country  $i$  since equity capital raised in country  $j$  is of lower capital (it is subject to a cost  $\Psi$ ). The fraction of bail-inable instruments for country  $j$  will then be higher than the one optimally chosen under the cooperative SPE regime if the home bias in country  $j$ ,  $(1 - \mu)$ , is small enough. In this case ex ante ring-fencing prevents banks from implementing full risk-sharing on liabilities. Ex post this forces the resolution authority to tax foreign investors more heavily in order to compensate for the capital shortfall. The case in which the degree of home bias is maximum and there is no cost of raising capital in the foreign country (raising capital in country  $i$  is equivalent to raise capital in country  $j$ ) corresponds in the limit to the closed economy: therefore in this case  $\xi^{i,MPE} = \xi^C$ . At

last, when the degree of home bias is nil, banks are fully dependent on liabilities in country  $i$ . In this case the resolution authority can only rely on an infinitesimal fraction of domestic liabilities to cover for the ex post capital shortfall, hence it needs to tax domestic investors in full.

To complete our assessment we plot numerically in Figure 3 the region in which  $\xi^{i,MPE} \geq \xi^C$  for different values of  $\mu$  and  $\beta$  and for given banks' portfolio allocation.

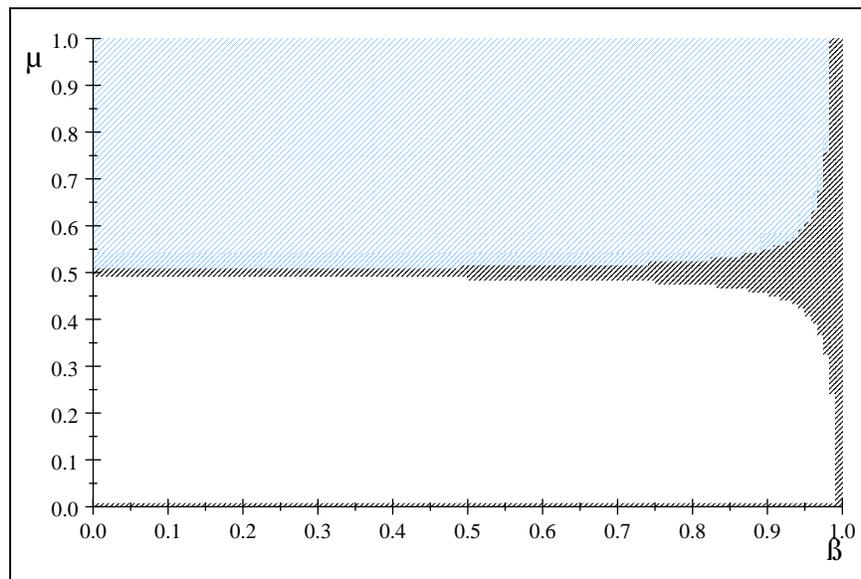


Figure 3. Regions in which  $\xi^{i,MPE} \geq \xi^C$  for different values of  $\beta$  and  $\mu$ .

Regions in which welfare losses under noncooperative SPE is larger than welfare under cooperative SPE for different values of  $\mu$  and  $\beta$ . The graph confirms numerically the reasonings done above based on analytical expressions.

### 3.5 Banks' Globalization Decisions in each Prudential Regime

Banks in our model and in real life react to the policy decisions by changing the share of foreign investment relatively to the domestic one once a regime is announced. If certain prudential regimes render unfavorable foreign investment this might trigger financial retrenchment on the side of the global groups.

In our model foreign exposure can be determined by substituting the optimal fraction of bail-inable bonds for each regime in banks' behavioral equations. As shown before given risk neutrality banks' asset exposure is determined in equilibrium through the equity requirement. Hence we obtain the endogenous foreign asset exposure of banks by substituting the optimal  $\xi$  into banks' equity requirement. Under the SPE cooperative regime one obtains the following foreign asset exposure:

$$A^{i,*} = -A^i + \frac{(1 - \xi)(\mu D^i + (1 - \mu)D^i)}{(1 - \beta)} \quad (23)$$

There is clearly a negative relation between the level of foreign asset investment and the optimal fraction of bail-inable instruments. Banks have lower incentive to invest in the foreign country if they realize that this choice entails larger resolution costs for banks' bondholders. This would in fact discourage investors from providing short term funding to banks and in turn increase the cost of funding. Since we have shown that investors' losses are generally higher under non-cooperative and uncoordinated regimes than under the cooperative regime, it follows that the latter fosters financial integration.

To analyse the comparison for the optimal level of foreign assets between SPE and MPE we focus on comparing the solution under MPE uncoordinated regime and the SPE coordinated regime. Specifically we compare the optimal fraction,  $\xi^{i,MPE}$ , for country i under the MPE against the optimal fraction,  $\xi^C$ , under the SPE-cooperative solution. We obtain that:

**Lemma 2.** If  $(A^{i,*})^{MPE} \leq (A^{i,*})^{SPE,C}$  if  $\mu \geq 2 - \frac{A^i(1-\beta)}{D^i}$ .

**Proof.** To compare the equilibrium level of foreign assets under the MPE and the SPE with cooperative authorities we must first substitute equation 8 into the equity constraint 23 and equation 19 foreign into the equity constraint 18. We then obtain the following expression for the level of foreign assets of domestic banks:

$$(A^{i,*})^{SPE,C} = \frac{D}{(1 - \beta)} - A^i \quad (24)$$

$$(A^{i,*})^{MPE} = \frac{\mu D}{2(1 - \beta)} - A^i \quad (25)$$

By comparing equations 24 and 25 we find that  $(A^{i,*})^{MPE} \geq (A^{i,*})^{SPE,C}$  if  $\mu \leq 2 - \frac{A^i(1-\beta)}{D^i}$ .

The above result shows that banks invest less in foreign assets under the SPE regime only when

the degree of exposure to foreign liabilities is below a certain threshold. As explained in other parts of the paper, under a cooperative SPE the domestic bank is liable for losses generated elsewhere in the group. This regulatory burden induces the domestic bank to retrench and generally refrain from foreign ventures, especially in smaller markets.

To complete the assessment of the endogenous banks' reaction to the announced policy regime we ask which business model a bank would choose in face of different policy decisions. Under an uncoordinated SPE regime banks can internationalize through branches or subsidiaries. In section 3.2.1 we saw that different business models entails different values for the optimal  $\xi$ . On reverse once the policy actions are announced banks choose the business model that minimizes their costs. In our framework the choice between a branch and a subsidiary does not entail any direct implication for profits<sup>27</sup>. However different business models do have implications for the regulatory burden imposed by equity requirement. In Lemma 1 we saw that for values of  $\mu \leq \frac{1}{2}$  equilibrium bond-holders losses are higher with subsidiaries than with branches. Higher  $\xi$  mitigate the banks' regulatory burden as it is easier to meet the equity requirement (both for the parent holding and foreign subsidiary offices). The shadow price of the regulatory constraint, as proxied by the lagrange multiplier on the constraint  $\lambda$ , falls. Hence we infer that for fairly decentralized groups a subsidiary structure reduces regulatory costs. The opposite is true for more centralized groups. The result is very realistic: decentralized groups with large local funding bases are likely to have a subsidiary structure.

## 4 Conclusions

This paper highlights a silent but sweeping reform of the global financial architecture. The new blue-print for resolving cross-border banks under SPE versus MPE is already having a major impact on the way national regulators interact across jurisdictions as well as on banks' business models and internationalization strategies.

Our paper provides a theoretical framework to analyze these innovations and their intended as well as unintended consequences. We consider strategic interactions between national regulators and two sources of cross country externalities in the form of banks' shared liabilities and their foreign

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<sup>27</sup>We neglected to consider for instance the tax burden under different business models.

exposures. We find that SPE resolution under coordination (where the home country authority intervenes at the level of the parent holding) minimizes welfare losses as intended. This is in line with the explicit preference regulators and the majority of global banks have expressed for this regime. However, we also show that SPE resolutions can have unintended consequences as it may foster financial disintegration in previously segmented markets.

The alternative approach namely MPE (each national authority intervenes locally) generate higher bond holder losses, in particular if the bank is funded primarily in the home country, i.e. has a high degree of home bias in its liabilities. However, MPE can be more efficient in the case of decentralized banking groups, characterized by a preponderance of local funding in the foreign countries. Again, this finding is in line with the expectations of regulators as well as with the intentions expressed in living wills of banks with this type of international retail model.

Our model focuses on a third equilibrium by relaxing the central condition for the efficiency of SPE, namely that the foreign authority accepts the lead of the home country (i.e. they both cooperate). We show how non-cooperation affects the equilibrium loss allocation and internationalization if cooperation breaks down: bond holders losses increase and banks react by reducing cross border exposures and by increasing subsidiarization. This might explain part of the observed process of global banks' cross border retrenchment and the move towards subsidiarization.

If the fear that cooperation under SPE will not be sustained in a crisis is indeed leading to inefficiently large risks and to financial disintegration, this would clearly be an unintended consequence of the new bank resolution architecture.

A redeeming factor for global regulation emerges from a final feature of our model. Higher capital requirements at home and abroad (in line with the new requirement for much higher total loss absorbing capital (TLAC) in systemic banks) blur the distinctions between the different outcomes and reduce welfare losses in all regimes.

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## 5 Appendix A. Banks' Optimization

Since all banks are alike we can drop the bank index  $i$ . Since assets returns are uncertain we introduce an expectation operator,  $E$ , which is conditional to the information available on assets' returns and on the announced policy regime. Banks choose  $A$ ,  $A^*$  and  $D$  to maximize at every period  $t$ :

$$E(\pi) = E(R^A)A + E(R^{A^*})A^* - R^D D \quad (26)$$

Banks shall also fulfill an equity regulatory requirements or a VaR constraint which can be written as follows:

$$CR = \frac{A + A^* - (\mu D + (1 - \mu)D)}{A + A^*} \geq \beta \quad (27)$$

Define as  $\lambda$  the lagrange multiplier in 27. The first order conditions to the banks' optimization problem read as follows:

$$\frac{\partial E(\pi)}{\partial A} = E(R^A) - \lambda \frac{D}{(A + A^*)^2} = 0 \quad (28)$$

$$\frac{\partial E(\pi)}{\partial A^*} = E(R^{A^*}) - \lambda \frac{D}{(A + A^*)^2} = 0 \quad (29)$$

$$\frac{\partial E(\pi)}{\partial D} = R^D + \frac{\lambda}{A + A^*} = 0 \quad (30)$$

$$\frac{\partial E(\pi)}{\partial \lambda} = \frac{A + A^* - (\mu D + (1 - \mu)D)}{A + A^*} \geq \beta \quad (31)$$

From 28 and 29 it is possible to establish that investment in assets is positive to the extent that  $\lambda$  is positive. Indeed the optimal total level of assets is given by:

$$(A + A^*) = \left( \frac{\lambda(\mu D + (1 - \mu)D)}{E(R^A)} \right)^{\frac{1}{2}}$$

Intuitively banks operate to the extent that they have enough stakes in the project. The  $\lambda$  is also the shadow price of their investment, which depends upon the regulatory requirement. The tighter is the regulatory requirement the higher is the shadow price of outside funding for the bank. The optimal share between domestic and foreign assets is obtained by merging 28 and 29. This gives:

$$A = \frac{E(R^{A^*})}{E(R^A)} - A^* \quad (32)$$

Intuitively arbitrage imposes that the allocation of investment across the two countries depends upon the relative returns.

The optimal share of deposits is determined by merging 28 and 30 and is given by:

$$D = \frac{E(R^A)}{R^D} \quad (33)$$

Intuitively as the cost of funds raises relative to asset returns the amount of short term liability falls (relatively to equities).

## 6 Appendix B. Nash equilibrium under non-cooperative SPE

Given the reaction function of the domestic and the foreign resolution authority respectively:

$$\xi = \frac{(\beta - 1)(A^i + A^{i,*})}{2\mu D^i} + \frac{1}{2} + \frac{(1 - \mu)}{2\mu}(1 - \xi^*) \quad (34)$$

$$\xi = \frac{(\beta - 1)(A^j + A^{j,*})}{2\mu D^j} + \frac{1}{2} + \frac{(1 - \mu)}{2\mu}(1 - \xi^*) \quad (35)$$

where the indices  $i$  and  $j$  indicate the domestic and the foreign country. In a symmetric equilibrium asset exposure becomes equivalent across the two countries. Let's define  $\Lambda = \frac{(\beta-1)(A^i+A^{i,*})}{2\mu D^i}$  and  $\delta = \frac{(1-\mu)}{\mu}$ . The optimal reaction function of the foreign supervisory authority can then be written as  $\xi^* = \Lambda + \frac{1}{2} - \delta(1 - \xi)$ . After substituting  $\xi^*$  into  $\xi$  we obtain:

$$\xi = \Lambda + \frac{1}{2} + \delta(1 - \Lambda + \frac{1}{2} - \delta(1 - \xi)) \quad (36)$$

After isolating  $\xi$  we obtain:

$$\xi = \Lambda \left( \frac{2}{2 + \delta} \right) + \left( \frac{1 + \delta}{2 + \delta} \right) \quad (37)$$

Substituting back for  $\Lambda$  and  $\delta$  and re-arranging delivers the Nash equilibrium level of  $\xi$  under the non-cooperative regime:

$$\xi^{NC} = \frac{(\beta - 1)(A^i + A^{i,*})}{D^i(\mu + 1)} + \frac{1}{1 + \mu} \quad (38)$$

Welfare losses for the domestic investors are then given by:

$$L_{bailin}^i = \left( \frac{(\beta - 1)(A^i + A^{i,*})}{D^i(\mu + 1)} + \frac{1}{1 + \mu} \mu \frac{D^i}{A^i + A^{i,*}} \right)^2 + \left( \frac{A^i + A^{i,*} - \left( \left( 1 - \frac{(\beta - 1)(A^i + A^{i,*})}{D^i(\mu + 1)} + \frac{1}{1 + \mu} \right) D^i \right)}{A^i + A^{i,*}} - \beta \right)^2 \quad (39)$$

The latter are depicted in Figure 1 in the main text which compares losses under the cooperative and non-cooperative regime.

## 7 Appendix C. Comparison of Policy Actions Under SPE

Equilibrium policy actions,  $\xi$ , can be summarized for the SPE cooperative versus non-cooperative in the following matrix, where columns indicate the strategies played by the foreign country, while rows indicate the strategies played by the home country.

Strategies	SPE coop	SPE non-coop
SPE-coop	$\frac{(\beta - 1)(A^i + A^{i,*})}{2D^i} + \frac{1}{2}$	$\frac{(\beta - 1)(A^i + A^{i,*})}{2D^i} + \frac{1}{2}$
	$\frac{(\beta - 1)(A^i + A^{i,*})}{2D^i} + \frac{1}{2}$	$\frac{(1 + \mu)(\beta - 1)(A^i + A^{i,*})}{4\mu D^i} + \frac{1 + 3\mu}{8\mu}$
SPE non-coop	$\frac{(1 + \mu)(\beta - 1)(A^i + A^{i,*})}{4\mu D^i} + \frac{1 + 3\mu}{8\mu}$	$\frac{(\beta - 1)(A^i + A^{i,*})}{D^i(\mu + 1)} + \frac{1}{1 + \mu}$
	$\frac{(\beta - 1)(A^i + A^{i,*})}{2D^i} + \frac{1}{2}$	$\frac{(\beta - 1)(A^i + A^{i,*})}{D^i(\mu + 1)} + \frac{1}{1 + \mu}$