Financing and Resolving Banking Groups*

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We study how bank resolution regimes affect banking groups' investments in loan-making units with different financial strength. Single-point-of-entry (SPOE) resolution preserves groups' structure, which permits efficient reinvestment in weaker units hit by negative shocks, but can prevent optimal investment ex ante. Multiple-point-of-entry (MPOE) resolution separately resolves weaker units following negative shocks and prevents reinvestment, but can foster ex ante investment. The relative efficiency of SPOE and MPOE resolution depends on banking groups' risk profiles and overall profitabilities. The coexistence of both resolution regimes increases economy wide efficiency relative to the adoption of a uniform resolution regime for all banks.

Keywords: Complex banking groups, Resolution regimes, Restructuring.

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1. Introduction

The financial crisis of 2007-2008 exposed the economic, fiscal, and social costs of bank failure, as well as the inadequacy of standard bankruptcy procedures for the banking system (Freixas, 2010; Lee, 2014). As a policy response, Title II of the U.S. Dodd-Frank Act and the E.U. Bank Recovery and Resolution Directive (BRRD) introduced new regulatory frameworks to prepare for and deal with bank failure, with the aims of lowering the public costs and of minimizing market and operational disruptions if such failure occurs.

The new regulations require detailed and up to date resolution plans, or "living wills," for banks and banking groups.[1] The resolution frameworks allow for two broad types of resolution plans, the so-called "single-point-of-entry" (SPOE) and "multiple-point-of-entry" (MPOE) resolution plans. Under SPOE, resolution always occurs at the banking group's holding company level (or parent bank), which is the sole "entry point" at which regulators can take control. The banking group is resolved as a single entity, and its individual units' losses are mutualized. Under MPOE, the banking group specifies further legal entities as additional entry points for the regulator. Each of these entry points can then be resolved separately from the rest of the banking group. In this case, it does not receive transfers from other parts of the group and its losses are not mutualized.

Both resolution regimes are regarded as major regulatory innovations, following intense policy debates (see Tucker, 2014a,b; Bolton et al., 2019, p. 12; Skeel Jr, 2014). Many large banks worldwide, including all Global Systemically Important Banks (G-SIBs) in the U.S., have adopted SPOE. A possible explanation for this predominance of SPOE might be that some regulators seem to favor this approach (FDIC and BOE, 2012; Powell, 2013; Stein, 2013; Tarullo, 2013; Lee, 2017; ACPR, 2017).[2,3] However, several large European banks, such as HSBC (2021), Santander (2021), and BBVA (2021), have chosen MPOE. A BBVA report (Pardo et al., 2014, pp. 13-14) justifies this choice by

[1] These resolution plans may be prepared by banks subject to regulatory approval (e.g. in the U.S.) or by regulators themselves (e.g. in France).

[2] Lee (2015, p. 466) argues that "FDIC staff, for instance, see the SPOE strategy as the more promising approach, particularly from the perspective of minimizing the potential for adverse consequences of a resolution of a large complex US financial institution". Incidentally, the only two systemically important U.S. banking institutions that chose MPOE in 2016, Wells Fargo and Bank of New York Mellon, had their resolution plans rejected by U.S. regulators. Some commentators have explicitly argued that the failing grade was indeed because these banks had failed to pick up on the preference of the regulators for SPOE (Lee, 2017). Still, the U.S. regulatory agencies officially claim that they "do not prescribe specific resolution strategies for any firm, nor do they identify a preferred strategy" (Federal Reserve and FDIC, 2019, p. 1442).

[3]

MPOE resolution providing "inbuilt limits to contagion," that, unlike SPOE resolution, prevent financial distress at the parent bank in case a subsidiary experiences failure.

This paper argues that there may be a trade-off between the efficient resolution of banking groups and their ability to provide loans and thereby to finance efficient investments in the real economy. This trade-off arises when outside investors cannot fully capture the present value of banks' investments, for instance, due to an agency problem between bank insiders and outside investors, as in our model. If banking units are hit by negative shocks, SPOE resolution will facilitate efficient reinvestment because it protects banking groups' corporate structure and their synergies ex post. But, the same ex post reinvestment and loss mutualization may also curb banks' ex ante financing and investment. MPOE resolution, in contrast, can prevent reinvestments and continuation of weaker units that do not benefit banks' investors. At the same time, precisely because MPOE resolution can limit investors' exposure to some negative shocks, it can increase banks' ex ante financing capacities and investment.

We characterize the conditions under which SPOE and MPOE resolutions are efficient and show that these conditions depend on the banking groups' characteristics, such as the risk profile and the profitability of their different units. In particular, MPOE resolution increases efficiency for banking groups with sufficiently diverse units as a result of heterogeneous business lines and diverse geographic footprints. We thus argue that the coexistence of both resolution regimes increases economy wide efficiency relative to the adoption of a uniform resolution regime for all banks.

We build a model of two (potentially) asymmetric banking units that could either operate as single-unit banks or as parts of a banking group. One of the units is weak in the sense that it has a lower financing capacity than the other, strong, unit. The operation of both units is efficient, but their financing capacities fall short of the present values of their loans because bankers must receive agency rents to monitor the loans. Joining the two units together as part of a banking group centralizes decision-making and allows the bank to (i) transfer excess financing capacity from the strong to the weak unit, while (ii) creating "incentive synergies" that reduce the cost of providing monitoring incentives.[4] These two types of financing synergies allow weak units to operate as part of a banking group, even when they are not viable as single-unit banks.

The units' loan portfolios are susceptible to exogenous adverse shocks that necessitate

[4]The use of a strong unit's excess financing capacity to finance a weak unit as part of a conglomerate is discussed in Fluck and Lynch (1999) and Inderst and Müller (2003). Diamond (1984), Laux (2001), and Cerasi and Daltung (2000) analyze incentive synergies that arise from combining multiple projects.

further investment in order to generate returns. We focus on the case in which the shocks are small enough to make reinvestment for both units efficient, but large enough to force the bank into resolution. Resolution provides a mechanism to raise new financing from capital markets for reinvestment that banks cannot raise privately. To do so a regulator temporarily takes over control, verifies banks' reinvestment needs, restructures existing liabilities to bail-in investors, and issues new securities. The regulator's objective is to maximize the net present value (NPV) of the bank ex post.[5]

As a benchmark against which to compare the resolution regimes, we derive the constrained optimal contract between bankers and outside investors. Because credit markets are competitive and bankers are the residual claimants, the private and social optimum are the same in our model. We show that it may sometimes be ex ante optimal to commit not to reinvest in the weak unit following the realization of a negative shock, even if reinvestment is ex post efficient. The reason is that, when the financing capacity the weak unit adds to the banking group is smaller than the reinvestment needed to generate returns following a shock, reinvestment in the weak unit requires a transfer of (additional) financing capacity from the strong unit. When investors' expected costs of making such a transfer are high enough, it becomes constrained optimal ex ante to commit not to reinvest in the weak unit; otherwise, outside investors will refuse to finance the banks' investment in the first place. At the same time, reinvesting in the strong unit increases the bank's financing capacity and is always optimal.

We then consider the effects of different resolution regimes on a bank's ability to finance its investment and reinvestment following a negative shock. SPOE resolution mutualizes losses and thus uses both units' financing capacity to reinvest in any unit that suffers a negative shock. Hence, SPOE resolution can implement the constrained optimal contract when it includes reinvestment in the weak unit. But, when it is constrained optimal to avert reinvestment in the weak unit, SPOE can discourage outside investors to provide financing ex ante . The reason is that outside investors anticipate that the regulator will impose a bail-in so as to use the strong unit's financing capacity for reinvestment in the weak unit.

Conversely, under MPOE resolution, the banking group can specify its weak unit as an additional entry point that will be resolved separately and without transfers from the other parts of the banking group. This prevents the regulator, against its own preferences, from reinvesting in the weak unit when the weak unit cannot self-finance its

[5]Our model focuses on the trade-off between different resolution regimes rather than on the need for resolution a resolution regime per se. However, we explicitly model the need for a resolution in an extension that features a model with adverse selection.

reinvestment. Outside investors anticipate that MPOE resolution limits their losses from reinvestment in the weak unit. We show that MPOE resolution, with an entry point in the weak unit, can implement the constrained optimum when preventing reinvestment in the weak unit is necessary for it to operate in the first place.[6] In contrast, we demonstrate that the strong unit should never serve as a entry point for resolution because reinvestment in the unit following a shock is always optimal. In this case, resolution at the holding company level is more efficient because this preserves the banking group's corporate structure and the associated incentive synergies.

We derive a series of policy and empirical implications from our model. First, both resolution regimes should be part of the regulatory toolbox because their relative efficiency is bank specific.

Second, MPOE resolution is optimal for banking groups with sufficiently heterogeneous units that have different scopes and competencies (such as investment and commercial banks) or geographic focuses. MPOE banks should designate large risky units as entry points so that they can be resolved separately in case of failure. At the same time, strong units should not be designated as entry points so that shocks to these units do not lead to inefficient changes to the group's structure.

Third, once a banking group has adopted a resolution regime, this choice will affect its future investment. SPOE banks will find it difficult to finance large and risky investments precisely because outside investors might not be willing to bear the risk of a bail-in. Conversely, MPOE banks will find it easier to make such investments because of their ability to avoid costly reinvestment and thus, limit investors' bail-in. Thus, MPOE banks are also less likely to curtail investments during crisis times, when the risk associated with investment increases and bank profitability decreases.

Fourth, we argue that the credibility of MPOE resolution might rely on coordination failures between different regulators in cross-border contexts. MPOE resolution can only limit outside investor's losses when it prevents the regulator from enforcing transfers, even if these transfers would be ex post efficient. In practice, national regulators may find it easier to make such commitments for foreign, rather than for domestic, units.[7] Such regulatory biases may thus explain why MPOE resolution is primarily observed in a cross-border context. In response to regulatory commitment problems, banking groups

[6] Wells Fargo's 2017 resolution plan exemplifies an explicit case calling for the separate liquidation of its institutional broker-dealer in case of resolution: "Our institutional broker-dealer, WFS LLC, would be resolved through a liquidation proceeding under SIPA, which is the law that typically governs the resolution of a brokerage firm that fails" (Wells Fargo, 2017, p. 9).

[7] The FDIC in the United States, for example, requires bank holding companies to serve as a "source of strength" for their bank subsidiaries (Title 12 of the U.S. Code §1831).

may actively spread their activities across borders in order to make an MPOE strategy credible and thereby increase their financing capacity and investment.

Fifth, we also show that when MPOE banks issue state contingent securities, such as contingent convertibles, they can avoid the resolution of their strong units when a weak unit gets resolved separately in response to a shock. This can reduce any possible direct and indirect costs that are associated with resolution.

Finally, resolution regimes also have implications for the total loss absorption capacity (TLAC) that regulators require from G-SIBs.[8] TLAC measures financial claims that can be written down or diluted to absorb losses during resolution. We show that MPOE resolution can require less TLAC compared to SPOE resolution because MPOE resolution limits outside investors' losses from reinvestment in weak units. This result goes in the opposite direction of the standard argument that SPOE resolution requires less loss absorption capacity than MPOE resolution as the former mutualizes losses among multiple units (e.g. Bolton and Oehmke, 2019).[9]

The literature on government intervention in failing banks has mostly focused on regulators' incentives to intervene (e.g., Mailath and Mester, 1994; Decamps et al., 2004; Beck et al., 2013; Freixas and Rochet, 2013) and the optimal design of bail-in and bail-out policies (e.g., Gorton and Huang, 2004; Diamond and Rajan, 2005; Farhi and Tirole, 2012; Bianchi, 2016; Keister, 2016; Walther and White, 2019; Colliard and Gromb, 2018; Keister and Mitkov, 2020). A number of papers have explored the supervision (but not resolution) of multi-unit banks (Calzolari and Lóránth, 2011; Calzolari et al., 2019; Lóránth et al., 2022), focusing on multinational banks.

Despite the intense policy debate on the resolution frameworks and the virtues of SPOE versus MPOE, the academic literature on the issue is scant. A notable exception is Bolton and Oehmke (2019), who discuss resolution regimes in a cross-border context. In their model, SPOE resolution is efficient because it provides diversification benefits and preserves operating synergies. But in a cross-border setting, national regulators are unable to commit to SPOE resolution, ex post, because doing so would involve transfers across jurisdictions. Furthermore, a lack of coordination among national regulators can result in an ex ante suboptimal choice of MPOE, even when regulators can commit to ex post transfers. MPOE resolution then emerges as a result of these regulatory fric-

[8]In the European Union, all banks (not just G-SIBs) are also subject to a minimum requirement for their own funds and eligible liabilities (MREL), which serves the same purpose as TLAC (SRB, 2021).

[9]Even under MPOE resolution, loss absorption capacities can be shared across units in the form of "internal TLAC" provided by the holding company (cf. FSB, 2015).

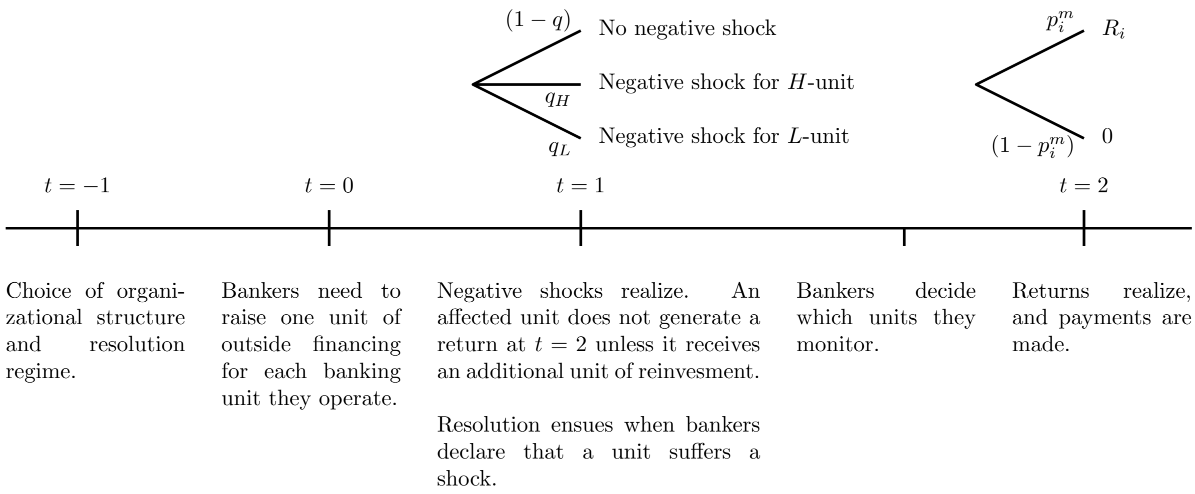

Figure 1: Timeline

tions, even though SPOE resolution dominates MPOE resolution in the absence of such frictionsFaia and Weder di Mauro (2016) similarly argue that, when regulators coordinate, the most efficient resolution regime is SPOE resolution. They also contend that MPOE resolution can increase banks' cross-border activities by limiting their exposure to foreign losses. We argue instead that we may primarily observe MPOE resolution in cross border contexts because regulators' reluctance to make cross-border transfers makes MPOE resolutions strategies credible. More importantly, we identify a different trade-off between resolution efficiency ex post and the ability to finance investment ex ante, which is not specific to cross-border entities and equally applies to banking groups operating within national borders.

2. Model

This section introduces a model of two, potentially asymmetric, banking units that raise financing from competitive capital markets to provide loans to the real sector. Banking units are subject to exogenous adverse shocks that require reinvestment. We compare the costs and benefits of different organizational forms and resolution regimes using the three-date model represented in Figure 1. As we show later the private and social optimum coincide in our model. Hence, it does not matter who chooses the organizational form and resolution regime.

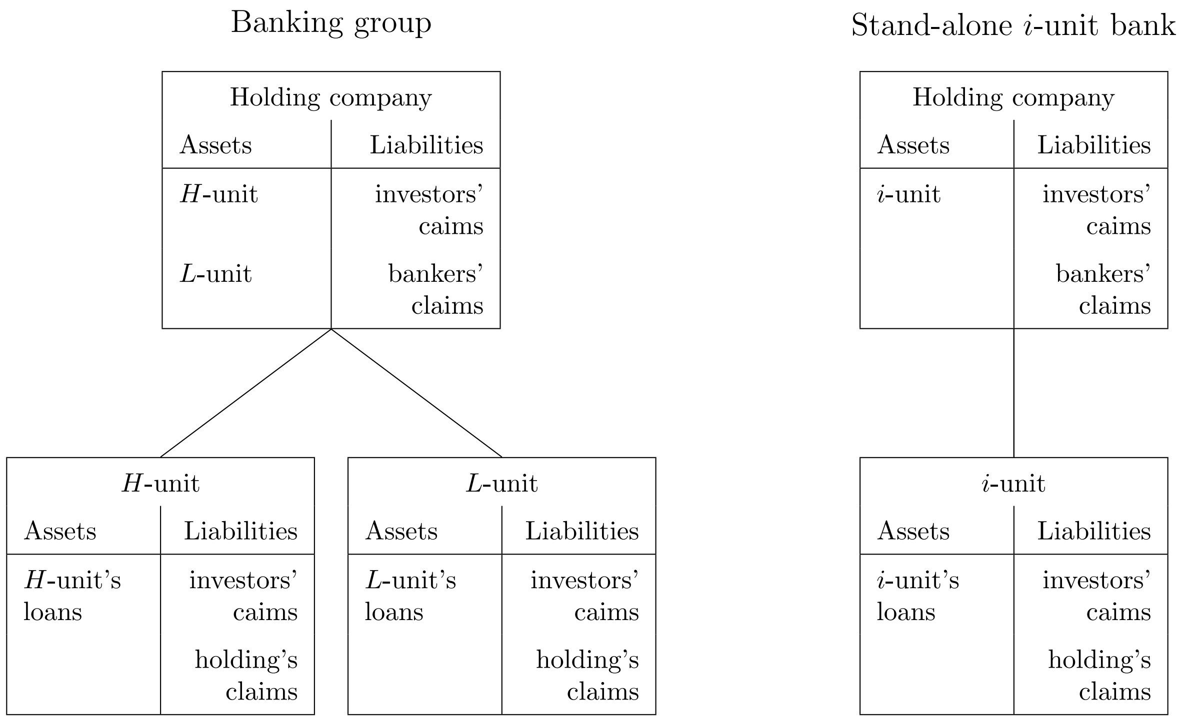

Figure 2: Banks' organizational structure

2.1. Organizational structure

We consider two banking units, $i \in \{H, L\}$, that have access to different pools of loans. The units may be asymmetric in the sense that their loan pools may have different payoff and risk characteristics. The two banking units can operate as part of the same banking group or as two independent single-unit banks (see Figure 2). A banking group consists of three legal entities: the holding company and two wholly-owned subsidiaries that operate the two banking units. A single-unit bank, which consists of a holding company and a wholly-owned subsidiary, is equivalent to a banking group that operates a single unit.[10]

All banks are run by teams of "bankers" that take all the decisions as long as their bank is not in resolution, at which point a regulator takes over the decision making (see below). Decision-making within a banking group is centralized. We abstract away from any internal agency problems within banking groups or within the teams of bankers. Single-unit banks make decisions independent of each other.

[10]In our model, a single-unit bank does not necessarily require a holding company. Including it allows for a clearer exposition of the core differences between banking groups and single-unit banks.

2.2. Investment

Bankers take decisions on how many units to finance, or "operate," and how to raise funding for their operation at $t = 0$. Each banking unit requires one unit of funding to make loans that return a final payoff at $t = 2$. A banking unit $i \in \{H, L\}$ generates a positive payoff R_i with probability p_i and a payoff of zero with the complementary probability. Bankers can increase the probability of a positive return of each i-unit from p_i to $p_i^m \equiv p_i + \Delta p_i$ if they monitor the i-unit's loans between dates $t = 1$ and $t = 2$. Monitoring is not observable and imposes a per-unit non-pecuniary cost c on bankers. The banking units' payoffs are assumed to be independent of each other.

Banking units are subject to exogenous adverse shocks at $t = 1$. If a unit suffers a shock it requires an additional unit of funding.[11] These shocks can be interpreted as shocks to the units' borrowers who require additional investment to complete their investment projects.[12] If the additional investment is not made, the banking unit does not generate any return from its loans at $t = 2$. In this case, monitoring is irrelevant. If the additional investment takes place, the bank's return distribution is the same as in the absence of a shock. We call units that receive a shock but no reinvestment "non-performing" and units that either do not suffer a shock or receive reinvestment "performing."

The ex ante probability that an i-unit is affected by a shock is q_i. Only one of the two units may suffer a shock and the overall probability that a shock occurs is $q \equiv q_H + q_L$.[13] Whether a banking unit suffers a shock is bankers' private information.

2.3. Financing

Bankers do not possess funds of their own and need to raise outside financing. Capital markets are competitive and thus outside investors provide resources as long as they break even in expectation. Hence, bankers are the residual claimants in our model. The inability of markets to observe the shock prevents parties from writing financing contracts that are contingent on the realization of the shock. Bankers are protected by

[11] It is straightforward to generalize our model to different shock sizes, s_i that can differ across units. We further discuss this in Section 6.

[12] Holmström and Tirole (1998) call such shocks "liquidity" shocks.

[13] This formulation allows us to encompass the case in which the two units are symmetric in terms of the shock ($q_H = q_L = q/2$), as well as the case in which the shock can only affect one of the two units ($q_i = q$, $q_{-i} = 0$). Bolton and Oehmke (2019) use a similar shock structure but, in their setup, the shock to one of the two units always occurs ($q = 1$) and the two units are symmetric ($q_H = q_L = q/2$).

limited liability All parties are risk neutral and have a discount factor of one.

2.4. Resolution

Resolution occurs if bankers report to the regulatory and supervisory authorities (the "regulator" thereafter) that a banking unit suffered a shock. The regulator temporarily takes control of the bank, which allows it to verify the occurrence of the shock.[14] In resolution, the regulator can restructure existing financial contracts and enter into new ones to raise new financing from capital markets for reinvestment. We assume that once resolution ensues, the regulator's objective is to maximize "ex post efficiency" or NPV at $t = 1$. To do so, it imposes the minimum losses, first on bankers and then on outside investors, that are necessary to maximize NPV.[15] If the regulator cannot help the bank to raise sufficient resources to reinvest in the affected unit, the unit becomes non-performing. Once resolution is complete, bankers retake control of the bank.[16]

We assume in the main body of the paper that resolution is essential, in the following sense.

Assumption 1. *In the absence of resolution, banks cannot raise sufficient financing to reinvest in units that suffer an adverse shock.*

We develop an extension of our model in Appendix A that provides explicit conditions under which Assumption 1 holds. In this extension, we assume that bankers can misappropriate funds that are not required to cover the bank's funding needs and can instead be used to obtain non-pecuniary private benefits. This possibility of misappropriation captures the idea that excess cash gives management the possibility to make decisions that benefit themselves at the expense of investors. While appropriate financial contracts may still lead to truthful reporting of the shock and avoid misappropriation of funds, such incentive schemes are costly, lower the returns that can be pledged to investors, and can thus prevent financing.[17]

The possibility of misappropriation does not affect outcomes when the regulator verifies the occurrence of shocks in resolution. Hence, in the presence of resolution, the

[14]Our model and results would not change if the regulator could directly observe the occurrence of shocks as a result of regulatory monitoring and reporting requirements.

[15]Note that this objective of resolution is different from typical bankruptcy procedures that are more creditor friendly and thus aim to maximizes investors' payoffs.

[16]Since the occurrence of a shock is exogenous to the bank, there is no reason to replace the bankers following a shock in our model.

[17]We show that when the non-pecuniary benefits from "consuming" excess funds are large, the presence of resolution is essential in the sense of Assumption 1.

expressions, trade-offs and results of the extended model would be the same as in the simplified model of the main text.

2.4.1. Entry points

Resolution plans designate one or more entities as “entry points” at which the regulator can take control. The holding company must always be an entry point to ensure that all parts of the banking group can be resolved. Further entry points can be defined at unit level.

Resolution occurs at an entry point if the corresponding entity, or one of its subsidiaries that is not an entry point itself, suffers a shock. Resolution at an entry point (i) separates the corresponding entity from its parent company and other subsidiaries of the parent company, and (ii) encompasses all subsidiaries of the corresponding entity, except for those subsidiaries that are themselves entry pointsat which resolution occurs independently at the same time. If separation of an entity impairs the operational efficiency of the remaining parts of the banking group because it destroys monitoring incentives, the remaining parts of the banking group enter resolution as well.

When multiple entities are resolved together their losses are mutualized, but there are no transfers between entities that are resolved separately. If resolution separates a part of the banking group from the holding company, some of the members of the original team of bankers will form a new, independent team to run the new bank. These bankers lose their claims in the remaining part of the banking group and obtain new claims on the new bank. We assume that the allocation of bankers and their claims among these different subgroups of bankers is such that it does not affect bankers’ ex ante incentives at $t = 0$.

2.4.2. Resolution regimes

We compare different configurations of entry points, which give rise to two different types of “resolution regimes.” An SPOE regime arises if a banking group specifies its holding company as its sole entry point. In this case, resolution always occurs at the holding company level, all entities are resolved jointly, and losses are mutualized. An MPOE regime arises instead if the banking group specifies multiple entry points and resolves different parts of a banking group separately. In our setting, MPOE resolution encompasses three different entry point configurations depending on which units are specified as entry points. The banking group can specify its L-unit, its H-unit, or both as entry points, in addition to the holding company. We refer to banks subject to the different resolution regimes as SPOE and MPOE banks, respectively.

For single-unit banks, the choice of resolution regime does not matter because the bank operates a single unit that cannot be split up.

2.5. Efficiency

We measure the performance or the ex ante efficiency of the different organizational structures and resolution regimes or entry point configurations in terms of the overall expected NPV creation. As bankers are the residual claimants, the bankers' private optimum and the social optimum coincide ex ante. We make two parameter assumptions to ensure that the decisions of operating either of the two units, as well as of reinvesting in a unit that suffers a shock, are efficient if and only if bankers monitor that unit.

We assume first that, with monitoring, each unit generates positive (expected) NPV at $t = 0$, even when reinvestment following a shock at $t = 1$ does not occur:

$$(1 - q_i)(p_i^m R_i - c) - 1 > 0 \; \forall i \in \{H, L\}.$$

Note that this condition implies that reinvesting in the unit following a shock at $t = 1$ also generates positive NPV: $p_i^m R_i - c - 1 > 0$. The NPV from reinvestment at $t = 1$ is higher than from investment at $t = 0$ because, in our setting, the unit will not suffer any other shock after $t = 1$. These two conditions in turn imply that operating the unit at $t = 0$ must also create positive NPV when reinvestment following a shock occurs: $p_i^m R_i - c - (1 + q_i) > 0$. Overall, since both units' operation at $t = 0$, as well as the reinvestment at $t = 1$, have positive NPV, we measure efficiency in terms of whether these investments can be financed.

Conversely, we assume that if the unit will not be monitored, reinvestment following a shock at $t = 1$ creates negative NPV:

$$p_i R_i - 1 < 0 \; \forall i \in \{H, L\}.$$

This condition in turn implies that, without monitoring, operating a unit at $t = 0$ is never efficient. The reason is that at $t = 0$, the possibility of a $t = 1$ shock implies either higher expected costs (with reinvestment), or a lower expected payoff (without reinvestment), when compared to the reinvestment decision at $t = 1$.

2.6. Discussion

We now discuss the main assumptions of our model.

2.6.1. Banks

The aim of the paper is to analyze how the choice of a resolution regime affects banks' ability to provide loans and thereby to finance investment in the real economy. We adopt a workhorse moral hazard model from corporate finance that allows us to highlight resolution regimes' differences regarding the possible bail-in of investors and their consequences for banks' ability to raise financing and investment. In addition, our model provides a framework to study some determinants of group formations and the effect of resolution regimes upon it. Banks in our model provide monitoring on behalf of investors that enables the financing of investment projects in the real economy. Thus, we model banks in the tradition of Diamond (1984) as delegated monitors. Still, our main results do not rely on the precise nature of the underlying (agency) friction, but on outside investors' inability to fully capture the present value of banks' investments. This creates a wedge between the ex post efficient continuation decision following a shock and the one compatible with outside investors' interest, resulting in a trade-off between ex post and ex ante efficiency.

The model purposefully leaves out other attributes of banks that are not essential for the main argument of the paper. In particular we focus on uninsured rather than on insured investors, and therefore on those that are sensitive to losses. This reflects international regulations after the financial crisis of 2007-2009, which require banks to issue claims that can be bailed-in to facilitate an orderly resolution and their recapitalization. We do not include deposit insurance and therefore disregard the additional distortions and conflict of interests that could result from it. In particular we do not address (and our model is not suitable to study) the standard over-investment issues resulting from the deposit insurance put option.

While we model the formation of new banking groups, the insights directly carry over to an existing banking group that considers additional investment in one of its units, or the creation of new units. The fixed investment sizes of our banking units serve as a simple shorthand for units with decreasing returns to scale, which provides incentives for the operation of multiple units.

2.6.2. The role of resolution

Resolution regimes provide a legal framework that ensures that bail-in occurs if and only if necessary. Banks are complex institutions, and the opacity of their investment (loans with propriety information) naturally gives rise to informational asymmetries between insiders and outside investors (Morgan, 2002; Iannotta, 2006; Flannery et al., 2013). Significant shocks to the banking group require prompt decisions, and bank regulators are in a unique position to act and facilitate the refinancing of banks in these situations, through the exchange of information and coordinating the actions of old and potential new investors.[18]

In an extension (see Appendix A), we model this as an asymmetric information problem where bank regulators can verify bankers' information about the shock and thus provide certification to markets. Resolution thus serves as a state verification device, similar to bankruptcy in Giammarino (1989) and Webb (1987). However, unlike these papers from the "costly state verification" literature (Townsend, 1979), we abstract from verification costs and any other direct costs of resolution (or default), for simplicity.

The bail-inable debt initially issued by banks in our model can be interpreted as a contingent contract that relies on regulatory certification. In fact, bail-inable debt contracts stipulate a write-down following the occurrence of a 'write-down event', which can be a 'contingency event' or a 'viability event.' Under the former, the Common Equity Tier 1 (CET1) ratio must fall below a certain threshold at any reporting date. Under the latter, 'the Regulator' must determine that a write-down is essential to prevent the bank from ceasing to carry on its business.

The regulator in our model suffers from a time inconsistency problem. As it maximizes ex post NPV, the regulator exhibits a bias towards reinvestment. In practice regulators are likely to exhibit even stronger biases towards the continuation of failing banks because of fears of market turmoil and potential contagion of bank failure to other banks (see e.g., Weder di Mauro, 2009). In our model, resolution regimes serve as commitment devices to overcome this time-inconsistency problem. MPOE resolution, in particular, prevents the regulator from enforcing transfers across units following a negative shock.

[18] According to the EU's Single Resolution Board (SRB) "Resolution occurs at the point where the authorities determine that a bank is failing or likely to fail, that there is no other supervisory or private sector intervention that can restore the institution to viability (for example by applying measures set out in a so-called recovery plan, which all banks are required to draft) within a short timeframe and that normal insolvency proceedings would cause financial instability while having an impact on the public interest."

2.6.3. Socially and privately efficient resolution

The private and social optimum coincide in our model because bankers are the residual claimants. Bankers obtain all the surplus from operating banking units because credit markets are competitive, and bankers do not lose their jobs in resolution. Replacing bankers in resolution would not increase the income that can be pledged to investors, as long as the group's new bankers also need monitoring incentives.[19]

However, the risk of loosing their job could distort bankers' operating decisions at $t = 0$. In particular, bankers may underinvest in group formation, i.e., not operate the L-unit, in order to reduce the incidence of resolution. They may also try to hide the shock resulting in underinvestment ex post and insufficient monitoring incentives. Naturally, the threat of replacement could also entail positive incentive effects in a model with endogenous shock probabilities.

3. Optimal Contracting Benchmark

As a benchmark to compare the resolution regimes against, we first derive a constrained optimal contract, which maximizes the bank's NPV creation. Bankers have an incentive to choose an optimal contract because they are the residual claimants.

Since resolution allows the regulator to (i) verify whether a shock has occurred or not and (ii) control the bank's reinvestment decision, we analyze the optimal contract when both of these features are contractible.[20] Bankers' monitoring decisions are non-contractible, whereas the banks' returns at $t = 2$ are contractible, as described in Section 2.2

The constrained optimal contract consists of two parts. The first part specifies the distribution of cash flows between bankers and outside investors at $t = 2$. The incentive payments that bankers require to monitor determine the maximum payments that can be credibly promised to outside investors at $t = 1$, that is a bank's $t = 1$ pledgeable income. We can restrict ourselves to contracts that ensure the monitoring of all performing units because otherwise, the initial investment as well as the reinvestment would be inefficient.

The optimal contract's second part determines the bank's operation decision at $t = 0$

[19]Quite recently, Swiss authorities quoted the need to motivate employee shareholders to continue working as one of the reasons for favoring shareholders over Additional Tier 1 (AT1) bondholders in the Credit Suisse bailout. The other reason was the fear of shareholders' blocking litigation and the worry about losing anchor investors (institutional buyers) that might be needed to meet future financing needs. (see e.g., Paz Valbuena and Eidenmüller, 2023)

[20]We restrict ourselves to reinvestment decisions that are deterministic functions of the shock.

and its reinvestment policy in case of a shock at $t = 1$. The optimal contract must satisfy outside investors' participation constraint, which requires them to break even in expectation. Bankers' participation constraint will not be binding because they earn agency rents and their outside option is zero.

We first analyze the case in which the two different units are operated as single-unit banks and then the case in which the two units are part of a banking group. In both cases, we solve the model by backward induction. We first identify the incentive contract that maximizes outside investors' cash flows at $t = 2$. We then determine the bank's reinvestment policy at $t = 1$ and the number of units it operates at $t = 0$.

3.1. Single-unit banks

To ensure monitoring, bankers of a single-i-unit bank must be provided with an incentive payment τ in case the bank generates a positive return. In the absence of a return, the contract that maximizes financing subject to limited liability pays the bankers zero. The incentive compatibility constraint for monitoring a performing i-unit is

$$p_i^m \tau - c \geq p_i \tau. \tag{1}$$

The lowest incentive payment that ensures monitoring of an i-unit bank is thus given by

$$\tau^i \equiv \frac{c}{\Delta p_i}.$$

Note that bankers require the same (minimum) incentive payment (or agency rent) in the absence of a shock and if the bank reinvests at $t = 1$ following a shock. The i-unit's $t = 1$ pledgeable income is then given by

$$P_i^1 \equiv p_i^m (R_i - \tau^i).$$

The pledgeable income at $t = 0$ depends on the reinvestment policy that the bank plans to implement following a shock, $\rho \in \{0, i\}$, where $\rho = 0$ denotes no reinvestment and $\rho = i$ denotes reinvestment. If the bank reinvests, its expected cost of reinvesting one unit of funding in case of a shock is q_i. If it does not reinvest, it will only be performing with probability $(1 - q_i)$. Hence, the $t = 0$ pledgeable income of an i-unit bank is given by

$$P_i^0(\rho) \equiv \begin{cases} P_i^1 - q_i & \text{if } \rho = i, \\ (1-q_i)P_i^1 & \text{if } \rho = 0. \end{cases}$$

A stand alone i-unit bank can operate at $t = 0$ if and only if its pledgeable income exceeds the initial financing costs, such that $P_i^0(\rho) \geq 1$ for some reinvestment policy ρ.

We now argue that, in our setup, a bank that can finance its operations at $t = 0$ will reinvest following a shock at $t = 1$. The reason is that if investors can break even on their initial $t = 0$ investment, which may suffer from a shock, they can also break even on reinvesting when a shock occurs because the bank never suffers another shock. Since reinvestment creates positive NPV it is constrained optimal.

Lemma 1. *It is constrained optimal to operate a single-i-unit bank if and only if the $t = 0$ pledgeable income is such that*

$$P_i^0(i) \equiv P_i^1 - q_i \geq 1. \tag{2}$$

In this case, it is also constrained optimal to reinvest following a shock at $t = 1$.

Proof. See Appendix B.1. □

Our single-unit bank model demonstrates three important points. First, a bank's ability to operate at $t = 0$ only depends on its $t = 1$ pledgeable income P_i^1 and the probability of receiving a shock q_i. Second, in our set-up, a single-unit bank will always reinvest following a shock because doing so is both efficient and maximizes the bank's pledgeable income when the bank can finance its operations at $t = 0$. Third, some units may not be able to finance themselves, even if their initial operation and reinvestment following a shock are efficient. This can occur if the bank's financing capacity falls short of the present value of the bank's assets because bankers must be incentivized to monitor loans: $P_i^0(i) = p_i^m(R_i - \tau^i) - q_i < p_i^m R_i - c - q_i$.

To facilitate the exposition we will distinguish between the H- and L-unit based on their $t = 1$ pledgeable income.

Assumption 2. *Without loss of generality, we assume that the pledgeable income of a single-H-unit bank at $t = 1$ is weakly higher than that of an L-unit bank: $P_H^1 \geq P_L^1$.*

3.2. Banking groups

We now analyze a banking group that owns the H- and the L-unit, and centralizes decision-making with a single team of bankers. As we will show below, forming a banking group can enable the operation of banking units that would not have been viable as single-unit banks.

Two effects of centralized decision-making make this possible. First, a unit's excess pledgeable income can be used to provide financing to a unit that cannot finance itself. Bankers are willing to make these transfers because they will earn extra agency rents from operating the second unit.[21] As a result, the operational decisions of a banking group only depend on its overall pledgeable income, and not on the pledgeable income of the individual units. This advantage of group formation has previously been studied by Fluck and Lynch (1999) and Inderst and Müller (2003).

Second, centralized decision-making for multiple units relaxes bankers' incentive compatibility constraints and reduces the minimum compensation that provides monitoring incentives. The reason is that bankers can cross-pledge the incentive payments they receive for monitoring a given unit such that they only receive compensation when both units succeed. These "incentive synergies" have been studied before by Laux (2001) and Diamond (1984). Cerasi and Daltung (2000) discuss them in the banking context.

3.2.1. Incentive contract

We first derive the incentive contract that maximizes outside investors' payment for a banking group with two performing units at $t = 1$. An incentive contract T_G is a vector of three different payments (τ_L, τ_H, τ_2) that bankers respectively receive when only the L-unit, only the H-unit, or both units generate a positive return at $t = 2$. As before it is optimal to make no payment in the absence of a return.

The following incentive compatibility constraints ensure that bankers monitor both units, rather than only the L-unit (IC:L), only the H-unit (IC:H), or neither unit (IC:0), respectively:

[21] This would not be possible if the other unit were run by a different group of bankers, who would require monitoring incentives of their own.

$$p^m_H p^m_L \tau_2 + p^m_H(1 - p^m_L)\tau_H + (1 - p^m_H)p^m_L \tau_L - 2c$$
$$\geq p_H p^m_L \tau_2 + p_H(1 - p^m_L)\tau_H + (1 - p_H)p^m_L \tau_L - c, \tag{IC:L}$$
$$\geq p^m_H p_L \tau_2 + p^m_H(1 - p_L)\tau_H + (1 - p^m_H)p_L \tau_L - c, \tag{IC:H}$$
$$\geq p_H p_L \tau_2 + p_H(1 - p_L)\tau_H + (1 - p_H)p_L \tau_L. \tag{IC:0}$$

Bankers' limited liability constraints are given by $\tau_2, \tau_H, \tau_L \geq 0$. Deriving the minimum compensation necessary to provide monitoring incentives for both units yields the following proposition.

Proposition 1.

1. There exists an incentive contract $T^*_G \equiv (\tau^*_L, \tau^*_H, \tau^*_2)$ with $\tau^*_2 > 0$ and $\tau^*_H = \tau^*_L = 0$ that maximizes the banking group's financing capacity.
   a) The banking group's $t = 1$ pledgeable income P^1_G is strictly larger than the sum of the pledgeable incomes of two single-unit banks $P^1_H + P^1_L$. We call the additional $t = 1$ pledgeable income, $P^1_S \equiv P^1_G - P^1_H - P^1_L$, the group's "incentive synergies."
   b) For given average success probabilities $(p_L+p_H)/2$ and $(\Delta p_L+\Delta p_H)/2$, the incentive synergies P^1_S are maximal when the two banking units are symmetric, that is, when $p_H = p_L$ and $\Delta p_H = \Delta p_L$.

Proof. See Appendix B.2. □

This proposition allows us to make three important points. First, the bank can maximize its financing using a simple incentive contract T^*_G. S

Second, Proposition 1 also shows that forming a banking group increases the overall pledgeable income due to incentive synergies. These synergies represent a form of cost saving that allow the bank to overcome the agency problems with lower amounts of agency rents, due to the cross-pledging of the rents from the two units.[22]

Third, the proposition also shows that the incentive synergies, P^1_S, are maximal when the two units are symmetric. The reason is that the sum of the single-unit banks' agency rents $p^m_H \tau^H + p^m_L \tau^L$ is maximal for symmetric units. Thus, cross-pledging these rents when the other unit succeeds relaxes the IC-constraints the most.

[22] In practice, these synergies could correspond to overall lower bonus pools and less-generous incentive payment schemes.

Finally, recall that when a banking group does not reinvest into a unit that suffers a shock at $t = 1$, the affected unit becomes non performing and never generates a positive return. Bankers' incentives to monitor the remaining performing i-unit are then exclusively determined by the payment τ_i, which they receive in case only the i-unit generates a return. Bankers will monitor the performing i-unit if τ_i satisfies the incentive compatibility constraint for a single-i-unit bank (1). As a result, the $t = 1$ pledgeable in this case is also by P_i^1.

3.2.2. Operation and Reinvestment

We now turn to the banking group's optimal reinvestment policy at $t = 1$ and operation decision at $t = 0$. We first analyze how the group's reinvestment policies affect its $t = 0$ pledgeable income. A banking group can operate both units at $t = 0$ if and only if its pledgeable income exceeds the initial financing costs for some reinvestment policy. We then show that a banking group that operates both units at $t = 0$ will always reinvest when the H-unit suffers a shock at $t = 1$. In contrast, it may not reinvest if the L-unit receives a shock.

We denote the reinvestment policy of a banking group that operates both units at $t = 0$ by $\rho \in \{2, H, L, 0\}$, where $\rho = 2$ denotes the case in which the bank reinvests in any unit that receives a shock, $\rho = i$ the case in which the bank reinvests in the i-unit if it receives a shock but not the other j-unit if that one receives the shock, and $\rho = 0$ the case in which the bank does not reinvest in any unit. If the bank reinvests in an i-unit, the associated expected cost is given by q_i; if not, outside investors maximum cash flows are P_j^1 $(j \neq i)$ rather than P_G^1 with probability q_i. Hence, the $t = 0$ pledgeable income for each reinvestment policy is given by

$$P_G^0(\rho) \equiv \begin{cases} P_G^1 - q & \text{if } \rho = 2, \\ (1 - q_L)P_G^1 + q_L P_H^1 - q_H & \text{if } \rho = H, \\ (1 - q_H)P_G^1 + q_H P_L^1 - q_L & \text{if } \rho = L, \\ (1 - q)P_G^1 + q_L P_H^1 + q_H P_L^1 & \text{if } \rho = 0 \end{cases} \tag{3}$$

and the bank can operate both units if $P_G^0(\rho) \geq 2$ for some ρ.

To understand the optimal reinvestment consider the effect of reinvestment in an i-unit on the banking group's $t = 0$ pledgeable income. A performing unit's marginal contribution to the banking group's $t = 1$ pledgeable income is $P_i^1 + P_S^1$, which includes the incentive synergies of operating both units together. If the unit contributes more than the cost of reinvestment following a shock, $P_i^1 + P_S^1 \geq 1$, we say that the unit can "fund its reinvestment." In this case, reinvesting in the i-unit increases the bank's $t = 0$ pledgeable income. Otherwise, when the unit cannot fund its reinvestment, then reinvestment requires a transfer of pledgeable income from the other unit and decreases the income that can be pledged by the banking group at $t = 0$.

Lemma 2. *Reinvesting in an i-unit that receives a shock at $t = 1$ increases the banking group's $t = 0$ pledgeable income if and only if the unit can fund its reinvestment:*

$$P_G^0(2) > P_G^0(j) \Leftrightarrow P_G^0(i) > P_G^0(0) \Leftrightarrow P_i^1 + P_S^1 > 1$$

where $j \neq i$ denotes the other banking unit.

Proof. Follows from the arguments in the text and simple algebra. □

We now argue that a banking group that can operate both units at $t = 0$ will always finance reinvestment in its H-unit. As in the case of single-unit bank, the $t = 1$ pledgeable income of a banking group with two performing units is higher than the $t = 0$ pledgeable income of a two-unit banking group because the shock can only occur at $t = 1$: $P_G^1 > P_G^0(\rho)\,\forall\rho$. Since a bank can only operate both units if there exists a reinvestment policy ρ such that $P_G^0(\rho) \geq 2$, a necessary condition for the operation of both units is

$$P_G^1 \equiv P_H^1 + P_L^1 + P_S^1 > 2. \tag{4}$$

Intuitively, this condition captures the fact that outside investors must be willing to finance the operation of both units in the absence of any (future) shocks. Condition (4) and $P_H^1 \geq P_L^1$ together imply that the H-unit can fund its reinvestment: $P_H^1 + P_S^1 > 1$. Otherwise, the units will never be able to finance their joint operation at $t = 0$ because either unit would require a transfer of pledgeable income from the other unit at $t = 0$. It thus follows from Lemma 2, that reinvestment in the H-unit increases the banking group's $t = 0$ pledgeable income. This implies that reinvestment in the H-unit is constrained optimal, as it creates positive NPV.

Lemma 3. *If a banking group operates both units* at $t = 0$*, then the H-unit can fund its reinvestment* at $t = 1$ *($P_H^1 + P_S^1 > 1$), and the banking group reinvests into the H-unit when it suffers a shock at $t = 1$.*

Proof. This proof follows from the arguments in the text. □

We will now determine the bank's reinvestment policy for its L-unit and its initial operation decisions. Because operation and reinvestment are efficient for both units, these decisions are determined by the bank's ability to finance them. Since a two-unit banking group always reinvests in the H-unit, the bank's financing capacity is determined by $P_G^0(H)$ and $P_G^0(2)$. Moreover, if a bank can operate both units, doing so is constrained optimal because it creates positive NPV, regardless of the reinvestment policy for the L-unit. We obtain the following result.

Proposition 2. *A banking group operates both units at $t = 0$ if and only if*

$$\max\{P_G^0(2), P_G^0(H)\} \geq 2. \tag{5}$$

It always reinvests in the H-unit when it receives a shock at $t = 1$. It withholds reinvestment when the L-unit suffers a shock if and only if

$$P_G^0(2) < 2 \leq P_G^0(H). \tag{6}$$

Proof. This proof follows from the arguments in the text. □

We illustrate the results of this proposition in Figure 3. First, to operate both units, the pledgeable income must be sufficiently high. Second, it might be optimal to not reinvest into the L-unit following a shock in order to finance its operation in the first place. This can occur when the L-unit cannot fund its reinvestment, which thus, decreases the bank's pledgeable income at $t = 0$:

$$P_G^0(2) < P_G^0(H) \Leftrightarrow P_L^1 + P_S^1 < 1. \tag{7}$$

If this condition is satisfied, reinvestment in the L-unit requires a transfer from the H-unit. If the expected size of this transfer $q_L(1 - P_L^1 - P_S^1)$ is large enough relative to the overall $t = 0$ pledgeable income, withholding reinvestment from the L-unit is necessary to operate both units at $t = 0$. Importantly, the reinvestment decision for the L-unit only depends on the group's joint pledgeable income as bankers are willing to make transfers between units.

3.3. Forming banking groups

Forming a banking group strictly increases efficiency when it increases investment relative to two single-unit banks. Lemma 1 shows that this is only possible when at least

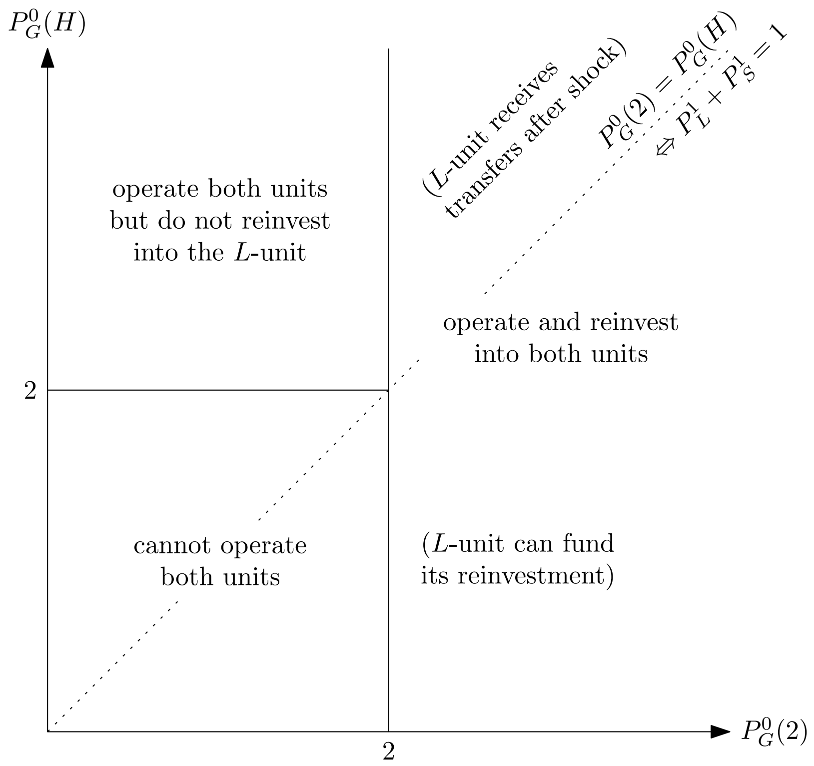

Figure 3: Constrained optimal reinvestment policies

one i-unit lacks the pledgeable income to operate independently: $P_i^0(i) < 1$. In this case, forming a banking group strictly increases efficiency when the group has sufficient pledgeable income to operate both units, regardless of whether it can reinvest in the L-unit or not. We, thus, obtain the following corollary.

Corollary 1. *Forming a banking group strictly increases efficiency when at least one unit cannot operate as a single-unit bank and the banking group can operate both units.*

Proof. This proof follows from Lemma 1 and Proposition 2. □

Since we are interested in the resolution of multi-unit banking groups we will focus on the cases where a banking group can operate both units.

Assumption 3. *The banking group can operate both units:* $\max\{P_G^0(2), P_G^0(H)\} \geq 2$.

4. Resolution

This section examines the extent to which the resolution regimes can implement the constrained optimal contract described in the previous section. Banks reinvestment is determined in resolution because the regulator must verify the occurrence of a shock.[23] We show that the resolution regimes impact a bank's reinvestment policy and its ability to raise funding for its initial operations because they affects the regulator's ability to raise additional financing in case of a shock. Whether SPOE or MPOE resolution can implement the constrained optimum depends on a bank's constrained optimal reinvestment policy for the L-unit.

At the same time, the different resolution regimes have no impact on the banks' ability to implement the incentive contracts τ^i and T^*_G. We later show in Section 4.5 that these incentive contracts can often be implemented by issuing simple debt securities.[24]

4.1. SPOE resolution

An SPOE resolution regime corresponds to a single entry point at the holding company. In this case, resolution always occurs at the holding company, all entities are resolved jointly, losses of any of the two units are mutualized, and the corporate structure does not change. As a result, upon resolution, the regulator can issue new claims backed by the cash flows of the entire banking group to finance reinvestment.

Because the $t = 1$ pledgeable income of a two-unit banking group must satisfy $P^1_G > 2$ (cf. Condition 4), the regulator can always finance reinvestment, after imposing sufficient write downs on existing claims. Since the regulator maximizes NPV and reinvestment is efficient, resolution of an SPOE bank will result in reinvestment in any unit that suffers a shock.

We now show, in three steps, that the $t = 0$ pledgeable income of an SPOE bank is $P^0_G(2)$. First, to maximize its financing the bank must sell securities that implement the incentive contract T^*_G. These securities are worth P^1_G in the absence of shock.

Second, if a shock occurs, bankers have an incentive to declare so: if they hide it and forego reinvestment, their payoff from the incentive contract T^*_G will be zero because the non-performing unit will not create a positive return at $t = 2$, and the payments for a single positive return are zero ($\tau^*_i = 0$).[25]

[23] Recall that we assume that the asymmetric information problem between bank and investors is so severe that banks cannot raise sufficient financing to reinvest in units that suffered shocks without resolution (Assumption 1).

[24] We consider complex securities with payoffs that condition on bankers' announcements about the occurrence of a shock in Appendix A, where we analyze banks' financing in the absence of resolution. With a resolution regime in place that will restructure financial claims when bankers report a shock there is no use for such complex securities.

[25] If banker would falsely claim that a shock has occurred the regulator would discover this once resolution ensues and only take actions that are warranted by the shock that have indeed occurred,

Third, when resolution ensues following a shock, the regulator will write down outside investors' claims to the extent that is necessary for financing reinvestment and maintaining bankers' monitoring incentives. The (initial) outside investors will, thus, obtain a payoff $P_G^1 - 1$, as bankers must retain the incentive contract T_G^* to continue monitoring.

Taking into account the probability of a shock, we can derive outside investors' expected payoff at $t = 0$: $(1-q)P_G^1 + q(P_G^1 - 1) = P_G^0(2)$. This is the maximum pledgeable income possible that results from an optimal contract with reinvestment in both units. We obtain the following Lemma.

Lemma 4. *SPOE resolution always reinvests in any unit that suffers a shock. The $t = 0$ pledgeable income of an SPOE bank is $P_G^0(2)$.*

Proof. Follows from the arguments in the text. □

4.2. MPOE resolution

Different configurations of entry points are possible in MPOE resolution. In our setting, an MPOE bank can specify entry points at the L-unit, the H-unit, or both, in addition to the holding company. These entry points determine an MPOE bank's reinvestment decisions and the amount of funding it can raise at $t = 0$.

4.2.1. Entry points and reinvestment

We first consider the effect of designating a unit as an entry point on the bank's reinvestment. If bankers report a shock and the affected i-unit is *not* an entry point, resolution ensues at the holding company level, and it proceeds as in the previous Section 4.1, resulting in reinvestment. Conversely, if the affected i-unit is an entry point, resolution ensues at the i-unit, and it is separated from the rest of the banking group. As a result, the regulator can only pledge the i-unit's cash flows to raise funding for reinvestment and cannot use the other unit's pledgeable income to make transfers. It follows that the regulator will only reinvest in the i-unit if its pledgeable income as a single-unit bank exceeds the cost of reinvestment: $P_i^1 > 1$. Otherwise, the i-unit becomes non-performing. We thus obtain the following lemma.

Lemma 5. *MPOE resolution will* not *reinvest in an i-unit that suffers a shock if and only if that unit is an entry point and its $t = 1$ pledgeable income $P_i^1 < 1$.*

Proof. This proof follows from the arguments in the text. □

irrespective of bankers original claims. Thus, bankers never have incentive to make any false reports.

4.2.2. Entry points and pledgeable income

We now turn to the effects of designating a unit as an entry point on the bank's pledgeable income and show that the pledgeable income of an MPOE bank is $P_G^0(H)$. As in the previous Section 4.1, a bank that maximizes its financing must sell securities that implement the incentive contract T_G^*. These securities are worth P_G^1 in the absence of shock; bankers have an incentive to truthfully report shocks; and if a shock occurs to a unit that is not an entry point, then resolution occurs at the holding company and outside investors' payoff is $P_G^1 - 1$.

However, if a shock occurs to an i-unit that is an entry point, that unit gets resolved separately. If $P_i^1 < 1$, the regulator cannot finance the unit's reinvestment and outside investors' payoff from the unit is 0. Conversely, if $P_i^1 \geq 1$, the regulator restructures the claims such that it can raise sufficient financing for reinvestment and the bankers obtain the minimum incentive payments that ensure monitoring τ^i. Doing so minimizes the losses of outside investors, who obtain a payoff $P_i^1 - 1$ from the i-unit.

The other j-unit ($j \neq i$), will also enter resolution because the incentive contract T_G^*, with $\tau_j^* = 0$, does not ensure monitoring of a single-j-unit bank.[26] The regulator will, thus, restructure claims such that bankers obtain the minimum incentive payment that ensures monitoring τ^j, and outside investors' payoff from the j-unit is P_j^1. It follows that outside investors' total payoff is

$$\max\{P_i^1 - 1, 0\} + P_j^1. \tag{8}$$

where the maximum term accounts for the reinvestment decision that we discussed above.

The expected value of outside investors' payoffs above corresponds to the bank's pledgeable income. Taking the pledgeable income of an SPOE banking group $P_G^0(2)$ as a benchmark, we can describe the pledgeable income of an MPOE banking group by adding the changes in outside investors' expected payoffs that result from designating a unit as an entry point. We obtain the following lemma.

Lemma 6. *The pledgeable income of an MPOE banking group is*

$$P_G^0(2) + \sum_{i \in \mathbf{E}} q_i(\max\{1 - P_i^1, 0\} - P_S^1) \tag{9}$$

where $\mathbf{E} \in \{\{L\}, \{H\}, \{L, H\}\}$ *denotes the units that the bank designates as entry points.*

[26] We discuss financing contracts that avoid the resolution of the unit that does not suffer a shock in Section 4.6.

Designating an i-unit as an entry point increases the bank's $t = 0$ pledgeable income if and only if this i-unit cannot fund its reinvestment: $P_i^1 + P_S^1 < 1$.

Proof. See Appendix B.3. □

Intuitively, separately resolving an i-unit that suffers a shock has two effects on outside investors: (i) it destroys the incentive synergies P_S^1 because resolution splits up the banking group and (ii) it saves outside investors from the possible losses due to reinvestment when the regulator cannot raise sufficient funding. The sum of these two effects is positive if and only if the i-unit cannot fund its reinvestment because outside investors would always make losses from providing the required financing in this case.

We know that the H-unit must be able to fund its reinvestment (cf. Lemma 3). It thus follows that MPOE resolution can only increase a bank's pledgeable income if the L-unit cannot fund its reinvestment. In this case, Expression (9) implies that designating the L-unit as an entry point yields a pledgeable income $P_G^0(2) + q_L(1 - P_i^1 - P_S^1) = P_G^0(H)$. Otherwise, designating either unit as an entry point will decrease the bank's pledgeable income. We obtain the following lemma.

Lemma 7. *MPOE resolution increases the banking groups' pledgeable income if and only if the L-unit cannot fund its reinvestment ($P_L^1 + P_S^1 < 1$) and the bank designates its L-unit subsidiary and its holding company as its entry points. In this case the bank's pledgeable income is $P_G^1(H)$.*

Proof. This proof follows from Lemma 6 the arguments in the text. □

4.3. Efficient Resolution

We will now show that SPOE and MPOE resolution regimes can respectively implement the different constrained optimal reinvestment policies for the L-unit in Proposition 2.[27] SPOE resolution ensures that the banking group's structure remains intact, the regulator reinvests in both units, and the bank's pledgeable income is $P_G^1(2)$ (cf. Lemma 4). Hence, SPOE resolution can implement the constrained optimum when it involves reinvestment in both units: $P_G^0(2) \geq 2$. Conversely, SPOE resolution will altogether prevent the $t = 0$ operation of the L-unit when it is constrained optimal to withhold its reinvestment: $P_G^0(2) < 2 \leq P_G^0(H)$. In this case, the expected transfers of pledgeable income that the L-unit requires for its operation at $t = 0$ and its reinvestment at $t = 1$ exceed the free pledgeable income of the H-unit.

[27]Remember that operating both units is constrained optimal due to Assumption 3.

MPOE resolution can prevent the regulator from reinvesting in the L-unit by specifying it as an entry point because the L-unit cannot raise the necessary financing for its reinvestment when it gets resolved separately and $P_L^1 < 1$ (cf. Lemma 5). At the same time, MPOE resolution will be able to ensure reinvestment and preserve the group's incentive synergies in case the H-unit suffers a shock when the H-unit is *not* specified as an entry point. As a result MPOE resolution allows for a pledgeable income of $P_G^0(H)$ when the L-unit cannot fund its reinvestment (cf. Lemma 7). It follows that MPOE resolution can achieve the constrained optimum when the L-unit must not reinvest due to $P_G^0(2) < 2 \leq P_G^0(H)$.

However, when $P_G^0(2) \geq 2$, MPOE resolution can create inefficiencies in two ways. First, if it designates an i-unit with $P_i^1 < 1$ as an entry point it will prevent reinvestment in this unit. This strictly reduces efficiency as compared to SPOE. Second, if it designates an i-unit with $P_i^1 \geq 1$ as an entry point, it destroys the incentive synergies P_S^1 when the unit gets separated from the rest of the group following a shock. Thus, although resolution will lead to reinvestment at $t = 1$, the loss in incentive synergies yields a lower $t = 0$ pledgeable income $P_G^0(2) - q_i P_S^1$, which we calculate using Expression (9). MPOE resolution, thus, prevents the efficient operation of the L-unit if its pledgeable income does not cover the initial investment costs once it designates an i-unit with $P_i^1 \geq 1$ as an entry point.

The above analysis of the two resolution regimes yields the following result.

Proposition 3. *The constrained optimal operation and reinvestment decisions can always be implemented by one of the two resolution regimes:*

1. *When $P_G^0(2) \geq 2$, SPOE resolution can implement the constrained optimum. SPOE resolution strictly increases efficiency over MPOE resolution, which designates an i-unit as an entry point, if $P_G^0(2) - q_i P_S^1 < 2$ for all i such that $P_i^1 \geq 1$.*
   a) *When $P_G^0(2) < 2 \leq P_G^0(H)$, MPOE resolution with the L-unit as an entry point can implement the constrained optimum. MPOE resolution strictly increases efficiency over SPOE resolution.*

Proof. This proof follows from the arguments in the text. □

Whether SPOE or MPOE resolution can implement the constrained optimum thus depends on the units' pledgeable incomes and their financing synergies, as well as on the likelihood of adverse shocks that increase the future financing needs of the different parts of the group. Clearly these parameters are banking group specific. It follows that a resolution framework can only ensure the implementation of the constrained optimum for all banking groups if it permits different resolution regimes for different banks.

Corollary 2. *A bank-specific choice between SPOE and MPOE resolution increases efficiency relative to the adoption of a uniform resolution regime for all banks.*

Proof. This proof follows from the arguments in the text. □

In practice, SPOE and MPOE resolutions do coexist, although regulators appear to prefer SPOE. One reason for this preference could be that SPOE resolution is ex post efficient while MPOE resolution is not, precisely in those cases in which it increases efficiency ex ante. However, we argue that both SPOE and MPOE resolutions should remain part of the regulatory toolbox because either resolution regime may be more efficient ex ante, depending on the characteristics of the banking group in question.

4.4. Which banks should choose which resolution regime?

Proposition 3 allows us to derive comparative static results on when MPOE resolution is more efficient than SPOE resolution and vice versa. We argue that MPOE resolution is optimal for banking groups that operate sufficiently asymmetric units that have sufficiently diverse operations, and include weaker units facing sizable negative shocks.

To gain intuition, we revisit and rewrite the condition under which MPOE resolution is optimal: $P_G^0(2) < 2 \leq P_G^0(H)$. The first inequality states that reinvestment into the L-unit after a shock must not be feasible. Rewriting this inequality

$$P_G^0(2) < 2 \Leftrightarrow q > P_G^1 - 2$$

shows that the probability of a shock q must be high enough relative to the banking group's $t = 1$ pledgeable income P_G^1 net of the initial investment costs.

The second inequality states that withholding reinvestment in the L-unit must free up enough pledgeable income so that the bank can operate both units at $t = 0$. Rewriting this inequality

$$P_G^0(H) \geq 2 \Leftrightarrow P_G^0(H) - P_G^0(2) \geq 2 - P_G^0(2) \Leftrightarrow q_L(1 - P_L^1 - P_S^1) \geq 2 + q - P_G^1$$

shows that MPOE resolution is optimal if the L-unit's $t = 1$ pledgeable income P_L^1 is low and the probability that the unit suffers a shock q_L is high for given q, P_G^1, and P_S^1.

We summarize this discussion in the following corollary.

Corollary 3. *MPOE resolution is constrained optimal for a banking group if and only if*

1. the probability of a shock q is high enough and the $t = 1$ pledgeable income P_G^1 is low enough.
   a) the L-unit's $t = 1$ pledgeable income P_L^1 is low enough and the probability that the unit suffers a shock q_L is high enough for a given shock probability q, pledgeable income P_G^1, and incentive synergies P_S^1.

Proof. This proof follows from the arguments in the text. □

Another important implication of Proposition 3 is that MPOE resolution is only more efficient than SPOE resolution if the two units are asymmetric: Otherwise, the two units must have the same pledgeable incomes $P_H^1 = P_L^1$ and Lemma 3 implies that both units must be able to fund their reinvestment. In this case, Lemma 2 implies that $P_G^0(2) \geq P_G^0(H)$ and it follows from Assumption 3 and Proposition 3 that SPOE resolution is optimal. We obtain the following corollary.

Corollary 4. *Symmetric banking groups should always choose SPOE resolution. A necessary condition for MPOE resolution is that the two banking units are asymmetric.*

Proof. This proof follows from the arguments in the text. □

Our model has several dimensions of asymmetry: the probability with which each unit receives a shock q_i for a given overall shock probability q, and the units' pledgeable incomes P_i^1, which in turn depend on the units' risk and return characteristics, p_i^m, Δp_i, and R_i. Note that asymmetry between the units also lowers the banking group's incentive synergies, P_S^1, and thus a banking group's overall financing capacity (cf. Proposition 1, Part 1b). This effect further strengthens the association between asymmetric banking units and MPOE resolution because MPOE resolution is efficient when a banking group's pledgeable income is too low to finance reinvestment in the L-unit.

4.5. Debt securities and incentives

Our model does not restrict the set of financial contracts that can be used by banks. Nevertheless the incentive contracts τ^i and T_G^* that maximize banks' financing can be implemented by issuing simple debt securities as long as the cost of monitoring c is not too high.

To see this, suppose that the banking group's holding company issues debt with a face value F that matures at $t = 2$, bankers hold the holding's equity, and no outside claims are issued at the subsidiary units. Setting $F = R_H + R_L - \tau_2^*$ then implements the contract T_G^* if

$$R_H + R_L - \tau^* \geq \max_i \{R_i\} \tag{10}$$

such that $\tau_L = \tau_H = 0$. Since the incentive payment τ^* is proportional to the monitoring costs c (see Expression (18) in Appendix B.2), we obtain the following result.

Corollary 5. *There exists a threshold on the monitoring cost $\bar{c}$ such that the incentive contract T_G^* can be implemented with a simple debt contract when $c \leq \bar{c}$.*

Proof. See Appendix B.4. □

Note that, when Condition (10) is violated, the outside investors payoff from the incentive contract T_G^* is not monotonous in the sense that their payoff decreases when both units succeed rather than a single unit. This may be problematic because it gives outside investors an incentive to sabotage operations and bankers incentives to boost cash flows through personal borrowing (cf. Innes, 1990). If we require incentive contract to be monotonous, they must contain incentive payments for the success of individual units, $\tau_H^*, \tau_L^* > 0$, when $c > \bar{c}$.[28] Such slightly more complex incentive contracts could be implemented by issuing different debt claims at the subsidiary and the holding company levels.

Finally, note that setting $F = R_i - \tau^i$ implements the contract that pays τ^i in case of success for a single-unit and that $R_i \geq \tau^i$ if and only if $P_i^1 \geq 0$.

4.6. Avoiding resolution

In our model, resolution has no direct costs. In practice, however, resolution entails costs. Thus, the question arises whether banking groups can sometimes limit the occurrence of resolution following a shock.

If a banking group plans to reinvest following a shock, then resolution is essential to raise the required financing (cf. Assumption 1) because the regulator verifies the

[28] See Bond and Gomes (2009) for an analysis of optimal incentive contracts in a multitask agency setting when payoffs must be monotonous. Since the exact shape of the incentive contracts does not directly affect the role of resolution regimes in our setting we do not discuss these issues further.

occurrence of a shock. In contrast, if there is no reinvestment in the L-unit after a shock, then the only function of resolution is to restructure financial claims. In particular, when MPOE resolution separately resolves the L-unit following a shock it writes down claims on (i) the L-unit, which becomes non-performing, and (ii) the remaining parts of of the banking group, in order to ensure monitoring of the H-unit. Hence, the question arises whether, in cases where the L-unit is resolved separately following a shock, it is possible to avoid the resolution of the remaining parts of the banking group while maintaining the bankers' incentives to monitor the H-unit.

A bank can achieve this by issuing securities at $t = 0$ that condition on the resolution of the L-unit. To see this, consider securities that (i) implement the incentive contract T_G^* unless the L-unit separately enters resolution and (ii) implement the incentive payment τ^H if the L-unit separately enters resolution. Then, if the bank chooses MPOE resolution and designates the L-unit as an entry point, outside investors' payoffs and the bank's pledgeable income are the same as in Section 4.2. However, once the L-unit enters resolution following a shock, there is no need to resolve the remaining parts of the banking group since bankers retain sufficient monitoring incentives.[29]

The above payoffs can be implemented with contingent convertibles (CoCos) if the monitoring cost satisfies $c \leq \bar{c}$. . Suppose that the banking group's holding company issues CoCos with a face value F_C that are fully written down in case the L-unit is resolved separately and otherwise mature at $t = 2$. At the same time, the banking group's holding issues simple debt with a face value F and equity that is held by bankers, as in Section 4.5. Setting $F = R_H - \tau^H$ and $F_C = R_H + R_L - \tau_2^* - F$ then implements that contract T_G^* if the L-unit is not resolved separately and τ^H if it is.

4.7. Sale of a Distressed Bank

When banks experience financial distress regulators often arrange the take over of the failing bank by another bank. These transactions are known as Purchase and Assumption in the parlance of the FDIC and Sale of Business Tool in the new EU regulation. A recent example of such a transaction was the sale of Banco Popular to Banco Santander for the symbolic price of €1 in June 2017. In this particular transaction Banco Popular's shareholders where fully bailed-in but no losses were imposed on its creditors.

In our model, under MPOE resolution renders the L-unit non-performing after a

[29]If the bank issues an incentive contract (τ_L, τ_H, τ_2) that is not contingent and ensures monitoring of the H-unit when the L-unit is resolved separately ($\tau_H \geq \tau^H$), one can show that the banking group's pledgeable income of the banking group decreases because it cannot exploit incentive synergies P_S^1.

shock. However, the presence of a suitable acquirer can provide additional funding that allows for reinvestment. The reason is that such an acquirer is willing to pay for the inside claims that provide monitoring incentives. Such an acquirer could be another bank with free pledgeable income that its bankers can use to acquire the inside claims. The amount of funding an acquirer can provide depends on its free pledgeable income and any incentive synergies.

The possibility of a take over also reduces the bail-in of investors following a shock because they may retain some claims on a banking unit that is taken over. Lower expected bail-ins increase a banking group's $t = 0$ pledgeable income and thus facilitate the formation and investment of banking groups.

5. Policy and Empirical Implications

This section presents a number of policy and empirical implications that result from our model. First, our model predicts which banking groups should prefer MPOE over SPOE and vice versa. Second, our model has implications for how MPOE banks should choose their entry points. Third, the model provides insights on how resolution and a given resolution regime affect the future investment decisions of banking groups. Fourth, the model can be used to demonstrate the possible consequences of a (sudden) change in economic conditions, for instance, as a result of a crisis. Finally, the model generates predictions about the viability/feasibility of the different resolution regimes in national and cross-border contexts.

5.1. Choice of resolution regimes and entry points

Our model predicts the type of banking groups which should favour SPOE and MPOE.. Corollaries 3 and 4 show that three features make a banking group more likely to choose MPOE resolution: First, units must be sufficiently asymmetric. This is likely to hold for units with heterogeneous operations, different scopes, and different competencies (such as investment and commercial banks) or geographic focuses. Second, the banking group's weak units must have large expected financing deficits with a relevant impact on the group's financing capacity. This is likely to be the case when the banking group's risky units are large relative to its strong units. Third, the group's overall riskiness must be sufficiently high relative to its expected return, to constrain its investment. This is more likely to happen when the group's overall profitability is low. We thus make the following prediction.

Prediction 1. *A banking group is more likely to choose MPOE over SPOE if (i) it consists of heterogeneous units, with different scopes, and different competencies or geographic focuses, (ii) it encompasses large risky units, and (iii) its overall profitability is low.*

Our model also predicts that the efficiency of MPOE resolution relies on the asymmetric treatment of different parts of a banking group. Lemma 7 shows that a unit should only serve as an entry point if its financing deficits in case of a shock can be large enough to endanger the (ex ante) funding of the banking group. This will be the case for large and risky units.[30] At the same time, other parts of the banking group must not be entry points so as to preserve synergies when these units suffer shocks that lead to resolution.

Prediction 2. *A banking group opting for MPOE resolution should specify entry points at its large risky units, enabling their separate resolution. Strong units should not be entry points so that resolution after a shock to these units can preserve the group structure.*

HSBC (2021) provides one example of such a structure. The banking group specifies its holding company and its U.S. and Asian operations as separate individual entry points (using intermediate holding companies for these activities), while its other subsidiaries, including its European operations, are not entry points. Hence, shocks to its U.S. or Asian operation may trigger a separate resolution of these parts, while the banking group's structure will be preserved if it suffers shocks to its European operations.

Other banks, particularly in Europe, achieve a similar outcome with a parent bank that is itself an operating unit and owns operating subsidiaries that are also specified as entry points. A negative shock to the parent will then lead to the joint resolution of the entire group, while other operating subsidiaries will be resolved separately if they receive a shock. Santander (2021), for example, consists of a parent bank, which includes its Spanish operations, and large international subsidiaries that are separate entry points.

5.2. Financing and investment decisions

The choice of a resolution regime will affect banks' future investment decisions (including M&A activities). The reason is that SPOE banks' outside investors are more exposed to

[30] If there are several layers of legal entities, as in the case of intermediate holding companies, a part of the banking group can be resolved separately if there exists an entry point between the parent bank and operating unit that suffers a shock.

the risks of new investments than are the investors of MPOE banks. Indeed, the former will more likely be bailed-in to reinvest in and save troubled units. Thus, SPOE banks will find it more difficult than MPOE banks to finance large, risky units which run the risk of potentially large financing deficits. Because MPOE banks can commit to not reinvest into failing units, they will be more capable of financing such large, risky units.

Naturally, these arguments depend on resolution regimes being fixed in the short to medium terms. However, resolution planning and regulatory approval are lengthy processes that make it difficult for banks to quickly adjust their resolution regimes.

Prediction 3. *MPOE banks are more likely than SPOE banks to finance large, risky investments with potentially large financing deficits.*

Our model also provides predictions on what may happen to an existing bank if economic conditions change. Consider, for instance, an economic crisis, in which the profitability of the banking units is likely to decrease, the probability of negative shocks is likely to increase, and, thus, the potential financing deficits of banks' weak units increase. SPOE banks are likely to curtail investments into weak units when their risks increase, in order to reduce their exposure. This effect will be amplified by decreasing profitability that increases the weak units' financing deficits and decreases overall financing capacity. In extreme cases, SPOE banks may find it necessary to divest their weak units. The effects for MPOE banks are likely to be muted because their weak units will be resolved separately, and, thus, the banking group is partially protected from increases in riskiness.

Prediction 4. *In a crisis, when risks increase and profitability decreases, MPOE banks are less likely to curtail investment into weak units than are SPOE banks.*

5.3. Cross-border banking and regulatory commitment

MPOE resolution in our setting requires regulators to not use the H-unit's pledgeable income for transfers to the L-unit when it suffers a shock. This requirement prevents reinvestment into the L-unit, even though reinvestment would be efficient ex post. In reality, regulators may not be easily able to rule out transfers and commit to withholding reinvestment from units for which they are responsible.[31] But, without such commitment, MPOE resolution loses its raison d'être.

[31]The FDIC in the United States, for example, requires bank holding companies to serve as a "source of strength" for their bank subsidiaries (Title 12 of the U.S. Code §1831)). As of 2009, the US requires foreign banks to establish intermediate holding companies for their U.S. activities in order to facilitate their supervision and resolution (Federal Reserve, 2019).

In a cross-border context, however, regulators may more easily be able to refuse transfers to units outside of their own jurisdiction. Thus, when banks spread their activities across multiple jurisdictions, this might serve as a credible commitment against reinvestment into weak units affected by a shock. As a result, MPOE resolution may be more viable in a cross-border context (where it is, actually, predominantly observed).

In addition, cross-border banks are more likely to include asymmetric units, some of which can be weaker and riskier, especially when their operations are located both in developed and in developing countries. As explained in Section 5.1, such banking groups will typically prefer MPOE resolution.

Prediction 5. *Cross-border banking groups are more likely to choose MPOE resolution than are banking groups operating within national borders.*

Finally, assuming that national regulators cannot commit to MPOE resolution strategies for banking groups operating within national borders, our model has predictions for banks' cross-border activities and asset allocation choices. MPOE banks might be more willing to engage in cross-border activities because they are partially protected from the risks associated with these activities. Banks may even opt to strategically spread their activities and assets across borders in order to make an MPOE resolution strategy credible by exploiting national regulators' reluctance to make cross-border transfers.

Prediction 6. *Banks that prefer MPOE are more likely to spread their activities and assets across borders.*

A similar prediction appears in Faia and Weder di Mauro (2016) who argue that MPOE bank may increase their cross–border activities because they can limit their exposure to foreign losses.[32] Our argument differs from Bolton and Oehmke (2019), where MPOE resolution only arises due to coordination failures between different national regulators, who fail to implement the more efficient SPOE resolution in a cross-border setting. Instead, we argue that coordination failures between regulators actually might be important to make MPOE resolution credible, which can increase efficiency.

6. TLAC

International regulations require that Global Systemically Important Banks (G-SIBs) have sufficient "total loss-absorbing capacity" (TLAC) to avoid a bail-out with public

[32] Bebchuk and Guzman (1999) make related arguments in the context of cross-border bankruptcies.

funds if resolution is required. TLAC consists of certain financial instruments that can be bailed-in to facilitate an orderly resolution and recapitalization of the bank. To ensure that bail-outs funded by Government resources can be avoided, a bank's TLAC must be able to absorb the highest level of possible losses (FSB, 2015). In the European Union, all banks (not just G-SIBs) are subject to a so-called "minimum requirement for own funds and eligible liabilities" (MREL), which serves the same purpose as TLAC (SRB, 2021).

In our setup, we define TLAC as the maximum amount of losses outside investors will need to absorb in the event of resolution. We measure these losses as the difference between the value of the outside investors' claims at $t = 0$ (equal to two) and the value of their claims following resolution. This definition excludes the losses that bankers suffer in resolution. We account for losses at the group level and do not separately account for the banking units' losses. This corresponds to a financing structure where TLAC is centrally issued at the holding level and the individual units' TLAC is provided by the holding company in the form of so-called "internal TLAC" (cf. FSB, 2015).

Clearly banks' required loss absorption capacity depends on the sizes of their units' shocks. Therefore in this section we allow the two units to suffer from different shock sizes s_L and s_H, respectively (rather than a uniform shock size $s = 1$ as in the rest of the paper). In this setup, we will distinguish strong and weak units according to their excess pledgeable incomes in case of a shock at $t = 1$: $P_H^1 - s_H \geq P_L^1 - s_L$ (rather than $P_H^1 \geq P_L^1$ in Assumption 2). The results of our main model continue to hold as long as each unit's shock size is smaller than the unit's $t = 0$ expected costs of operating and reinvesting: $s_i < (1 + q_i s_i)$. This condition ensures that reinvestment following a shock creates a positive NPV whenever the unit's investment creates positive NPV (cf. Section 2.5). It follows further that for a banking group that can operate both units $P_H^1 + P_S^1 > s_H$, and it is always constrained optimal to reinvest in the H-unit (cf. Lemma 3).

Outside investors' losses depend on the banking group's reinvestment decisions. If an i-unit receives reinvestment after a shock, its expected payoff is given by $P_G^1 - s_i$. If it does not, its expected payoff is P_j^1, where $j \neq i$ denotes the remaining unit. Since outside investors provide two units of financing at $t = 0$ and break even in expectation, their losses are given by $2 - (P_G^1 - s_i)$ and $2 - P_j^1$, respectively. It follows that reinvestment in an i-unit increases outside investors' losses if and only if the unit cannot fund its reinvestment: $P_i^1 + P_S^1 < s_i$.

SPOE resolution reinvests into either unit following a shock. Thus, the maximum losses outside investors must be ready to absorb are

$$\max\{2-(P_G^1-s_H),2-(P_G^1-s_L)\}. \tag{11}$$

where the two terms correspond to the H-unit and the L-unit suffering a shock, respectively.

An MPOE bank does not reinvest in an i-unit if (i) the unit is an entry point and (ii) its pledgeable income $P_i^1 < s_i$. It follows that designating an i-unit as an entry point reduces outside investors' losses when the unit cannot fund its reinvestment: $P_H^1 + P_S^1 < s_H$. Otherwise it increases their losses. Since $P_H^1 + P_S^1 > s_H$, MPOE resolution can reduce outside investors' losses if and only if $P_L^1 + P_S^1 < s_L$ and the L-unit is designated as an entry point. In this case the maximum losses outside investors must be ready to absorb are

$$\max\{2-(P_G^1-s_H),2-P_H^1\}. \tag{12}$$

Comparing the terms in Expressions (11) and (12), we obtain the following result.

Proposition 4. *MPOE resolution requires* less *loss absorption capacity than SPOE resolution if and only if $P_L^1 + P_S^1 < s_L$ and $s_H < s_L$.*

Proof. See Appendix B.5. □

MPOE resolution thus reduces TLAC if (i) it reduces outside investors' losses from shocks to the L-unit by withholding reinvestment and (ii) shocks to the L-unit cause higher losses than shocks to the H-unit and thus, determine the overall required loss absorption capacity. Note that withholding reinvestment from the L-unit destroys the associated (positive) NPV and, thus, increases overall losses. However, part of these losses is borne by the bankers, who lose their agency rents for monitoring the L-unit. In SPOE resolution, bankers do not lose their agency rents as both units receive reinvestment after a shock, and, therefore, existing outside investors absorb the losses. Thus, MPOE resolution reduces the losses outside investors need to absorb by changing the distribution of losses between bankers and outside investors.

A common argument is that SPOE resolution requires less loss absorption capacity than does MPOE (e.g., in Bolton and Oehmke, 2019). The reason is that SPOE banks can share the same loss absorption capacity across multiple units. In contrast, MPOE banks require separate loss absorption capacity in each unit and thus cannot benefit from diversification. However the use of internal TLAC provided by the holding company allows both SPOE and MPOE banks to share their loss absorption capacity across units (cf. FSB, 2015).[33] MPOE banks may in practice fail to share their loss absorption capacities across units when they raise their external financing through their subsidiaries and, thus, require more loss absorption capacity. Still, MPOE banks might need less loss absorption capacity than do SPOE banks because of the limits MPOE resolution imposes on outside investors' losses.

7. Conclusions

This paper analyzes how the choice of resolution regimes affects banking groups' financing and investment decisions. SPOE resolution mutualizes banking groups' losses, which allows for ex post efficient reinvestment in weak units that enables them to continue operating following a negative shock. However, loss mutualization increases the losses outside investors must bear in the case of shocks due to agency frictions. As a result, SPOE resolution can prevent financing of ex ante efficient investment opportunities. MPOE resolution separately resolves banking units and prevents transfers from strong to weak units. Hence, MPOE resolution will prevent reinvestment in weaker units and ultimately force them to shut down after a negative shock. This in turn limits outside investors' losses and can increase ex ante (efficient) investment.

MPOE resolution increases efficiency for banking groups with sufficiently asymmetric units, which can, for example, result from a banking group operating units with heterogeneous business lines and/or diverse geographic footprints. For a given resolution regime, banks opting for MPOE resolution will be more likely to make large and risky investments and less likely to curtail investments in crises periods compared to SPOE banks.

To achieve efficiency, MPOE banks should designate their weak units as separate entry points to make sure that these weak units are resolved separately if experiencing a negative shock. Moreover, by issuing state contingent securities MPOE banks may protect the stronger units from being brought into the resolution process if other units in the group suffer a harmful shock. MPOE banks may also require less TLAC than SPOE banks because MPOE resolution limits outside investors' losses from reinvestment in weaker units.

Our model suggests that the coexistence of both resolution regimes in the regulatory toolkit increases economy wide efficiency relative to the adoption of a uniform resolution

[33] Note that diversification can only reduce the maximum possible losses in a literal sense if units' losses exhibit perfect negative correlation, which is the assumption in Bolton and Oehmke (2019) and our paper.

regime for all banks. This supports the regulatory practice of allowing banks to choose between MPOE and SPOE resolution subject to regulatory approval. MPOE resolution plans may, however, suffer from regulatory commitment problems when they prevent regulators from reinvesting in units that suffer negative shocks and ultimately force these units to shut down. One way to circumvent these commitment problems could be to engage in cross border activities in order to exploit regulators' reluctance to make transfers across jurisdictions. Limiting regulator's ability to make transfers ex post would be even more important if, unlike in our model, regulators had a strict preference for reinvestment in order to continue banking operations even when doing so is inefficient ex post.

A. Contracting in the Absence of Resolution

This appendix develops an extension to show the conditions under which resolution is essential, in the sense that reinvestment would not occur without a resolution framework. More precisely, we provide conditions under which capital markets would not provide sufficient funding at $t = 0$ if the regulator is not involved at $t = 1$.

A.1. Model extension

We extend our model from Section 2 by introducing the possibility that bankers can misappropriate funds. We assume that if bankers raise additional funds at $t = 1$ in the absence of any shock, they can take a hidden action that uses these funds to create a non-pecuniary private benefit $b < 1$.[34] Because $b < 1$, raising and misappropriating funds in the absence of a shock is inefficient. The threat of misappropriation creates an additional agency problem between bankers and outside investors.

In the presence of resolution, the possibility of misappropriation does not alter the results of our main model. The reason is that bankers can never raise excess funds for misappropriation because resolution allows the regulator to verify whether a shock has occurred. In the absence of resolution, however, implementing efficient reinvestment policies and avoiding misappropriation at the same time will only be possible if bankers have incentives to truthfully report the occurrence of shocks. We show that, while appropriate financial contracts lead to truthful reporting, they are costly, lower the returns that can be pledged to investors, and can thus prevent bank financing.

[34] For tractability we do not consider the possibility of misappropriation if a shock occurs. Doing so would complicate the analysis without providing additional insights.

As in Section 3 we analyze the design of an optimal contract at $t = 0$ that specifies a bank's operation decisions at $t = 0$, the reinvestment decision at $t = 1$, and the distribution of cash flows at $t = 2$. Contrary to Section 3.1, the occurrence of a shock at $t = 1$ is bankers' private information and not contractible, due to the absence of a resolution process that serves as a verification device. Instead the provision of funds and the distribution of cash flows will depend on a "message" about the occurrence of a shock that bankers can send to outside investors.

Bankers, who are the residual claimants, will choose a financing contract at $t = 0$ that maximizes NPV, subject to the outside investors' break even condition. Since there is symmetric information at $t = 0$ this is a mechanism design problem and we exploit the revelation principle to focus on contracts where bankers are given incentives to truthfully report whether a shock has occurred and which unit has been affected. Moreover, bankers will never choose a contract that involves misappropriation of funds as it involves an inefficient destruction of resources. For the same reason, bankers will never choose a contract that does not provide monitoring incentives on the equilibrium path, where bankers truthfully reveal their private information.

We introduce the following notation. For a single-i-unit bank, a message $\mu = i$ indicates that the bankers claim that the banking unit has suffered a shock whereas $\mu = 0$ indicates that they claim no shock occurred. Bankers' payments at $t = 2$ are given by $\tau(\mu)$ in case of a positive return (zero in case of zero return), where the payments now depend on the message μ that bankers send. A reinvestment policy $\rho = i$ indicates that outside investors provide additional funds at $t = 1$ when bankers claim that a shock occurred, whereas $\rho = 0$ indicates that outside investors do not provide such funds despite bankers claiming that the shock has occurred.

Similarly, for a banking group a message $\mu = i$ indicates that bankers claim the group's i-unit suffered a shock and $\mu = 0$ indicates that they claim no shock occurred. Bankers' payments at $t = 2$ are given by $T_G(\mu) \equiv (\tau_L(\mu), \tau_H(\mu), \tau_2(\mu))$ for $\mu \in \{0, H, L\}$, where the subscripts denote the unit or units with positive returns, as in the main text. A reinvestment policy $\rho = 2$ indicates that investors provide additional funds when bankers claims that either unit has suffered a shock, $\rho = i$ indicates that investors provide additional funds if and only if bankers claim that the i-unit suffers a shock, and $\rho = 0$ indicates that investors never provide additional funds.

A.2. Single-unit banks

In the absence of resolution bankers need incentives to truthfully reveal the occurrence of a shock, in addition to monitoring incentives. Bankers' truth-telling incentives will depend on the banks reinvestment policy, which determines bankers' opportunities for misappropriation.

First, consider a bank that reinvests in the case when its bankers claim it has suffered a shock ($\rho = i$). In this case, the contract must ensure that bankers do not have incentives to falsely report a shock ex post, in order to raise and misappropriate funds from outside investors. Such truth-telling will be incentive compatible if the compensation received by bankers' exceeds the benefits of misappropriation they forego when no shock occurs. We thus obtain the incentive compatibility constraint

$$p_i^m \tau(0) \geq p_i^m \tau(i) + b \tag{13}$$

where we assume that bankers monitor on the equilibrium path. Bankers always have incentives to truthfully report when a shock occurs because their payoff is zero when the bank's single unit becomes non performing.

The truth-telling constraint (13) implies that bankers will earn an information rent when the bank does not receive a shock. This rent will equal the expected benefit of misappropriation that bankers could obtain from falsely reporting shocks $(1-q_i)b$. These rents reduce the bank's pledgeable income from a pure market solution $P_i^M(i)$ relative to the bank's pledgeable income in the presence of resolution $P_i^0(i)$, which we derive in the main text. As a result, the bank's ability to finance reinvestment is reduced.

Second, consider a bank that does not reinvest when its bankers claim that it has suffered a shock: $\rho = 0$. In this case, outside investors never provide additional funds and there will never be an opportunity to misappropriate funds. Hence, bankers' truth-telling constraints will not be binding, bankers do not earn any truth telling rents, and $P_i^M(0) = P_i^0(0)$.

Combing the two cases we obtain the following result.

Lemma 8. *In the absence of resolution, the $t = 0$ pledgeable income of a single-unit bank is*

$$P_i^M(\rho) = \begin{cases} P_i^0(i) - (1 - q_i)b & \rho = i \\ P_i^0(0) & \rho = 0. \end{cases}$$

The bank cannot finance reinvestment when $P_i^M(i) = P_i^0(i) - (1 - q_i)b < 1$.

Proof. See Appendix B.6 □

A.3. Banking groups

With two banking units, bankers' messages contain two types of information. They report (i) whether a shock has occurred or not and (ii) which unit has suffered the shock. As in the single-unit case, the contract must ensure that bankers do not have incentives to falsely report a shock, which would allow them to raise and misappropriate funds. The contract must provide these incentives whenever there is reinvestment following a shock to one of the two units ($\rho \in \{H, L, 2\}$). As in the single-unit case, the associated agency rent will equal the expected benefit of misappropriation that bankers could obtain from falsely reporting shocks in their absence $(1-q)b$.

Unlike in the single-unit case, bankers have the possibility to misreport which of the two units has actually suffered the shock. Thus, if the reinvestment policy only provides reinvestment for the H-unit ($\rho = H$), the contract must ensure that bankers do not falsely report a shock to the H-unit when the L-unit suffers a shock, which could be used to reinvest in the L-unit. Because the L-unit becomes non-performing and does not require monitoring when it does not receive reinvestment, the associated incentive compatibility constraint is

$$p_H^m \tau_H(L) - c \geq p_H^m p_L^m \tau_2(H) + p_H^m(1-p_L^m)\tau_H(H) + (1-p_H^m)p_L^m \tau_L(H) - 2c. \tag{14}$$

where we again assume that bankers monitor on the equilibrium path.

The truth-telling constraint (14) implies that for the reinvestment policy $\rho = H$ the bankers will earn an information rent if the L-unit receives a shock. The size of this rent will equal the expected gain, in the bankers minimum payoff, from monitoring both units (which they do following a shock to the H-unit) rather than only the H-unit (which they do following a shock to the L-unit): $q_L[(p_H^m p_L^m \tau_2^* - 2c) - (p_H^m \tau^H - c)]$, which can be rewritten as

$$q_L(p_H^m p_L^m \tau_2^* - p_H^m \tau^H - c).$$

Crucially, Condition (14) implies that bankers' compensation when the L-unit receives a shock must be at least as high as when the H-unit receives a shock and receives reinvestment. But, when bankers' compensation does not decrease as a result of withholding reinvestment from the L-unit, outside investors gains from withholding reinvestment from the L-unit are smaller or equal to the change in NPV $1 - p_L R_L$, which is negative.

Intuitively, outside investors could only gain from withholding reinvestment from the L-unit at the expense of bankers, who loose monitoring rents, which is not possible when bankers can misreport which unit has suffered a shock. It follows that the pledgeable income must be higher when there is reinvestment in both units rather than only the H-unit: $P_G^M(2) > P_G^M(H)$. Clearly, analogous arguments apply in case there is only reinvestment in the L-unit ($\rho = L$).

It follows that the bank can only operate both units when it has enough pledgeable income to be able to reinvest into both units when bankers obtain rents to prevent misappropriation in the absence of shocks.

Lemma 9. *In the absence of resolution, the $t = 0$ pledgeable income of a banking group is*

$$P_G^M(\rho) \equiv \begin{cases} P_G^0(2) - (1-q)b & \text{if } \rho = 2, \\ P_G^0(H) - (1-q)b - q_L(p_H^m p_L^m \tau_2^* - c - p_H^m \tau^H) & \text{if } \rho = H \\ P_G^0(L) - (1-q)b - q_H(p_L^m p_H^m \tau_2^* - c - p_L^m \tau^L) & \text{if } \rho = L, \\ P_G^0(0) & \text{if } \rho = 0. \end{cases}$$

The banking group cannot finance reinvestment into any unit ($\rho \neq 0$) when $P_G^M(2) < 2$.

Proof. See Appendix B.7 □

A.4. Essential resolution

Banks that reinvest ($\rho \neq 0$) in the absence of resolution have a lower $t = 0$ pledgeable income than in the presence of resolution (cf. Lemmas 8 and 9). When this decrease prevents banks from financing reinvestment without resolution Assumption (1) in the main text is satisfied. This case occurs when bankers private benefits from misappropriating funds b are large enough such that neither a banking group, a single-H-unit bank, nor a single-L-unit bank can finance itself at $t = 0$ when it chooses to reinvest following a shock at $t = 1$. These different types of banks are captured by the maximum term in the following proposition.

Proposition 5. *Banking groups and single-unit banks cannot finance reinvestment in the absence of resolution when*

$$b > \max\left\{\frac{P_G^0(2) - 2}{1-q}, \frac{P_H^0(H) - 1}{1-q_H}, \frac{P_L^0(L) - 1}{1-q_L}\right\}.$$

Proof. Follows from Lemmas 8 and 9. □

As we have mentioned earlier, banks' ability to finance themselves in the presence of a resolution regime is not affected by b because the regulator can verify whether a shock has occurred and which unit is affected. Thus, bankers can never raise funds for misappropriation or to reinvest in a unit that should not receive reinvestment. Hence, in the presence of resolution, the extended model yields the same trade-offs results and expressions as the simplified model we use in the main text.

B. Proofs

B.1. Lemma 1

Inspection of $P_i^0(\rho)$ shows that (i) $P_i^0(\rho) < P_i^1$ for any reinvestment policy ρ and (ii) $P_i^0(i) \geq P_i^0(0) \Leftrightarrow P_i^1 \geq 1$. The bank can operate the i-unit as a single-unit bank if and only if there exists a reinvestment policy $\rho \in \{i, 0\}$ such that $P_i^0(\rho) \geq 1$. From (i) and (ii) above it follows that for all ρ

$$P_i^0(\rho) \geq 1 \Rightarrow P_i^1 > 1 \Rightarrow P_i^0(i) \geq P_i^0(0).$$

It follows that a bank can operate if and only if $P_i^0(i) \geq 1$, in which case it can also reinvest following a shock. Since reinvestment creates positive NPV it is constrained optimal to do so.

B.2. Proof of Proposition 1

Proof of Part 1. In order to show that $\tau_2^* > 0$ and $\tau_H^* = \tau_L^* = 0$ minimizes bankers' compensation, we first show that for any incentive contract (τ_L, τ_H, τ_2) that satisfies the three IC constraints (IC:L,IC:H,IC:0) there exists another incentive contract $(0, 0, \tau_2')$ that yields the same expected compensation and satisfies the IC constraints. The contract $(0, 0, \tau_2')$ yields the same expected compensation when it satisfies

$$p_H^m p_L^m \tau_2' = p_H^m p_L^m \tau_2 + p_H^m (1 - p_L^m) \tau_H + (1 - p_H^m) p_L^m \tau_L.$$

To check that the resultant contract $(0, 0, \tau_2')$ satisfies the IC constraints, first note that the left-hand-side of the IC constraints does not change by construction. Second, substituting the contracts $(0, 0, \tau_2')$ and (τ_L, τ_H, τ_2) into the IC constraints (IC:L,IC:H,IC:0) shows that their respective right-hand-sides decrease:

$$
\begin{aligned}
p_H p_L^m \tau_2' - c - (p_H p_L^m \tau_2 + p_H(1-p_L^m)\tau_H + (1-p_H)p_L^m \tau_L - c) &= -\Delta p_H \frac{p_L^m}{p_H^m}\tau_L \\
p_H^m p_L \tau_2' - c - (p_H p_L^m \tau_2 + p_H(1-p_L^m)\tau_H + (1-p_H)p_L^m \tau_L - c) &= -\Delta p_L \frac{p_H^m}{p_L^m}\tau_H \\
p_H p_L \tau_2' - (p_H p_L \tau_2 + p_H(1-p_L)\tau_H + (1-p_H)p_L \tau_L) &= -\Delta p_L \frac{p_H}{p_L^m}\tau_H - \Delta p_H \frac{p_L}{p_H^m}\tau_L.
\end{aligned}
$$

We now derive the lowest incentive payment τ^* such that $(0, 0, \tau_2^*)$ satisfies the three IC constraints. Clearly at least one IC constraint must be binding.[35] First, suppose that the (IC:L) constraint is binding which yields

$$p_H^m p_L^m \tau_2^* - 2c = p_H p_L^m \tau_2^* - c \Rightarrow \tau_2^* = c(\Delta p_H p_L^m)^{-1}$$

It is easy to show that this compensation contract satisfies the other IC constraints if and only if

$$\Delta p_H p_L^m \leq p_H \Delta p_L. \tag{15}$$

Second, when the (IC:H) constraint is binding

$$p_H^m p_L^m \tau_2^* - 2c = p_H^m p_L \tau_2^* - c \Rightarrow \tau_2^* = c(\Delta p_L p_H^m)^{-1}$$

and the other IC constraints are satisfied if and only if

$$\Delta p_L p_H^m \leq p_L \Delta p_H. \tag{16}$$

Third when the (IC:0) constraint is binding

$$p_H^m p_L^m \tau_2^* - 2c = p_H p_L \tau_2^* \Rightarrow \tau_2^* = 2c(p_H^m p_L^m - p_H p_L)^{-1}$$

and the other IC constraints are satisfied if and only if

$$\Delta p_H p_L^m \geq p_H \Delta p_L \text{ and } \Delta p_L p_H^m \geq p_L \Delta p_H. \tag{17}$$

Together the conditions (15–17) partition the entire parameter space. Hence, the three

[35]Unlike in Laux, 2001 it is possible that one of the IC constraints for monitoring a single unit (IC:L) or (IC:H) is binding because of the units' asymmetry.

case together yield

$$\tau_2^* = c \begin{cases} (\Delta p_H p_L^m)^{-1} & \Delta p_H p_L^m \leq p_H \Delta p_L \\ (\Delta p_L p_H^m)^{-1} & \Delta p_L p_H^m \leq p_L \Delta p_H \\ 2(p_H^m p_L^m - p_H p_L)^{-1} & \text{otherwise.} \end{cases} \tag{18}$$

Note that τ_2^* is continuous. □

Proof of Part 2. With $\tau_2^* > 0$ and $\tau_H^* = \tau_L^* = 0$, the banking group's pledgeable income is given by

$$P_G^1 = p_H^m R_H + p_L^m R_L - p_H^m p_L^m \tau_2^*.$$

The incentive synergies are thus given by

$$P_S^1 \equiv P_G^1 - P_H^1 - P_L^1 = p_H^m \tau^H + p_L^m \tau^L - p_H^m p_L^m \tau_2^*$$

Substituting for τ^H, τ^L, and τ^* (Expression (18)) yields the incentive synergies

$$P_S^1 = c \left(\frac{p_H^m}{\Delta p_H} + \frac{p_L^m}{\Delta p_L} - \begin{cases} \frac{p_H^m}{\Delta p_H} & \Delta p_H p_L^m \leq p_H \Delta p_L \\ \frac{p_L^m}{\Delta p_L} & \Delta p_L p_H^m \leq p_L \Delta p_H \\ \frac{2 p_H^m p_L^m}{p_H^m p_L^m - p_H p_L} & \text{otherwise} \end{cases} \right) \tag{19}$$

Note that since τ_2^* is continuous P_S^1 is continuous as well. Inspection of Expression (19) shows that $P_S^1 > 0$ in all three cases. □

Proof of Part 3. We let $\bar{p} \equiv \frac{p_L + p_H}{2}$ and $\Delta\bar{p} \equiv \frac{\Delta p_H + \Delta p_L}{2}$ denote the average success probability without monitoring and the average impact of monitoring respectively. We define the following two vectors $\mathbf{p} \equiv (p_H, p_L, \Delta p_H, \Delta p_L)$ and $\bar{\mathbf{p}} \equiv (\bar{p}, \bar{p}, \Delta\bar{p}, \Delta\bar{p})$. We solve the following maximization program for any given $\bar{\mathbf{p}}$:

$$\max_{\mathbf{p}} P_S^1 \tag{20}$$

subject to

$$p_L + p_H = 2\bar{p} \tag{21}$$

$$\Delta p_H + \Delta p_L = 2\Delta\bar{p} \tag{22}$$

First, consider the parameter range where $\Delta p_H p_L^m > p_H \Delta p_L$ and $\Delta p_L p_H^m > p_L \Delta p_H$, which includes the case $\mathbf{p} = \bar{\mathbf{p}}$. In this case Expression (19) implies that $P_S^1 = c(\frac{p_H^m}{\Delta p_H} + \frac{p_L^m}{\Delta p_L} - \frac{2p_H^m p_L^m}{p_H^m p_L^m - p_H p_L})$. Checking the first and second order conditions (after substituting for p_H^m and p_L^m) it is easy to show that $\mathbf{p} = \bar{\mathbf{p}}$ is a local maximum within the parameter range.

Second, consider the parameter range $\Delta p_H p_L^m \leq p_H \Delta p_L$. Expression (19) implies that $P_S^1 = c\frac{p_L^m}{\Delta p_L}$. The directional derivative towards $\bar{\mathbf{p}}$,

$$\nabla_{\mathbf{p}} P_S^1 \cdot (\bar{\mathbf{p}} - \mathbf{p}) = c\frac{p_H \Delta p_L - \Delta p_H p_L}{2\Delta p_L^2}.$$

This expression is positive in the parameter range we consider because $p_H \Delta p_L \geq \Delta p_H p_L^m > \Delta p_H p_L$. Since the parameter range $\Delta p_H p_L^m \leq p_H \Delta p_L$ does not include $\mathbf{p} = \bar{\mathbf{p}}$ the solution to the maximization program (20–22) cannot be in the interior of the parameter range. Analogous arguments apply to the third parameter range $\Delta p_L p_H^m \leq p_L \Delta p_H$.

Because P_S^1 is continuous, the three cases above imply that $\mathbf{p} = \bar{\mathbf{p}}$ is the solution to the maximization program (20–22). □

B.3. Lemma 6

Proof. From the main text it follows that designating an i-unit as an entry point, changes outside investors' payoff in case that i-unit suffers a shock. Since outside investors break even in expectation, their change in expected payoff at $t = 0$ corresponds to the change in the bank's pledgeable income. Hence, the payoffs we derive in the main text and the probability that an i-unit suffers a shock q_i imply that the effect of designating an i-unit as an entry point on the bank's pledgeable income is

$$q_i(\max\{P_i^1 - 1, 0\} + P_j^1 - (P_G^1 - 1)).$$

Substituting for $P_G^1 \equiv P_i^1 + P_j^1 + P_S^1$ and some algebra allows us to rewrite the above expression as

$$q_i(\max\{1 - P_i^1, 0\} - P_S^1). \tag{23}$$

Since $P_S^1 > 1$, it follows that the change in pledgeable income (23) is positive if and only if $P_i^1 + P_S^1 \leq 1$.

From Lemma 4 we know that the pledgeable income of a banking group that does not specify any i-unit as an entry point is given by $P_G^0(2)$. Adding the effects of designating different i-units as entry point from Expression (23) for the different possible sets of additional entry points $\mathbf{E} \in \{\{L\}, \{H\}, \{L, H\}\}$ yields the pledgeable income (9). $\square$

B.4. Corollary 5

Proof. Expression 18 implies that τ^* satisfies Condition (10) if and only if

$$c \leq \bar{c} \equiv \min_{i \in \{H,L\}} R_i \begin{cases} \Delta p_H p_L^m & \Delta p_H p_L^m \leq p_H \Delta p_L \\ \Delta p_L p_H^m & \Delta p_L p_H^m \leq p_L \Delta p_H \\ \frac{1}{2}(p_H^m p_L^m - p_H p_L) & \text{otherwise.} \end{cases}$$

$\square$

B.5. Proposition 4

Proof. Comparing Expressions (11) and (12) shows that

$$\begin{aligned} &\max\{2 - (P_G^1 - s_H), 2 - P_H^1\} < \max\{2 - (P_G^1 - s_H), 2 - (P_G^1 - s_L)\} \\ &\qquad \Leftrightarrow \max\{2 - (P_G^1 - s_H), 2 - P_H^1\} < 2 - (P_G^1 - s_L) \\ &\qquad\qquad \Leftrightarrow P_L^1 + P_S^1 < s_L \wedge s_H < s_L. \end{aligned}$$

The remainder of the proof follows from the main text. $\square$

B.6. Lemma 8

Proof. First, consider the case of a bank that reinvests when bankers claim it suffered a shock ($\rho = i$). Truth telling requires that Condition (13) is satisfied. To ensure monitoring on the equilibrium path, the payments $\tau(0)$ and $\tau(i)$ must both satisfy the monitoring IC-constraint (1): $p_i^m \tau - c \geq p_i \tau$. Combining the monitoring IC constraint with the truth-telling constraint (13), the bankers' payoffs are minimized when $\tau(i) = \tau^i \equiv c/\Delta p_i$ and $\tau(0) = \tau^i + b/p_i^m$.

Second, consider a bank that chooses not to reinvest when the bankers claim it suffered a shock ($\rho = 0$). When no shock occurs, bankers will report truthfully if and only if $p_i^m \tau(0) \geq p_i^m \tau(i)$. If a shock occurs bankers' payoffs are zero, independently of the message. In addition, monitoring on the equilibrium path requires that $\tau(0)$ satisfies the monitoring IC-constraint (1). It follows that $\tau(0) = \tau^i$ and $\tau(i) \in [0, \tau^i]$ minimize bankers' expected payment subject to the relevant IC constraints.

Based on these compensation contracts and reinvestment policies, we obtain the following $t = 0$ pledgeable income

$$P_i^M(\rho) = \begin{cases} P_i^1 - (1-q_i)b - q_i & \rho = i \\ (1-q_i)P_i^1 & \rho = 0. \end{cases}$$

Comparing $P_i^M(\rho)$ above and $P_i^0(\rho)$ from our main model yields the Lemma. $\square$

B.7. Lemma 9

Proof. We consider the different reinvestment policies of the banking group in turn.

Case 1: $\rho = 2$. A banking group that reinvests into any unit when either of them suffers a shock obtains funds whenever bankers claim that a unit suffers a shock. As before, bankers must have monitoring incentives on the equilibrium path. Since both units will always be performing, this requires that the incentive contract $T_G(\mu) \equiv (\tau_L(\mu), \tau_H(\mu), \tau_2(\mu))$ satisfies the monitoring IC-constraints for two units (IC:L,IC:H,IC:0) for all μ.

Let us now consider in turn the three possible shock realizations. Bankers have an incentive to truthfully report the absence of a shock rather than to falsely claim the occurrence of a shock and misappropriate the funds they would obtain from outside investors if and only if

$$\begin{aligned} &p_H^m p_L^m \tau_2(0) + p_H^m(1-p_L^m)\tau_H(0) + (1-p_H^m)p_L^m\tau_L(0) \\ &\qquad \geq p_H^m p_L^m \tau_2(i) + p_H^m(1-p_L^m)\tau_H(i) + (1-p_H^m)p_L^m\tau_L(i) + b \ \forall i \in \{H, L\}. \quad (24) \end{aligned}$$

Since outside investors will provide funds for reinvestment into either unit, bankers only have an incentive to truthfully report the identity of either unit when it suffers a shock, respectively, if the identity of the unit does not affect their expected payoff:

$$\begin{aligned} &p_H^m p_L^m \tau_2(L) + p_H^m(1-p_L^m)\tau_H(L) + (1-p_H^m)p_L^m\tau_L(L) \\ &\qquad = p_H^m p_L^m \tau_2(H) + p_H^m(1-p_L^m)\tau_H(H) + (1-p_H^m)p_L^m\tau_L(H). \quad (25) \end{aligned}$$

As we discuss below the IC-constraints for truthfully reporting that a shock occurs (to either unit) will not be binding.

Let us now solve for the contract that minimizes bankers' payments. The IC-constraint (25) and Proposition 1 imply that $T_G(L) = T_G(H) = (0, 0, \tau_2^*)$ minimizes bankers' payoff when the bank suffers a shock. In the absence of a shock, bankers' payoffs are minimized when, in addition, the IC-constraints (24) are binding.[36] This can be achieved by setting

$$T_G(0) = (0, 0, \tau_2^* + \frac{b}{p_H^m p_L^m})$$

which obviously satisfies the monitoring IC-constraint. Finally, note that bankers have an incentive to truthfully report that a shock has occurred because their payoff, in the absence of reinvestment, would be zero.

Case 2: $\rho = H$. A banking group that reinvests when its H-unit suffers a shock but not when its L-unit suffers a shock only receives funding when bankers claims that the H-unit suffers a shock. As before bankers must have monitoring incentives on the equilibrium path. Since both units will be performing if no shock occurs or the H-unit suffers a shock, the incentive contracts $T_G(0)$ and $T_G(H)$ must satisfy the monitoring IC-constraints for two units (IC:L,IC:H,IC:0). Since the L-unit becomes non performing when it suffers a shock the incentive contract $T_G(L)$ must include a payoff for success of the H-unit $\tau_H(L)$ that satisfies the single-unit monitoring IC-constraint (1).

Let us consider the three possible shock realizations in turn. In the absence of a shock, bankers have an incentive to truthfully report the absence of a shock, rather than claiming that the H-unit suffered a shock if and only if

$$\begin{aligned} &p_H^m p_L^m \tau_2(0) + p_H^m(1 - p_L^m)\tau_H(0) + (1 - p_H^m)p_L^m \tau_L(0) \\ &\geq p_H^m p_L^m \tau_2(H) + p_H^m(1 - p_L^m)\tau_H(H) + (1 - p_H^m)p_L^m \tau_L(H) + b. \end{aligned} \tag{26}$$

The IC constraint for bankers not to claim that the L-unit suffered a shock, depends on the monitoring incentives $T_G(L)$ provides off the equilibrium path when both units operate. We will show below that this IC constraint is not binding.

If the L-unit suffers a shock, the following two IC-constraints ensure bankers' truthful reporting, in which case the bank obtains no funds for reinvestment, rather than claiming (i) the H-unit suffered a shock, in which case the bank receives funds that can be reinvested into the L-unit[37] or (ii) no unit suffered a shock, in which case the bank

[36]Both IC constraints will bind at the same time due to the IC-constraint (25).

[37]This yields Expression (14) in the text above, which we reproduce below for convenience.

obtains no funds for reinvestment, respectively:

$$\begin{aligned}
&p_H^m \tau_H(L) - c \\
&\geq p_H^m p_L^m \tau_2(H) + p_H^m (1 - p_L^m) \tau_H(H) + (1 - p_H^m) p_L^m \tau_L(H) - 2c && (27) \\
&\geq \max\{p_H^m \tau_H(0) - c, p_H \tau_H(0)\} && (28)
\end{aligned}$$

where the maximum operator accounts for the fact that monitoring may not occur off the equilibrium path.

If the H-unit suffers a shock, truthful reporting occurs when the following two IC-constraints hold:

$$\begin{aligned}
&p_H^m p_L^m \tau_2(H) + p_H^m (1 - p_L^m) \tau_H(H) + (1 - p_H^m) p_L^m \tau_L(H) - 2c \\
&\geq \max\{p_L^m \tau_L(L) - c, p_L \tau_L(L)\} && (29) \\
&\geq \max\{p_L^m \tau_L(0) - c, p_L \tau_L(0)\}. && (30)
\end{aligned}$$

Again the the maximum operators account for the fact that monitoring may not occur off the equilibrium path.

Let us now solve for the contract that minimizes bankers' payments. In case the H-unit receives a shock, it follows from Proposition 1 that setting $T_G(H) = (0, 0, \tau_2^*)$ minimizes bankers' payoffs. Bankers' payoffs from reporting that the L-unit suffered a shock are minimized when the IC-constraint (27) is binding, which can be achieved by setting

$$T_G(L) = (0, p_L^m \tau_2^* - c/p_H^m, 0).$$

Note that in the absence of a shock, $T_G(H)$ yields higher off-the-equilibrium-path payoffs for bankers than $T_G(L)$. As a result, bankers' payoffs from reporting that no shock occurs are minimized when the IC-constraint (26) is binding. The IC-constraint not to report that the L-unit has suffered a shock will not be binding. Setting

$$T_G(0) = (0, 0, \tau_2^* + \frac{b}{p_H^m p_L^m})$$

ensures that the IC-constraint (24) is binding for $\mu = H$. It is easy to check that $T_G(L)$ and $T_G(0)$ satisfy the remaining IC-constraints for truthful reporting (27-30) and monitoring.

Case 3: $\rho = L$. This case is analogous to Case 2: $\rho = H$.

Case 4: $\rho = 0$. A banking group that never reinvests never receives additional funding.

Bankers' payoffs are minimized subject to the relevant monitoring IC-constraints when $T_G(0) = (0, 0, \tau_2^*)$, $T_G(L) = (0, \tau^H, 0)$, and $T_G(H) = (\tau^L, 0, 0)$. It is easy to check that these contracts also ensure truthful revelation of the shock state.

Pledgeable income. Based on the compensation contracts and reinvestment policies in the cases above, rearrangement of terms yields the following $t = 0$ pledgeable income

$$P_G^M(\rho) \equiv \begin{cases} P_G^1 - q - (1-q)b & \text{if } \rho = 2, \\ P_G^1 - q_H - q_L p_L R_L - (1-q)b & \text{if } \rho = H, \\ P_G^1 - q_L - q_H p_H R_H - (1-q)b & \text{if } \rho = L, \\ (1-q)P_G^1 + q_L P_H^1 + q_H P_L^1 & \text{if } \rho = 0. \end{cases}$$

Comparing $P_G^M(\rho)$ above and $P_G^0(\rho)$ from our main model yields the expression for $P_G^M(\rho)$ we report in the lemma.

Finally, substitution and algebra show that

$$P_G^M(2) > P_G^M(H) \Leftrightarrow P_G^1 - q - (1-q)b > P_G^1 - q_H - q_L p_L R_L - (1-q)b \Leftrightarrow p_L R_L > 1.$$

This condition must hold true because reinvestment creates positive NPV. An analogous arguments yields $P_G^M(2) > P_G^M(L)$. We thus obtain the second part of the Lemma. □

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