

Resolution Design and Investment in Banking Groups *

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We study how resolution regimes affect investment in banking groups with subsidiaries of varying financial strength. Centralized regimes that preserve the group structure enable ex post support for weaker units but may constrain ex ante investment. In contrast, 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 groups risk profile and profitability. Allowing both regimes to coexist improves efficiency relative to imposing a uniform regime across all groups. A single resolution authority may face a time-inconsistency problem in enforcing limits on ex post risk-sharing.

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1 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.¹ In contrast, sev-

¹For 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.

eral 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 orientation”, which may refer to an enhanced ability to raise funding and expand lending (Pardo et al., 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 financing capacity and a “weak” unit with relatively low 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.² 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 stand-alone 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

²The use of a strong units 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).

regulator the authority to restructure the banking groups financial contracts.³

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 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 private restructuring generally fails to implement the constrained efficient allocation. The reason is that outside investors will never voluntarily restructure their claims to allow reinvestment if their expected payoff from closing the shocked unit and continuing the non-shocked unit exceeds their expected payoff from reinvestment. We assume that if the banking group enters resolution, the regulator can enforce reinvestment even when it is ex post suboptimal for outside investors. The regulator's ability to implement contracting outcomes that cannot be implemented by private restructuring provides an endogenous justification for resolution in our model.

We consider two resolution regimes: a centralized single-point-of-entry (SPOE) regime

³According 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."

and a decentralized multiple-point-of-entry (MPOE) regime. We show that the regulator can always implement the constrained efficient allocation using one of these regimes. 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.

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.

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 into 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 et al., 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, 2020; Segura and Suarez, 2023). While several articles have explored the supervision of multiunit banks (Calzolari and Lóránth, 2011; Calzolari et al., 2019; Lóránth et al., 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.⁴ 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 regulators may be unable to commit to SPOE resolution in a cross-border setting because doing so involves transfers across jurisdictions. 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

⁴See also Segura and Vicente (2019) for a model of bank resolution in an asymmetric banking union.

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 et al., 2022; Philippon and Wang, 2023).

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

2.1 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. The units may be 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.⁵ 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 of the two units may suffer a shock at date 1, implying that the probability that one of the two units suffers a shock equals $q = q_H + q_L$.⁶ 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.”

⁵The liquidity shock can be interpreted as a shock to the unit's borrowers who require additional funds to complete their investment projects.

⁶Our 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 ($q_H = q_L = 1/2$).

2.2 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:*

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

Assumption 1 implies that continuing a unit if it suffers a shock at date 1 generates positive NPV if bankers monitor the unit: $p_i^m R_i - c > 1$.⁷ 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:*

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

Assumption 2 implies that operating either unit at date 0 is never efficient if it is not

⁷The 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.

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.

2.3 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.⁸ We also assume that outside investors cannot force banking units to invest in liquid assets at date 0.⁹ This assumption prevents banking units from self-insuring against liquidity shocks by hoarding liquid assets ex ante.

2.4 Resolution

Resolution, which may ensue after a banking unit suffers a shock at date 1, gives the regulator the authority to restructure the banking group's financial contracts and to shut down one or more of its units. 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

⁸This 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.

⁹This assumption may reflect the fact that banks are opaque, keeping detailed information about the composition of their assets secret (Dang et al., 2017).

point is the holding) suffers a shock and is unable to continue operating outside 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.¹⁰ Thus, resolution allows the regulator to implement contracting outcomes that private parties are unable to implement outside of resolution.

The objective of the regulator is to maximize the net present value (NPV) of the banking group at any point in time.^{11,12} 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.¹³ 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.

We compare 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 the units, and the banking group's corporate structure does not change after resolution. In contrast,

¹⁰Since the resolution policy is common knowledge, any expected losses imposed on outside investors ex post are necessarily priced in ex ante.

¹¹This objective differs from standard bankruptcy procedures, which typically aim to maximize investors' recovery values in case of default.

¹²Since 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.

¹³We discuss what happens if the regulator cannot commit to a resolution regime in Section 6.2.

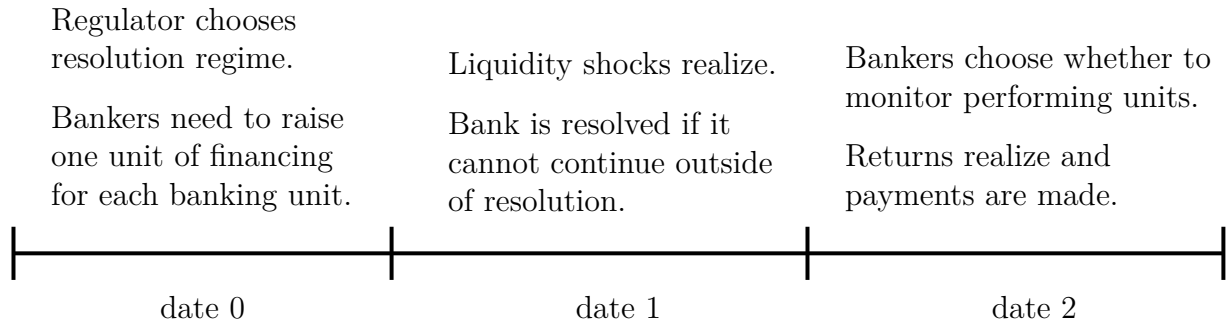


Figure 1: Sequence of events.

a MPOE regime is one where, 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.

Figure 1 summarizes the sequence of events of the model.

3 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 contractible.¹⁴ 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.

¹⁴We assume that the liquidity shock is observable. Just like in Holmström and Tirole (1998), our results are unaffected if only the bank observes the liquidity shock providing that the bank has no alternative use of funds at date 1.

The optimal contract consists of two parts. The first part specifies the distribution of cash flows between bankers and outside investors at date 2. The second part specifies 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 ensure that all performing units are monitored. The incentive payment that bankers require to monitor determines 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 abstract from the limited commitment problem of outside investors. That is, we allow for contracts that specify reinvestments at date 1 that are ex post suboptimal for outside investors. We discuss how outside investors' limited commitment problem affects the implementation of the optimal contract and provides an endogenous justification for resolution in Section 4.

3.1 Incentive contract

We first derive bankers' optimal incentive payment when each unit operates independently from the other. We then derive the optimal incentive payment when both units operate within a banking group which centralizes decision-making under a single team of bankers.

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 constraint for bankers to monitor unit i is

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

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

$$\tau_i \equiv \frac{c}{\Delta p_i}, \quad \forall i \in \{H, L\} \quad (2)$$

and unit i 's pledgeable income at date 1 equals

$$\mathcal{P}_i^1 \equiv p_i^m (R_i - \tau_i), \quad \forall i \in \{H, L\}. \quad (3)$$

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 .¹⁵

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 pledge-*

¹⁵See the Appendix for an explicit derivation of \mathcal{P}_G^1 .

able income is strictly larger than the sum of the pledgeable incomes of two individual performing units:

$$\mathcal{P}_G^1 > \mathcal{P}_H^1 + \mathcal{P}_L^1.$$

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.¹⁶ The reason is that centralized decision making relaxes bankers' limited liability constraint by allowing them to "cross-pledge" the agency rent from one unit to mitigate the moral hazard problem afflicting the other unit. As a result, operating the two units jointly reduces the minimum payment that bankers must receive while preserving their monitoring incentives. These "incentive synergies" are a form of cost saving and increase the banking group's total pledgeable income.

If both units are operating, the optimal incentive contract T_G^* stipulates a positive payment to bankers if and only if both units succeed at date 2. If a unit becomes non-performing at date 1, the optimal incentive contract stipulates a positive payment to bankers if and only if the remaining performing unit succeeds at date 2. If the H -unit is continued, bankers receive τ_H in case of success. If the L -unit is continued, bankers receive τ_L in case of success. These payments correspond to the incentive payments that bankers receive when the units are operated independently of each other.

¹⁶See Cerasi and Daltung (2000) for an application to banking.

3.2 Operation and reinvestment decisions

We now turn to the banking group's optimal reinvestment policy at date 1 and operation decision at date 0. We are interested in studying the resolution of multiunit banking groups. Hence, without loss of generality, we restrict attention to cases where bankers choose to operate both units together within a banking group at date 0. Operating both units together is strictly more efficient than operating the units independently whenever at least one unit cannot operate independently at date 0.¹⁷

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.

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,

¹⁷A unit cannot operate independently if the initial investment cost exceeds its date 0 pledgeable income.

given the reinvestment policy ρ , is thus

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

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 ρ . 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 ρ .

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

$$\mathcal{P}_G^0(2) > \mathcal{P}_G^0(j) \Leftrightarrow \mathcal{P}_G^0(i) > \mathcal{P}_G^0(0) \Leftrightarrow \mathcal{P}_i^1 + \mathcal{P}_S^1 \geq 1, \quad (4)$$

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 (4) must be satisfied for the H -unit if the banking

group can finance the operation of both units at date 0. Otherwise, the banking group could never operate both units at date 0 since the group's date 1 (and hence date 0) pledgeable income would be less than 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:*

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

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 illustrates Proposition 2. The date 0 operation decision and date 1 reinvestment policy only depend on the banking group's total pledgeable income because it can make transfers between units. Since continuing the H -unit if it suffers a shock increases the banking group's date 0 pledgeable income, it is always optimal to reinvest in the H -unit. Whether or not it is optimal to reinvest in the L -unit depends on how continuation of the L -unit affects the banking group's date 0 pledgeable income.

If condition (4) fails to hold for the L -unit, reinvesting in the L -unit following a shock (which occurs with probability q_L) requires a transfer from the H -unit, which reduces the banking group's date 0 pledgeable income ($\mathcal{P}_G^0(2) < \mathcal{P}_G^0(H)$). If the expected transfer is sufficiently large such that $\mathcal{P}_G^0(2) < 2$, then operating both units at date 0 requires withholding reinvestment from the L -unit if it suffers a shock.

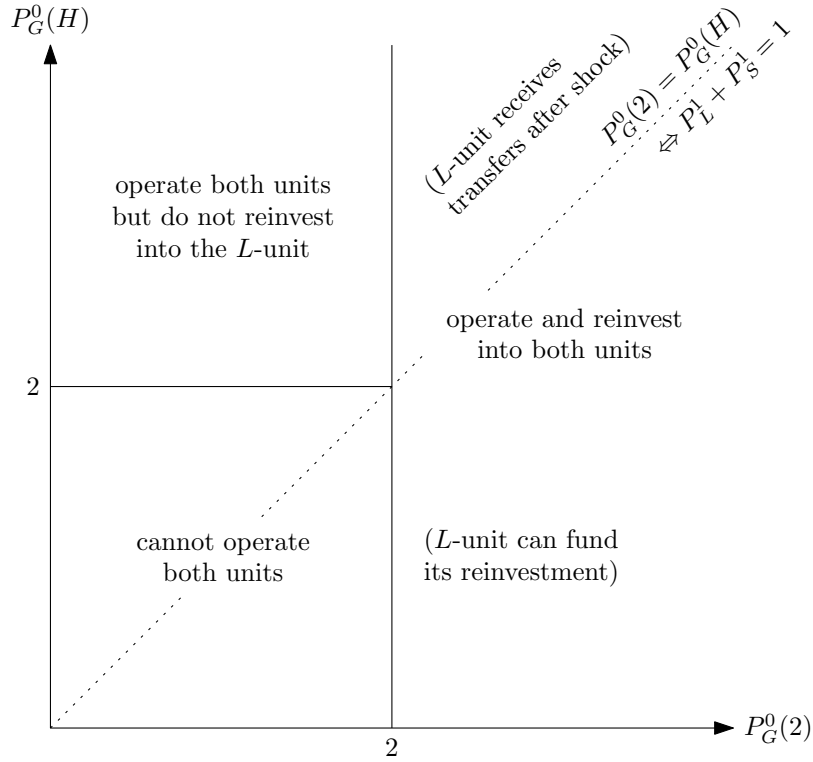


Figure 2: Constrained efficient operation and reinvestment decisions

Remark. The optimal contracting benchmark is closely related to the constrained efficient investment policy in Holmström and Tirole (1998). The key difference with Holmström and Tirole (1998) is that the banking group has the option to continue operating even if one of its units becomes non-performing.

Suppose that the banking group must continue both units when one unit suffers a shock. In this case, the constrained efficient investment policy is the same as in Holmström and Tirole (1998). If $\mathcal{P}_G^1 \geq 3$, it is not necessary to contract liquidity ex ante since the banking group always has sufficient pledgeable income to refinance either of the two units at date 1. If $3 > \mathcal{P}_G^1 \geq 2 + q$, the optimal contract features “liquidity insurance”: investors incur a loss if one of the units suffers a shock, but are compensated with a high

return if neither of the units suffers a shock. Finally, if $\mathcal{P}_G^1 < 2 + q$, it is not feasible for the banking group to raise financing at date 0 if it must continue both units when one unit suffers a shock.

Allowing the banking group to continue operating even if one of its units become non-performing gives the group additional flexibility to manage its liquidity risk. If condition (4) fails to hold for the L -unit, then closing the L -unit if it suffers a shock increases the group's date 0 pledgeable income by $\mathcal{P}_G^0(H) - \mathcal{P}_G^0(2) = q_L(1 - \mathcal{P}_L^1 - \mathcal{P}_S^1) > 0$. If the increase in pledgeable income from not continuing the L -unit exceeds the group's expected funding shortfall, $2 - \mathcal{P}_G^0(2) = (2 + q) - \mathcal{P}_G^1 > 0$, it becomes feasible to raise financing to operate both units at date 0 even if $\mathcal{P}_G^1 < 2 + q$.

4 Private Restructuring

We now turn to the implementation of the constrained efficient allocation characterized in Section 3. In this section, we show that private restructuring, even if frictionless, may fail to implement the constrained efficient allocation when outside investors cannot commit to reinvestments at date 1 that are ex post suboptimal from their perspective.¹⁸

In the next section, we show how a resolution regime that specifies one or more of the banking group's units as an "entry point" can implement the constrained efficient allocation. To simplify the exposition, we assume in the next two sections that the incentive contracts T_G^* (for two performing units) and τ_i (for a single performing unit) can be implemented both outside and within the resolution process. We show in Section 5.4

¹⁸See Colliard and Gromb (2025) for a model of private restructuring with frictions.

how simple debt securities can “replicate” these incentive contracts.

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:

$$\mathcal{P}_G^1 - 1 \geq \max\{\mathcal{P}_j^1, p_j R_j\}, \quad \forall j \neq i. \quad (5)$$

The left-hand-side of condition (5) 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 (5) 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 τ_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 3. *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 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 private investors prefer not to restructure the bankers' contract after the L unit is shut down.

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

$$\tau_H > \hat{\tau} \equiv \frac{\Delta p_H}{p_H + \Delta p_H} R_H.$$

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.

5 Resolution

This section shows how a resolution regime that transfers contracting decisions to a resolution authority can implement the constrained efficient allocation. Contrary to private restructuring, the regulator can enforce reinvestments which are ex post suboptimal for outside investors (i.e., which violate condition (5)). The regulator's ability to implement contracting outcomes that circumvent outside investors' limited commitment problem provides an endogenous justification for resolution 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.

5.1 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 the SPOE regime 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 necessary 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 under SPOE to finance reinvestment by imposing sufficiently large write-downs on outside investors' outstanding claims at date 1.

5.2 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 stand-alone 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 0.¹⁹ 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, $1 - \mathcal{P}_i^1 > 0$. Hence, the regulator will only designate the L -unit

¹⁹Breaking 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.

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 τ_2 if and only if both units succeeds at date 2) such that bankers receive a positive payment τ_H if and only if the H -unit succeeds at date 2 and zero otherwise.

5.3 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 4. *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.

If $2 \leq \mathcal{P}_G^0(2) < \mathcal{P}_G^0(H)$, the MPOE regime fails to implement the constrained efficient allocation by preventing the ex post efficient continuation of the L -unit. Moreover, private restructuring also fails to implement the constrained efficient allocation because outside investors will never voluntarily reinvest in the L -unit following a shock (Proposition 3). Thus, SPOE resolution is essential since it allows the regulator to enforce reinvestment in the L -unit.

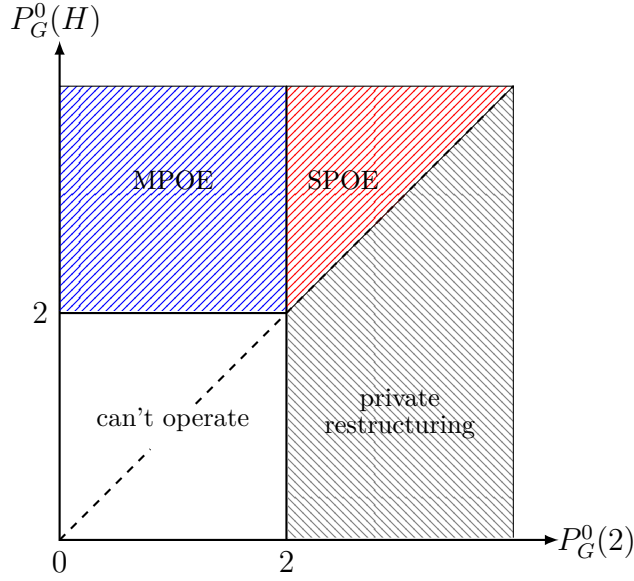


Figure 3: Efficiency of Resolution Regimes and Private Restructuring

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 at date 1 by shutting down the L -unit. As a result, the regulator must designate the L -unit as an entry point to implement the constrained efficient allocation. If outside investors prefer to restructure bankers' incentive contract if the L -unit is shut down, then the constrained efficient allocation can also be implemented through private restructuring. However, if outside investors prefer not to restructure the incentive contract ($\tau_H > \hat{\tau}$), 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.

5.4 Implementing the incentive contract

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

Proposition 5. *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 will reach date 2 with this financing structure. This financing structure implements the optimal incentive contract T_G^* as long as

$$F_{G0} \geq \max\{R_H, R_L\}. \quad (6)$$

Substituting F_{G0} into condition (6) and solving for τ_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 τ_2^* if both units succeed.²⁰

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

²⁰If 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.

income for reinvestment at date 1. Consider a write-down Δ 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 τ_2^* satisfy the following resource constraint:

$$F_{G0} - \Delta + F_{G1} + \tau_2^* \leq R_H + R_L. \quad (7)$$

The optimal write-down dilutes outside investors as little as possible to ensure reinvestment and monitoring of the continued units. Thus, condition (7) 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 implements the optimal incentive contract T_G^* as long as

$$(F_{G0} - \Delta^*) + F_{G1} \geq \max\{R_H, R_L\} \quad (8)$$

which is equivalent to condition (6).

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 τ_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 1.²¹ 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 τ_H otherwise.

6 Discussion

6.1 Which banks should be subject to MPOE?

Proposition 4 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

$$\mathcal{P}_G^1 < 2 + q. \tag{9}$$

The left-hand side of condition (9) 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 , in which case the banking group must

²¹Contingent convertible securities have the advantage of avoiding the regulator from having to restructure the banking group's claims ex post, which is beneficial if resolution involves direct costs.

raise an additional unit of funds to continue the unit).

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

$$q_L(1 - \mathcal{P}_L^1 - \mathcal{P}_S^1) \geq (2 + q) - \mathcal{P}_G^1. \quad (10)$$

The left-hand side of condition (10) 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). 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 ,*
- *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 must require 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.

6.2 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 the 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.

7 Empirical Implications

7.1 Choice of resolution regime

Corollary 1 implies that banking units must be sufficiently asymmetric for the regulator to prefer MPOE to SPOE resolution. Our model has several dimensions of asymmetry: (i) the probability with which each unit receives a shock, q_i , and (ii) the units' pledgeable incomes, \mathcal{P}_i , which depend on their risk and return characteristics (p_i^m , Δp_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.*

Three features of a banking group make the regulator more inclined to choose MPOE over SPOE resolution. First, units must be sufficiently asymmetric, reflecting heterogeneous operations with different scopes, competencies or geographic focuses. Since the banking group's incentive synergies decrease as units become more asymmetric, the costs from separately resolving heterogeneous units under MPOE will be relatively small. Second, the banking group's overall profitability must be sufficiently low so that its ability to raise funds from outside investors is sensitive to variations in its pledgeable income. Third, the banking group's weaker units must have large expected financing deficits, implying that weaker units have low pledgeable income or are disproportionately likely to suffer liquidity shocks. In this case, continuing weaker units following a shock requires large transfers from stronger units, which makes it more difficult for the banking group to raise the initial financing needed to operate these units.

7.2 Choice of entry points

Lemma 3 implies that a unit should only be designated as an entry point under MPOE if its financing deficit in case of a shock is sufficiently large. Crucially, stronger units should not be designated as entry points to preserve the banking group's incentive synergies when these units suffer a shock.

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 part of the banking group, while the banking group's 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 the joint resolution of the entire banking group, while its operating subsidiaries will be resolved separately in case one of them suffers a shock.

7.3 Financing and investment decisions

A key implication of our model is that resolution regimes affect banking groups' investment decisions. The reason is that investors in SPOE banks are more exposed to the risk stemming from future investments compared to investors in MPOE banks since the former are more likely to be bailed-in than the latter. As a result, SPOE banks will have greater difficulty financing risky units exposed to potentially large financing deficits. Since MPOE banks can commit not to reinvest in failing units, they will be more capable of financing such risky units.

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

Given MPOE banks' greater flexibility in shutting down failing units following a shock, they are less likely to curtail invests into weaker units if 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 their weaker units in order to continue operating their stronger units.

7.4 Cross-border banking

As discussed in Section 6.2, 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, which is consistent with its prevalence in cross-border resolution regimes. 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).²²

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 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.

²²If 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.

8 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 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 ones 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.

Appendix: Proofs

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):

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

$$\geq p_H^m p_L \tau_2 + p_H^m (1 - p_L) \tau_H + (1 - p_H^m) p_L \tau_L - c, \quad (\text{IC:H})$$

$$\geq p_H p_L \tau_2 + p_H (1 - p_L) \tau_H + (1 - p_H) p_L \tau_L. \quad (\text{IC:0})$$

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

$$p_H^m p_L^m \tau'_2 = p_H^m p_L^m \tau_2 + p_H^m (1 - p_L^m) \tau_H + (1 - p_H^m) p_L^m \tau_L. \quad (11)$$

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

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

Next, we derive the lowest payment τ_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.²³ 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

$$\Delta p_H p_L^m \leq p_H \Delta p_L. \quad (12)$$

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

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

²³Contrary 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.

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

$$\Delta p_L p_H^m \leq p_L \Delta p_H. \quad (13)$$

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

$$\Delta p_H p_L^m \geq p_H \Delta p_L \text{ and } \Delta p_L p_H^m \geq p_L \Delta p_H. \quad (14)$$

Conditions (12)–(14) partition the entire parameter space. Hence, the three cases together imply

$$\tau_2^* = c \begin{cases} (\Delta p_H p_L^m)^{-1} & \Delta p_H p_L^m \leq p_H \Delta p_L \\ (\Delta p_L p_H^m)^{-1} & \Delta p_L p_H^m \leq p_L \Delta p_H \\ 2(p_H^m p_L^m - p_H p_L)^{-1} & \text{otherwise.} \end{cases} \quad (15)$$

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

$$\mathcal{P}_G^1 = p_H^m R_H + p_L^m R_L - p_H^m p_L^m \tau_2^*, \quad (16)$$

and the incentive synergies are equal to

$$\mathcal{P}_S^1 = \mathcal{P}_G^1 - \mathcal{P}_H^1 - \mathcal{P}_L^1 = p_H^m \tau_H + p_L^m \tau_L - p_H^m p_L^m \tau_2^*. \quad (17)$$

Substituting for τ_H , τ_L , and τ_2^* yields

$$\mathcal{P}_S^1 = c \left(\frac{p_H^m}{\Delta p_H} + \frac{p_L^m}{\Delta p_L} - \begin{cases} \frac{p_H^m}{\Delta p_H} & \Delta p_H p_L^m \leq p_H \Delta p_L \\ \frac{p_L^m}{\Delta p_L} & \Delta p_L p_H^m \leq p_L \Delta p_H \\ \frac{2p_H^m p_L^m}{p_H^m p_L^m - p_H p_L} & \text{otherwise} \end{cases} \right) \quad (18)$$

Inspection of condition (18) 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 ρ . 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

$$\mathcal{P}_G^1 = \mathcal{P}_H^1 + \mathcal{P}_L^1 + \mathcal{P}_S^1 > 2. \quad (19)$$

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 (19), 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 $\mathcal{P}_G^0(2) > 2$, 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

$$\mathcal{P}_G^1 < 2 + q. \quad (20)$$

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

$$\mathcal{P}_L^1 + \mathcal{P}_S^1 < 1. \quad (21)$$

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

$$q_L(1 - \mathcal{P}_L^1 - \mathcal{P}_S^1) \geq (2 + q) - \mathcal{P}_G^1. \quad (22)$$

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

Proof of Proposition 3

$\mathcal{P}_G^0(2) \geq 2$ 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:

$$\mathcal{P}_G^1 - 1 < \mathcal{P}_H^1. \quad (23)$$

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

$$\mathcal{P}_L^1 + \mathcal{P}_S^1 < 1, \quad (24)$$

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 Δp_H but avoids having to increase bankers' payment

in case the H -unit succeeds from 0 to τ_H . Outside investors prefer not to restructure bankers' incentive contract if and only if $\mathcal{P}_H < p_H R_H$, which is equivalent to

$$\tau_H > \frac{\Delta p_H}{p_H + \Delta p_H} R_H. \quad (25)$$

If condition (25) 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 1). \square

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

$$(1 - q)\mathcal{P}_G^1 + q(\mathcal{P}_G^1 - 1) = \mathcal{P}_G^0(2), \quad (26)$$

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

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 stand-alone 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 τ_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 τ_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

$$\max\{\mathcal{P}_i^1 - 1, 0\} + \mathcal{P}_j^1. \quad (27)$$

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

$$q_i \left(\max\{\mathcal{P}_i^1 - 1, 0\} + \mathcal{P}_j^1 - (\mathcal{P}_G^1 - 1) \right). \quad (28)$$

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

$$q_i (\max\{0, 1 - \mathcal{P}_i^1\} - \mathcal{P}_S^1). \quad (29)$$

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

From 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

$$\mathcal{P}_G^0(2) + q_L(1 - \mathcal{P}_L^1 - \mathcal{P}_S^1) = \mathcal{P}_G^0(H), \quad (30)$$

which corresponds to the banking group's date 0 pledgeable income if the L -unit is shut down following a shock. \square

Proof of Proposition 4

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. \square

Proof of Proposition 5

In order to implement the optimal incentive contract, condition (6) must be satisfied.

Substituting F_{G_0} into condition (6) yields

$$R_H + R_L - \tau_2^* \geq \max\{R_H, R_L\} \quad (31)$$

Solving this condition for τ_2^* , we obtain

$$\tau_2^* \leq \min\{R_H, R_L\} \quad (32)$$

which is the condition specified in the proposition. \square

Proof of Corollary 1

The first part of the corollary follows immediately from conditions (9) and (10). 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:

$$\max_{\mathbf{p}} P_S^1 \quad (33)$$

subject to

$$p_L + p_H = 2\bar{p} \quad (34)$$

$$\Delta p_H + \Delta p_L = 2\Delta\bar{p} \quad (35)$$

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 (18) implies that

$$P_S^1 = c \left(\frac{p_H^m}{\Delta p_H} + \frac{p_L^m}{\Delta p_L} - \frac{2p_H^m p_L^m}{p_H^m p_L^m - p_H p_L} \right). \quad (36)$$

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

$$\nabla_{\mathbf{p}} P_S^1 \cdot (\bar{\mathbf{p}} - \mathbf{p}) = c \frac{p_H \Delta p_L - \Delta p_H p_L}{2\Delta p_L^2} > 0, \quad (37)$$

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. \square

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 $\mathcal{P}_G^0(2) < 2$. \square

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