

# Resolution Design and Investment in Banking Groups

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## Abstract

We study how resolution regimes affect investment in banking groups with subsidiaries of varying financial strength. Centralized regimes that preserve the group's structure enable ex post support for weaker units but may constrain ex ante investment. Decentralized regimes that resolve units separately may enhance ex ante investment but limit risk-sharing ex post. The relative efficiency of each approach depends on the group's risk profile and profitability. Allowing both regimes to co-exist improves efficiency relative to imposing a uniform regime across all groups. However, a decentralized regime may not be credible if the regulator cannot commit to limit ex post risk-sharing.

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# I. Introduction

The financial crisis of 2007-08 revealed the significant costs associated with large bank failures, as well as the limitations of traditional bankruptcy procedures in addressing the risks posed by complex banking groups (Freixas, 2010; Lee, 2014). In response, policymakers in major jurisdictions introduced new resolution frameworks, including Title II of the U.S. Dodd-Frank Act and the EU’s Bank Recovery and Resolution Directive, to facilitate the orderly restructuring of failing financial institutions.

These new frameworks require systemically important financial institutions to develop, in coordination with regulators, resolution plans (commonly referred to as “living wills”) to enable a speedier and more efficient resolution process. Two main approaches have emerged: one that centralizes resolution at the group level, and another that permits separate resolution of individual legal entities within a banking group. These two approaches differ in how losses are allocated across different stakeholders and the extent to which financial resources can be transferred across legal entities if a banking group enters resolution.

Many large banking groups – including all U.S.-based Global Systemically Important Banks (G-SIBs) – have opted for centralized resolution strategies. While U.S. authorities affirm that no particular resolution plan is mandated (Federal Reserve and FDIC, 2019), they appear to favor a centralized approach, arguing that it can mitigate systemic risk and strengthen the resilience of subsidiaries during financial distress.<sup>1</sup> In contrast, several major European banking groups – including HSBC, Santander, and BBVA – have implemented more decentralized resolution plans. These are often justified as mechanisms to contain financial distress within individual subsidiaries and to support banking groups’ “long-term strategic

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<sup>1</sup>For example, Lee (2015) notes that FDIC staff, for instance, see the [centralized] 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.

orientation”, which may refer to an enhanced ability to raise funding and expand lending (Pardo, Mirat and Santillana, 2014).

This paper shows that there exists a trade-off between the efficient resolution of banking groups and their ability to finance productive investments in the real economy. This trade-off arises when outside investors cannot fully capture the present value of banks’ investments due, for example, to agency problems between bank insiders and outside investors (Holmström and Tirole, 1998). Centralized resolution strategies facilitate reinvestment when individual banking units suffer negative liquidity shocks by preserving banking groups’ corporate structure and facilitating transfers across units. However, this loss mutualization may inhibit banking groups’ ability to raise financing and thereby restrain productive investments. Decentralized resolution strategies, in contrast, lower investors’ risk of being bailed-in to rescue weaker units, which increases banking groups’ financing capacity. Limiting risk-sharing, however, comes at the cost of closing weaker units even when their continuation is preferred to liquidation from a present value perspective. Our results show that the efficient choice between a centralized and decentralized resolution strategy critically depends on banking groups’ risk and return characteristics.

We consider a three-date model of a banking group with two asymmetric banking units. Banking units do not have internal funds, and each unit must raise one unit of external funds at date 0 to originate risky loans that mature at date 2. Loans deliver strictly positive net present value only if bankers engage in costly and unobservable monitoring. Because bankers must receive agency rents to monitor, only a portion of loan cash flows can be pledged to outside investors. This in turn limits the external financing capacity of each unit relative to the present value of its loan portfolio.

We distinguish between a “strong” unit with relatively high ex ante financing capacity

and a “weak” unit with relatively low ex ante financing capacity. Joining the two units together as part of a banking group allows to transfer financing capacity from the strong to the weak unit.<sup>2</sup> These financing synergies allow the weak unit to operate as part of a banking group, even when it is not able to operate as a standalone unit. Centralizing decision-making at the group level also creates “incentive synergies” that reduce the cost of providing bankers with monitoring incentives as in Laux (2001). These incentive synergies are a form of cost saving and increase the group’s total financing capacity.

At date 1, a banking unit may experience a liquidity shock that requires additional financing to continue operating. We focus on the case where liquidity shocks are small enough to make reinvestment in either unit efficient, but large enough to require the banking group to restructure its outstanding claims to cover the reinvestment cost. We assume that outside investors cannot commit to contracts that require reinvestments at date 1 that are ex post suboptimal from their perspective. This limited commitment friction limits banking groups’ ability to insure themselves against future liquidity shocks. If a unit suffers a shock and cannot continue operating, resolution ensues, which gives a regulator the authority to restructure the banking group’s financial contracts.<sup>3</sup>

As a benchmark against which to compare different resolution regimes, we first derive the constrained efficient allocation given bankers’ unobservable monitoring decisions. We show that it may sometimes be ex ante optimal to commit not to reinvest in the weak unit if it suffers a shock, even though reinvestment is always ex post efficient. Shutting down the weak unit is costly because it destroys the incentive synergies from operating both units together

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<sup>2</sup>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).

<sup>3</sup>According to the EU’s Single Resolution Board (2024): “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 [...] and that normal insolvency proceedings would cause financial instability while having an impact on the public interest.”

within a banking group. At the same time, continuing the weak unit may require transferring financing capacity from the strong unit. If the expected transfer from the strong unit is large enough, financing the operation of both units at date 0 requires the weak unit to be shut down following a shock. Otherwise, it is strictly optimal to reinvest in either of the two units following a shock.

We show that a resolution regime which, following a shock that prevents continued operation, assigns contracting decisions to a resolution authority implements the constrained efficient allocation.<sup>4</sup> We consider two resolution regimes: a centralized single-point-of-entry (SPOE) regime and a decentralized multiple-point-of-entry (MPOE) regime. Under SPOE resolution, resolution ensues at the holding company level, which is the sole “entry point” at which the regulator can intervene. In this case, all units are resolved jointly, losses are mutualized, and the banking group’s corporate structure is preserved after resolution. Conversely, under MPOE resolution, at least one of the banking group’s units is designated as an additional entry point at which the regulator can intervene. Resolution at the unit level breaks up the banking group: units are ring-fenced (preventing transfers across units) and are operated independently after resolution.

SPOE resolution is optimal whenever reinvesting in either unit following a shock is constrained efficient. However, if continuing the weak unit requires a sufficiently large transfer from the strong unit, SPOE resolution decreases the banking group’s financing capacity since investors rationally anticipate to be bailed-in if the weak unit suffers a shock. If this decrease in financing capacity is sufficiently large, SPOE resolution becomes inefficient by undermining the banking group’s operation at date 0.

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<sup>4</sup>We show in the Internet Appendix that private restructuring generally fails to implement the constrained efficient allocation. Outside investors will not voluntarily restructure their claims whenever their expected payoff from closing a shocked unit exceeds that from reinvestment. We assume that the regulator can enforce reinvestment even when it is ex post suboptimal for outside investors. This assumption captures the scope of what resolution policy can achieve relative to private restructuring.

If reinvesting in the weak unit is constrained efficient, then MPOE resolution is never strictly optimal. By resolving units separately, MPOE resolution destroys the incentive synergies of the banking group and may prevent the efficient continuation of a shocked unit. However, an MPOE regime that designates the weak unit as an entry point can implement the constrained-efficient allocation when operating the banking group at date 0 requires shutting down the weak unit after a shock. By blocking transfers from the rest of the group, MPOE resolution commits the regulator to preclude the continuation of the weaker unit unless it can self-finance reinvestment. By contrast, the regulator should never designate the strong unit as an entry point because reinvestment in the strong unit always increases the group's financing capacity.

We show that if the weak unit is designated as an entry point and shut down following a shock, outside investors' claims must be restructured in order to preserve bankers' incentives to monitor the strong unit. This implies that both the weak unit and the rest of the banking group must enter resolution when the weak unit is hit by a shock. The optimal incentive contract can be implemented using holding-company debt with appropriate write-down imposed in resolution. Alternatively, the regulator can require the ex ante issuance of contingent convertible securities whose payoff depends on whether the weak unit is shut down. Such securities avoid the need for ex post restructuring of claims, which may be beneficial when resolution involves direct costs.

MPOE resolution, if it is strictly optimal, requires the regulator to shut down the weak unit if it suffers a shock. This resolution strategy is ex post inefficient (and, hence, time-inconsistent) since reinvestment in the weak unit generates positive NPV. If the regulator seeks to maximize the banking group's NPV at any point in time and is unable to commit to a resolution policy, it will always prefer to continue the weak unit ex post by transferring

financing capacity from the strong unit. The regulator's inability to commit involves a cost since outside investors may refuse to finance the operation of both units at date 0 if they expect to be bailed-in if the weak unit suffers a shock.

We argue that coordination failures between different regulators in a cross-border context may increase the credibility of MPOE resolution. National regulators may find it easier to commit to MPOE resolution if some of the banking group's units are located abroad rather than within national borders. In particular, they may find it less costly to let foreign units fail compared to domestic ones. Such asymmetries help explain why MPOE resolution is more commonly observed in cross-border contexts. Anticipating regulators' time-consistency problem, banking groups may even expand strategically across borders to improve their access to funding and investment opportunities.

Our results speak directly to ongoing debates about the design and scope of centralized bank resolution within the EU. Although the Single Resolution Board (SRB) already acts as the central resolution authority for significant banks in the euro area, discussions continue over the merits and limitations of further centralization. Proponents, including the European Commission and the European Central Bank, highlight the ability of the SRB to enable faster and more coordinated responses when cross-border banks fail (Single Resolution Board, 2024). Our results show that there may be costs to centralizing resolution processes in some circumstances if regulators cannot commit to ring fence banking groups' weaker subsidiaries.

We derive a number of empirical implications from our model. First, we show that MPOE resolution is optimal for banking groups with sufficiently heterogeneous banking units. Second, we show that banking groups subject to MPOE resolution are more likely to finance risky units with large expected financing deficits, and less likely to curtail investment to such units when bank profitability decreases compared to banking groups subject to SPOE. Lastly,

we show that only weak units should be designated as entry points under MPOE. If strong units suffer a shock, resolution should instead ensue at the holding company level in order to preserve the banking group's corporate structure and the associated incentive synergies. This result rationalizes why some European banking groups like BBVA prefer a "hybrid" resolution approach, using a SPOE scheme for stronger subsidiaries located in Europe and a MPOE scheme for weaker subsidiaries located in third countries (Pardo et al., 2014).

**Related Literature.** Our paper relates to the literature on bank resolution, including papers that focus on regulators' incentives to intervene (Boot and Thakor, 1993; Mailath and Mester, 1994; Freixas and Rochet, 2013; Morrison and White, 2013; Schilling, 2023; König, Mayer and Pothier, 2024). Others study the optimal design of bail-in and bail-out policies (Gorton and Huang, 2004; Diamond and Rajan, 2005; Farhi and Tirole, 2012; Bianchi, 2016; Keister, 2016; Dávila and Walther, 2020; Keister and Mitkov, 2023; Segura and Suarez, 2023). While several articles have explored the supervision of multiunit banks (Calzolari and Lóránth, 2011; Calzolari, Colliard and Lóránth, 2019; Lóránth, Segura and Zeng, 2022), the literature on the resolution of multiunit banks is more limited.

Despite the intense policy debate on the design of resolution frameworks and the merits of SPOE versus MPOE resolution, the academic literature on the topic is scant. A notable exemption is Bolton and Oehmke (2019), who analyze resolution regimes in a cross-border context.<sup>5</sup> Contrary to our paper, they do not study how resolution regimes affect banking groups' financing capacity and investment decisions. Instead, they focus on coordination frictions among national regulators that impede the implementation of the efficient resolution strategy. In their model, SPOE resolution is always efficient because it provides diversification benefits and preserves financing synergies. However, national

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<sup>5</sup>See also Segura and Vicente (2026) for a model of bank resolution in an asymmetric banking union.

regulators may be unable to commit to SPOE resolution in a cross-border setting because doing so involves transfers across jurisdictions.<sup>6</sup> Faia and Weder di Mauro (2016) similarly argue that the most efficient regime is SPOE resolution if there is coordination among national regulators.

Our paper identifies a novel trade-off that is not specific to cross-border entities. In contrast to the papers mentioned above, we show that MPOE resolution may be more efficient than SPOE resolution if banking groups face agency frictions that limit their financing capacity. As such, our model allows to analyze the optimal selection of entry points under MPOE resolution, an issue which previous papers do not address. Contrary to Bolton and Oehmke (2019), we find that regulators' lack of commitment may impede the efficient implementation of MPOE resolution but that SPOE resolution is always time consistent. In this regard, our paper contributes to the broader literature studying the time-consistency problems associated with bank resolution policy (Walther and White, 2019; Martynova, Perotti and Suarez, 2022; Philippon and Wang, 2023).

## II. Model

We consider a three-date model with a banking group consisting of three legal entities: a holding company and two wholly-owned banking units, indexed by  $i \in \{H, L\}$ . Operational and contracting decisions are made by a centralized team of bankers, unless the group enters resolution, in which case contracting decisions are transferred to a resolution authority. We abstract from internal agency frictions within the group. The banking group does not possess any internal funds and must raise financing from outside investors to operate. All agents are

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<sup>6</sup>In an extension, Bolton and Oehmke (2019) show that SPOE, by transferring cash flows to subsidiaries operating in other jurisdictions, may dampen bankers' effort incentives. Their model provides another example of how the anticipation of resolution-induced transfers affects ex ante outcomes, albeit through a channel that is distinct from the one emphasized in our paper.

risk-neutral and protected by limited liability. There is no time discounting, and the risk-free rate is normalized to zero.

## A. Banking units

Each banking unit requires one unit of funds at date 0 to make loans that return a final payoff at date 2. We assume that the payoffs of the two banking units are independent. Units may be ex ante asymmetric, reflecting access to different pools of loans that differ in their payoff and risk characteristics.

A banking unit  $i \in \{H, L\}$  generates a positive payoff  $R_i$  with probability  $p_i$  and 0 with probability  $1 - p_i$ . Bankers can increase the probability of a positive return of unit  $i$  from  $p_i$  to  $p_i^m = p_i + \Delta p_i$  by monitoring the unit's loans between date 1 and date 2. Monitoring is not observable and involves a non-pecuniary cost  $c$  per monitored unit.

Banking units are subject to exogenous liquidity shocks at date 1. If a unit suffers a shock, it requires one additional unit of financing to continue operating.<sup>7</sup> If a shocked unit fails to raise the additional funds, its loans are liquidated for a value of 0 and monitoring becomes irrelevant. If a shocked unit succeeds in raising the additional funds, the payoff structure of its loans is the same as in the absence of the shock.

The probability that unit  $i$  suffers a liquidity shock is  $q_i$ . We assume that only one unit may suffer a shock at date 1, implying that the probability that one of the two units suffers a shock equals  $q = q_H + q_L$ .<sup>8</sup> We call a shocked unit that does not reinvest “non-performing.” A unit that does not suffer a shock, or suffers a shock and reinvests, is called “performing.”

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<sup>7</sup>The liquidity shock can be interpreted as a shock to the unit's borrowers who require additional funds to complete their investment projects.

<sup>8</sup>Our shock structure nests the one used by Bolton and Oehmke (2019). In their model, one of the two units always suffers a shock ( $q = 1$ ) and the two units are assumed to be symmetric ( $q_H = q_L = 1/2$ ). The assumption that only one of the two units may suffer a shock at date 1 is without loss of generality. As we show in Section V, our results only depend on how the banking group's financing capacity compares to its expected investment need.

## B. Assumptions

We impose the following assumptions to ensure that the decision of operating either of the two units, as well as continuing a unit that suffers a shock, is efficient if and only if bankers monitor the unit.

**Assumption 1.** *Each unit generates positive NPV at date 0 if it is monitored, even if there is no reinvestment after a shock at date 1:*

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

Assumption 1 implies that continuing a unit if it suffers a shock at date 1 generates positive NPV if bankers monitor the unit:  $p_i^m R_i - c > 1$ .<sup>9</sup> These two conditions in turn imply that a monitored unit generates positive NPV at date 0 if there is reinvestment after a shock:  $p_i^m R_i - c > 1 + q_i$ . Since both units generate positive NPV regardless of whether they continue after a shock, it is efficient to operate both units at date 0 if they are monitored.

**Assumption 2.** *Continuing either unit following a shock at date 1 generates negative NPV if it is not monitored:*

$$(2) \quad p_i R_i < 1, \quad \forall i \in \{H, L\}.$$

Assumption 2 implies that operating either unit at date 0 is never efficient if it is not monitored. The reason is that, at date 0, the possibility that the unit suffers a shock implies either higher expected costs (if there is reinvestment) or lower expected return (if there is no reinvestment) compared to reinvestment at date 1.

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<sup>9</sup>The NPV from reinvestment at date 1 is higher than the NPV from investment at date 0 because the unit faces no liquidity shock after date 1.

## C. Financing

The capital market is competitive, and outside investors provide funds as long as they break even in expectation. We assume that outside investors cannot commit at date 0 to contracts requiring reinvestments at date 1 that are ex post suboptimal from their perspective. This limited commitment friction prevents banking units from using pre-arranged financing agreements (e.g., irrevocable lines of credit) to finance their operations.<sup>10</sup> We also assume that outside investors cannot force banking units to invest in liquid assets at date 0.<sup>11</sup> This assumption prevents banking units from self-insuring against liquidity shocks by hoarding liquid assets ex ante.

## D. Resolution policy

Resolution gives the regulator the authority to restructure the banking group's financial contracts and to shut down one or more of its units at date 1. If the regulator prefers to continue a unit, it imposes the minimum losses on outside investors to enable reinvestment at date 1. We abstract from any direct cost of resolution.

Contrary to private contracting, we assume that the regulator can enforce reinvestment at date 1 even when it is privately suboptimal for outside investors.<sup>12</sup> Resolution therefore allows the regulator to implement contracting outcomes that private parties cannot achieve outside resolution. This assumption reflects a central feature of modern bank resolution regimes. Statutory bail-in and transfer powers allow authorities to impose losses and enforce continuation outcomes that cannot be achieved through voluntary private restructuring, due to

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<sup>10</sup>This assumption does not prevent banking units from diluting outside investors' claims at date 1, but does require that any such private restructuring be ex post optimal for outside investors.

<sup>11</sup>This assumption may reflect the fact that banks are opaque, keeping detailed information about the composition of their assets secret (Dang, Gorton, Holmström and Ordóñez, 2017).

<sup>12</sup>Since the resolution policy is common knowledge, any expected losses imposed on outside investors ex post are necessarily priced in ex ante.

coordination problems and/or creditor veto rights.<sup>13</sup> These features are illustrated by the 2017 Banco Popular resolution, where equity, AT1 holders, and subordinated creditors were written down overnight to enable an immediate going-concern transfer without creditor consent, and by the 2023 Credit Suisse case, where losses were imposed on AT1 holders to facilitate an immediate merger despite the absence of unanimous investor agreement.<sup>14</sup> We abstract from these legal and institutional details and impose this assumption to capture the expanded set of allocations that resolution policy can implement relative to private restructuring.

## E. Resolution regimes

A resolution regime specifies one or more “entry points”, that is, legal entities at which the regulator is empowered to initiate restructuring. Resolution ensues at an entry point if that entity (or one of its subsidiaries if the entry point is the holding company) suffers a shock at date 1 and is unable to continue operating outside resolution. Resolution regimes and entry points are chosen ex ante at date 0 (i.e., before units suffer a shock), conditional on the units’ observable characteristics.<sup>15</sup>

We compare, essentially, two different resolution regimes: single point of entry (SPOE) and multiple point of entry (MPOE) regimes. A SPOE regime is one where the holding company is designated as the sole entry point. In this case, resolution is executed at the holding company level. All units are resolved jointly, losses are mutualized across units, and the banking group’s corporate structure does not change after resolution. In contrast, a

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<sup>13</sup>An analog outside banking is the U.S. Chapter 11 reorganization, where courts can confirm reorganization plans that impose continuation on dissenting creditor classes through cramdown provisions.

<sup>14</sup>See Single Resolution Board (2017), *Banco Popular Resolution*, available at <https://www.srb.europa.eu/en/content/banco-popular>, and Swiss Financial Market Supervisory Authority (FINMA), *Information on the basis for writing down AT1 capital instruments*, available at <https://www.finma.ch/en/news/2023/03/20230323-mm-at1-kapitalinstrumente/>.

<sup>15</sup>Since bankers’ monitoring decision only takes place after the realization of the liquidity shock, it does not matter whether units’ “type” (strong or weak) is revealed before or after the realization of the shock as long as the regulator can commit to condition its resolution policy on the observed type.

MPOE regime is one in which, in addition to the holding company, one or more of its units are designated as separate entry points. Resolution at the unit level breaks up the banking group. Units are ring-fenced, which prevents transfers across units, and are operated independently after resolution. If the resolution of one unit undermines the operational efficiency (monitoring incentives) of the other unit, the regulator retains the authority to restructure the other unit.

## F. Regulatory objectives

The objective of the regulator is to maximize the net present value (NPV) of the banking group at any point in time.<sup>16</sup> In the main part of the paper, we assume that the regulator can commit to a resolution regime at date 0. Continuing a unit following a shock at date 1 always generates positive NPV if bankers monitor (Assumption 1). However, continuation may not be ex ante optimal if reinvestment prevents the operation of the banking group at date 0. As a result, the regulator may face a time-consistency problem if it cannot commit to the resolution regime. We discuss what happens if the regulator cannot commit to a resolution regime in Section V.

Figure 1 summarizes the sequence of events of the model.

[Figure 1 here]

## III. Optimal Contracting Benchmark

As a benchmark, we first derive the constrained efficient allocation. We assume that the returns at date 2, as well as the continuation decision of each unit at date 1, are

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<sup>16</sup>Since the banker is the residual claimant, the objectives of the regulator and the banker are aligned in our model. Thus, the banker would choose the same resolution regime as the regulator.

contractible.<sup>17</sup> The bankers' monitoring decisions, however, are unobservable and hence non-contractible. The optimal contracting benchmark maximizes the banking group's NPV subject to bankers' moral hazard problem.

The optimal contract has two components. First, it specifies the date 2 allocation of cash flows between bankers and outside investors. Second, it determines the banking group's operation decision at date 0 and its reinvestment policy at date 1. Assumption 1 and 2 imply that we can restrict attention to contracts that induce monitoring of all performing units. The incentive payments required for monitoring pin down the maximum payment that can be credibly promised to outside investors; that is, the banking group's *pledgeable income*.

The optimal contract must satisfy outside investors' participation constraint, which requires them to break even in expectation. When deriving the optimal contract, we allow for contracts that specify reinvestments at date 1 that are ex post suboptimal for outside investors. In the Internet Appendix, we discuss how outside investors' limited commitment may prevent implementation of the optimal contract, motivating the role of resolution policy in our model.

## A. Incentive contract

We first derive bankers optimal incentive payments for standalone units and then for units operating within a banking group under centralized decision-making.

If unit  $i \in \{H, L\}$  is operated independently and is performing at date 1, the optimal incentive contract given bankers' limited liability specifies a payment  $\tau_i \geq 0$  to the bankers in case unit  $i$  generates a positive return at date 2 and zero otherwise. The incentive compatibility

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<sup>17</sup>We assume that the liquidity shock is observable. As in Holmström and Tirole (1998), our results are unaffected if only the bank observes the shock, provided it has no alternative use of funds at date 1.

constraint for bankers to monitor unit  $i$  is

$$(3) \quad p_i^m \tau_i - c \geq p_i \tau_i, \quad \forall i \in \{H, L\}.$$

The lowest payment that ensures that bankers monitor unit  $i$  is thus given by

$$(4) \quad \tau_i \equiv \frac{c}{\Delta p_i}, \quad \forall i \in \{H, L\}$$

and unit  $i$ 's pledgeable income at date 1 equals

$$(5) \quad \mathcal{P}_i^1 \equiv p_i^m (R_i - \tau_i), \quad \forall i \in \{H, L\}.$$

We assume that the date 1 pledgeable income of the  $H$ -unit is weakly higher than that of the  $L$ -unit:  $\mathcal{P}_H^1 \geq \mathcal{P}_L^1$ . This assumption, which is without loss of generality, allows us to distinguish between the  $H$ - and  $L$ -unit based on their date 1 pledgeable income.

If both units operate within a banking group and are performing at date 1, the optimal incentive contract  $T_G \equiv (\tau_L, \tau_H, \tau_2)$  must specify three different payments to bankers depending on whether only the  $L$ -unit, only the  $H$ -unit, or both units generate a positive return at date 2. We denote the banking group's date 1 pledgeable income by  $\mathcal{P}_G^1$ .<sup>18</sup>

**Proposition 1.** *The optimal incentive contract  $T_G^*$  for two performing units within a banking group satisfies  $\tau_2^* > 0$  and  $\tau_H^* = \tau_L^* = 0$ . The banking group's date 1 pledgeable income is strictly larger than the sum of the pledgeable incomes of two individual performing units:*

$$(6) \quad \mathcal{P}_G^1 > \mathcal{P}_H^1 + \mathcal{P}_L^1.$$

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<sup>18</sup>See the Appendix for an explicit derivation of  $\mathcal{P}_G^1$ .

We call the additional date 1 pledgeable income from operating the units within a group,

$\mathcal{P}_S^1 \equiv \mathcal{P}_G^1 - \mathcal{P}_H^1 - \mathcal{P}_L^1$ , the group's "incentive synergies".

Proposition 1, which generalizes the main result of Laux (2001) to the case of asymmetric projects, shows that total pledgeable income at date 1 is maximized if both units operate within a banking group.<sup>19</sup> Centralized decision making relaxes bankers' limited liability constraint by allowing agency rents to be cross-pledged across units, which lowers the incentive payments required to induce monitoring of both units. These cost savings generate additional pledgeable income, which we refer to as "incentive synergies."

Under the optimal contract  $T_G^*$ , bankers are paid only when both units succeed at date 2 ( $\tau_2^*$ ) if both units are performing. If one unit becomes non-performing at date 1, bankers' incentive pay depends solely on the success of the remaining unit and coincides with the standalone incentive payment,  $\tau_H$  or  $\tau_L$ .

## B. Operation and reinvestment decisions

We are interested in studying the resolution of multiunit banking groups. Thus, without loss of generality, we focus on cases where bankers choose to operate both units within a banking group at date 0. Joint operation is strictly more efficient than operating the units as standalone units whenever at least one unit cannot operate independently.<sup>20</sup>

A reinvestment policy for the banking group consists of a choice variable  $\rho \in \{2, H, L, 0\}$ , where  $\rho = 2$  denotes the case where the banking group reinvests in any unit that receives a shock,  $\rho = i \in \{H, L\}$  the case where the banking group reinvests if and only if unit  $i$  suffers a shock, and  $\rho = 0$  the case where the banking group does not reinvest in any unit that receives a shock.

<sup>19</sup>See Cerasi and Daltung (2000) for an application to banking.

<sup>20</sup>A unit cannot operate independently if the initial investment cost exceeds its date 0 pledgeable income.

If the reinvest policy stipulates continuing unit  $i$ , the expected cost of reinvesting one unit of funds in case of a shock (which occurs with probability  $q_i$ ) is  $q_i$ . In contrast, if the reinvestment policy stipulates closing down unit  $i$  if it suffers a shock, the unit becomes non-performing with probability  $q_i$ . The date 0 pledgeable income of the banking group, given the reinvestment policy  $\rho$ , is thus

$$(7) \quad \mathcal{P}_G^0(\rho) \equiv \begin{cases} \mathcal{P}_G^1 - q & \text{if } \rho = 2, \\ (1 - q_L)\mathcal{P}_G^1 + q_L\mathcal{P}_H^1 - q_H & \text{if } \rho = H, \\ (1 - q_H)\mathcal{P}_G^1 + q_H\mathcal{P}_L^1 - q_L & \text{if } \rho = L, \\ (1 - q)\mathcal{P}_G^1 + q_L\mathcal{P}_H^1 + q_H\mathcal{P}_L^1 & \text{if } \rho = 0 \end{cases}$$

The banking group can operate both units at date 0 if and only if outside investors' participation constraint is satisfied. This requires that the banking group's date 0 pledgeable income exceeds the initial investment cost,  $\mathcal{P}_G^0(\rho) \geq 2$ , for some reinvestment policy  $\rho$ . Notice that the banking group's date 1 pledgeable income is greater than its date 0 pledgeable regardless of the reinvestment policy because there are no liquidity shocks after date 1: that is,  $\mathcal{P}_G^1 > \mathcal{P}_G^0(\rho)$  for all  $\rho$ .

**Lemma 1.** *Reinvesting in unit  $i$  increases the banking group's date 0 pledgeable income if and only if unit  $i$ 's standalone pledgeable income at date 1 plus the investment synergies from operating both units together exceed the reinvestment cost:*

$$(8) \quad \mathcal{P}_G^0(2) > \mathcal{P}_G^0(j) \Leftrightarrow \mathcal{P}_G^0(i) > \mathcal{P}_G^0(0) \Leftrightarrow \mathcal{P}_i^1 + \mathcal{P}_S^1 \geq 1,$$

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

Lemma 1 implies that the banking group can always continue the  $H$ -unit after a shock at date 1. Since  $\mathcal{P}_H^1 \geq \mathcal{P}_L^1$ , condition (8) must hold for the  $H$ -unit if the group can operate both units at date 0. Otherwise, the group's date 1 (and hence date 0) pledgeable income would be insufficient to cover the initial investment cost. As a result, we can restrict attention to policies which reinvest in both units following a shock ( $\rho = 2$ ), or only reinvest if the  $H$ -unit suffers a shock ( $\rho = H$ ).

**Proposition 2.** *A banking group can operate both units at date 0 if and only if:*

$$(9) \quad \max\{\mathcal{P}_G^0(2), \mathcal{P}_G^0(H)\} \geq 2.$$

*The banking group always reinvests in the  $H$ -unit after a shock and withholds reinvestment from the  $L$ -unit if and only if  $\mathcal{P}_G^0(2) < 2 \leq \mathcal{P}_G^0(H)$ .*

[Figure 2 here]

Figure 2 illustrates Proposition 2. Because the group can transfer resources across units, both the date 0 operation decision and the date 1 reinvestment policy depend only on total pledgeable income. Since continuing the  $H$ -unit after a shock increases the banking group's date 0 pledgeable income, it is always optimal to reinvest in the  $H$ -unit.

Reinvesting in the  $L$ -unit, by contrast, may require a transfer from the  $H$ -unit when condition (8) fails, reducing the group's pledgeable income ( $\mathcal{P}_G^0(2) < \mathcal{P}_G^0(H)$ ). If this reduction is large enough such that  $\mathcal{P}_G^0(2) < 2$ , operating both units at date 0 requires withholding reinvestment from the  $L$ -unit following a shock. Otherwise, reinvestment in the  $L$ -unit is optimal, since continuation yields positive NPV if bankers monitor.<sup>21</sup>

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<sup>21</sup>The benchmark is closely related to the constrained efficient investment policy in Holmström and Tirole (1998), with the key difference that the banking group may continue operating even if one unit becomes non-performing at date 1.

## IV. Resolution

This section shows how a resolution regime that transfers contracting decisions to a resolution authority can implement the constrained efficient allocation. We show in the Internet Appendix that private restructuring generally fails to implement the constrained efficient due to outside investors' inability to commit to reinvestments at date 1 which are ex post suboptimal from their perspective. The regulator's ability to implement contracting outcomes that circumvent outside investors' limited commitment problem rationalizes the need for resolution policy in our model.

The resolution regime, which specifies how financial contracts can be restructured, determines the regulator's ability to raise additional financing in case a unit suffers a shock and cannot continue outside of resolution. As a consequence, the resolution regime affects both the set of feasible reinvestment decisions at date 1 and the banking group's operation decision at date 0. To simplify the exposition, we assume to begin that the incentive contracts  $T_G^*$  (for two performing units) and  $\tau_i$  (for a single performing unit) can be implemented both outside and within the resolution process. We show at the end of this section how simple debt securities can "replicate" these incentive contracts.

### A. SPOE resolution

A SPOE regime is one where the regulator specifies a single entry point at the holding company level. In this case, if one of the banking group's units suffers a shock, all entities are resolved jointly and losses are mutualized across units. The banking group's corporate structure does not change after resolution.

**Lemma 2.** *Under SPOE, the regulator finances reinvestment in any unit that suffers a shock at date 1. The date 0 pledgeable income of the banking group under SPOE is equal to  $\mathcal{P}_G^0(2)$ .*

The regulator prefers to continue all units at date 1 since a shocked unit generates positive NPV as long as bankers monitor (Assumption 1). To this end, the regulator restructures financial contracts to maximize the banking group's date 1 pledgeable income, imposing the minimum losses on outside investors to enable reinvestment while preserving bankers' monitoring incentives. Since the banking group's date 1 pledgeable income must exceed the reinvestment cost if the banking group can operate at date 0, the regulator can always issue new securities at date 1 under SPOE to finance reinvestment by imposing sufficiently large write-downs on outside investors' outstanding claims.

## B. MPOE resolution

A MPOE regime, contrary to a SPOE regime, allows the regulator to specify more than one of the banking group's legal entities as an entry point. In particular, the regulator can specify entry points at the individual unit level (the  $L$ -unit, the  $H$ -unit, or both individual units), in addition to the holding company level.

If unit  $i \in \{H, L\}$  suffers a shock and is not designated as an entry point, resolution proceeds at the holding company level. In this case, just like under the SPOE regime, the regulator will always finance reinvestment in the unit. In contrast, if unit  $i$  is designated as an entry point, resolution ensures at the individual unit level. In this case, the regulator breaks up the banking group. The shocked unit is ring-fenced from the other unit, implying that the regulator cannot transfer cash flows from the non-shocked unit to the shocked unit. Units operate independently if continued following the shock, which destroys the incentive synergies from operating the two units together. As a result, the regulator can only finance reinvestment in unit  $i$  when it is designated as an entry point if its standalone date 1 pledgeable income exceeds the reinvestment cost ( $\mathcal{P}_i^1 \geq 1$ ).

**Lemma 3.** *Designating unit  $i$  as an entry point increases the banking group's pledgeable income if only if  $\mathcal{P}_i^1 + \mathcal{P}_S^1 < 1$ . The date 0 pledgeable income of the banking group under a MPOE regime that designates the  $L$ -unit as an entry point is equal to  $\mathcal{P}_G^0(H)$ .*

Designating a unit with  $\mathcal{P}_i^1 \geq 1$  as an entry point does not affect the banking group's reinvestment policy compared to SPOE. The reason is that the unit can always cover the reinvestment cost if it suffers a shock. However, ring-fencing the unit destroys the incentive synergies, which reduces the banking group's pledgeable income and may jeopardize its ability to operate at date 0.<sup>22</sup> It follows that the regulator will never designate the  $H$ -unit as an entry point since its date 1 pledgeable income always exceeds the reinvestment cost if the banking group can operate both units at date 0 (Lemma 1).

Designating a unit with  $\mathcal{P}_i^1 < 1$  has two opposing effects on the banking group's date 0 pledgeable income. Separately resolving the unit destroys the incentive synergies,  $\mathcal{P}_S^1$ , but also avoids having to make a transfer from the non-shocked unit to cover the shocked unit's funding shortfall,  $1 - \mathcal{P}_i^1 > 0$ . The regulator will only designate the  $L$ -unit as an entry point if this transfer exceeds the foregone incentive synergies from separately resolving the unit: that is, if  $\mathcal{P}_L^1 + \mathcal{P}_S^1 < 1$ .

If  $\mathcal{P}_L^1 + \mathcal{P}_S^1 < 1$  and the  $L$ -unit is designated as an entry point, it must be shut down following a shock. In this case, the regulator must also restructure outside investors outstanding claims to ensure that bankers monitor the (non-shocked)  $H$ -unit. This requires that both the  $L$ -unit and the rest of the banking group enter resolution if the  $L$ -unit suffers a shock. The regulator then restructures bankers' date 0 incentive contract (which specified a positive payment  $\tau_2$  if and only if both units succeeds at date 2) such that bankers receive a positive payment  $\tau_H$  if and only if the  $H$ -unit succeeds at date 2 and zero otherwise.

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<sup>22</sup>Breaking up the banking group at date 1 and continuing both units independently may prevent it from operating at date 0 if the incentive synergies are sufficiently large.

## C. Efficient resolution regime

Assumption 1 implies that it is efficient to operate and reinvest in both units because both units generate NPV if they are monitored. Thus, the choice of resolution regime depends on how the resolution regime affects the banking group's date 0 pledgeable income since this determines the banking group's ability to raise the initial financing needed to operate both units at date 0.

**Proposition 3.** *The constrained efficient allocation can always be implemented by one of the two resolution regimes:*

- *The SPOE regime implements the constrained efficient allocation if and only if  $\mathcal{P}_G^0(2) \geq 2$ .*
- *The MPOE regime that designates the  $L$ -unit as an entry point implements the constrained efficient allocation if  $\mathcal{P}_G^0(2) < 2 \leq \mathcal{P}_G^0(H)$ .*

SPOE resolution ensures that the regulator will continue both units following a shock, which is ex post efficient. Hence, the SPOE regime implements the constrained efficient allocation whenever the banking group's date 0 pledgeable income exceeds the initial investment cost given continuation of both units. However, if continuing the  $L$ -unit requires a sufficiently large transfer from the  $H$ -unit such that  $\mathcal{P}_G^0(2) < 2$ , the SPOE regime fails to implement the constrained efficient allocation by preventing the banking group from efficiently operating both units at date 0.

MPOE resolution can implement the constrained efficient allocation when shutting down the  $L$ -unit following a shock increases the banking group's date 0 pledgeable income ( $\mathcal{P}_G^0(2) < \mathcal{P}_G^0(H)$ ). In this case, the  $L$ -unit cannot operate independently since  $\mathcal{P}_L^1 < 1$ , implying that designating the  $L$ -unit as an entry point allows the regulator to commit to shut

down the  $L$ -unit if it suffers a shock. At the same time, MPOE resolution allows reinvestment in the  $H$ -unit while preserving the banking group's incentive synergies as long as the  $H$ -unit is not designated as an entry point.

[Figure 3 here]

Figure 3 depicts how to implement the constrained efficient allocation. If  $2 \leq \mathcal{P}_G^0(H) \leq \mathcal{P}_G^0(2)$ , resolution is not needed because outside investors are willing to restructure their claims to allow efficient reinvestment in both units at date 1. However, if  $2 \leq \mathcal{P}_G^0(2) < \mathcal{P}_G^0(H)$ , SPOE resolution is essential since it allows the regulator to enforce reinvestment in the  $L$ -unit. In contrast, if  $\mathcal{P}_G^0(2) < 2 \leq \mathcal{P}_G^0(H)$ , operating both units at date 0 requires to free up pledgeable income by shutting down the  $L$ -unit at date 1 if it suffers a shock. As a result, the regulator must designate the  $L$ -unit as an entry point to implement the constrained efficient allocation. If outside investors prefer not to restructure the incentive contract if the  $L$ -unit is shut down (see the Internet Appendix), MPOE resolution is essential since it allows the regulator to restructure outside investors' outstanding claims to ensure that bankers monitor the  $H$ -unit if the  $L$ -unit is shut down.

## D. Implementing the incentive contract

So far, we have assumed that bankers' incentive contract can be implemented both outside and within resolution. We now show how debt securities together with appropriate write-downs can replicate the payoff structure of the optimal incentive contract.

**Proposition 4.** *The optimal incentive contract can be implemented using debt securities issued at the holding company level and appropriate write-downs if  $\tau_2^* \leq \min\{R_H, R_L\}$ .*

Suppose that the banking group issues debt securities at the holding company level at date 0 with a face value  $F_{G0} = R_H + R_L - \tau_2^*$  maturing at date 2. Bankers own the equity of

the holding company. If neither of the two units suffers a shock, the banking group reaches date 2 with this financing structure. This financing structure implements the optimal incentive contract  $T_G^*$  as long as

$$(10) \quad F_{G0} \geq \max\{R_H, R_L\}.$$

Substituting  $F_{G0}$  into condition (10) and solving for  $\tau_2^*$  yields  $\tau_2^* \leq \min\{R_H, R_L\}$ , implying that the value of bankers' equity is zero if just one unit succeeds at date 2 and  $\tau_2^*$  if both units succeed.<sup>23</sup>

If one of the units suffers a shock and it is constrained efficient to continue the unit, the regulator writes down some of the banking group's outstanding debt to free up pledgeable income for reinvestment at date 1. Consider a write-down  $\Delta$  of the outstanding debt  $F_{G0}$ . The write-down must be large enough so that the sum of the face value of the original debt after the write down ( $F_{G0} - \Delta$ ), the face value of new debt  $F_{G1}$ , and bankers' compensation  $\tau_2^*$  satisfy the following resource constraint:

$$(11) \quad F_{G0} - \Delta + F_{G1} + \tau_2^* \leq R_H + R_L.$$

The optimal write-down dilutes outside investors as little as possible to ensure reinvestment and monitoring of the continued units. Thus, condition (11) must hold with equality. Using the definition of  $F_{G0}$ , it follows that the optimal write-down satisfies  $\Delta^* = F_{G1}$ : that is, the write-down should be equal to the face value of new debt. This new financing structure

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<sup>23</sup>If this condition fails to hold, then debt securities issued at the holding company level fail to replicate the optimal incentive contract because bankers receive a positive payment even if only one unit succeeds at date 2. In this case, replicating the optimal incentive contract requires to issue debt securities at both the subsidiary and the holding company level.

implements the optimal incentive contract  $T_G^*$  as long as

$$(12) \quad (F_{G0} - \Delta^*) + F_{G1} \geq \max\{R_H, R_L\}$$

which is equivalent to condition (10).

If it is constrained-efficient to shut down the  $L$ -unit following a shock, the incentive contract must ensure that bankers still monitor the  $H$ -unit. To this end, the regulator needs to write-down the outstanding debt  $F_{G0}$  to  $F_H = R_H - \tau_H$  so that bankers receive a payment of  $\tau_H$  in case the  $H$ -unit succeeds and 0 otherwise. An alternative way to implement this resolution policy is to require the banking group to issue convertible securities at date 0 whose payoff depends on whether or not the  $L$ -unit is shut down at date 1. In particular, suppose that the banking group issues non-convertible debt with face value  $F_H = R_H - \tau_H$  at date 0, together with convertible debt with face value  $F_C = R_L - \tau_2^* + \tau_H$  that is fully written down in case the  $L$ -unit is shut down at date 1. This financing structure implements the incentive contract  $T_G^*$  if the  $L$ -unit does not suffer a shock and  $\tau_H$  otherwise.

## V. Discussion

### A. Which banks should be subject to MPOE?

Proposition 3 allows to derive comparative static results regarding the optimality of MPOE resolution. Two conditions must be satisfied in order for the MPOE regime to implement the constrained efficient allocation. First, the banking group should not be able to raise sufficient funds to operate both units at date 0 if the  $L$ -unit is continued following a

shock:  $\mathcal{P}_G^0(2) < 2$ . Rewriting this first inequality yields

$$(13) \quad \mathcal{P}_G^1 < 2 + q.$$

The left-hand side of condition (13) equals the banking group's total pledgeable income at date 1. The right-hand side equals its expected investment cost (recall that one of the two units suffers a shock with probability  $q = q_H + q_L$ , in which case the banking group must raise an additional unit of funds to continue the unit).<sup>24</sup>

Second, the banking group should be able to raise sufficient funds to operate both units at date 0 if the  $L$ -unit is shut down following a shock:  $\mathcal{P}_G^0(H) \geq 2$ . Rewriting this second inequality yields

$$(14) \quad q_L(1 - \mathcal{P}_L^1 - \mathcal{P}_S^1) \geq (2 + q) - \mathcal{P}_G^1.$$

The left-hand side of condition (14) equals the expected increase in the banking group's pledgeable income if the  $L$ -unit is shut down following a shock (which occurs with probability  $q_L$ ).<sup>25</sup> The right-hand side equals the banking group's expected funding shortfall if both units are continued following a shock.

**Corollary 1.** *The constrained efficient allocation can be implemented by the MPOE regime but not by the SPOE regime if and only if:*

- *the probability of a liquidity shock ( $q$ ) is sufficiently high, and the banking group's total pledgeable income ( $\mathcal{P}_G^1$ ) is sufficiently small; and, given  $q$  and  $\mathcal{P}_G^1$ ,*

<sup>24</sup>Allowing both units to suffer a liquidity shock does not alter the comparison between SPOE and MPOE since the ranking only depends on how the banking group's pledgeable income compares to its expected investment need. If both units may suffer a shock, the expected reinvestment cost equals  $q_H(1 - q_L) + q_L(1 - q_H) + 2q_Hq_L = q_H + q_L$ , so that condition (13) remains unchanged.

<sup>25</sup>If both units may suffer shock at date 1, the probability that the  $L$ -unit suffers a shock equals  $q_L(1 - q_H) + q_Hq_L = q_L$ , so that condition (14) remains unchanged.

- *the probability that the  $L$ -unit suffers a shock ( $q_L$ ) is sufficiently high, and the investment synergies ( $\mathcal{P}_S^1$ ) are small relative to the  $L$ -unit's funding shortfall.*

*If the two units are symmetric, the banking group's investment synergies are maximized, and the SPOE regime implements the constrained efficient allocation. A necessary condition for MPOE resolution is that the two units are asymmetric.*

Corollary 1 implies that the banking group's units must be sufficiently asymmetric for the regulator to prefer MPOE to SPOE resolution. Indeed, if the two units had the same pledgeable income ( $\mathcal{P}_H^1 = \mathcal{P}_L^1$ ), the  $L$ -unit would always be able to fund its reinvestment at date 1 if the banking group can operate both units at date 0. In this case, Lemma 2 implies that reinvestment in the  $L$ -unit is not only feasible but also efficient. Hence, the SPOE regime can always implement the constrained efficient allocation if the two units are symmetric.

In order for MPOE to be strictly optimal, the  $L$ -unit requires a transfer from the  $H$ -unit to be able to reinvest after a shock:  $\mathcal{P}_L^1 < 1$ . In other words, the moral hazard problem afflicting the operation of the  $L$ -unit must be sufficiently severe. Moreover, as shown by Lemma 3, the transfer from the  $H$ - to the  $L$ -unit must exceed the foregone investment synergies from breaking up the banking group,  $\mathcal{P}_S$ . Otherwise, designating the  $L$ -unit as an entry point reduces the banking group's pledgeable income. The incentive synergies from operating both units together decreases as the units becomes more asymmetric because it reduces the extent to which the banking group can cross pledge agency rents. As a result, the costs from separately resolving the units will be low if they are sufficiently asymmetric, making the regulator more inclined to choose MPOE rather than SPOE resolution.

Corollary 1 speaks directly to the costs and benefits of centralized versus decentralized resolution regimes. Centralized regimes allow for transfers across units and thereby facilitate ex post risk-sharing. This benefit of centralization may explain why US authorities appear to

have an implicit preference for centralized resolution schemes as a way to promote financial stability (Lee, 2015). However, if units are sufficiently asymmetric, our model shows that a decentralized regime may be preferable. The reason is that decentralization facilitates the ring-fencing of weaker subsidiaries, which may enhance banks' financing capacity and ability to expand lending. Taken together, our results highlight that allowing both SPOE and MPOE frameworks to coexist can improve efficiency relative to adopting a uniform resolution framework for all banks.

## B. Regulatory commitment

MPOE resolution requires the regulator not to transfer part of the  $H$ -unit's pledgeable income to finance reinvestment in the  $L$ -unit if it suffers a shock. Since the  $L$ -unit generates positive NPV if it is monitored, shutting down the  $L$ -unit at date 1 is ex post inefficient. Hence, shutting down the  $L$ -unit is not dynamically consistent from the perspective of NPV maximization.

**Corollary 2.** *If the regulator cannot commit to a resolution regime at date 0, it can only implement the constrained efficient allocation if  $\mathcal{P}_G^0(2) \geq 2$ .*

Time consistency is not an issue if SPOE resolution implements the constrained efficient allocation ( $\mathcal{P}_G^0(2) \geq 2$ ) since continuation of the  $L$ -unit after a shock is both ex ante and ex post efficient in this case. However, the regulator will fail to implement the constrained-efficient allocation if it cannot commit to shut down the  $L$ -unit following a shock when MPOE is strictly optimal ( $\mathcal{P}_G^0(2) < 2 \leq \mathcal{P}_G^0(H)$ ). The regulator's lack of commitment in this case implies that the banking group will be unable to invest in both units at date 0 since outside investors rationally expect to be bailed-in if the  $L$ -unit suffers a shock at date 1.

It is interesting to compare the welfare costs stemming from the regulator's lack of

commitment with those stemming from outside investors' limited commitment problem. The regulator's time-consistency problem prevents it from shutting down the  $L$ -unit when it is ex ante optimal to do so. In contrast, outside investors' inability to commit to contracts requiring reinvestments that are ex post suboptimal from their perspective may prevent efficient reinvestment in the  $L$ -unit. These starkly different inefficiencies result from the fact that the regulator and outside investors do not have the same objective: the former seeks to maximize the banking group's NPV, while the latter seek to maximize their expected payoff (which depends on the banking group's pledgeable income). Absent bankers' moral hazard problem, the banking group's pledgeable income and NPV would coincide. In this case, both the regulator's and outside investors' lack of commitment would be inconsequential and resolution policy would be irrelevant.

Corollary 2 points to a potential drawback of centralized resolution regimes, and informs ongoing policy discussions within the EU about the merits of the Single Resolution Board (which is directly responsible for the resolution of systemically important banks in the EU banking union). In particular, we show that centralized resolution regimes may reduce investment in banking groups when regulators cannot credibly commit to ring-fence weaker subsidiaries. As such, our model highlights a potential cost of centralized resolution regimes that counterbalances the coordination benefits typically emphasized in policy debates.

## **VI. Empirical Implications**

### **A. Choice of resolution regime**

Corollary 1 implies that units must be sufficiently asymmetric for the regulator to prefer MPOE to SPOE. Asymmetry arises in our model from: (i) each unit's shock probability,

$q_i$ , and (ii) its pledgeable income,  $\mathcal{P}_i$ , which depends on its risk and return characteristics ( $p_i^m$ ,  $\Delta p_i$ , and  $R_i$ ).

**Prediction 1.** *A banking group is more likely to be subject to MPOE than SPOE if: (i) its overall profitability is low, (ii) it consists of sufficiently heterogeneous units, and (iii) its weaker units have large expected financing deficits.*

Low profitability implies limited buffers relative to expected funding needs, making access to external finance particularly sensitive to changes in financing capacity. If units are sufficiently asymmetric – reflecting different scopes, competencies, or geographic focuses – the incentive synergies are small, reducing the loss from separate resolution. If weaker units have large expected financing deficits, continuing them after a shock requires substantial transfers from stronger units, lowering financing capacity and restricting the group’s ability to raise the funds needed to operate both units.

## **B. Choice of entry points**

Lemma 3 implies that a unit should be designated as an entry point under MPOE only if its financing deficit following a shock is sufficiently large. Crucially, stronger units should not be resolved separately in order to preserve incentive synergies.

**Prediction 2.** *A banking group’s weaker units should be designated as entry points under MPOE. Stronger units should not be designated as entry points.*

HSBC (2021) provides an example of a banking group subject to MPOE. The banking group specifies its holding company and its U.S. and Asian subsidiaries as separate entry points, while its other subsidiaries (including its European subsidiaries) are not designated as entry points. As a result, shocks to its U.S. or Asian operations may trigger a separate

resolution of these parts of the banking group, while the corporate structure will be preserved if it suffers shocks to its European operations.

Other banks, especially in Europe, are subject to a similar resolution framework. In the case of Santander (2021), the parent bank (which is itself an operating unit) designates its international subsidiaries as separate entry points. A shock to the parent bank will lead to joint resolution of the entire group, while operating subsidiaries will be resolved separately if one of them suffers a shock.

### **C. Financing and investment decisions**

A key implication of our model is that resolution regimes affect investment decisions. Investors in SPOE banks are more exposed to risks from future investments, since they are more likely to be bailed-in than investors in MPOE banks.

**Prediction 3.** *Banking groups subject to MPOE are more likely to finance risky investments with potentially large financing deficits, and less likely to curtail investment in weaker units than banking groups subject to SPOE.*

Given their greater flexibility to shut down failing units following a shock, MPOE banks are less likely to curtail investment in weaker units as they become riskier. This effect will be amplified during economic crises when the profitability of the banking group as a whole is low. In extreme cases, SPOE banks may even find it necessary to divest weaker units to continue operating stronger ones.

### **D. Cross-border banking**

As discussed in Section V, MPOE resolution requires regulators to credibly refrain from using the pledgeable income of the  $H$ -unit to support the  $L$ -unit following a shock. Such

a resolution framework is ex post inefficient and thus difficult to enforce when a single regulator oversees the entire group. In cross-border settings, regulators can more credibly deny support to units outside of their jurisdiction. Thus, jurisdictional separation can act as a commitment device and make MPOE resolution easier to enforce.

**Prediction 4.** *Cross-border banking groups are more likely to be subject to MPOE compared to banking groups operating within a single national/regulatory jurisdiction.*

Prediction 4 is consistent with the prevalence of MPOE in cross-border settings. For example, as of 2009, the United States requires foreign banks to establish intermediate holding companies for their U.S. activities to facilitate their separate supervision and resolution (Federal Reserve, 2019).<sup>26</sup> Prediction 4 is also consistent with the findings of Faia and Weder di Mauro (2016), who argue that MPOE resolution makes banks more inclined to increase their cross-border activities because they can limit their exposure to foreign losses. Our model's predictions differ from Bolton and Oehmke (2019), however, who argue that MPOE resolution should only arise as a consequence of coordination failures between different national regulators who fail to implement the more efficient SPOE resolution regime. In our model, coordination failures between regulators may actually be desirable insofar as they make MPOE resolution more credible, which can increase efficiency.

## VII. Conclusion

This paper studies how the choice between centralized and decentralized resolution regimes affects banking groups' financing and investment decisions. Under centralized approaches, losses are mutualized across banking units, enabling ex post efficient

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<sup>26</sup>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 company and the operating unit that suffers a shock.

reinvestment in weaker units following negative liquidity shocks. This risk-sharing makes reinvestment more likely, but also increases the losses borne by investors in case of a shock. As a result, centralized resolution approaches may constrain banking group's ability to raise external funding and finance productive investments. In contrast, decentralized approaches allow for resolving individual banking units separately and prevent stronger units from cross-subsidizing weaker ones. Such a decentralized resolution approach may increase banking groups' investment capacity, but comes at the cost of limiting risk-sharing ex post.

Our model highlights that the coexistence of SPOE and MPOE frameworks can enhance the overall efficiency of the banking system relative to a uniform resolution approach, in contrast with some authorities' apparent preference for a uniform, centralized resolution strategy. The MPOE approach is optimal when a banks units are highly heterogeneous, exhibit low overall profitability, and include risky subsidiaries facing large expected funding shortfalls. These findings help explain why several major European banking groups with operations spanning diverse jurisdictions have adopted more decentralized resolution strategies. Furthermore, under MPOE, banking groups should designate weaker units as separate resolution entities while keeping stronger units consolidated to preserve financing synergies. This reasoning is consistent with the hybrid resolution structures observed in practice, with some banking groups applying a SPOE framework for stronger subsidiaries while adopting an MPOE framework for more vulnerable affiliates.

We also show that MPOE resolution can give rise to a time-consistency problem. When a weak unit suffers a shock, the regulator should, in principle, permit its failure. Yet, doing so can be ex post inefficient, since continuing the unit through transfers from stronger affiliates may generate positive net present value for the group as a whole. If regulators cannot credibly commit to close down weak units when warranted, they may instead provide internal

support ex post, thereby undermining the credibility and effectiveness of the MPOE framework. Our results help rationalize why MPOE resolution is more commonly observed in cross-border contexts, where national regulators may find it easier to commit to closing foreign units compared to domestic ones in case of distress.

From a policy perspective, our results highlight that the design of resolution regimes must strike a careful balance between centralized coordination and credible commitment. Excessive centralization can undermine commitment by making it harder for authorities to let weak subsidiaries fail, thereby distorting investment and risk-taking incentives. In contrast, partial decentralization (e.g., by assigning resolution authority to national supervisors) can strengthen regulatory credibility, albeit at the cost of weaker cross-border coordination and potential inefficiencies in group-level resolution.

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# Appendix.

## Proof of Proposition 1

If both units operate within a banking group, the following incentive compatibility constraints must hold to ensure that the bankers monitor both units, rather than only the  $L$ -unit (IC:L), only the  $H$ -unit (IC:H), or neither of the two units (IC:0):

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

Bankers' limited liability constraints are given by  $\tau_2, \tau_H, \tau_L \geq 0$ .

To show that  $\tau_2^* > 0$  and  $\tau_H = \tau_L = 0$  minimizes the bankers' expected payment, we first show that for any incentive contract  $T_G = (\tau_L, \tau_H, \tau_2)$  that satisfies the three IC constraints (IC:L, IC:H, IC:0) there exists another incentive contract  $T'_G = (0, 0, \tau'_2)$  that yields the same expected payment and slackens the IC constraints. Contract  $T'_G$  yields the same expected payment as contract  $T_G$  providing that

$$\text{(A1)} \quad p_H^m p_L^m \tau'_2 = p_H^m p_L^m \tau_2 + p_H^m (1 - p_L^m) \tau_H + (1 - p_H^m) p_L^m \tau_L.$$

Since the expected payment is the same, the left-hand side of the IC constraints is the same under contract  $T_G$  as under contract  $T'_G$ . However, switching from contract  $T_G$  to contract  $T'_G$

decreases the right-hand-sides of the three constraints since

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

Next, we derive the lowest payment  $\tau_2^*$  such that the incentive contract  $T_G^* = (0, 0, \tau_2^*)$  satisfies the three IC constraints. At least one of the constraints must bind, since otherwise it would be possible to lower the expected payment while preserving bankers' monitoring incentives.<sup>27</sup> First, suppose that the (IC:L) constraint is binding

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

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

$$(A2) \quad \Delta p_H p_L^m \leq p_H \Delta p_L.$$

Second, suppose that the (IC:H) constraint is binding

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

In this case, the other IC constraints are satisfied if and only if

$$(A3) \quad \Delta p_L p_H^m \leq p_L \Delta p_H.$$

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<sup>27</sup>Contrary to Laux (2001), it is possible that one of the IC constraints for monitoring a single unit, IC:L or IC:H, is binding because the units are asymmetric.

Third, suppose that the (IC:0) constraint is binding

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

In this case, the other IC constraints are satisfied if and only if

$$(A4) \quad \Delta p_H p_L^m \geq p_H \Delta p_L \text{ and } \Delta p_L p_H^m \geq p_L \Delta p_H.$$

Conditions (A2)–(A4) partition the entire parameter space. Hence, the three cases together imply

$$(A5) \quad \tau_2^* = c \begin{cases} (\Delta p_H p_L^m)^{-1} & \Delta p_H p_L^m \leq p_H \Delta p_L \\ (\Delta p_L p_H^m)^{-1} & \Delta p_L p_H^m \leq p_L \Delta p_H \\ 2(p_H^m p_L^m - p_H p_L)^{-1} & \text{otherwise.} \end{cases}$$

The banking group's date 1 pledgeable income given  $T_G^*$  is

$$(A6) \quad \mathcal{P}_G^1 = p_H^m R_H + p_L^m R_L - p_H^m p_L^m \tau_2^*,$$

and the incentive synergies are equal to

$$(A7) \quad \mathcal{P}_S^1 = \mathcal{P}_G^1 - \mathcal{P}_H^1 - \mathcal{P}_L^1 = p_H^m \tau_H + p_L^m \tau_L - p_H^m p_L^m \tau_2^*.$$

Substituting for  $\tau_H$ ,  $\tau_L$ , and  $\tau_2^*$  yields

$$(A8) \quad \mathcal{P}_S^1 = c \left( \frac{p_H^m}{\Delta p_H} + \frac{p_L^m}{\Delta p_L} - \begin{cases} \frac{p_H^m}{\Delta p_H} & \Delta p_H p_L^m \leq p_H \Delta p_L \\ \frac{p_L^m}{\Delta p_L} & \Delta p_L p_H^m \leq p_L \Delta p_H \\ \frac{2p_H^m p_L^m}{p_H^m p_L^m - p_H p_L} & \text{otherwise} \end{cases} \right)$$

Inspection of condition (A8) shows that  $\mathcal{P}_S^1 > 0$  in all three cases.  $\square$

## Proof of Lemma 1

The banking group's date 1 pledgeable income exceeds its date 0 pledgeable income regardless of the reinvestment policy:  $\mathcal{P}_G^1 > \mathcal{P}_G^0(\rho)$  for all  $\rho$ . Since the bank can only operate both units if there exists a reinvestment policy such that  $\mathcal{P}_G^0(\rho) \geq 2$ , a necessary condition to operate both units at date 0 is

$$(A9) \quad \mathcal{P}_G^1 = \mathcal{P}_H^1 + \mathcal{P}_L^1 + \mathcal{P}_S^1 > 2.$$

Suppose that unit  $i \in \{H, L\}$  suffers a shock at date 1 and requires an additional unit of funding to continue operating. Reinvesting in unit  $i \in \{H, L\}$  increases the banking group's pledgeable income if and only if  $\mathcal{P}_i^1 + \mathcal{P}_S^1 \geq 1$ . Condition (A9), together with  $\mathcal{P}_H^1 \geq \mathcal{P}_L^1$ , imply that the sum of the  $H$ -unit's pledgeable income and the incentive synergies from operating both units together must exceed its reinvestment cost if it suffers a shock: i.e.,  $\mathcal{P}_H^1 + \mathcal{P}_S^1 > 1$ . Hence, reinvesting in unit  $H$  necessarily increases the banking group's pledgeable income if it can operate both units at date 0.  $\square$

## Proof of Proposition 2

From Lemma 1, continuation of the  $H$ -unit following a shock is always feasible. If  $\mathcal{P}_G^0(2) \geq 2$ , then it is feasible to operate both units at date 0 if the  $L$ -unit continues following a shock. Since both units generate positive NPV if they are monitored (Assumption 1), it is efficient to operate both units at date 0.

If  $\mathcal{P}_G^0(2) < 2$ , then it is not feasible to operate both units at date 0 if the  $L$ -unit continues following a shock. Rewriting this inequality yields

$$(A10) \quad \mathcal{P}_G^1 < 2 + q.$$

Withholding reinvestment from the  $L$ -unit when it suffers a shock increases the banking group's date 0 pledgeable income ( $\mathcal{P}_G^0(H) > \mathcal{P}_G^0(2)$ ) if and only if

$$(A11) \quad \mathcal{P}_L^1 + \mathcal{P}_S^1 < 1.$$

If  $\mathcal{P}_G^0(H) \geq 2$ , then it is feasible to operate both units at date 0 if the  $L$ -unit is shut down.

Rewriting this inequality yields

$$(A12) \quad q_L(1 - \mathcal{P}_L^1 - \mathcal{P}_S^1) \geq (2 + q) - \mathcal{P}_G^1.$$

It follows that withholding reinvestment from the  $L$ -unit if it suffers a shock is optimal if and only if  $\mathcal{P}_G^0(2) < 2 \leq \mathcal{P}_G^0(H)$ . □

## Proof of Lemma 2

By Assumption 1, it is efficient to reinvestment in both units following a shock providing that bankers monitor the unit. By Proposition 1, the banking group's date 1 pledgeable income given the optimal incentive contract  $T_G^*$  is equal to  $\mathcal{P}_G^1$ . Since  $\mathcal{P}_G^1 > 2$  if both units can operate at date 0 in a banking group, it is feasible to reinvest in a shocked unit at date 1 if all outstanding claims are written down. Taking into account that a unit suffers a shock with probability  $q$ , outside investors expected payoff under SPOE is equal to

$$(A13) \quad (1 - q)\mathcal{P}_G^1 + q(\mathcal{P}_G^1 - 1) = \mathcal{P}_G^0(2),$$

which corresponds to the banking group's date 0 pledgeable income given continuation of both units following a shock. □

## Proof of Lemma 3

If unit  $i \in \{H, L\}$  is designated as an entry point and suffers a shock, it is resolved separately from the other unit. In order for the regulator to prefer continuing unit  $i$  independently, bankers' monitoring incentives must be preserved. If  $\mathcal{P}_i < 1$ , the unit's standalone pledgeable income is insufficient to cover the reinvestment cost, in which case it is shut down. If  $\mathcal{P}_i \geq 1$ , reinvestment is feasible if all outstanding claims are written down. In this case, bankers of the resolved unit receive a positive payment  $\tau_i$  if and only if unit  $i$  succeeds at date 2. This incentive contract maximizes the unit's pledgeable income, and outside investors receive a payoff of  $\mathcal{P}_i^1 - 1 > 0$  from reinvesting.

The non-shocked unit  $j$  must also enter resolution to preserve bankers' monitoring incentives if unit  $i$  is resolved. The regulator restructures outside investors' claims such that

bankers obtain the minimum incentive payment  $\tau_j$  that ensures monitoring. The value of outside investors' restructured claims is  $\mathcal{P}_j^1$ . It follows that outside investors' total payoff after resolution if unit  $i$  is designated as an entry point is equal to

$$(A14) \quad \max\{\mathcal{P}_i^1 - 1, 0\} + \mathcal{P}_j^1.$$

If unit  $i$  is not designated as an entry point and suffers a shock, outside investors' payoff after resolution is  $\mathcal{P}_G^1 - 1$ , just like under SPOE. Hence, the change in outside investors' expected payoff from designating unit  $i$  as an entry point is

$$(A15) \quad q_i (\max\{\mathcal{P}_i^1 - 1, 0\} + \mathcal{P}_j^1 - (\mathcal{P}_G^1 - 1)).$$

Since outside investors break even in expectation, the change in their expected payoff equals the change in pledgeable income. Substituting for  $\mathcal{P}_G^1$  yields

$$(A16) \quad q_i (\max\{0, 1 - \mathcal{P}_i^1\} - \mathcal{P}_S^1).$$

Since  $\mathcal{P}_S^1 > 0$ , it follows that the change in pledgeable income is positive if and only if  $\mathcal{P}_i^1 + \mathcal{P}_S^1 < 1$ .

Form Lemma 2, the date 0 pledgeable income of a banking group that does not specify any unit as a separate entry point is  $\mathcal{P}_G^0(2)$ . It follows that the date 0 pledgeable income of the banking group if the  $L$ -unit is designated as an entry point is equal to

$$(A17) \quad \mathcal{P}_G^0(2) + q_L(1 - \mathcal{P}_L^1 - \mathcal{P}_S^1) = \mathcal{P}_G^0(H),$$

which corresponds to the banking group's date 0 pledgeable income if the  $L$ -unit is shut down

following a shock. □

### Proof of Proposition 3

That the SPOE regime implements the constraint efficient allocation if and only if  $\mathcal{P}_G^0(2) \geq 2$  follows immediately from the fact that reinvestment is efficient if a unit is monitored (Assumption 1) and Lemma 2. That the MPOE regime designates the  $L$ -unit as an entry point implements the constrained efficient allocation if  $\mathcal{P}_G^0(2) < 2 \leq \mathcal{P}_G^0(H)$  follows immediately from Lemma 3. □

### Proof of Proposition 4

In order to implement the optimal incentive contract, condition (10) must be satisfied. Substituting  $F_{G0}$  into condition (10) yields

$$(A18) \quad R_H + R_L - \tau_2^* \geq \max\{R_H, R_L\}$$

Solving this condition for  $\tau_2^*$ , we obtain

$$(A19) \quad \tau_2^* \leq \min\{R_H, R_L\}$$

which is the condition specified in the proposition. □

### Proof of Corollary 1

The first part of the corollary follows immediately from conditions (13) and (14). To prove the second part, 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 increase in the success probability from

monitoring. We define the following two vectors  $\mathbf{p} \equiv (p_H, p_L, \Delta p_H, \Delta p_L)$  and  $\bar{\mathbf{p}} \equiv (\bar{p}, \bar{p}, \Delta \bar{p}, \Delta \bar{p})$ , and solve the following maximization program:

$$(A20) \quad \max_{\mathbf{p}} P_S^1$$

subject to

$$(A21) \quad p_L + p_H = 2\bar{p}$$

$$(A22) \quad \Delta p_H + \Delta p_L = 2\Delta \bar{p}$$

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  $\mathbf{p} = \bar{\mathbf{p}}$ . In this case, condition (A8) implies that

$$(A23) \quad P_S^1 = c \left( \frac{p_H^m}{\Delta p_H} + \frac{p_L^m}{\Delta p_L} - \frac{2p_H^m p_L^m}{p_H^m p_L^m - p_H p_L} \right).$$

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  $\Delta p_H p_L^m \leq p_H \Delta p_L$ . Condition (A8) implies that  $P_S^1 = c \frac{p_L^m}{\Delta p_L}$ . The directional derivative towards  $\bar{\mathbf{p}}$  is

$$(A24) \quad \nabla_{\mathbf{p}} P_S^1 \cdot (\bar{\mathbf{p}} - \mathbf{p}) = c \frac{p_H \Delta p_L - \Delta p_H p_L}{2\Delta p_L^2} > 0,$$

where the inequality follows because  $p_H \Delta p_L \geq \Delta p_H p_L^m > \Delta p_H p_L$  in the parameter range we consider. 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 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, implying that the incentive synergies are maximized if the units are symmetric. □

## **Proof of Corollary 2**

By Assumption 1, continuing a unit following a shock generates positive NPV if bankers monitor, implying that continuation of the  $L$ -unit at date 1 is always ex post efficient. However, if  $\mathcal{P}_G^0(2) < 2$ , it is not possible to operate both units together within a banking group at date 0 if the  $L$ -unit is continued following a shock. Hence, if the regulator cannot commit to a resolution regime at date 0, it fails to implement the constrained efficient allocation whenever  $\mathcal{P}_G^0(2) < 2$ . □

FIGURE 1

Sequence of events.

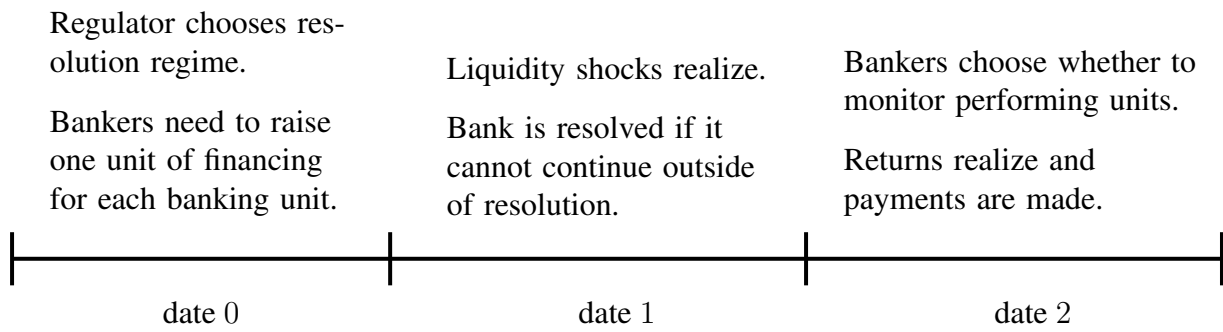


FIGURE 2

Constrained efficient operation and reinvestment decisions.

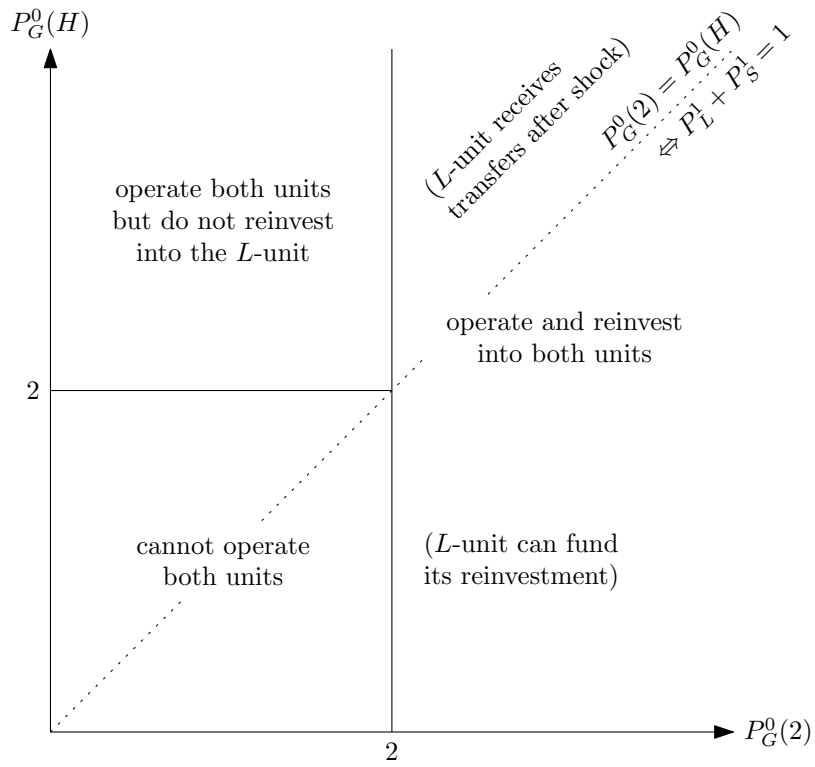
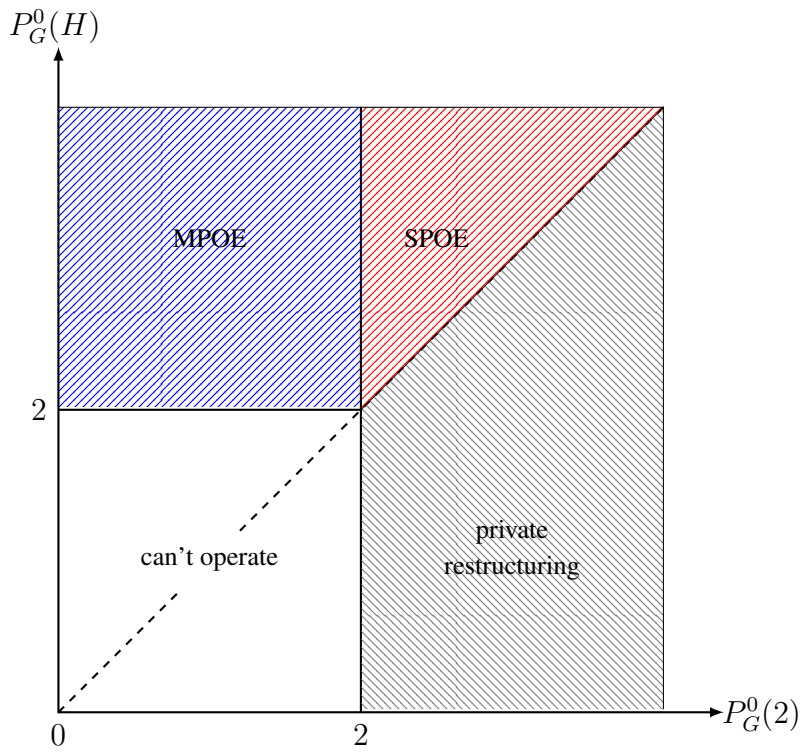


FIGURE 3

Efficiency of resolution regimes and private restructuring.



## Internet Appendix.

In this internet appendix, we show that private restructuring, even if frictionless, may fail to implement the constrained efficient allocation characterized in Section III.<sup>28</sup> The reason is that outside investors cannot commit to reinvestments at date 1 that are ex post suboptimal from their perspective.

If  $\mathcal{P}_G^1 < 3$ , the banking group must dilute outstanding investors at date 1 to raise the additional funding needed to continue a unit following a shock. Given that outside investors cannot commit to liquidity ex ante, they will only agree to be diluted if their payoff from reinvesting exceeds their payoff from closing the shocked unit and continuing the non-shocked unit. Outside investors will agree to refinance unit  $i \in \{H, L\}$  at date 1 if and only if:

$$(B1) \quad \mathcal{P}_G^1 - 1 \geq \max\{\mathcal{P}_j^1, p_j R_j\}, \quad \forall j \neq i.$$

The left-hand-side of condition (B1) equals the banking group's date 1 pledgeable income net of the reinvestment cost, which corresponds to outside investors' maximum payoff if unit  $i$  is continued. The right-hand-side of condition (B1) equals outside investors' maximum payoff if unit  $i$  is shut down. In this case, outside investors must decide whether to restructure bankers' incentive contract. If the contract is restructured to ensure that bankers' monitoring incentives are preserved, bankers' payment if unit  $j$  succeeds must be increased from 0 to  $\tau_j$ , and outside investors' payoff is  $\mathcal{P}_j^1$ . Otherwise, if the contract is not restructured, unit  $j$  continues but its success probability decreases from  $p_j^m$  to  $p_j$ , and outside investors' payoff is  $p_j R_j$ .

**Proposition B1.** *Suppose that the banking group operates both units at date 0 and that reinvestment following a shock requires to dilute investors' claims ( $\mathcal{P}_G^1 < 3$ ). Private*

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<sup>28</sup>See Colliard and Gromb (2025) for a model of private restructuring with frictions.

restructuring fails to implement the constrained efficient allocation if

- $2 \leq \mathcal{P}_G^0(2) < \mathcal{P}_G^0(H)$ , or
- $\mathcal{P}_G^0(2) < 2 \leq \mathcal{P}_G^0(H)$  and outside investors prefer not to restructure the bankers' contract if the  $L$  unit is shut down.

Investors prefer not to restructure bankers' contract if unit  $L$  is shut down whenever:

$$(B2) \quad \tau_H > \hat{\tau} \equiv \frac{\Delta p_H}{p_H + \Delta p_H} R_H.$$

*Proof.*  $\mathcal{P}_G^0(2) \geq 2$  is equivalent to  $\mathcal{P}_G^1 > 2 + q$ . If this condition is satisfied, it is feasible (and hence efficient) to continue both units if one of them suffers a shock. A sufficient condition for outside investors to refuse to refinance the  $L$ -unit is:

$$(B3) \quad \mathcal{P}_G^1 - 1 < \mathcal{P}_H^1.$$

Substituting for  $\mathcal{P}_G^1$ , this condition simplifies to

$$(B4) \quad \mathcal{P}_L^1 + \mathcal{P}_S^1 < 1,$$

which is equivalent to  $\mathcal{P}_G^0(2) < \mathcal{P}_G^0(H)$ . Hence, if  $2 \leq \mathcal{P}_G^0(2) < \mathcal{P}_G^0(H)$  outside investors will never refinance the unit even though continuation is efficient.

If  $\mathcal{P}_G^0(2) < 2$ , it is efficient to withhold reinvestment from the  $L$ -unit if it suffers a shock. Not restructuring bankers' incentive contract if the  $L$ -unit is shut down reduces the  $H$ -unit's success probability by  $\Delta p_H$  but avoids having to increase bankers' payment in case the  $H$ -unit succeeds from 0 to  $\tau_H$ . Outside investors prefer not to restructure bankers'

incentive contract if and only if  $p_H R_H > \mathcal{P}_H$ , which is equivalent to

$$(B5) \quad \tau_H > \frac{\Delta p_H}{p_H + \Delta p_H} R_H.$$

If condition (B5) is satisfied, outside investors prefer continuing the  $H$ -unit without monitoring if the  $L$ -unit is shut down, which is inefficient since a unit generates negative NPV if it is not monitored (Assumption 2). □

Continuing a unit following a shock generates positive NPV if the unit is monitored (Assumption 1). Hence, as long as reinvesting in the  $L$ -unit does not prevent the banking group from operating both units at date 0 ( $\mathcal{P}_G^0(2) \geq 2$ ), it is efficient to continue the  $L$  unit following a shock (Proposition 2). Bankers' moral hazard problem, however, implies that the payment promised to outside investors' after restructuring cannot exceed the banking group's pledgeable income. Since the  $H$ -unit can continue operating even if the  $L$ -unit is shut down, outside investors will never refinance the  $L$ -unit if it reduces the banking group's date 0 pledgeable income ( $\mathcal{P}_G^0(2) < \mathcal{P}_G^0(H)$ ). The reason is that reinvestment in this case requires outside investors to incur an expected loss of at least  $1 - \mathcal{P}_L^1 - \mathcal{P}_S^1 > 0$ .

Private restructuring may also fail to implement the constrained efficient allocation even if it is optimal to withhold reinvestment from the  $L$ -unit ( $\mathcal{P}_G^0(2) < 2$ ). This will be the case whenever outside investors prefer not to restructure bankers' incentive contract to ensure that bankers still monitor the  $H$ -unit. Even though a unit generates negative NPV if it is not monitored, outside investors' date 0 investment is sunk at date 1. Hence, if the incentive payment needed to preserve bankers' monitoring incentives is sufficiently large ( $\tau_H > \hat{\tau}$ ), outside investors will prefer inefficiently continuing the  $H$ -unit without monitoring rather than restructuring bankers' incentive contract.