DISCUSSION PAPER SERIES

DP11171

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

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FINANCIAL ECONOMICS and INTERNATIONAL MACROECONOMICS AND FINANCE

ISSN 0265-8003

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Discussion Paper 11171
Published 16 March 2016
Submitted 16 March 2016

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Abstract

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JEL Classification: G18, F3

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

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Acknowledgements
This research has been supported by the DG-ECFIN grant "Forward to a New Normal", of which Faia and Weder di Mauro were fellows. An earlier version of this paper carried the title "Cross Border Resolution of Global Banks". We thank Stijn Claessens and Luc Laeven for very useful and constructive comments. We are grateful for comments by the participants at the workshops and the final conference (June 2015) of the EU Fellowship initiative. We thank participants and discussants at the European Policy workshop (October 2015)

Cross-Border Resolution of Global Banks*

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

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First draft: October 2014. This draft: March 2016.

Abstract

The design of resolution regimes for global groups has been the central theme since the global financial crisis. No model rationalized the optimal design of bail-in regimes and their welfare consequences. We do so in a model with strategically optimizing authorities and banks. We model three regimes: cooperative-SPE (Single Point of Entry), uncooperative-SPE and MPE (Multiple Points of Entry). 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. High capital requirements by acting as discipline devise reduce losses and blur the difference between regimes. SPE has however 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.

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1 Introduction

Following the default of Lehman Brothers, governments around the world had to mobilize enormous rescue packages to cope with widespread financial panic. In these efforts a fundamental flaw of the

*This research has been supported by the DG-ECFIN grant "Forward to a New Normal", of which Faia and Weder di Mauro were fellows. An earlier version of this paper carried the title "Cross Border Resolution of Global Banks" (Faia and Weder di Mauro [19]). We thank Stijn Claessens and Luc Laeven for very useful and constructive comments. We are grateful for comments by the participants at the workshops and the final conference (June 2015) of the EU Fellowship initiative. We thank participants and discussants at the European Policy workshop (October 2015).

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international financial architecture became apparent, namely the inability of national supervisors to orchestrate orderly bank resolutions across borders. Since then, the international regulatory community has made efforts in devising the best approach to resolving large and cross-border banking groups.

Prior to the recent crisis and right after it banks' resolutions have been conducted primarily through bail-outs. The arguments were clear. There was primarily the need to implement a fast action to stop financial and banking panics, as the latter have higher costs as they progress. Bail-out packages are enacted much faster than standard bankruptcy procedures, thereby also contributing to reduce the costs of uncertainty. The recent bail-outs have shown however that those procedures are in fact excessively costly, particularly when a banking panic is already in place, and not very efficient. They are also politically unpalatable: in the midst of a crisis which hits tax payers' income severely it became hard to justify their financial involvement into banks' bail-outs. The Financial Stability Board at first, followed by many other national authorities, had then advocated for bail-in resolution procedures[1]. Bail-in procedures require the statutory power of the resolution authority to restructure the liabilities of a distressed financial institution by writing down unsecured debt and/or converting it to equity. They have many advantages. At first and most evidently, they do not involve tax payers' money, hence they are politically acceptable. Several other advantages include: avoidance of long delays, transparency and ex ante commitment (recovery and resolution plans, also known as living wills, are devised already in normal times and based on stress test scenarios), reduction of banks' incentives toward risk taking and moral hazard.

Bail-in procedures have also a few drawbacks. The most important one is that they are difficult to implement, particularly so when global systemically important banks are involved (G-SIB since now on). Large and global banking groups have foreign branches and/or subsidiaries. In both cases and to the extent that G-SIBs are involved, a bail-in resolution requires coordination and sometimes long bargaining between two or more resolution authorities. For G-SIBs an important dimension of the bail-in design concerns the identification of the resolution authorities involved. The bail-in regimes can be activated under a single point of entry (SPE hereafter) or under multiple points of entry (MPE hereafter) regimes. In the first case resolution losses are imputed to the bondholders of

[1] The Singly Resolution Board, the central authority for the euro area established with the Bank Restructuring and Resolution Directive of 2014 (BRRD), did the same.

the G-SIB parent holding (which must guarantee ex ante enough loss absorbing capacity) and the statutory power for resolution is assigned to the authority of the parent holding country. In case of MPE losses are borne by the branches where they are generated and home countries' authorities have statutory power. Such distinction in regimes has far-reaching consequences. It affects the way in which authorities internalize cross-country spill-overs and their commitment, it affects the way banks function and whether they decide to internationalize, but most importantly it determines the investors of which country bear losses.

This distinction in regimes, so far not widely known nor explored by academics, is the most important innovation in financial regulation in recent decades. For prudential authorities in recent years the choice between SPE and MPE has been the question to be answered[2]. From a theoretical point of view the question is akin to as the question regarding optimality of cooperative regimes (currency areas are or pegs) vis-à-vis non-cooperative ones (flexible exchange rates): SPE require indeed an equivalent decision from national policy makers to relinquish their power to the home country authority. In Europe the creation of the Single Resolution Authority is a move toward a regime of coordinated SPE.

Our paper examines this question. We do so by devising a game-theoretic model that embeds the main mechanisms, namely the strategic interaction among national authorities (and between banks and regulators) in an environment with supervisors', investors' and banks' optimal decisions. In our two countries model banks optimize profits, invest and raise liabilities domestically and abroad and face equity requirements. Regulatory authorities implement bail-in under SPE with cooperative or uncooperative behaviour and MPE (decentralized policy regime). The strategic interaction takes place over two periods. First, authorities announce the regime (given banks' behavioral decisions); then banks react endogenously to the announced regime and choose the level of foreign exposure or the business structure (branch versus subsidiary). Strategic interactions in our model emerge because of a shared liability effect (the fraction of foreign bail-inable bonds enters banks' equity requirements) and because of an asset internationalization effect (parent holding are required to pre-position foreign equity capital under SPE regimes). Similar externalities have been highlighted, albeit in a different context, by Calzolari et. al. [10]. The conflict emerge also since

[2] See Tucker[33].

national authorities do not weight the interest of foreign investors as opposed to single resolution authorities. Hence cross-country externalities emerge.

Several results stand out. First, the fractions of bail-inable bonds (namely losses to investors) under the non-cooperative SPE regimes are larger than under the cooperative regimes for low degrees of liabilities home bias. When banks raise more than $\frac{1}{2}$ of their liabilities abroad, most of the bail-in bond losses accrue onto foreign investors, whose utility is neglected by national regulators acting under a non-cooperative regime. Overall welfare losses (which includes both bond-holders and equity-holders welfare) under the non-cooperative SPE regime are higher than under the SPE cooperative, except for very high level of the capital requirement. Generally speaking cooperative actions are efficient relatively to noncooperative ones. In the uncooperative Nash equilibrium authorities fail to internalize cross-country spill-overs and this results in higher losses. Our model also speaks on the interaction between ex ante prudential regulations and bail-in regimes. Ex ante prudential regulation (as exemplified by the capital requirement or equity capital pre-positioning) acts as preemptive discipline devise: it reduces ex post welfare losses under any resolution regime and blurs the difference between cooperative and non-cooperative regimes. This result effectively rationalizes the role of the Total Loss Absorption Capacity regulatory policy. When comparing MPE versus SPE regimes we find that bond-holders losses are higher under the noncooperative MPE regime, except under low degree of home bias, which identifies the case of a highly decentralized banking group. When the business structure is very segmented, both on the liabilities as well on the asset side, cross-countries strategic externalities are very limited and it is not efficient to re-shuffle resources across countries. The results are in line with data from the living wills of systemically important financial institutions. These data, which have only recently become available, show which regimes are deemed optimal based on a revealed preference argument (of both banks and regulators) and give interesting indications on the type of collective action problems involved. The data which we introduce in the next section show that SPE is deemed more efficient except for a few highly decentralized groups. At last we consider the optimal resolution design for non-cooperative SPE with business models based on subsidiarization. The importance for the role of subsidiaries versus branches also in the transmission of shocks has been highlighted also before in the literature (see Aiyar, Calomiris, Hooley, Korniyenko and Wieladek[4]). We assume that

parent holding's liabilities are protected from subsidiaries' needs (no shared liabilities)[3], on the other side capital pre-positioning is required and downstreaming (transfer of equity capital the center to periphery) is possible. Under those assumptions the home regulators' objectives end up assigning less weight onto bond-holders losses and more weight onto capital short-falls. As a result bond-holders losses end up being higher than under the non-cooperative SPE with branches the more so for highly decentralized groups. Notwithstanding those losses remain higher than under the cooperative regime for the usual failure to internalize spillovers.

The choice of the resolution regime also bears consequences for financial integration, as banks endogenously react to the announced regime. Ideally more financial integration is superior due to improved risk-sharing possibilities. Our model shows that since under SPE the parent holding remains fully liable for foreign subsidiaries' losses (hence for foreign units' risk taking), incentives to venture into foreign markets are reduced[4]. SPE efficiently minimizes investors' losses, but may also induce financial retrenchment if markets are highly segmented. Conversely, SPE will induce higher financial integration in integrated markets. Finally we show that for fairly decentralized groups (with higher than half foreign liabilities) it is preferable to decentralize through a subsidiary structure. As explained above in this case the optimal fraction of bail-inable bonds is higher than under branches: from the point of view of the home regulators this severs the purpose of protecting the parent holding from severe downstreaming. As a result banks' regulatory burden in terms of equity capital costs is smaller with subsidiary than with branches. The financial retrenchment result is in line with past literature (see Bremus and Fratzscher [9], Cetorelli and Goldberg[11], Claessens and van Horen [14], Giannetti and Laeven [24] on the different aspects of financial retrenchment).

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 discusses policy implications. Section 5 concludes.

[3] Most jurisdictions prescribes limited liability for parent holdings except of course for equity capital losses. Moreover in many cases national deposit insurances protect short term liabilities of parent holdings.

[4] The comparison between SPE-cooperative and non-cooperative in relation to the degree of financial retrenchment instead depends upon the degree of home bias.

2 Review of literature and evidence on regime choices

The structure of the economic problem as well as of the model employed in section 3 is akin to the theoretical underpinnings behind the choice of international monetary regimes. SPE implies relinquishing policy authority as in the fixed exchange rate regimes or in currency areas[5]. There are currently no papers nor models examining the choice of international financial regulation and/or resolution regimes. The closest contribution in the spirit to our paper is Calzolari et. al. [10]: the authors present an insightful model based on a game-theoretic approach to study coordinated versus non-coordinated regime for the supervisory policies. They also find that banks might endogenously react to centralized supervision by retrenching. Contrary to them we focus on resolution regimes (hence on SPE versus MPE). Several other features distinguish our model from their. First we obtain regulators' objective aggregating investors' welfare, hence we also capture the trade-off between bondholders and equity-holders. Second, in our model regulators' actions and Nash strategies are continuous (the optimal fraction of bail-inable bonds), while Calzolari et. al. [10] consider binary actions. Finally global groups in our model are assumed to invest also in foreign assets beyond rasing liabilities abroad and are subject ex ante to regulatory requirements. Other papers on regulatory coordination and asymmetries are: Dell'Ariccia and Marquez [15], Freixas [23], Niepmann and Schmidt-Eisenlohr [29]. Finally Beck and Wagner [7] using data and theory show how supervisors intervened depending on the distribution of asset, liabilities and equity claims across markets.

Since we are focusing on the case of G-SIBs and on the role of regimes for financial retrenchment, some recent empirical studies are informative for our purpose. The recent empirical literature on global banks has focused on two themes. The first was the analysis of the role of global banks in the transmission of shocks (see among others Cetorelli and Goldberg [12], Aiyar, Calomiris and Wieladek[3], Peek and Rosengreen [31]). The second strand examined the evolution of financial retrenchment over recent years. Claessens and van Horen [14] show a sharp reduction in cross-border lending, in particular by advanced countries hit by systemic crisis; they however argue against the notion that banking globalization has reversed as there is still a lot of foreign banks entry by

[5] The spirit of our model, albeit not the type of regimes and micro-foundations, is indeed close to Giavazzi and Pagano [26], Bayoumi and Eichengreen [5] and Alesina and Barro [1].

emerging markets and developing countries. Giannetti and Laeven [24],[25] find that banks have increased home bias when their country experienced a banking crisis. Bremus and Fratzscher [9] and De Haas and Van Lelyveld [16] all document a retreat from cross border lending after the global financial crisis. Battistini et. al. [6] show that the European periphery banks have increased home bias in their sovereigns' debt. Moreover, in Europe, the retrenchment is particularly pronounced for banks that received state aid. Tightening regulations at home and host countries explains a large share of the overall reduction in cross border claims as shown by IMF [28]. This observation is in line with one result of our model showing that the choice of cross-border resolution regimes may foster financial dis-integration.

2.1 Living Wills of G-SIB

Before presenting and solving the model it is instructive to examine a novel dataset showing the regime jointly preferred by resolution authorities and banks. Bail-in procedures are obviously novel enough that a history of resolutions is not available[6]. However, recovery and resolution plans (living wills) give indication on the regime considered most efficient by both banks and regulatory authorities. The logic behind the survey is as follows. Over the last years supervisors have required banks to prepare a plan that explains step by step how the recovery or resolution would take place in the event of a severe negative shock. The U.S. plans require simulating a specific failure and explaining the planned reaction to this, but the details are confidential. Only a summary section outlining the strategy is published by the Federal Reserve Board. By analyzing these data, we find that the living wills can provide insights on three fronts. They capture the revealed preferences of the bank and of the home country supervisor on the choice between SPE and MPE, hence providing an indication on the optimality of the regimes. They shed a light on the sheer number and complexity of supervisory bodies and possible collective action problems. At last, they show how banks reacted to the imperative of bail-in resolution across multiple jurisdictions. It is interesting to note also that several observations emerging from this data are in line with the results of our model, as highlighted below.

[6] So far there have been only very few bail-in events and most of them have been hybrid bail-in / bail-out (see Faia and Weder di Mauro [19]) for a discussion of cases. Schaefer et. al [32] use some cases of bail-in events to estimate the effect on banks' CDS spreads in the rest of Europe. They find that the Cyprus bail in, in particular had a significant effect in reducing bail-out expectations across European banks.

Table 1 summarizes the preferred recovery and resolution plan (RRP hereafter) of banks which fall under the Dodd Frank U.S. reporting requirement but are headquartered in Europe. The revealed preference of the majority of global banks and of their home regulators is a SPE strategy. Only HSBC and BBVA have MPE as their preferred resolution strategy. Note 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 preference for MPE is 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 quite independently from headquarters. The other systemically important global Spanish bank, Banco Santander, has a similar business model and should also prefer a MPE approach as explained by the Banco de Espana (Alvarez and Fernandez [2]). For such a bank a MPE strategy seems a better fit than for a bank with centralized capital and liquidity management and large intra-group positions. This observation is well in line with results of our model in section 3, which show that under a low degree of home bias (which would be the case with highly decentralized business models) MPE and SPE perform equally in terms of generated losses, while MPE tend to foster financial globalization. Highly decentralized business models imply that banks' headquarters are unwilling to assume the responsibility of possible risk-taking behaviour from the periphery and that national supervisors find it harder to implement cooperative solutions (as in both countries stakes are higher). It is on the other side fairly intuitive to imagine that SPE would be preferable under a more centralized business model.

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 [17]

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 RRPs (and Annual Report 2014 for DB and BBVA). Comparability restricted due to different accounting.

The living wills also inform about the banks' expectations on which regime would the regulator deem more appropriate for them to be implemented in the event of distress. The following quote from the Deutsche Bank living will is instructive on this point: "The FMSA and the global Crisis Management Group, which consists of representatives of the principal regulators of the DB Group, are working under the assumption of resolution through bail-in under a single point of entry ("SPE") approach as the preferred resolution strategy, which is intended to cover the whole DB Group, including the DB Group's U.S." (RRP 2015, p. 39). There is also an additional reason for which banks' revealed preferences are an indication of the loss minimizing regime. Banks operate primarily through outside funding, hence they have generally an interest to act under regimes that do not discourage their liability holders or their stakeholders to run. This concern is well exemplified by the following quote from the DB living will: "The SPE strategy is viewed by DBAG as the most appropriate for the DB Group, because it will, inter alia, maximize the value of the DB Group for the benefit of its stakeholders, preserve critical operations and otherwise minimize any adverse impact of the DB Group's failure on financial stability in Germany and the other jurisdictions in which it has material operations, including the United States. (..) This SPE strategy will require globally coordinated action (including among regulators) in order to resolve the DB Group and avoid adverse

impacts on financial stability" (RRP 2015, p. 39). The quote also shows banks' awareness of the complexity behind cooperative actions in this context. Cooperative behaviour is made difficult also by the increasing number of authorities that are currently involved in banks' supervision and resolution. At the international level, there are supervisory colleges, which shall coordinate on recovery plans (for banks under distress but not bankrupt) and crisis management groups, which shall coordinate on resolution plans (see BIS (2014)). At the regional level, supervisors of European banks are organized in resolution colleges (EBA (2014)). Table 2, taken from the living will of Credit Suisse, shows the number of material supervisory authorities that have intervention powers for the group. There are 19 out of which 5 are in the United States alone. This seems to give some ground for the fear that coordination may be rather difficult to achieve during a crisis.

Table 2: Example of Multiple Supervisors: List of Material supervisory authorities of Credit Suisse

Swiss Financial Market Supervisory Authority (FINMA)	Switzerland
Federal Reserve Bank of New York	United States
US Securities and Exchange Commission (SEC)	United States
New York State Department of Financial Services New York State	United States
Financial Industry Regulatory Authority (FINRA)	United States
US Commodity Futures Trading Commission (CFTC)	United States
UK Prudential Regulation Authority (PRA)	United Kingdom
UK Financial Conduct Authority (FCA)	United Kingdom
Cayman Islands Monetary Authority	Cayman Islands
Central Bank of the Bahamas	Bahamas
Securities Commission of the Bahamas	Bahamas
Banco Central do Brasil	Brazil
Guernsey Financial Services Commission	Guernsey
Monetary Authority of Singapore (MAS)	Singapore
Japan Financial Services Agency	Japan
Hong Kong Securities and Futures Commission Hong Kong	China
Software Technology Parks of India	India
India Department of Telecommunication	India
India Development Commissioner, Special Economic Zone	India

Source: Global Recovery and Resolution Plan Credit Suisse, July 1 2015, p 18

At last, notice that living wills give indications on banks' incentives to de-globalize under certain regimes. G-SIBs have generally reacted to the changed financial architecture by re-organizing their business model to fulfill TLAC standards. In particular banks with preferences for SPE have

tended to reduce intra-group dependencies[7]. Equally our model in section 3 shows that GSIBs under SPE regimes tend to reduce exposure to foreign assets: the parent holding responsibility for bearing losses elsewhere in the group reduces incentives to globalize.

3 Two Country Model with Cross-Border Banking under Single Point of Entry Resolution

Our evidence above clearly points at the role of policy coordination in generating possible strategic externalities. In our framework there are two potentially critical coordination externalities. The first operate via a mis-coordination or collective action problem among different authorities: if they do not internalize the spillovers stemming from the optimal allocation of losses across counties, this might potentially lead to resource costs. The second relevant coordination problem relates to the strategic interaction between the regulator and the banks. The latter indeed anticipate the regulators' optimal choice and might preempt their policy action with a portfolio rebalance which might have unintended consequences. Regimes which tend to discipline bondholders of global groups more heavily might discourage banks from investing abroad.

Given the nature of the strategic interactions described, we address those issues by building a model with a game-theoretic approach. All agents in our economy form decisions by solving optimization problems under full information. Strategic interactions take place between banks and regulators and between regulators in different countries. The time-line of our policy game consists of three periods and can be described as follows. At time $t = 0$ banks decide foreign asset investment and regulatory requirements are imposed. At time $t = 1$ and for given banking asset and liability structure, policy makers in the two countries simultaneously announce the bail-in policy (consisting in the optimal fraction of bail-inable bonds) under the uncoordinated regime (Nash equilibrium). In the fully coordinated regime such a policy is decided and announced by the single resolution authority. At time $t = 2$ banks react to the policy regime by choosing the extent to which they wish to globalize and also their business model (branches versus subsidiaries).[8].

[7] See e.g. UBS Quarterly Report Q32015 p. 12 for a desciption of the changes to the group legal structure in response to resolutions regulation (https://www.ubs.com/global/en/about_ubs/investor_relations/quarterly_reporting/2015.html)

[8] We do not consider deliberately a fully dynamic model with infinite horizon. The latter indeed typically gives raise to an infinite number of equilibria, see Benoit and Krishna [8]). This would prevent us from gaining any policy

Our model is comprised of two countries which we label i and j. In each country there is a banking group which has activities in the foreign country and there is also a resolution authority. Resolution authorities can activate bail-ins in coordinated or uncoordinated fashion. Banks have cross-border assets, cross-border liabilities and fulfil equity requirements. Variable A^i identifies domestic assets and $A^{i,*}$ identifies foreign assets held by a global bank resident in country i (and with subsidiaries in j). 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. Banks raise funds through deposits[9] and other short term liabilities domestically,D^i, which pay a return, R^D, to investors. Due to arbitrage risk-free returns R^D are equalized across countries. *Beggar-thy-neighbour* effects emerge in our model as national regulators, while tempted to protect national bond-holders, end up increasing overall losses for the entire global group. Two are the main channels considered. The first channel operates through the impact of bail-in on *shared liabilities*. Global groups' capital requirements are defined based upon group-wise consolidated budgets and include domestic and foreign liabilities. Under uncoordinated bail-in foreign authorities attempt to reduce losses for foreign bond-holders: this increases the deviation of the parent holding capital requirement from the regulatory target. However larger capital short-fall in equilibrium force uncoordinated resolution authorities to set higher bond-holders losses (relatively to the case with coordinated actions). The second is an *asset globalization* channel. When banks are globally more exposed on the asset side than on the liabilities' side[10], 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 expropriate a larger fraction of short term liabilities in order to cover for the capital shortfall.

In the next section we start by describing the banks' optimization problem and the its constraints. Next we lay down the optimization problems for the optimal policy design. The solution to the strategic game follows. The equilibrium solution in each regime is then compared in terms of losses to investors and banks' incentives to de-centralize (achieving financial integration). At last we assess implications of each regime for banking globalization by examining banks' reaction

conclusions in terms of the interaction between regulators and banks and among regulators across countries.

[9] For simplicity we assume that there are only uninsured deposits. First, insured deposits are actually a small fraction of all short term liabilities. Second, if all liabilities were fully insured shocks to asset returns would not pose any default challenge for the bank.

[10] As we will see below this is the case also when regulation imposes capital pre-positioning for subsidiaries.

functions to the policy regime.

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 share of domestic versus foreign raised short term liabilities (which we also call the degree of home bias, μ) is determined by the local supply of funds and is taken as given by banks. Ex ante banks choose A^i, $A^{i,*}$ and D^i to maximize at every period t:

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

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

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

In need of liquidity banks start to sell assets, however they can do it only until the capital requirements is violated. If this happens, banks go technically on default. Notice that the constraint in 2 represents the case of a bank which globalize through branching (foreign offices are not a separate legal entity). It is assumed indeed that the capital requirement is defined on the group-wise consolidated budget as foreign branch liabilities can be used to cover group-wise capital short-fall. This case is surely the relevant one when examining coordinated SPE regime, as in this case the single resolution authority only acts on the group-wise liabilities in face of a group-wise capital short-fall. This business model is a possibility also in a regime with uncoordinated SPE, which is what we examine in section 3.2. In section 3.2.1 instead we consider the case of global groups operating through subsidiaries. This case becomes relevant only under the non-coordinated SPE regime: we will return on this point later on.

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 on the two countries. In case of equality of returns there is an indeterminacy. Finally the total amount of deposits is determined by the ratio between the cost of deposits and the relative return on assets. However

since deposits supply is exogenously given in the two countries, the banks' optimality condition on deposits implies that returns on short term liabilities adjust so as to equilibrate demand and supply.

Before proceeding to the description of the resolution regimes we also lay down the banks' regulatory requirements under the MPE regime. Under MPE banks are required to hold equity capital in both countries to cover for losses on assets[11]. They face two different equity constraints in each country (both national regulators impose regulatory constraints) and in relation to the assets invested in the foreign branch. Raising capital in the periphery country entails some sunk cost, Ψ. This cost captures several aspects of the lumpiness associated with opening activities in foreign markets. First, it captures the bare costs of installing the branch or the subsidiary facilities abroad. Second, when entering the foreign market banks shall advance a payment to the local insurance fund. Such transfer cannot be recovered when exiting the market prior to the end of the business year. Third, the cost captures the idea that bank capital raised in peripheral countries might potentially be of lower quality, hence the cost enlarges the region of the capital short-fall. At last, the cost captures negative reputation effects on the entire group if it was forced to close down operations in a periphery country. Overall its main role is to rule out the equilibrium in which the bank exits the foreign market in the face of temporary losses. It is important to stress now, though it will be clear in the derivations of the MPE regime, that such cost does not affect the comparison of the welfare losses through which we rank regimes. Under MPE banks' constraints read as follows:

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

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

Constraints 3 and 4 can be interpreted as follows. In each country the regulator sets two different regulatory requirements and the bank fulfills the constraints by raising capital in each country separately.

[11] 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.

3.2 Cooperative versus non cooperative SPE regimes

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. 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 ξ of bail-inable short term liabilities: those liabilities will either bear direct losses or will be transformed into equities valued at lower prices. In the non cooperative solution the regulatory authority of each country chooses a fraction ξ out of short term liabilities held domestically, namely μD^i for country i and $(1-\mu)D^i$ for the foreign country. In the cooperative solution the resolution authority chooses a fraction ξ of the total $(\mu D^i + (1-\mu)D^i)$[12]. In this section we focus on global groups with branching, hence the relevant regulatory constraint is given by equation 2.

Resolution authorities choose ξ in the bail-in case to maximize investors' welfare (investors in our economy include both bond-holders and equity-holders) or equivalently to minimize their losses. Appendix B shows how aggregating investors indirect utilities through equal Pareto-Negishi weights leads to the aggregate regulator objective function. The latter endogenously embeds the trade-off that the resolution authority faces between the cost imposed to investors of short term liabilities (which we proxy with $(\xi\mu\frac{D^i}{A^i+A^{i,*}})^2$ for the uncoordinated regime and with $(\xi\frac{(\mu D^i+(1-\mu)D^i)}{A^i+A^{i,*}})^2$ for the coordinated one) and the deviation of the actual equity capital from the regulatory target, namely the capital shortfall $(CR-\beta)^2$. A higher ξ means that a larger fraction of investors suffers losses and/or is forced to transform (subordinated or unsubordinated) bonds into risky equities (at discounted prices). On the other side a higher ξ, by injecting more equities, allows the bank to meet its regulatory capital requirement. The resolution authority (whether national or supra-national) therefore faces a trade-off between conflicting investors interests (see Appendix B for microfoundations). As it will become clear soon under the uncoordinated regime an additional conflict emerge as national regulators do not internalize the losses of foreign bond-holders.

Generally speaking each regulator chooses the policy instrument, namely the fraction of bail-

[12] Notice that since we assumed equality of risk-free returns, R^D, across countries there is indeterminacy between domestic and foreign liability: we will indeed fix the fraction of foreign held liabilities exogenously and study the implications of each regimes under different liabilities structure.

inable bonds, that maximizes the objective function, subject to the banks' behavioral equations which determine banks' asset exposure. In Appendix A it is shown that given banks' risk neutrality the equity requirement is sufficient to determine banks' asset exposure. Hence the relevant constraint for the resolution authority is the banks' equity requirement for given resolution regime:

$$CR = \frac{A^i + A^{i,*} - (\mu(1-\xi)D^i + (1-\mu)(1-\xi^*)D^i)}{A^i + A^{i,*}} \geq \beta \tag{5}$$

Before laying down the optimal regime design two considerations are worth noting. They will help us to highlight the source of strategic externalities under non-coordinated regimes. First, cross-country spillovers materialize in that the foreign resolution decisions, ξ^*, affect the domestic parent holding equity requirement 5. The attempt of the foreign resolution authority to protect resident bond-holders (by reducing ξ^*) produces negative externalities as it impairs the possibility for the parent holding of satisfying group-wise equity requirements. Second, we assume that domestic and foreign resolution authorities have symmetric objectives. This implies that in our model cross-country spillovers do not emerge due to ad-hoc differences in regulators' preferences, but are genuinely due to the endogenous impact of policy actions on banks' behavior and incentives.

In the *non cooperative* regime each national regulator decides the fraction of domestic short term liabilities, ξ, that shall be transformed into bank equities, by taking as given the fraction chosen by the other national regulator, ξ^*. The resulting equilibrium would be a standard Nash prisoner's dilemma. Hence the regulator of country i chooses ξ to minimize:

$$L^i_{bailin} = (\xi\mu\frac{D^i}{A^i + A^{i,*}})^2 + (CR - \beta)^2 \tag{6}$$

subject to equation 5.

The optimization problem can be written as follows:

$$Min_\xi(\xi\mu\frac{D^i}{A^i + A^{i,*}})^2 + (\frac{A^i + A^{i,*} - (\mu(1-\xi)D^i + (1-\mu)(1-\xi^*)D^i)}{A^i + A^{i,*}} - \beta)^2 \tag{7}$$

The first order conditions with respect to ξ delivers the following solution:

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

The optimization problem of the foreign resolution authority leads to a symmetric reaction assuming an equivalent degree of home bias, $\mu = \mu^*$. To obtain the Nash equilibrium we substitute

the foreign authority reaction function into equation 8 (derivations are shown in Appendix C). This leads to:

$$\xi^{NC} = \frac{(\beta - 1)(A^i + A^{i,*})}{D^i(2\mu - 1)} + \frac{1}{1 + \mu} \tag{9}$$

In the *cooperative regime* a single resolution authority chooses ξ to minimize:

$$L^i_{bailin} = (\xi \frac{(\mu D^i + (1 - \mu)D^i)}{A^i + A^{i,*}})^2 + (CR - \beta)^2 \tag{10}$$

subject to the constraint 5. The first order condition reads as follows:

$$\xi \left[\frac{(\mu D^i + (1 - \mu)D^i)}{A^i + A^{i,*}} \right]^2 + (CR - \beta) \left[\frac{(\mu D^i + (1 - \mu)D^i)}{A^i + A^{i,*}} \right] = 0 \tag{11}$$

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

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

It is interesting to note that the optimal policy instrument under the cooperative regime is independent from the degree of home bias in bond holding. In fact in this case the regulator internalizes the spillovers across countries independently from the relative fraction 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 regulator incentives toward protecting domestic investors at the expenses of foreign ones.

To assess the role of policy coordination we shall now first compare the policy instruments under the two SPE regimes. For any level of total asset exposure we can compare the limiting behavior of ξ^{NC} and ξ^C for extreme values of μ. When the degree of home bias is maximum, $\mu = 1$, bond-holders losses under the non-cooperative regime become $\xi^{NC} = \frac{(\beta-1)(A^i+A^{i,*})}{D^i} + \frac{1}{2}$ which is strictly larger than $\xi^C = \frac{(\beta-1)(A^i+A^{i,*})}{2D^i} + \frac{1}{2}$. When liabilities are raised only locally resolution authorities tend to ring fence and do not internalize the effects of their decisions on foreign banks' branches. Under $\mu = \frac{1}{2}$ bond-holders losses under the non-cooperative regime become infinite, hence certainly larger than ξ^C. This case corresponds to a perfect beggar-thy-neighbour effect: each authority tends to ring fence domestic bondholders; this results in larger deviations of the parent holding equity requirement from the target. In equilibrium such deviations call for larger

resolution interventions in on the consolidated budget. Eventually each authority is forced to fully expropriate national bond-holders.

To give a clear assessment of the losses comparison across the two regimes we simulate the optimal fractions for given level of asset exposure (we do so in Figure 1 and Figure 2 below, respectively for bond-holder losses and for overall welfare losses). It is interesting in particular to examine changes in the optimal fraction of bail-inable instruments for different levels of the equity requirements and for different liabilities structures. The level of the equity requirements indicates the extent to which resolution interventions are needed ex post: for high level of equity requirements the resolution region is minimized ex post and this renders different regimes marginally equivalent ex post. The structure of liabilities gives an indication on the extent of cross-countries spillovers and on the size of the strategic interactions. The higher the bank is exposed into foreign markets, the higher is the extent of strategic externalities. Those two parameters are then crucial to understand the interplay between collective externalities, optimal regimes and welfare losses[13].

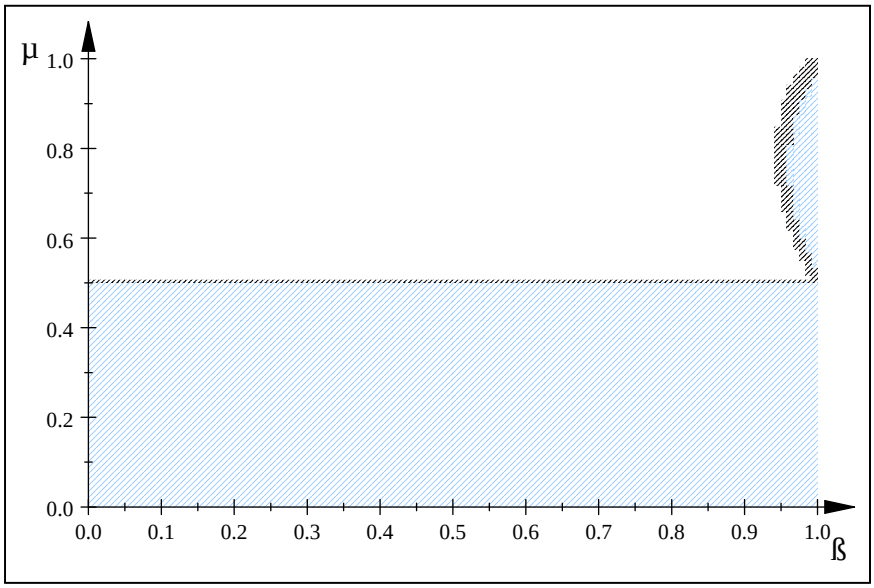

Figure1. Regions in which $\xi^{NC} \geq \xi^{C}$ for different values of β and μ.

[13]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.

Figure 1 above shows the region in which $\xi^{NC} \geq \xi^{C}$ for different values of the parameters μ and β. The numerical results clearly show that under the non-cooperative regime the resolution authorities decides to tax investors more by setting a higher fractions of bail-inable bonds whenever the degree of home bias in liabilities in smaller than 0.5. The result holds generally for almost any level of 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 its own actions have on the parent holding equity requirements and eventually on the foreign bondholders. Each supervisory authority acts myopically and does not internalize aggregate costs. This implies that in the prisoner's dilemma equilibrium the costs for bondholders in each country are higher than under the cooperative solution. This is the more so when the degree of home bias is below $\frac{1}{2}$. Indeed in this case each resolution authority is tempted to shift bond losses onto foreign bond-holders, whose utility is neglected by national regulators acting under a non-cooperative regime. The optimal fraction of bail-inable bonds become equal under the cooperative and the non-cooperative regime when $\mu = \frac{1}{2}$. In this case the benefits from taxing (assigning losses) foreign investors become equivalent to the costs from the spillovers, hence the regulator has no longer incentives toward a thy-neighbour-beggar type of policy. At last notice that for very high levels of the equity requirements the cooperative regime ceases to be superior: for both regulators the costs of deviating from the banks' equity target becomes pre-dominant, hence they loose any incentive to ring fence domestic bond-holders.

We can summarize the policy actions of the two regulators through a standard game matrix:

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

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

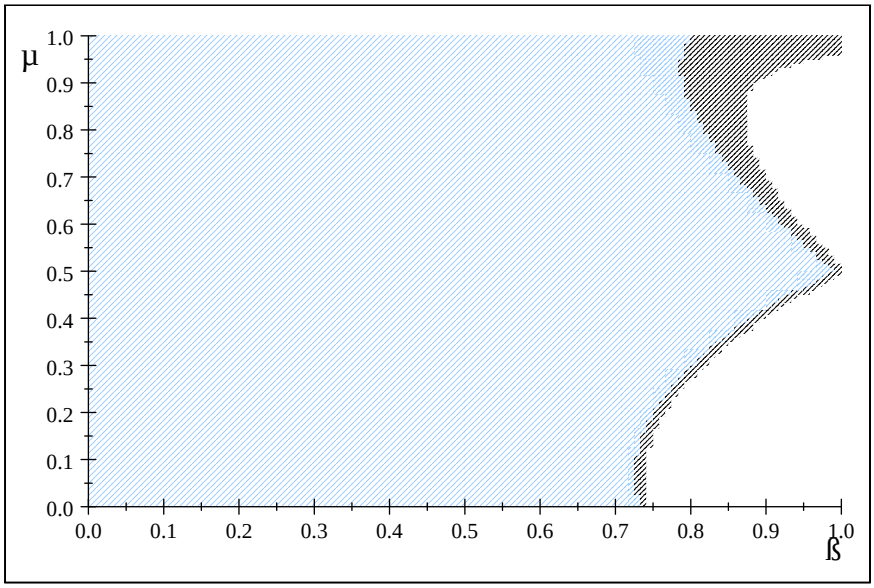

Figure 2. Regions in which welfare losses under non-ccoperative SPE is larger than welfare under cooperative SPE for different values of μ and β.

Figure 2 shows that the welfare loss under the non-cooperative regime is higher than the one under cooperative regime (shaded area in blue) except under high values of the capital requirements. The result is reasonable. Generally speaking cooperative actions are efficient relatively to noncooperative ones within the environment of the Nash games. This is so, since as explained, the cooperative regulator internalizes the cross-country spillovers. When the capital requirement is very high the welfare losses under the two SPE regimes become the same (black shaded area) or are reversed (white shaded area). As explained above under this case costs from equity target deviations become predominant for regulator in both countries, hence their temptation to ring fence fades away and so do strategic externalities. An alternative interpretation for this result is that strict ex ante prudential regulations (as exemplified by the capital requirement) have a preemptive role and by reducing the likelihood of crises they also reduce bail-in 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[14] so as to absorb most losses emerging during the resolution procedure[15]. If the majority of losses are assigned to equity-holders, bond-holders loss absorption capacity becomes less salient (independently from their allocation among the two countries).

3.2.1 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 single resolution authority takes into account the fully consolidated budget of the group, independently from potentially different business models[16]. The same is true under the multiple points of entry regimes (discussed in the next section) since in this case each national resolution authority only examines the local offices liability structure. The difference instead becomes salient under a non-cooperative SPE regimes. In this case the resolution procedure is implemented at the center, but liabilities are not shared across group offices. This implies that the subsidiary raises liabilities locally and cannot rely upon parent holding liabilities. 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.[34]).The non-cooperative SPE regime derived in the previous section was modelled under the assumption of shared liability, a case which applies to branching: equity requirements of the group were indeed constructed by looking at the consolidated group budget (hence total group assets minus total group liabilities). We argued that cross-countries spillovers emerged precisely due to the shared liability structure since the optimal fraction of foreign bail-inable bonds does affect the parent holding equity requirement. In this section we consider the implication of the alternative case, namely a non-cooperative SPE in presence of foreign subsidiaries. The difference between branches and subsidiaries relates to several aspects of the business model, ranging from the tax burdens to the allocation of revenues and/or of equity capital liabilities. We do not examine

[14] This actually holds for both branches and subsidiaires.

[15] 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.

[16] 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.

all those aspects, but rather focus on the characteristic which is relevant for the resolution regime. Current regulations force parent holding to pre-position equity capital onto the subsidiary[17]. This is a relevant aspect as it implies that the parent holding becomes directly liable for subsidiaries capital short-falls (downstreaming)[18]. As the latter depends upon the optimal fraction of foreign bail-inable bonds the scope for cross-countries externalities emerges also in this case, albeit with quantitative differences with respect to branch case. Specifically the parent holding faces two different regulatory requirements, one for national activities and one for the subsidiary:

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

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

Under an SPE regime resolution decisions on ξ are undertaken by the resolution authority of the parent holding country and they are applied to both domestic and foreign liabilities, to the extent that the latter enter the pre-positioned equity capital. Strategic interactions emerge primarily between the global banking group and the resolution authority of the parent holding[19]. Also notice that based on current regulations the equity requirement, β, holds equally for both parts of the group. The optimization problem for the resolution regime now reads as follows:

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

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

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

where $\Omega = 2\mu + \frac{(1-\mu)^2}{\mu}$ and where $\Theta = \mu + \frac{(1-\mu)^2}{\mu}$[20]. It is instructive to compare ξ^S to the

[17] 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.

[18] Notice that in the business model with subsidiary the parent holding can protect its liabilities and does not have to transfer liquidity to the subsidiaries, but it is liable for capital short-fall and it might be forced to transfer capital (downstreaming).

[19] 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 poblem of the local resolution authority as it does not affect the optimal choices of the host regulator.

[20] We derived this symmetric under the assumption that the asset expsoure across countries is the same, hence $A^i = A^{i,*}$. This maintains symmetry with the other cases considered. The general expression for ξ redas 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 $\Theta = \mu\frac{D^i}{A^i} + \frac{(1-\mu)^2}{\mu}\frac{D^i}{A^{i,*}}\frac{A^i}{A^{i,*}}$.

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 μ, the numerical comparison of the optimal fractions is not feasible[21]. We therefore proceed to the comparison for limiting values of μ.The following ranking emerges.

Lemma 1. *For given values of μ the following ranking holds:*

For $\mu = 1$	$\xi^S = \frac{(\beta-1)(A^i)}{2D^i} + \frac{1}{2} \geq \xi^C = \frac{(\beta-1)(A^i+A^{i,*})}{2D^i} + \frac{1}{2}$ $\xi^S \geq \xi^{NC}$ when $A^i \geq A^{i,*}$
For $\mu = \frac{1}{2}$	$\xi^S \geq \xi^C$ when $\left[\frac{A^i}{D^i} - \frac{(A^i+A^{i,*})}{2D^i}\right] \leq \frac{5}{(1-\beta)}$; $\xi^S \leq \xi^{NC} \to \infty$
For $\mu = 0$	$\xi^S = 1 > \xi^C = \frac{(\beta-1)(A^i+A^{i,*})}{2D^i} + \frac{1}{2}$; $\xi^S = 1 < \xi^{NC} = \frac{(1-\beta)(A^i+A^{i,*})}{D^i} + 1$

The ranking in Lemma 1 can be rationalized as follows. The optimal fraction of bail-inable bonds in presence of a subsidiary is generally higher than the corresponding optimal fraction under coordinated SPE. The rationale for this result follows the intuition discussed extensively above. The resolution authority of the parent holding wishes to minimize losses solely of domestic bond-holders (costs are indeed $(\xi\mu\frac{D^i}{A^i})^2)$) and for this reason it does not internalize fully the effects of its actions on the group-wise consolidated budget. The attempt to ring fence domestic bond-holders results in capital short-falls (second round losses) which require further haircuts. As a result in equilibrium investors' losses end up being larger than for the case in which a single resolution authority weights equally the interests of domestic and foreign bondholders. The relative comparison of the ξ^S and $\xi^{NC}$is more complex. In both cases regulators fail to internalize cross-country spillovers, however regulators' objectives are different in the two cases (subsidiary versus branch). The general result is that for highly centralized groups (μ approaching 1, hence liabilities raised primarily at 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 ξ^S as low as possible. The capital pre-positioning however works as discipline devise: since $(1-\mu)$ approaches zero, ξ^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

[21] For each value of β there are always two value of μ that solve the inequalities $\xi^S \geq \xi^C$ or $\xi^S \geq \xi^{NC}$.

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).

Overall bond-holders losses with subsidiaries are higher compared to cooperative regimes and to non-cooperative regimes with branches. This result can be explained also in terms of the nature of cross-country spillovers. With subsidiaries there is no shared liability effect since there is no consolidated group budget, but cross-country spillovers do emerge due to an asset internationalization effect, which materializes under capital pre-positioning. The home regulator in its objective has to trade-offs the costs for bond-holders with the capital short-falls (both domestically and abroad). The presence of two different capital requirements tilts the balance toward weighting more the costs from equity short-falls As a result bond-holders are assigned higher losses compared to most other regimes.

To sum up when groups are decentralized SPE-coordinated regimes induce them to invest less in foreign assets and SPE-uncoordinated induce them to prefer subsidiary to branches. The choice of opening up subsidiaries can also be interpret as a form of financial dis-integration.

3.3 The Model under Multiple Points of Entry

Under the multiple points of entry regulation the resolution authority of each country is delegated to resolve the bank branch resident in their own country. Practically this case corresponds to ring fencing. And by construction in this case the optimal design of resolution procedures is implemented under non cooperative regime. In country i the resolution authority chooses ξ to minimize:

$$MinL^i_{bailin,MPE} = (\xi\mu\frac{D^i}{A^i})^2 + (CR - \beta^i)^2 \tag{17}$$

subject to:

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

The first order condition in this case reads as follows:

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

Notice that under MPE there is no interaction between the optimal fraction of bail-inable deposits in country i and country j. The authority of the foreign country chooses ξ^* to:

$$MinL^j_{bailin,MPE} = (\xi^*(1-\mu)\frac{D^i}{A^i})^2 + (CR - \beta^j)^2 \tag{20}$$

s. to:

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

The first order conditions in this case reads as follows:

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

Notice that the cost of raising capital does not affect the ranking of the MPE regime relatively to the SPE regime. Under an $\Psi = 0$ the optimal fraction ξ becomes symmetric across the two countries but overall it is different than the optimal fraction determined under any SPE regime. When $\Psi \geq 0$, the optimal fraction of bail-inable deposits is higher in the foreign country than in the home country. This is rather intuitive. Since equity capital in the foreign country features a cost (part of the capital is wasted due to lower quality), the resolution authority of the foreign country must bail in a higher fraction of short term liabilities to allow the foreign branch of the bank to meet the equity requirement.

We can now systematically compare the fraction, ξ, under MPE and SPE regime. We use as benchmark the value of ξ under the cooperative SPE regime, as in this case the regulator does not suffer any bias vis-a-vis its own country/electorate. Table 3 below shows a systematic comparison between $\xi^{j,MPE}$ and ξ^C for different values of the parameters and for different levels of the foreign asset exposure.

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

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

Let's first examine and comment on the comparison of the home country losses under MPE and SPE (namely rows 1 and 2 of Table 3). Intuitively if the degree of home bias in country i, μ, is maximum and if there are no extra costs from raising capital abroad, we approach the case of a large closed economy. In this case the optimal fraction of bail-inable instruments is the same in the ring-fencing and in the fully cooperative approach. Generally speaking the optimal fraction of bail-inable instruments in country i under MPE is larger than the optimal one under the cooperative

SPE 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 Ψ). 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 μ and β and for given banks' portfolio allocation.

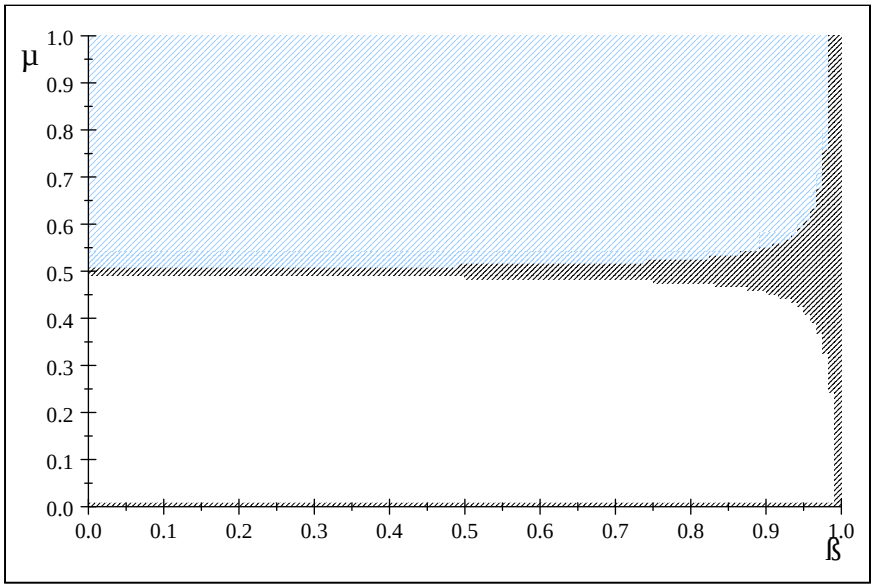

Figure 3. Regions in which $\xi^{i,MPE} \geq \xi^{C}$ for different values of β and μ.

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

3.4 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 bailinable 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 ξ into banks' equity requirement. Under the SPE cooperative regime one obtains the following foreign asset exposure:

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

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, ξ^{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 12 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:

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

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

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 ξ. 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[22]. 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 ξ 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 λ, 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.

3.5 Conclusions

One of the most important revolutions which took place following the 2007-2009 financial crisis has been the re-design of resolution regimes which nowadays mostly take the form of bail-in procedures with single point of entry. In the US FDICs has viewed the SPE as the preferred resolution strategy for about two years[23]. In Europe the Single Supervisory Mechanism has not yet reached one year, while the Single Resolution Mechanism has just started to function. Yet, many regulations and the architecture of financial supervision and resolution are already in place. Much of this architecture had been devised in discussions of policy circles, but so far no theoretical or empirical background had been given to assess the consequences of such regulations. Our theoretical model rationalizes the main channels and the sources of strategic interactions. The conclusions in terms of regime optimality as well as of financial integration are also largely in line with the indications obtained by the data on living wills.

Data for banks' living wills indicate that common wisdom assign to SPE resolution regimes higher efficiency in terms of loss minimization. Our model provides a rationale for this. In the resolution of large and ramified G-SIB, SPE regimes resolve the policy mis-cooperation problem

[22] We neglected to consider for instance the tax burden under different business models.

[23] See FDIC 18. December 2013 https://www.fdic.gov/news/board/2013/2013-12-10_notice_dis-b_fr.pdf).

and reduce the collective action externalities. Cooperative or centralized authorities internalize the spill-overs emerging from the beggar thy-neighbour policy thereby reducing second-round losses. The opposite is true in the MPE regime. In the face of banks' defaults, ring-fencing by focusing only on local losses makes the G-SIB under-capitalized with respect to the risks emanating from its global operations. Under-capitalized banks remain fragile. This increases the likelihood of future contagion effects (through reputation, franchising and confidence) and of further capital injections through second round write down of investors' bonds. Such an outcome is likely to be the case under uncoordinated SPE and even more so under MPE.

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4 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:

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

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

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

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

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

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

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

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

From 28 and 29 it is possible to establish that investment in assets is positive to the extent that λ 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 λ 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:

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

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:

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

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

5 Appendix B. Regulators' Objective Micro-foundations

The regulator chooses its policy to maximize the indirect utility of agents in the economy, namely bond-holders e equity-holders. Investors (bond and equity holders) are assumed to be risk averse. The regulator will choose optimal policy by maximizing the sum of investors' losses weighted by Pareto-Negishi weights. We assume for simplicity that the regulator weights equally both agents. Different weights can be accommodated and would not change the qualitative results. It is possible to show that investors' welfare optimization is equivalent to loss minimization under a convex optimization problem.

We start to lay down the bond-holders objective. Under the noncooperative regime the regulator weights only the utility of domestic bondholders, under the cooperative regime the regulator takes into account welfare also of the foreign investors. We start to lay down the case of non-cooperative regulators. Bond-holders choose consumption, C, and short term liability,D, to maximize utility subject to a budget constraint. We assume that beyond investment income bondholders also receive some exogenous income, Y (which might be considered as exogenous labour income). Hence they choose C and D to maximize:

$$Max_{C,D} U(C) \tag{34}$$

s. to:

$$C + \xi\mu D = R^D D + Y \tag{35}$$

The bondholders budget constraint takes into account that bondholders receive a return R^D on banks' short term liabilities investment. They also suffer a potential loss $\xi\mu D$ in case of bail-in.

Bondholders' utility function is concave. For simplicity and to work with a linear-quadratic optimization problem, we assume a quadratic form, $U(C) = \alpha + (C)^2$[24]. This results in the following indirect utility:

$$V(C) = \alpha + (R^D D + Y - \xi\mu D)^2 \tag{36}$$

By duality theorem maximizing the concave equation 36 is equivalent to minimize the following convex indirect utility:

$$\widetilde{V}(C) = (\xi\mu D)^2 \tag{37}$$

We now lay down the indirect utility of equity-holders. They invest ex ante an amount $S = \frac{1}{R^E}$ in equities and receive 1 at the end of the period. Given the presence of the regulatory requirement, if banks' asset losses materialize the equity-holders are called to cover a percentage β of those losses. Hence equity-holders' take into account this expected loss into their budget constraint. They choose consumption, C^e, and equities, S, to maximize:

$$Max_{C^e,E} U(C^e) \tag{38}$$

s.to:

$$C^e = E - \beta(A + A^*) \tag{39}$$

For those investors we equally assume a quadratic utility, hence their indirect utility reads as follows:

$$V(C^e) = \alpha + (S - \beta(A + A^*))^2 \tag{40}$$

Again base don a duality theorem the maximand of 40 is equivalent to the minimand of the following indirect convex utility:

$$\widetilde{V}(C^e) = (S - \beta(A + A^*))^2 \tag{41}$$

Before aggregating the utilities of the two type of investors we must re-normalize so that they are expressed in the same units. We do so by expressing the consumption in terms of banks' total assets. This implies the following aggregate indirect utility:

$$V(C, C^e) = (\frac{\xi\mu D}{A + A^*})^2 + (\frac{S - \beta(A + A^*)}{A + A^*})^2 \tag{42}$$

[24] If utility were assumed logarithmic or CRRA they would lead to an observationally equivalent optimization problem by taking second order Taylor expansions of the utility and of the constraints.

We can then re-arrange the expression above as follows:

$$V(C, C^e) = (\frac{\xi\mu D}{A + A^*})^2 + (\frac{A + A^* - (1-\xi)D}{A + A^*} - \beta(A + A^*))^2 \tag{43}$$

6 Appendix C. Nash equilibrium under non-cooperative SPE

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

$$\xi = \frac{(\beta - 1)(A^i + A^{i,*})}{2\mu D^i} + \frac{1}{2} + \frac{(1-\mu)}{2\mu}(1 - \xi^*) \tag{44}$$

$$\xi = \frac{(\beta - 1)(A^j + A^{j,*})}{2\mu D^i} + \frac{1}{2} + \frac{(1-\mu)}{2\mu}(1 - \xi^*) \tag{45}$$

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 ξ^* into ξ we obtain:

$$\xi = \Lambda + \frac{1}{2} + \delta(1 - \Lambda + \frac{1}{2} - \delta(1 - \xi)) \tag{46}$$

After isolating ξ we obtain:

$$\xi = \Lambda \left(\frac{2}{2 + \delta}\right) + \left(\frac{1 + \delta}{2 + \delta}\right) \tag{47}$$

Substituting back for Λ and δ and re-arranging delivers the Nash equilibrium level of ξ under the non-cooperative regime:

$$\xi^{NC} = \frac{(\beta - 1)(A^i + A^{i,*})}{D^i(2\mu - 1)} + \frac{1}{1 + \mu} \tag{48}$$

Welfare losses for the domestic investors are then given by:

$$L^i_{bailin} = (\frac{(\beta - 1)(A^i + A^{i,*})}{D^i(2\mu - 1)} + \frac{1}{1 + \mu}\mu\frac{D^i}{A^i + A^{i,*}})^2 + (\frac{A^i + A^{i,*} - ((1 - \frac{(\beta-1)(A^i+A^{i,*})}{D^i(2\mu-1)} + \frac{1}{1+\mu})D^i)}{A^i + A^{i,*}} - \beta)^2 \tag{49}$$

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