FTG Working Paper Series

Financial Restructuring and Resolution of Banks

by

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Working Paper No. 00065-01

Finance Theory Group

www.financetheory.com

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March 15, 2024

Abstract

How do resolution frameworks affect the private restructuring of distressed banks? We model a bank's shareholders and creditors negotiating a restructuring, under two frictions: asymmetric information about asset quality, and externalities on the government. High-quality banks signal themselves by delaying the negotiation, which is socially inefficient. Public policies can improve welfare if they reduce the signaling motive or increase the negotiation surplus. Stricter bail-in rules make debt more information-sensitive and increase delays. The bank chooses a capital structure with too little renegotiable debt, giving a new rationale for, e.g., TLAC ratios.

Keywords: Bank resolution, bail-out, bail-in, debt restructuring.

JEL classification: G21, G28.

*We are grateful to Viral Acharya, Bruno Biais, Max Bruche, Darrell Duffie, Paolo Fulghieri, Andrew Gracie, Matthias Kahl, Gyongyi Loranth, Alan Morrison, Fausto Panunzi, Thomas Philippon, Ansgar Walther, Jessie Wang, Lucy White for helpful comments and suggestions, as well as to participants to the 2017 DNB-Riksbank Macroprudential Conference, 2017 BAFFI CAREFIN-Intesa Banking Conference, 14th Annual Corporate Finance Conference at Washington University, 4th CSEF Banking Conference, 3rd annual Chicago Financial Institutions Conference, FIRS 2018, OxFIT 2018, 2018 Cambridge - Corporate Finance Theory Symposium, and seminar participants at Arizona State University, Bank for International Settlements, Bank of Italy, Bocconi University, Católica Lisbon School of Business and Economics, CEMFI, Copenhagen Business School, EPFL and HEC Lausanne, ESSEC, HEC Paris, Humboldt University, IESEG, INSEAD, Luxembourg School of Finance, New Economic School, Pompeu Fabra, Science Po Paris, Toulouse School of Economics, the Universities of Amsterdam, Bonn, Bristol, British Columbia, Cambridge, Lugano, Mannheim, Paris II, Paris Dauphine, Porto, and Vienna. We thank Lucie Bois and Chhavi Rastogi for excellent research assistance. This work was supported by the French National Research Agency (F-STAR ANR-17-CE26-0007-01), the Investissements d'Avenir Labex (ANR-11-IDEX-0003/Labex Ecodec/ANR-11-LABX-0047), the Chair ACPR/Risk Foundation "Regulation and Systemic Risk", and the Natixis Chair "Business Analytics for Future Banking".

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In Memoriam

Denis Gromb passed away on 30 October 2022. This new version of our joint work is dedicated to his memory and to his wife Clare and daughter Livia.

While the latest publicly available version of this paper is dated 2 May 2018, Denis and I had been working on an ambitious revision slowly but continuously over the years, and this version is very close to the last one we discussed together. Any merit should thus be equally shared between the two co-authors. As Denis could not read this version, I am fully responsible for any remaining error and for any part of the text below Denis' writing standards.

It was a great privilege and a lot of fun to work on this paper with Denis. He is sorely missed.

Jean-Edouard Colliard

Introduction

In the wake of the financial crisis of 2008, many bank resolution regimes were strengthened (e.g., via the U.S. Dodd-Frank Act or the European Bank Recovery and Resolution Directive (BRRD)). These frameworks and the tools they employ (e.g., bail-ins) are designed to safeguard public interest by facilitating either the orderly wind down or the viable continuation of failing banks, while minimizing the cost to taxpayers. These post-crisis resolution regimes were put to the test in 2023, with uninsured depositors of Silicon Valley Bank and Signature Bank being unexpectedly rescued by the FDIC due to a "systemic risk exception", and the contentious decision by Swiss regulator FINMA to write down the AT1 securities issued by Crédit Suisse without fully allocating losses to the shareholders first.[1]

How to efficiently resolve a failing bank is an important question ex post, but resolution rules also have an important impact on private negotiations to rescue the bank ex ante. Before a bank fails, its private stakeholders, i.e., shareholders and creditors, can engage in a workout to reduce debt, increase maturity, inject capital, etc. Indeed, at least in principle, excessive debt can be restructured in a way that benefits all parties (Haugen and Senbet, 1978). Such voluntary restructurings, common for non-financial corporations, are also important for banks.[2] The multiple bank failures of 2023 are a reminder that the negotiation process can take time, and often fails.[3] The restructuring of Monte dei Paschi di Siena (MPS) in 2016 was perhaps the best illustration that the private restructuring of a bank's liabilities can involve complex dynamic negotiations with multiple parties including here, at least, shareholders, creditors, and the government (Figure 1). In this case, private parties failed to reach an agreement, which led to a recapitalization by the Italian government.[4]

[1] See, e.g., the "Joint Statement by the Department of the Treasury, Federal Reserve, and FDIC", March 12, 2023, and "Credit Suisse Investors Challenge Switzerland's $17 Billion Bond Write-Down", Alexander Saeedy and Margot Patrick, Wall Street Journal, April 21, 2023.

[2] See Senbet and Wang (2012)'s survey on the financial restructuring of non-financial firms. For banks, a prime example is the Liability Management Exercises European banks conducted during the 2008 crisis. The banks offered to buy back their subordinated hybrid bonds at a discount, to cut leverage. According to Vallée (2019), a total of EUR 87 bn of hybrid bonds were tendered, creating EUR 30 bn of capital gains for European banks.

[3] First Republic Bank received liquidity support from major U.S. banks in March 2023, then unsuccessfully tried to negotiate a private sector solution before the FDIC finally organized the sale of the bank on 1 May. Silicon Valley Bank announced a share sale two days before it collapsed. Crédit Suisse conducted an important capital raise with the support of its major shareholders in December 2022, which proved insufficient to save the bank.

[4] Another example is given by Bignon and Vuillemey (2018), who study the failure of a clearinghouse and show how attempts at reaching a private solution failed due to bargaining inefficiencies.

[Figure 1]

In the case of MPS, it was clear that, failing a restructuring, the bank would ultimately be resolved. We call "resolution regime" the rules governing the distribution of losses in resolution. Our paper focuses on regimes in which shareholders are wiped-out in resolution, but private creditors may be partially reimbursed ("bailed out") by the government. By affecting the outside option of a bank's different claimholders, the resolution regime affects the process of private restructuring before the bank actually fails.[5] This raises important questions. In particular, does a tougher resolution regime, in effect a forced debt restructuring, favor of hinder private negotiations leading to a voluntary restructuring?

In this paper, we propose a model in which asymmetric information about the bank's assets generates a delay in restructuring a distressed bank, and this delay depends on the resolution regime. We show that the delay depends on how much the shareholders would gain by overstating the quality of the bank's assets, relative to the surplus they capture if the restructuring is successful. We derive a number of policy implications from this general principle. In particular, we show that a tougher resolution regime, all else equal, slows down the process.

More specifically, we consider a manager running a bank on behalf of existing shareholders. The bank has a portfolio of risky assets, and its liabilities consist of government-insured deposits, bonds, and equity. Bonds are uninsured, but in case of default the government would reimburse the bondholders after imposing a certain haircut. The bank is in financial distress, which creates the potential for a debt-overhang problem: the manager should make a remedial investment to increase the probability that the bank's assets pay off, but he does not, as this would mostly benefit the creditors and the government. To try and avoid this (opportunity) cost of financial distress, the manager can approach the creditors, and possibly the government, to negotiate a restructuring.

We begin by analyzing purely private restructuring negotiations involving the bank's manager (acting on behalf of the shareholders) and its bondholders but not the government. We model the negotiation process as a continuous time bargaining game in which, at each date, the manager can make an offer to the creditors. If creditors accept it, the game stops and the agreement is

[5] The corporate finance literature emphasizes that bankruptcy rules do affect corporate financial policies (e.g., leverage) or the likelihood of private workouts out-of-court. See, e.g., Acharya *et al.* (2011a), Acharya *et al.* (2011b).

implemented. If instead they reject the offer, the manager can make a new offer at a later date. However, delaying agreement with the creditors is costly: in each period a publicly observable shock may occur, after which it is no longer possible to improve the performance of the bank's assets. Bargaining then becomes useless and breaks down.

As a benchmark case, assume that the manager and the creditors are equally informed about the quality of the bank's assets. In principle, debt renegotiation can achieve the jointly efficient outcome with certainty: the total value of debt and equity being higher, the manager can exchange the existing debt against new claims such that shareholders and creditors are better off; absent frictions, the offer is made and accepted immediately.[6] Things are different once we assume the manager to be better informed than creditors about the assets' quality. Indeed, information asymmetry hinders the negotiation process, and an efficient outcome is no longer guaranteed. The manager has an incentive to claim that the bank's asset quality is high to extract better terms from the creditors. Anticipating such behavior, creditors would reject the offer.

In our analysis, the manager can use the timing of his offer to signal the assets' quality. The cost of delaying an offer is that bargaining may break down in the meantime. In equilibrium, it must thus be that by delaying his offer, the manager can extract a better deal from creditors, which he trades off against the risk that bargaining may break down. We assume that restructuring creates less value for higher quality banks, so that their shareholders bear a lower opportunity cost if restructuring negotiations fail. Hence, the manager of a higher quality bank is more willing to bear the risk of delaying his offer. As a result, a separating equilibrium can arise in which the manager makes an offer after a delay that is longer for higher quality banks. In equilibrium, the bank's quality is revealed to creditors but at the cost of potentially long negotiation delays, and the risk of breakdown they entail. The delay, which is socially costly, is determined by two effects. When the joint surplus from restructuring the bank is higher, this increases the incentives to find an agreement and reduces the delay ("surplus effect"). When the manager can extract a larger share of the surplus by misrepresenting the bank's quality, the incentives to hide the bank's type are higher and a longer delay is necessary to signal this type ("signaling effect").

[6] Such financial restructuring can take different forms (see Landier and Ueda (2009)). For instance, the management could offer creditors a debt-to-equity swap, buy back part of the debt at a discount, or propose a write-down.

We endogenize the bank's capital structure by letting the manager choose between deposits, bonds, and equity, before knowing the bank's type but anticipating the equilibrium of the restructuring game. While deposits are the cheapest source of funding due to (unpriced) deposit insurance, the bank cannot negotiate with dispersed depositors. This makes bonds also an attractive source of funding because they can speed up the restructuring of the bank. We show that the manager will always choose a capital structure such that during the restructuring game the manager would like to convince creditors that the bank is in better shape than it really is. By relying more on bonds at the margin, the manager creates an incentive in the other direction: if bondholders believe that the bank is in worse shape, they expect to receive a lower payoff if the bank is not restructured, which makes them willing to accept terms more favorable to the bank. A capital structure with more bonds decreases the signaling effect, and leads to more efficient restructuring. The optimal capital structure strikes the optimal trade off between this effect and the lower cost of deposits.

Next, we extend the model to allow the bank manager to involve the government to partake in negotiations. Indeed, purely private negotiations between shareholders and creditors exert externalities on the government, which is insuring the deposits and may bail out the bondholders. As a consequence, the set of banks that engage in restructuring negotiations and the pace at which they conduct them may not be optimal from the government's viewpoint. It may thus be desirable for the government to join the negotiations, and speed up the process. This can be achieved by offering subsidies for reaching an agreement (e.g., capital injection or debt guarantees). We characterize the equilibrium outcomes and show that now deposits also create an incentive for the manager to pretend the bank quality is lower, as this will make the government more willing to contribute to the restructuring. Bonds then lose the only advantage they had over deposits under private restructuring, and the optimal capital structure is now to use only deposits.

We use this setup to study the resolution regime's impact on the renegotiation process. We first study the impact of imposing a higher haircut on bondholders in resolution. We find that, for a given capital structure, this makes it more difficult to restructure the bank. Indeed, higher haircuts render the shareholders' expected payoff more sensitive to the creditors' beliefs about the bank's quality. This is because these beliefs affect the terms of financing and more so for higher haircuts.

Indeed, creditors being less insured against default, their claims are more information-sensitive. Thus the manager has much to gain for his shareholders by delaying making an offer, as the deal he can extract improves a lot with time. Consequently, longer delays are needed for signaling. This *signaling effect* implies that higher haircuts may slow down the restructuring process. Moreover, higher haircuts reduce the joint surplus restructuring creates for shareholders and creditors because they reduce future payments by the government. This *surplus effect* too implies that higher haircuts may slow down the restructuring process.

Second, we study the impact of involving the government in the restructuring process, compared to the case of private negotiation. We find that, depending on circumstances that we delineate, government involvement can speed up restructuring negotiations, as perhaps one might have expected, but can also slow them down. Indeed, involving the government means that the bargaining surplus considered is larger. This tends to speed up the bargaining process via the surplus effect. However, it is possible that the government makes larger transfers for banks of higher quality. If so, the benefits of pretending the bank to be of higher quality than it is are larger, and delays increase via the signaling effect.

Third, we study the wedge between the privately optimal capital structure chosen by the bank, and the socially optimal one. We show that the bank can issue too few bonds, so that a regulation forcing the bank to hold a minimum level of renegotiable debt would be welfare-improving. This is because the existence of such debt reduces the bank manager's incentives to pretend the bank is of higher quality than it really is, which alleviates the asymmetric information problem and speeds up the restructuring process. Due to this effect the socially optimal capital structure may not have any equity, despite equity not having any particular cost in our model.

Related literature. Our paper is related to a recent literature motivated by post-crisis regulatory reforms which studies important policy trade-offs when designing a resolution framework.[7] In Clayton and Schaab (2022) for instance, increasing the use of bail-inable debt, to facilitate recapitalization ex post, comes at the cost of providing weaker monitoring incentives ex ante. In Lambrecht and Tse (2023) different bail-out rules and implementations of bail-in lead to different lending and

[7]See also policy-oriented pieces, e.g., Dermine (2016), Gracie (2016), Huertas (2016) or Philippon and Salord (2017).

risk-taking behavior by the bank. Segura and Suarez (2023) study a model of bank restructuring under asymmetric information, in which the restructuring process is a mechanism designed by the public sector. Bolton and Oehmke (2018) study resolution rules for multinational banks, and how national authorities may fail to agree on the efficient loss-allocation rule. Banal-Estanol *et al.* (2021) show a trade-off between the ex-post efficiency of these rules and ex-ante investment incentives. Segura and Vicente (2018) analyze how to resolve and partially bail-out banks in a banking-union, in a way that ensures all countries agree to participate. Our paper enriches this literature by considering the impact of the resolution framework on private negotiations before the resolution occurs, a question which to our knowledge has not been studied.[8]

Several papers also study when a regulator should optimally trigger resolution. Early work in this literature includes for instance Mailath and Mester (1994) or Decamps *et al.* (2004), and more recently Freixas and Rochet (2013), Schilling (2023), and Koenig *et al.* (2023). Our focus is different as the timing of resolution is exogenous in the model. Instead the timing of restructuring is endogenous, and driven by signaling considerations that are typically absent from this literature. An exception is Walther and White (2020), in which triggering a resolution early can signal negative information to the market and precipitate a run.

An extant literature studies the alternatives to bank liquidations, such as bail-outs (e.g., Gorton and Huang (2004), Diamond and Rajan (2005), Dávila and Walther (2020)), asset purchases by the government (Philippon and Skreta (2012), Tirole (2012)), or acquisition by stronger banks (Acharya and Yorulmazer (2008), Perotti and Suarez (2002)). A particularly related paper is Philippon and Schnabl (2013), who study the optimal way for a government to recapitalize a banking sector under debt overhang. Instead, we study how government intervention affects private incentives to restructure a bank. Aghion *et al.* (1999) point out different informational benefits of bail-outs, which encourage banks to report negative news to the regulator. Instead, we study how regulation affects the bank's incentives to reveal information to market participants. Also related is the recent literature on contingent convertible securities ("CoCos"), which can be seen as a way to commit to

[8]The paper closest to considering this question is probably Keister and Mitkov (2023), which offers a model in which bail-ins are part of the optimal contract the bank offers creditors, and bail-outs delay the privately optimal bail-in. We consider an ex-post debt renegotiation process rather than a contract the bank could commit to ex ante, and we find that bail-outs speed up the private restructuring process.

a given allocation of losses to creditors if certain events materialize (see Flannery (2014)'s review). Our paper adds to this literature by showing how the ex post allocation of losses in resolution affects the incentives to restructure the bank and thus avoid resolution.

Our paper is also related to corporate finance theory work on debt restructuring.[9] Most papers in this literature focus on the problem of coordinating the multiple creditors of the firm. Bulow and Shoven (1978) study debt renegotiation when dispersed creditors cannot partake in negotiations, which generates an inefficiency. Gertner and Scharfstein (1991) study public debt restructurings, in which dispersed creditors can partake via exchange offers. Inefficiencies arise from their free-riding behavior, not from information frictions as in our model. In a related setup, Donaldson *et al.* (2022) show that a more creditor-friendly bankruptcy procedure can surprisingly facilitate restructuring, which echoes our result that more generous resolution speed up restructuring, although the mechanism is very different. Lehar (2015) studies a model with free-riding externalities, which in particular delivers the insight that more efficient bankruptcy procedures imply less efficient ex ante bargaining, which is close to what we call the "surplus effect". More related to our setup are a few papers considering the role of information. Giammarino (1989) shows debt renegotiation does not succeed with probability 1 in the presence of asymmetric information, so that bankruptcy costs cannot be completely avoided by renegotiation. Dou *et al.* (2021) propose a rich structural model of reorganization that features both a coordination problem and an asymmetric information problem and quantifies their relative strength, but the focus is not on how ex-post allocation rules affect these frictions. Finally, in Kahl (2002) delay in debt restructuring can be useful as information about the firm arrives over time. In contrast, in our model the bank manager knows the bank's quality, which delay serves to signal. Moreover, due to the positive externalities of renegotiation on the government, the equilibrium delay is suboptimal.

Technically, our model builds on models of bargaining under asymmetric information (see Ausubel *et al.* (2002)'s survey), where "signaling through delay" is key (e.g., Cramton (1984)). Formally, the problem we consider is close to a bargaining game with common values, in which the informed party makes the offers. A difference is that instead of selling a good for cash, the informed

[9] There is a specific literature on delays in sovereign debt restructuring, e.g., Alesina and Drazen (1991), Pitchford and Wright (2012), and Lehar and Stauffer (2015).

party offers to exchange existing financial claims (e.g., debt) against new financial claims (e.g., lower debt). Thus, information affects both terms of the exchange, as well as all parties' outside options.

The paper proceeds as follows. Section 1 presents a model of the process of restructuring a distressed bank. Sections 2 and 3 study restructuring without and with government involvement, respectively. Section 4 covers policy implications and extensions. Section 5 concludes. Proofs omitted in the text are in the Appendix and the Online Appendix.

1 The Model

We develop a model to study the restructuring and resolution of banks in financial distress. For simplicity, the model assumes universal risk-neutrality and no discounting. We solve for the Perfect Bayesian Nash equilibria under Cho and Kreps (1987)'s Intuitive Criterion.

Bank. At time $t = -1$, a bank must finance a set-up cost $I_0 > 0$ from a mix of D_0 insured deposits and B_0 uninsured bonds, the shortfall $K_0 = I_0 - D_0 - B_0$ being raised from equity. For simplicity, we assume it cannot raise more than I_0, i.e., $K_0 \geq 0$.[10] All claims are issued on a competitive market populated by risk-neutral investors, whose alternative to buying the claims is to invest in a risk-free asset with a 0% net interest rate. Hence, bondholders are promised a repayment $R_0 \geq B_0$ such that the expected repayment to bondholders is equal to B_0. Deposits are perfectly insured, hence the bank promises to repay depositors D_0. Finally, raising K_0 in equity costs exactly K_0 to the initial shareholders of the bank.

The bank's assets (e.g., loans) are of quality $\theta \in [0, 1]$: they yield a single cash-flow equal to Z with probability θ or 0 otherwise. The cash-flow realizes at a random time $T \in [0, +\infty)$: in each infinitesimal time period dt, it realizes with probability βdt where $\beta > 0$. Asset quality is initially unknown and drawn from distribution $f(\cdot)$ with c.d.f. $F(\cdot)$ over $[0, 1]$. Only the bank manager learns θ, at time $t = 0$. We assume f is C^0 and strictly positive over $[0, 1]$. We assume that setting up the bank is efficient, i.e.,

$$Z\mathbb{E}(\theta) \geq I_0. \tag{H1}$$

[10] In particular, the bank cannot store cash or pay shareholders an initial dividend. By storing cash, the bank could evade the problem of financing under asymmetric information central to our model. A rationale for the bank not raising more than I is that fly-by-night operators with no project would swamp the market (Rajan, 1992).

Financial distress. We model the financial distress of the bank as a low asset quality, which can be increased at the cost of a new investment. As we will see below, this new investment needs to be financed by external investors who don't know the value of θ. Formally, from time $t = 0$ to random time T when the cash-flow realizes, the bank can improve its asset quality: by investing $I > 0$ it can increase the probability that the assets yield Z from θ to $p(\theta) = \theta + m(1 - \theta)$. Note that $p(\theta) > \theta$ and $p(\theta)$ increases with θ.

Resolution. If the assets yield cash-flow Z at time T, the bank repays deposits and bonds and shareholders receive $(Z - D_0 - R_0)$.[11] If instead they yield 0, the bank defaults and enters resolution.[12] Depositors are fully insured: they are made whole by a government transfer of D_0. As for bondholders, they are bailed out with probability $(1 - h)$, in which case they receive a government transfer of R_0 making them whole, but otherwise face a bail-in and receive no transfer. Bail-in probability h is equivalent to a fraction h of the bonds' face value being bailed in, i.e., to a haircut.[13]

Restructuring process. If the investment is made, the total surplus created is $(p(\theta) - \theta)\, Z$, at a cost of I. However, the initial shareholders capture only $(p(\theta) - \theta)\,(Z - D_0 - R_0)$. This creates a debt overhang problem so that, in general, making the investment (if efficient) would require that the bank restructures its liabilities. To avoid dealing with uninteresting cases, we assume that shareholders and bondholders would gain from making the investment for some asset qualities θ and for all capital structures and resolution frameworks:

$$I < \min\left(m(Z - I_0), Z - \frac{I_0}{\mathbb{E}(\theta)}\right). \tag{H2}$$

Moreover, as is standard in the literature on financing under asymmetric information, we assume that I can only be paid by raising external funds, either from bondholders or from new shareholders.[14] Given this, we model the process of restructuring over $[0, T)$. Frictionless negotiations

[11] Indeed, if $Z < D_0 + R_0$, depositors and bondholders would receive (together) at least Z when the assets generate cash-flow Z. From condition (H1), the value of deposits and bonds would exceed I_0 which we have ruled out.

[12] Since assets pay zero in default, the seniority of depositors and bondholders plays no role.

[13] E.g., the BRRD requires that a minimum 8% of liabilities be bailed-in before the Single Resolution Fund (SRF), the EU-level fund for resolving failing banks, can be used.

[14] In principle, if I and θ are both sufficiently low the initial shareholders find it profitable to finance I without any contribution from the bondholders. However, for any I satisfying (H2) there are types θ such that debt overhang ma-

between the bank's claimants would yield the efficient outcome (Haugen and Senbet, 1978): invest if and only if $(p(\theta) - \theta) Z \geq I$. However, we assume two frictions. First, by time $t = 0$, the bank manager (acting on existing shareholders' behalf) knows asset quality θ but other parties only know its distribution $f(\cdot)$. Thus negotiations take place under asymmetric information. Second, the government may not partake in the restructuring, in which case restructuring does not internalize externalities on the government. We call this baseline case *private restructuring*. In Section 3 we let the bank manager negotiate with both the bondholders and the government, a case we call *publicly subsidized restructuring*.

We study the impact of those frictions in a model of the restructuring process in which the manager chooses both a restructuring plan to offer bondholders and the timing of that offer.

First, the manager chooses a restructuring plan whereby bondholders contribute I and exchange their existing bonds with face value R_0 against new debt with face value R.[15] As part of the plan, the bank manager commits to making investment I. We assume that bondholders accept any offer making them at least as well off as in the status quo.[16]

Second, the manager chooses his offer's timing $t \in [0, +\infty)$. Delayed offers involve a risk the cash-flow realizes before the offer is made, in which case investing is no longer possible and the restructuring process ends. Otherwise, the game continues until bondholders accept an offer or the process ends because cash-flow realizes. For simplicity, the manager cannot make offers after one has been accepted.

terializes and the initial shareholders refuse to pay I, even though this investment is socially efficient. Our assumption simplifies the model by assuming a problem of financing under asymmetric information for any θ, not only for higher values.

[15] Within our model this is optimal. Absent bail-outs ($h = 1$), debt, equity, and all other uninsured claims are equivalent because there are two states one of which with a zero payoff. When $h < 1$, since by assumption bonds may be bailed out, it is optimal for the bank to offer to replace existing bonds with new bonds. Note that I may be an opportunity cost for bondholders. For instance, if liquidated immediately, some loans could generate I to be paid immediately to bondholders, but if rolled over, generate Z with probability $m(1 - \theta)$. By rolling over the loans, bondholders would forgo an immediate payment I and extend their debt maturity with a new higher face value.

[16] See Gertner and Scharfstein (1991) for a model of how exchange offers for senior debt can implement a debt write-down for dispersed creditors.

2 Private Restructuring

We study the private restructuring process between the bank manager and bondholders and the bank's capital structure choice.

2.1 Restructuring for a Given Capital Structure

We first characterize restructuring for a given capital structure. An equilibrium of the restructuring subgame (i.e., for $t \in [0, +\infty)$) specifies for each asset quality θ whether the manager makes an offer, and if he does, the repayment (or "restructuring plan") $R^*(\theta)$ offered and its timing $\Delta^*(\theta)$; it also specifies bondholders' beliefs for each possible repayment-delay pair (R, Δ), i.e., a posterior distribution over asset qualities. Without loss of generality, we only consider equilibria in which equilibrium offers are immediately accepted.[17]

2.1.1 Restructuring Plans

In an equilibrium, (accepted) offers must satisfy several constraints. First, the manager must prefer the offer to the status quo. For asset quality θ, with no offer, shareholders' status quo payoff is:

$$\bar{E}(R_0, \theta) = \theta(Z - D_0 - R_0). \tag{1}$$

That is, they get $(Z - D_0 - R_0)$ provided the bank does not default, which occurs with probability θ, and zero otherwise. If instead the manager offers R and bondholders accept the offer, they get:

$$\bar{E}(R, p(\theta)) = p(\theta)[Z - D_0 - R] = [1 - (1 - \theta)(1 - m)][Z - D_0 - R]. \tag{2}$$

That is, given the new bonds' face value R, shareholders get $[Z - D_0 - R]$ unless the bank defaults, which occurs with probability $(1 - \theta)(1 - m)$. Shareholders have to be better off with an (accepted)

[17] It is easy to construct equilibria in which the manager makes offers that are never accepted. We see such trivial offers as being equivalent to non-offers.

offer R than under the status quo, i.e., $\bar{E}(R, p(\theta)) \geq \bar{E}(R_0, \theta)$, which can be written as:

$$R \leq R_{max}(\theta) \equiv \frac{(p(\theta)-\theta)(Z-D_0)+\theta R_0}{p(\theta)} = \frac{m(1-\theta)(Z-D_0)+\theta R_0}{1-(1-\theta)(1-m)}. \tag{3}$$

Note that $R_{max}(\theta)$ is less than $(Z - D_0)$ and thus always feasible.[18]

A second constraint is that bondholders must be better off accepting the offer than rejecting it. If bondholders believing the expected asset quality to be $\hat{\theta}$ reject the offer, their expected payoff is:

$$\bar{C}(R_0, \hat{\theta}) = [1-(1-\hat{\theta})h]R_0. \tag{4}$$

That is, bondholders receive R_0 unless the bank defaults, which they expect to occur with probability $(1-\hat{\theta})$, and they are bailed in, which occurs with probability h. If instead they accept the offer to contribute I and replace their bonds with new bonds with face value R, their expected payoff is:

$$\bar{C}(R, p(\hat{\theta})) - I = [1-(1-p(\hat{\theta}))h]R - I = [1-(1-\hat{\theta})(1-m)h]R - I. \tag{5}$$

That is, they pay I and receive R unless the bank defaults and they are bailed in, which occurs with probability $(1-p(\hat{\theta}))h$. They prefer accepting the offer, i.e., $\bar{C}(R, p(\hat{\theta})) - I \geq \bar{C}(R_0, \hat{\theta})$, if:

$$R \geq R_{min}(\hat{\theta}) \equiv \frac{[1-(1-\hat{\theta})h]R_0}{[1-(1-\hat{\theta})(1-m)h]} + \frac{I}{[1-(1-\hat{\theta})(1-m)h]}. \tag{6}$$

The restructuring plan $R_{min}(\hat{\theta})$ is the most aggressive one bondholders will accept if they perceive asset quality to be $\hat{\theta}$. The first term is below R_0: it is the debt write-down making bondholders indifferent between the new debt under the new repayment probability $[1-(1-p(\hat{\theta}))h]$ and the old debt R_0 under the old repayment probability $[1-(1-\hat{\theta})h]$. The second term reflects funding: it is the face value competitive bondholders would set to lend I given the new repayment probability.[19]

Knowing the type θ of a bank, one can find a restructuring offer R acceptable to both the bondholders and the shareholders if and only if $R_{max}(\theta) \geq R_{min}(\theta)$. Under our assumption on $p(.)$,

[18] $R_{max}(\theta)$ is a weighted average of $(Z - D_0)$ and R_0 which is less than $(Z - D_0)$, implying $R_{max}(\theta) \leq (Z - D_0)$.
[19] Whether this funding is provided by existing bondholders or new financiers is immaterial to our analysis.

the set of types θ such that this is possible is particularly simple:[20]

Lemma 1. *There exists a unique* $\theta^* \in (0,1)$ *such that* $R_{max}(\theta) \geq R_{min}(\theta)$ *if and only if* $\theta \in [0, \theta^*]$.

The cutoff type θ^* is the highest θ such that restructuring creates a surplus for the bank's shareholders and bondholders. Importantly, the surplus for the government is not taken into account (see the policy discussion in Section 4). We now study whether the manager has an incentive and the possibility to signal the asset quality. The incentive to signal in the model is to affect bondholders' beliefs and negotiate a lower repayment. Whether the manager wants to signal high or low asset quality will depend on whether $R_{min}(\hat{\theta})$ decreases with $\hat{\theta}$. We have

$$\dot{R}_{min}(\hat{\theta}) = \frac{hmR_0}{[1-(1-\hat{\theta})(1-m)h]^2} - \frac{h(1-m)I}{[1-(1-\hat{\theta})(1-m)h]^2}. \tag{7}$$

Thus, two opposite effects captured by expression (7)'s two terms drive how perceived asset quality $\hat{\theta}$ impacts $R_{min}(\hat{\theta})$. On the one hand, if bondholders believe $\hat{\theta}$ to be high, they value the existing bonds highly and will agree only to a small write-down against what they view as a small rise in asset quality. On the other hand, as in the standard problem of financing under asymmetric information (Myers and Majluf (1984)), they will set a low face value to finance I as they perceive default risk as small. Which effect dominates, i.e., the sign of $\dot{R}_{min}(\hat{\theta})$, depends on that of $mR_0 - (1-m)I$.

Lemma 2. *The most aggressive plan* $R_{min}(\hat{\theta})$ *bondholders will accept decreases (resp. increases) with perceived asset quality* $\hat{\theta}$ *if and only if the bank's capital structure satisfies (resp. does not satisfy):*

$$mR_0 \leq (1-m)I \tag{H3}$$

As R_0 depends on the capital structure decision of the bank, we will characterize restructuring depending on whether condition (H3) holds. We will then show that the bank always chooses a capital structure satisfying (H3).

The manager is able to use delaying an offer as a credible signal of a high asset quality in our

[20] A linear specification for $p(.)$ ensures that this set is an interval for any possible values of D_0 and R_0, which we will endogenize later. If one keeps D_0 and R_0 exogenous instead, Lemma 1 holds under some restrictions on D_0 and R_0 for a general function $p(.)$ satisfying condition (H4) below. Lemmas 2 and 3, and Propositions 1 and 2 then also hold.

model, because the function p we picked satisfies a more general condition:

$$\frac{\partial}{\partial\theta}\left(\frac{p(\theta)}{\theta}\right) < 0. \tag{H4}$$

This condition means that restructuring the bank in order to increase the success probability from θ to $p(\theta)$ matters less for high-quality banks. The next Lemma summarizes the implications of this property for signaling in this model.

Lemma 3. *Under (H4): (i) If type $\theta \in [0,1]$ weakly prefers the pair (R,Δ) to (R',Δ') and $\Delta > \Delta'$, then any $\theta' > \theta$ strictly prefers (R,Δ) to (R',Δ'); (ii) $R_{max}(.)$ is weakly decreasing; (iii) $R^*(.)$ is weakly decreasing and $\Delta^*(.)$ weakly increasing; (iv) If type $\theta \in [0,1]$ makes an offer after a finite delay in equilibrium, then any type $\theta' < \theta$ also makes an offer after a finite delay.*

We now show that there can be only two types of equilibria: a separating equilibrium in which Δ^* is strictly increasing, and a pooling equilibrium in which Δ^* is constant.

2.1.2 Separating Equilibrium

In this section, we assume condition (H3) to hold. Thus, the manager has an incentive to convey that asset quality is high to get better terms from bondholders. We show that, in equilibrium, he does so by using his offer's timing: the higher the asset quality, the more delayed the offer.

Proposition 1. *Under condition (H3), the equilibrium strategies of any Perfect Bayesian Nash equilibrium satisfying the Intuitive Criterion are as follows.*

- *For asset quality $\theta < \theta^*$, the manager waits $\Delta^*(\theta)$ to propose a restructuring plan $R^*(\theta)$ which bondholders accept immediately, with $R^*(\theta)$ decreasing and $\Delta^*(\theta)$ increasing in θ defined by:*

$$R^*(\theta) = R_{min}(\theta) \tag{8}$$

$$\Delta^*(\theta) = \int_0^\theta \frac{E_1(x,x)}{\beta[E(x,x) - \bar{E}(R_0,x)]}dx, \tag{9}$$

with

$$E(x,y) \equiv \bar{E}(R_{min}(x), p(y)) \tag{10}$$

$$E_1(x,y) = \frac{\partial E(x_0,y_0)}{\partial x_0}|_{x_0=x,y_0=y} = -p(y)\dot{R}_{min}(x). \tag{11}$$

- *For asset quality $\theta \geq \theta^*$, the manager proposes no restructuring plan.*

The Appendix A.4 specifies beliefs supporting this equilibrium behavior and satisfying the Intuitive Criterion and a closed-form expression for Δ^*.

The equilibrium has a simple structure: the higher the asset quality θ, the longer the delay $\Delta^*(\theta)$ the manager waits before offering a more aggressive plan, i.e., a lower $R^*(\theta)$. In equilibrium the bondholders perfectly infer the type θ making the offer, and the manager offers the most aggressive plan bondholders will accept given θ, i.e., $R^*(\theta) = R_{min}(\theta)$. For asset quality above a threshold θ^*, the manager makes no offer, or equivalently the delay is infinite.

As per expression (9), delay $\Delta^*(\theta)$ increases with θ, i.e., banks with better quality assets take longer to restructure and thus run a higher risk that restructuring fails. The reason is that delay is being used to signal higher asset quality, which convinces bondholders to extend better terms, i.e., $R^*(\theta)$ decreases with θ.[21] Note also that $R_{min}(\theta)$ being strictly decreasing under condition (H3), this implies that the equilibrium is fully separating (for all types below the threshold).

The reason types below a threshold offer a plan is that, for a given repayment, the lower the asset quality, the more shareholders benefit from restructuring, i.e., $R_{max}(\theta)$ decreases with θ. The reason offers are the most aggressive possible is as follows. If $R^*(\theta) > R_{min}(\theta)$, type θ can offer a slightly lower repayment $R' < R^*(\theta)$ after a slightly longer delay $\Delta' > \Delta^*(\theta)$ such that this offer, if accepted, is marginally profitable. Due to the single-crossing property (H4), only types slightly below θ find the lower repayment worth the longer delay, i.e., deviation (R', Δ') profitable. Under the Intuitive Criterion, bondholders must believe asset quality to be only slightly below θ, and so they break even with repayment R': they accept the offer, giving a profitable deviation to type θ.

Next, we derive the equilibrium delay $\Delta^*(\theta)$. Say bondholders believe that for asset quality $\theta \in$

[21] Note that asset quality refers only to unobserved asset quality, holding observed quality constant.

$[0, \theta^*)$, the manager offers plan $R^*(\theta) = R_{min}(\theta)$ at time $\Delta^*(\theta)$. For asset quality θ, the manager's problem amounts to choosing which asset quality $\hat{\theta}$ to convey to bondholders, which he can do by delaying his offer until $\Delta^*(\hat{\theta})$ and offering $R^*(\hat{\theta})$. With probability $(1 - e^{-\beta\Delta^*(\hat{\theta})})$, restructuring ends before time $\Delta^*(\hat{\theta})$ and shareholders get the status quo payoff $\bar{E}(R_0, \theta)$. Otherwise, restructuring reaches time $\Delta^*(\hat{\theta})$, bondholders accept plan $R^*(\hat{\theta})$, and shareholders' payoff is $\bar{E}(R_{min}(\hat{\theta}), \theta) = E(\hat{\theta}, \theta)$. Shareholders' expected payoff is thus:

$$[1 - e^{-\beta\Delta^*(\hat{\theta})}]\bar{E}(R_0, \theta) + e^{-\beta\Delta^*(\hat{\theta})}E(\hat{\theta}, \theta). \tag{12}$$

The manager's action must be optimal given the bondholders' beliefs, i.e., for all $\theta \in [0, \theta^*]$, (12) must be maximized for $\hat{\theta} = \theta$. Differentiating expression (12) with respect to $\hat{\theta}$ gives:

$$e^{-\beta\Delta^*(\hat{\theta})}\left[E_1(\hat{\theta}, \theta) - \beta\dot{\Delta}^*(\hat{\theta})(E(\hat{\theta}, \theta) - \bar{E}(R_0, \theta))\right]. \tag{13}$$

The condition captures the manager's trade-off when, having reached time $\Delta^*(\hat{\theta})$, he considers further delaying his offer. Without further delay, the manager would offer $R(\hat{\theta})$ and shareholders' payoff would be $E(\hat{\theta}, \theta)$. The marginal benefit of delaying the offer by $\dot{\Delta}^*(\hat{\theta})d\hat{\theta}$ is that the bondholders' belief about asset quality would increase by $d\hat{\theta}$ so that, if restructuring continues, the shareholders' payoff increases by $E_1(\hat{\theta}, \theta)d\hat{\theta}$. The marginal cost of delaying the offer is that the likelihood that restructuring ends increases by $\beta\dot{\Delta}^*(\hat{\theta})d\hat{\theta}$, in which case shareholders get $\bar{E}(R_0, \hat{\theta})$, hence an opportunity cost of $E(\hat{\theta}, \theta) - \bar{E}(R_0, \hat{\theta})$. For $\hat{\theta} = \theta$ to be optimal, the marginal benefit of delaying the offer must equal its marginal cost, i.e., expression (13) must equal zero, which can be written as:

$$\dot{\Delta}^*(\theta) = \frac{E_1(\theta, \theta)}{\beta[E(\theta, \theta) - \bar{E}(R_0, \theta)]}. \tag{14}$$

Note that in equilibrium, for the lowest asset quality possible ($\theta = 0$), shareholders obtain the worst terms. Hence, it must be that for $\theta = 0$, the manager does not wait to make an offer (i.e., $\Delta^*(0) = 0$), as a deviation would otherwise be profitable. Integrating expression (14) gives the equilibrium delay (9).

Expression (14) highlights that two factors determine delays, which we refer to as the *surplus* *effect* and the *signaling effect*.

First, in the denominator, $[E(\theta,\theta) - \bar{E}(R_0,\theta)]$ is the shareholders' gain from immediate restructuring. Since shareholders extract all the surplus, it equals the joint surplus created for shareholders and bondholders. Parameter β reflects the possible loss of that surplus due to restructuring ending, which is the cost of delay. A larger surplus leads to shorter delays because it increases the cost of waiting, and thus waiting a given amount of time is a stronger signal of quality. We call this effect the *surplus effect*.

$$\begin{aligned} E(\theta,\theta) - \bar{E}(R_0,\theta) &= m(1-\theta)(Z - D_0 - R^*(\theta)) - \theta(R^*(\theta) - R_0) \\ &= [m(1-\theta)(Z-D_0) - I] + (1-\theta)(1-h)\frac{(1-m)I - mR_0}{1-(1-\theta)(1-m)h} \end{aligned} \tag{15}$$

This expression illustrates that restructuring increases shareholder surplus through two effects: it increases total surplus by $[m(1-\theta)Z - I]$, of which shareholders capture $[m(1-\theta)(Z-D_0) - I]$, and it leads to a higher bond level which implies a net increase in expected shortfall in default of

$$(1-\theta)[(1-m)R^*(\theta) - R_0] = (1-\theta)\frac{(1-m)I - mR_0}{[1-(1-\theta)(1-m)h]} > 0. \tag{16}$$

This increases shareholder surplus due to the increase in expected bail-out payments.

Second, the numerator $E_1(\theta,\theta)$ reflects the sensitivity of shareholders' payoff to asset quality $\hat{\theta}$ as perceived by bondholders. The higher this sensitivity, the more shareholders benefit from "lying-by-delaying", and thus the longer the delay needed for banks with higher quality assets to separate. We call this effect the *signaling effect*.

$$E_1(\theta,\theta) = -p(\theta)\dot{R}^*(\theta) > 0. \tag{17}$$

The expression for $E_1(\theta,\theta)$ captures the fact that shareholders benefit from bondholders believing asset quality to be higher, because this makes bondholders ready to accept a lower repayment R^*.

Figure 2 illustrates the equilibrium delay $\Delta^*(\theta)$ in an example.[22] Figure 3 compares, for an

[22] The parameters used to generate the figures are reported in Appendix B.

actual asset quality θ, the shareholders' expected payoff if bondholders perceive asset quality to be $\hat{\theta}$ vs. if they believe it to be θ, and confirms that in this example $\Delta(\theta)$ induces truthful revelation.

[Figures 2 and 3]

2.1.3 Pooling Equilibria

Now assume condition (H3) not to hold, so that $R_{min}(\theta)$ increases in θ. In that case, the manager has an incentive to convey that asset quality is low to get better terms from bondholders. However, as per the single-crossing property (H4), delay can only help higher asset quality banks separate from lower asset quality banks. Hence, no signalling is possible and only pooling equilibria obtain under the Intuitive Criterion.

Proposition 2. *If condition (H3) does not hold, the equilibrium strategies of any Perfect Bayesian Nash equilibrium satisfying the Intuitive Criterion are as follows.*

- *There are equilibria in which types $\theta \in [0, \theta^*]$ offer the same plan $R^*(\theta) = R_{max}(\theta^*)$ immediately, i.e., with $\Delta^*(\theta) = 0$, and types $\theta > \theta^*$ make no offer.*
- *All other equilibria are such that for some $\bar{\theta} > \theta^*$, types $\theta \in [0, \bar{\theta}]$ offer the same plan $R^*(\theta) = \bar{R}$ after the same delay $\Delta^*(\theta) = \bar{\Delta}$, with $\bar{R} = R_{max}(\bar{\theta}) < R_{max}(\theta^*)$. All types $\theta > \bar{\theta}$ make no offer.*

The Appendix OA.1 specifies beliefs supporting the equilibrium behavior in each case and satisfying the Intuitive Criterion.

This case occurs when the bank issued so many bonds in $t = -1$ that the manager then wants to pretend the bank's assets are worse than they really are. No signaling is possible in this case when $p(.)$ satisfies (H4). We will now show that it is never optimal for the bank to adopt such a capital structure in the first place, so that we do not comment further on pooling equilibria.

2.2 Optimal Capital Structure

2.2.1 The Optimal Capital Structure Leads to a Separating Equilibrium

We now study the manager's choice of a capital structure for the bank, i.e., of the mix of deposits, bonds, and equity to finance the bank's set up cost I_0 at $t = -1$ (before the manager learns θ). We show that the optimal capital structure satisfies condition (H3).

Denoting V the bank's expected profit for a given capital structure at $t = -1$, and using $K_0 = I_0 - B_0 - D_0$, regardless of the type of equilibrium after $t = 0$ we have

$$
\begin{aligned}
V &= \int_0^{\bar{\theta}} \left[e^{-\beta\Delta^*(\theta)} \bar{E}(R^*(\theta), p(\theta)) + \left(1 - e^{-\beta\Delta^*(\theta)}\right) \bar{E}(R_0, \theta) \right] dF(\theta) \\
&+ \int_{\bar{\theta}}^1 \bar{E}(R_0, \theta) dF(\theta) - (I_0 - B_0 - D_0). \qquad (18)
\end{aligned}
$$

The bank's uninsured bonds are priced competitively, so that

$$
\begin{aligned}
B_0 &= \int_0^{\bar{\theta}} \left[e^{-\beta\Delta^*(\theta)} (\bar{C}(R^*(\theta), p(\theta)) - I) + \left(1 - e^{-\beta\Delta^*(\theta)}\right) \bar{C}(R_0, \theta) \right] dF(\theta) \\
&+ \int_{\bar{\theta}}^1 \bar{C}(R_0, \theta) dF(\theta). \qquad (19)
\end{aligned}
$$

Using (1) and (4), we have

$$
\bar{E}(R_0, \theta) + \bar{C}(R_0, \theta) = \theta(Z - D_0) + (1 - \theta)(1 - h)R_0. \qquad (20)
$$

We use (19) to replace B_0 in (18), and then use (20) to obtain

$$
\begin{aligned}
V &= \mathbb{E}(\theta)Z - I_0 + (1 - \mathbb{E}(\theta))D_0 + (1 - \mathbb{E}(\theta))(1 - h)R_0 \\
&+ \int_0^{\bar{\theta}} e^{-\beta\Delta^*(\theta)} [\bar{E}(R^*(\theta), p(\theta)) + \bar{C}(R^*(\theta), p(\theta)) - I - \bar{E}(R_0, \theta) - \bar{C}(R_0, \theta)] dF(\theta). \qquad (21)
\end{aligned}
$$

This expression has a natural economic interpretation. On the first line, $\mathbb{E}(\theta)Z - I_0$ is the social value of the bank's project in the absence of restructuring, which is independent of the capital structure. The other two terms reflect that with probability $1 - \mathbb{E}(\theta)$ the government will make a transfer, the value of which is extracted ex ante by the bank's shareholders. This transfer is of size D_0 for deposits, and $(1-h)R_0$ for bonds. On the second line, we have the expected value of restructuring. The value of restructuring for a given θ can be expressed as:

$$\begin{aligned} & \bar{E}(R^*(\theta), p(\theta)) + \bar{C}(R^*(\theta), p(\theta)) - I - \bar{E}(R_0, \theta) - \bar{C}(R_0, \theta) \\ = \;& [p(\theta) - \theta]Z - I - [p(\theta) - \theta]D_0 + (1-h)[R^*(\theta)(1-p(\theta)) - R_0(1-\theta)]. \end{aligned} \tag{22}$$

Conditionally on restructuring taking place, the total surplus created is $[p(\theta) - \theta]Z - I$. From this total, the bank shareholders lose $[p(\theta) - \theta]D_0$, which reflects the lower probability that the government reimburses depositors. In addition, the transfers to bondholders are also affected.

The optimal capital structure maximizes V in D_0 and B_0, under the constraint that deposits, bonds, and equity are all positive. As (21) and (22) make clear, the trade-off is between extracting more transfers from the government and reducing the delay in restructuring. Our main result regarding the optimal capital structure is the following:

Proposition 3. *At $t = -1$, the manager optimally chooses a capital structure such that condition (H3) holds. Hence, the equilibrium restructuring outcome is characterized by the separating equilibrium of Proposition 1.*

The intuition is the following. If the manager chooses a capital structure with B_0 so high that (H3) does not hold, this leads to a pooling equilibrium. In the best case, this pooling equilibrium would be such that all types in $[0, \theta^*]$ restructure after a delay of 0. The manager should consider decreasing B_0 and increasing D_0 so that (H3) holds with an equality, which leads to a separating equilibrium in which all types in $[0, \theta^*]$ restructure after a zero delay too. Because the bank relies more on insured deposits and less on bonds, it extracts more future subsidies from the government in expectation, which makes this capital structure more profitable.[23] Hence, the optimal capital structure necessarily leads to a separating equilibrium (possibly in the special case where (H3) holds with an equality). In the remainder of this section, we thus no longer consider capital structures

[23] A significant complication in the proof is that the bank needs to offer higher future repayments when relying on uninsured bonds, so that it is not obvious that bonds always lead to lower government subsidies than deposits. The analytically involved part of the proof is about showing that this is indeed the case.

leading to a pooling equilibrium.

Figure 4 shows in a numerical example how the capital structure varies with I_0 and h. We obtain three types of solution: (i) The bank uses only deposits ($D_0 = I_0$), (ii) The bank uses only bonds ($B_0 = I_0$), (iii) The bank uses a mix of deposits and bonds such that the separating constraint (H3) is binding. In cases (i) and (ii) the equilibrium delay is positive, and it is null in case (iii). In all cases the bank issues no equity. In this example a lower h or a higher I_0 push the bank to rely more on deposits and less on bonds.[24]

[Figure 4]

2.2.2 Trade-Off between Deposits, Bonds, and Equity

From expression (9) we can derive how equilibrium delays vary with the bank's capital structure.

Corollary 1. *Under condition (H3), the capital structure affects restructuring as follows.*

- *The equilibrium threshold θ^* decreases and the equilibrium delay $\Delta^*(\theta)$ increases with D_0.*
- *The equilibrium threshold θ^* decreases with B_0. There exists $\tilde{\theta} \in (0, \theta^*)$ such that the equilibrium delay decreases with B_0 for $\theta \leq \tilde{\theta}$. Otherwise the equilibrium delay increases in B_0, but less than in D_0.*

Increasing D_0 has no signaling effect (it does not affect $R^*(\hat{\theta})$) but reduces shareholders and bondholders' joint surplus from restructuring, thus increasing delays via the surplus effect. The drop in surplus arises from a debt overhang problem (Myers, 1977): with higher deposits, the government gains more from restructuring without contributing to its cost. This greater externality implies a lower cost of waiting and so longer delays are needed for signaling. It also implies that shareholders and bondholders' joint surplus is positive for a smaller range of asset qualities, i.e., θ^* decreases.

The intuition for the impact of B_0 is as follows. A higher asset quality as perceived by bondholders matters in two ways. On the one hand, it implies a lower debt face value needed to finance I. This gives the manager an incentive to pretend asset quality is high (a "Myers-Majluf problem"). On the

[24] We have not been able to find an example of parameters for which the bank chooses a positive level of equity, or an interior solution with B_0 and D_0 both positive but (H3) slack. However, we have not been able to prove that such solutions never exist.

other hand, bondholders are willing to agree to a smaller write-down of their existing debt, which gives the manager an incentive to pretend asset quality is low (a "debt renegotiation problem"). Under condition (H3), the Myers-Majluf problem dominates. Because a higher B_0 counter-balances the manager's incentive to pretend asset quality to be high, it reduces the asymmetric information problem, which lowers the equilibrium delay.

3 Publicly Subsidized Restructuring

Private restructuring exerts externalities on the government through the public funds used for deposit insurance and bondholder bailout payments. Which banks engage in restructuring and the pace at which they conduct this process may not be optimal from the government's viewpoint. The government may thus gain from joining the process. We analyze this case now.

3.1 Restructuring for a Given Capital Structure

We extend our model to account for the government's possible participation in the restructuring process. As before, the bank manager chooses a restructuring plan offer and the offer's timing. Now, however, the manager has to make an offer (I_C, R) to bondholders but also an offer (I_G, D) to the government, with $0 \leq I_G < I$ and $I_C = I - I_G$. If both are accepted, the bondholders and the government contribute I_C and I_G to the investment I, and the bank, if successful, pays R to bondholders, D_0 to depositors, and $(D - D_0)$ to the government. If either the government or the bondholders reject the offer, then restructuring does not take place.

Our modelling fits different real-world situations. If $I_G > 0$ and $D > D_0$, the government lends money to the bank or, equivalently, injects equity at a possibly subsidized price. If $I_G > 0$ and $D = D_0$, the government finances part of the investment. If $D < D_0$, the government commits to making a payment to the bank conditionally on success.

3.1.1 Restructuring Plans

The analysis follows closely that in the previous section, with the exception that the manager's offer must be accepted both by the bondholders and the government, and the bank can now propose

$D \neq D_0$. This leads us to extend the notations as follows. For a given deposit repayment d, bond repayment r, and success probability x, we define the expected payoff to the government, the bondholders, and the shareholders, as:

$$\begin{aligned} \bar{G}(d,r,x) &= x(d-D_0)+D_0-(1-x)[D_0+(1-h)r] && (23) \\ \bar{C}(d,r,x) &= [1-(1-x)h]r && (24) \\ \bar{E}(d,r,x) &= x[Z-d-r]. && (25) \end{aligned}$$

The government's payoff has two components. Given its role as a deposit insurer, the government is like a bondholder with a claim D_0 on the bank, who can finance an investment I_G in exchange for a new claim with face value D. In addition, as a source of bail-outs, the government gains an additional term when the bank's probability of default decreases. To emphasize the symmetry between the government and bondholders, we add the (constant) repayment to depositors D_0. In particular, the government's outside option is:

$$\bar{G}(D_0,R_0,\theta)=\theta D_0-(1-\theta)(1-h)R_0. \tag{26}$$

The payoffs for shareholders and bondholders are identical to the previous section, except for the possibility to have $D \neq D_0$.

If restructuring does not occur, the government receives $\bar{G}(D_0,R_0,\theta)$, the bondholders $\bar{C}(D_0,R_0,\theta)$, and the shareholders $\bar{E}(D_0,R_0,\theta)$. If the offers (I_G,D) and (I_C,R) are accepted, restructuring occurs. The government obtains $\bar{G}(D,R,p(\theta))-I_G$, the bondholders $\bar{C}(D,R,p(\theta))-I_C$, and the shareholders $\bar{E}(D,R,p(\theta))$.

To highlight the parallel with the previous section, we define the counterparts to R_{max} and R_{min} in this case. Note that $\bar{E}(d,r,x)$ only depends on the sum $d+r$. In particular, type θ prefers making an offer (D,I_G,R,I_C) to not making an offer if and only if $R+D \leq P_{max}(\theta)$, with:

$$P_{max}(\theta)=Z-\frac{\theta}{p(\theta)}[Z-D_0-R_0]=\frac{m(1-\theta)Z+\theta(D_0+R_0)}{1-(1-\theta)(1-m)}. \tag{27}$$

$P_{max}(\theta)$, the maximum total repayment type θ accepts, is akin to R_{max} in the previous section. Due to (H4), it decreases with θ: higher types gain less in restructuring and require lower repayments.

Similarly, consider offer $(D_{min}(\theta), I_C, R_{min}(\theta), I_G)$ which bondholders and the government are indifferent between accepting and rejecting if they believe the type is θ. That is, $\bar{C}(D_{min}(\theta), R_{min}(\theta), \theta) - I_C = \bar{C}(D_0, R_0, \theta)$ and $\bar{G}(D_{min}(\theta), R_{min}(\theta), \theta) - I_G = \bar{G}(D_0, R_0, \theta)$. We denote $P_{min}(\theta) = R_{min}(\theta) + D_{min}(\theta)$, with:

$$R_{min}(\theta) = \frac{[1-(1-\theta)h]R_0 + I_C}{1-(1-\theta)(1-m)h} \tag{28}$$

$$D_{min}(\theta) = \frac{D_0\theta + I_G}{p(\theta)} + \frac{(1-h)[I_C(1-p(\theta)) - (p(\theta)-\theta)R_0]}{p(\theta)[1-h(1-p(\theta))]} \tag{29}$$

$$P_{min}(\theta) = \frac{I + \theta(R_0 + D_0)}{1-(1-m)(1-\theta)} \tag{30}$$

$$\dot{P}_{min}(\theta) = \frac{-[(1-m)I - m(R_0 + D_0)]}{[1-(1-m)(1-\theta)]^2}. \tag{31}$$

P_{min} is the minimal repayment the bondholders and the government ask from the bank, akin to R_{min} in the previous section. Note that it depends on I_C and I_G only through their constant sum I. Moreover, P_{min} is decreasing in θ if and only if:

$$m(R_0 + D_0) \leq (1-m)I \tag{H3-G}$$

The interpretation is the same as in the previous section: this condition means that the "Myers-Majluf" effect dominates the debt renegotiation effect. Since in this case the bank can be seen as renegotiating the repayment of deposits with the government, the magnitude of the second effect depends on $R_0 + D_0$ rather than on R_0 only.

Finally, using (27) and (30), we see that $P_{min}(\theta) \leq P_{max}(\theta)$ if and only if $\theta \leq \theta^{**}$ with:

$$\theta^{**} = 1 - \frac{I}{mZ}. \tag{32}$$

Given the definition of $P_{min}(\theta)$ and $P_{max}(\theta)$, θ^{**} can also be interpreted as the highest type for which restructuring creates value for the shareholders, the bondholders, and the government jointly. Differently private restructuring, now all types below θ^{**} can restructure with positive probability.

3.1.2 Separating and Pooling Equilibria

We now solve for the equilibria of the publicly subsidized restructuring game. As under private restructuring, there are separating or poling equilibria, depending on whether (H3-G) is met.

Proposition 4. *Under condition (H3-G), any Perfect Bayesian Nash equilibrium satisfying the Intuitive Criterion is as follows.*

- *For asset quality $\theta < \theta^{**}$, the manager proposes a plan $(R^{**}(\theta), I_C^{**}(\theta), D^{**}(\theta), I_G^{**}(\theta))$ after delay $\Delta^{**}(\theta)$, which bondholders accept immediately, with $(R^{**} + D^{**})$ decreasing and Δ^{**} increasing in θ and satisfying:*

$$\begin{aligned} I_C^{**}(\theta) + I_G^{**}(\theta) &= I & (33)\\ R^{**}(\theta) &= R_{min}(\theta) & (34)\\ D^{**}(\theta) &= D_{min}(\theta), & (35)\end{aligned}$$

  and

$$\Delta^{**}(\theta) = \int_0^\theta \frac{E_1(x,x)}{\beta[E(x,x) - \bar{E}(D_0, R_0, x)]}dx \qquad where \quad E(x,y) \equiv \bar{E}(D^{**}(x), R^{**}(x), y). \quad (36)$$

- *For asset quality $\theta \geq \theta^{**}$, the manager proposes no restructuring plan.*

The Appendix OA.2 specifies beliefs supporting this equilibrium behavior and satisfying the Intuitive Criterion and a closed-form expression for Δ^{**}.

This equilibrium resembles that in Proposition 1. Note that there are different equilibria corresponding to different breakdowns of I between $I_C^{**}(\theta)$ and $I_G^{**}(\theta)$. Different breakdowns lead to different equilibrium offers but the equilibrium payoffs of each player or group of players do not change. In this separating equilibrium, when an offer is made the bank's type is revealed and the investment I is financed competitively by either the bondholders or the government, so that the Modigliani-Miller irrelevance result applies.

Figure 5 plots $\Delta^{**}(\theta)$ in an example and compares it with $\Delta^{*}(\theta)$. Note that, depending on the capital structure, publicly subsidized restructuring can be faster or slower than private restructuring. We will comment more on this comparison in Section 4.

[Figure 5]

If instead condition (H3-G) does not hold, we obtain a pooling equilibrium:

Proposition 5. *If condition (H3-G) does not hold, the Perfect Bayesian Nash equilibria satisfying the Intuitive Criterion are as follows.*

- *An equilibrium exists in which types $\theta \in [0, \theta^{**}]$ make the same offer $(R^{**}, I_C^{**}, D^{**}, I_G^{**})$ immediately, i.e., with $\Delta^{**}(\theta) = 0$, and with $I_G^{**} + I_C^{**} = I$ and $R^{**} + D^{**} = P_{max}(\theta^{**})$. Types $\theta > \theta^{**}$ make no offer.*

- *All other equilibria are such that for some $\bar{\theta} > \theta^{**}$, types $\theta \in [0, \bar{\theta}]$ make the same offer $(\bar{R}, \bar{I_C}, \bar{D}, \bar{I_G})$ with $\bar{I_C} + \bar{I_G} = I$ and $\bar{R} + \bar{D} = P_{max}(\bar{\theta})$ after the same delay $\bar{\Delta} \geq 0$. Types $\theta > \bar{\theta}$ make no offer.*

The Appendix OA.3 specifies beliefs supporting the equilibrium behavior in each case and satisfying the Intuitive Criterion.

3.2 Optimal Capital Structure

Under condition (H3-G), the impact of the capital structure on restructuring delays can still be understood as the combination of a surplus effect, coming from the term $[E(x,x) - \bar{E}(D_0, R_0, x)]$ in (36), and a signaling effect, coming from the term $E_1(x,x)$. We have:

$$E(x,x) - \bar{E}(D_0, R_0, x) = m(1-x)Z - I \quad (37)$$

$$E_1(x,x) = \frac{(1-m)I - m(D_0 + R_0)}{1 - (1-x)(1-m)} \quad (38)$$

The surplus effect is independent of the capital structure. This comes from the bank now capturing the entire restructuring surplus, which is independent of the capital structure. The signaling effect does depend on the capital structure. Two points are noteworthy. First, both D_0 and R_0 create an incentive for the bank to report a lower type, to induce bondholders and the government to accept an offer. Through this effect, replacing equity with bonds at the margin lowers E_1 and hence reduces the delay. Second, a marginal increase in bonds leads to a larger increase in the nominal value of total debt $(D_0 + R_0)$ than a marginal increase in deposits. Thus, replacing deposits with bonds at the margin also lowers E_1 and reduces delay.

Corollary 2. *Under condition (H3-G), the capital structure affects restructuring as follows.*

1. *The equilibrium delay $\Delta^{**}(\theta)$ decreases with D_0 and B_0.*

2. *The impact of B_0 on delays is stronger than the impact of D_0.*

3. *The set of types $[0, \theta^{**}]$ that restructure is independent of D_0 and B_0.*

That deposits now have a signaling effect generates a corner solution for the capital structure, differently from what happens under private restructuring:

Proposition 6. *Assume that, when the capital structure is such that (H3-G) does not hold, the pooling equilibrium that obtains is the optimal one from the perspective of the bank. Then the bank's optimal capital structure is to use only deposits: $D_0 = I_0, B_0 = 0$. This structure leads to a separating equilibrium if $(1-m)I \geq mI_0$, and to a pooling equilibrium otherwise.*

Intuitively, bonds are more expensive than insured deposits, as they lead to lower payments by the government. Its only advantage is that each unit of bond has a larger signaling effect than deposits. It decreases the bank's incentives to misreport its type more, and thus reduces the delay more than deposits. However, this effect is never sufficiently strong to overcome the difference in government payments, so that using bonds is suboptimal. Equity is also suboptimal, as it leads to no government payment and has no signaling effect.[25]

Another implication of the proposition is that the capital structure is independent of the haircut h. Since the delay Δ^{**} is also independent of h, the haircut h actually has no impact on the expected

[25] A subtle point in the proposition is the selection of a particular equilibrium in the pooling region. The equilibrium we select has $\bar{\theta} = \theta^{**}$, and $\bar{R}$ and $\bar{D}$ are such that the government is indifferent between accepting and rejecting the offer, whereas the bondholders make a positive surplus ex post. This is optimal from the perspective of the bank, as this surplus can be recovered by asking for a higher B_0, whereas any surplus left to the government is lost. It may be possible to construct equilibria with positive levels of R_0 or of equity by artificially selecting very inefficient pooling equilibria when the bank only uses deposits, and more efficient ones when the bank relies on bonds. Our assumption on equilibrium selection prevents such a construction.

payoff to the government, the bondholders, or the shareholders, even though it does have an impact on the equilibrium offer made by the bank.

4 Policy Implications and Possible Extensions

4.1 Policy Implications

We use our model to discuss three questions relevant for policy: (i) What is the socially optimal level of the haircut h? (ii) Is it welfare-improving to move from private to publicly subsidized restructuring? (iii) What regulatory constraints on the bank's capital structure can improve welfare?

To answer these questions, we first define social welfare in this model as the unweighted sum of expected payoffs for the bank's shareholders, the bondholders, and the government. Defining $\bar{\theta}$ the highest type for which restructuring occurs and $\Delta(\theta)$ the restructuring delay for type θ, social welfare $\mathcal{W}$ is given by:

$$\mathcal{W} = \mathbb{E}[\theta]Z - I_0 + \int_0^{\bar{\theta}} e^{-\beta\Delta(\theta)}[m(1-\theta)Z - I]dF(\theta). \tag{39}$$

Social welfare reduces to the net expected value of the bank's initial investment, plus the expected benefits from restructuring. The only endogenous quantities in this expression are $\Delta(\theta)$ and $\bar{\theta}$. Recall that $m(1-\theta)Z - I \geq 0$ if and only if $\theta \leq \theta^{**}$. We deduce the following result:

Lemma 4. *Under publicly subsidized restructuring, reducing the delay $\Delta^{**}(\theta)$ increases the social welfare $\mathcal{W}$.*

Under private restructuring, define:

$$\hat{D} = \frac{(1-h)[(1-m)I - mR_0]}{mZ - (1-m)hI} Z. \tag{40}$$

If $D_0 \geq \hat{D}$, then $\theta^* \leq \theta^{**}$ and reducing the delay $\Delta^*(\theta)$ increases the social welfare $\mathcal{W}$. If $D_0 < \hat{D}$, then $\theta^* > \theta^{**}$: reducing the delay $\Delta^*(\theta)$ increases the social welfare $\mathcal{W}$ for $\theta \in [0, \theta^{**}]$ and decreases $\mathcal{W}$ for $\theta \in [\theta^{**}, \theta^*]$.

Under publicly subsidized restructuring, all parties are represented in the restructuring and the process is successful if and only if it improves social welfare. Hence, reducing the delay necessarily improves welfare. Under private restructuring, restructuring exerts an externality on the government. When D_0 is large this externality is positive: the bank does not take into account that restructuring is good for the deposit insurer. Thus, there are few types for which restructuring occurs, but as a result speeding up the restructuring for those types necessarily improves welfare. Conversely, when D_0 is low and θ is sufficiently large restructuring exerts a negative externality on the government: it increases the size of potential future bail-outs for bondholders. Speeding up restructuring for such types then decreases social welfare.

4.1.1 Haircuts

We use this Lemma to study whether imposing higher haircuts on bondholders improves welfare. We start with the case of a given capital structure. The case to have in mind here would be one of a government announcing more/less generous bail-out rules, for instance to address some negative shock on financial stability. In the short-run banks would not have the time to fully adjust their capital structure. We can solve analytically for the impact of h on social welfare, keeping D_0 and R_0 constant:

Implication 1. *For a given D_0 and R_0, an increase in the haircut h has no impact on social welfare $\mathcal{W}$ under publicly subsidized restructuring. Under private restructuring, an increase in h always increases the delay $\Delta^*(\theta)$. As a result, such an increase has a negative impact on social welfare if $D_0 \geq \hat{D}$, or if $D_0 \leq \hat{D}$ and $\Pr(\theta \leq \theta^{**})$ is high enough.*

It is clear from the expression of $\Delta^{**}(\theta)$ that h has no effect on the delay under publicly subsidized restructuring: because both the government and the bondholders are part of the restructuring, the bank makes them offers that neutralize any ex post transfers between them. When the government is not part of the restructuring, $\Delta^*(\theta)$ increases in h via two effects. First, h increases $E_1(\theta, \theta)$, a signaling effect: as h increases, the bank's bonds become riskier and hence more information-sensitive. Facing a higher risk of not being reimbursed, the bondholders ask for a repayment R that is more sensitive to the bank's type. This increases the bank's incentive to misreport its type, which leads to longer delays. Second, h also lowers $E(\theta, \theta) - \bar{E}(R_0, \theta)$, a surplus effect. This effect is not obvious. On the one hand, a higher h implies a lower bail-out of existing bondholders if restructuring does not occur, which increases the surplus from renegotiation by lowering $\bar{E}(R_0, \theta)$. On the other hand, a higher h also implies a lower bail-out of the new debt if restructuring occurs, which decreases the surplus from renegotiation by lowering $E(\theta, \theta)$. Under (H3), the new debt is sufficiently large for the second effect to dominate.

In the longer-run, if regulation credibly commits the government to a certain haircut h, the bank is going to adjust its capital structure to h, which is also going to affect the delay in restructuring. Under publicly subsidized restructuring, the capital structure does not depend on h, so that h is still neutral. Under private restructuring, the role of h is more ambiguous and depends on what type of capital structure is optimal for the bank:

Implication 2. *Under private restructuring, a marginal increase in h affects the optimal capital structure and the restructuring delay as follows:*

- If the bank is financed only with deposits, $D_0 = I_0$, the capital structure does not change and the restructuring delay increases.

- If the bank is financed only with bonds, $B_0 = I_0$, then R_0 increases. The restructuring delay increases for all θ higher than $\tilde{\theta}$ (defined in Corollary 1).

- If the separating constraint is binding, $mR_0 = (1 - m)I$, the restructuring delay is zero and is unaffected.

Lemma 4 then gives how the impact of h on delay translates into an impact on social welfare.

This proposition shows that the impact of h on social welfare can go either way once the capital structure is endogenized, due to the interaction of several different effects. An increase in h makes bonds more expensive relative to deposits, which encourages the bank to finance itself more with deposits. However, because a higher h also leads to longer delay, the bank may want to compensate by relying more on bonds. Hence, the balance between deposits and bonds does not necessarily move monotonically with h. Moreover, the impact of bonds on the restructuring delay depends on θ, and thus depending on the distribution an increase in R_0 may either increase or decrease expected delays. Finally, depending on the distribution reducing delays may be good or bad for social welfare.

Figure 6 illustrates Implications 1 and 2. On the left panel we plot $\Delta^*(\theta)$ for 4 values of h between 0.1 and 0.75, keeping the capital structure constant. Consistent with Implication 1, a higher haircut always leads to a longer delay. On the right panel we use the optimal capital structure for each h. For $h = 0.1$ and $h = 0.25$ the optimal structure only has deposits, so that the delay is longer with $h = 0.25$ than for $h = 0.1$. For $h = 0.5$ and $h = 0.75$ instead the optimal structure only uses bonds and the delay is shorter with $h = 0.75$ except for very large values of θ.[26]

[Figure 6]

While we cannot derive a clear solution for the optimal haircut h, our main takeaway here is a new negative effect of high haircuts: higher haircuts on bonds make them more information-sensitive, which all else equal under private restructuring slows down the restructuring process. In some cases a higher h may further encourage the bank to rely on deposits, thus further increasing delays in restructuring. Conversely, a haircut of zero makes the bank's bonds insensitive to risk and suppresses the asymmetric information problem. As a result, a haircut of zero always guarantees immediate restructuring in this model. In practice this new effect needs to be traded off against well-understood negative consequences of bail-outs, such as more hazard.

4.1.2 Publicly Subsidized Restructuring

Our next question is whether it is welfare-improving to move from private to publicly subsidized restructuring. Again we start by taking the capital structure of the bank as given. This could reflect for instance a situation in which there are no clear rules on government involvement, and after bad news on a bank is revealed the government can choose whether to negotiate with the bank. Mathematically, we compare $\Delta^*(\theta)$ and $\Delta^{**}(\theta)$ for the same values of D_0 and R_0.

Implication 3. *For a given D_0 and R_0, if h is close enough to 1 and $R_0 = 0$ then the restructuring delay is lower under publicly subsidized restructuring. Conversely, when h is close enough to zero the delay is lower under private restructuring. Lemma 4 then gives how the impact of h on delay translates into an impact on social welfare.*

[26] These values are difficult to see on the graph as $\tilde{\theta}$ is very close to θ^*.

Government involvement thus has an ambiguous impact on social welfare, due to two opposite effects being at play. The most intuitive one is a surplus effect: under publicly subsidized restructuring, the entire social surplus is internalized in the negotiation. When the government surplus is positive this speeds up the restructuring and improves welfare. However, there is also a signaling effect, which can be in the other direction: when the bank manager considers misreporting the bank's type by waiting longer, this affects the government's beliefs about the bank. Depending on the capital structure and the distribution, the bank may have an extra incentive to pretend its type is high in order to extract more rents from the government. An important take-away for policymakers here is that the case for involving the government is particularly strong when the bank relies a lot on insured deposits and restructuring creates an important positive externality on the government. Otherwise, the case for publicly subsidized restructuring is less clear and involving the government may even be counterproductive in some cases.

In the longer-run, an explicit regulation may define whether and when the government is allowed to intervene.[27] The bank's capital structure will then adjust to this policy, which will also impact restructuring delays and welfare.

Implication 4. *Under publicly subsidized restructuring, the bank optimally chooses a capital structure with only deposits, $D_0 = I_0$. When $(1-m)I \leq mI_0$ this leads to the first best outcome and achieves a strictly higher social welfare than under private restructuring. When $(1-m)I > mI_0$ social welfare may be higher or lower under publicly subsidized restructuring than under private restructuring.*

This implication is a direct consequence of Proposition 6. Under publicly subsidized restructuring, deposits no longer increase restructuring delays and the bank finds it optimal to only use deposits. If $(1-m)I \leq mI_0$ a pooling equilibrium obtains, in which all types between 0 and θ^{**} restructure immediately, which is the first best. Otherwise, this capital structure leads to positive delays, which may be higher than under private restructuring according to Implication 3. An interesting interpretation of this result is that it may be optimal to allow the government to intervene only conditionally on the capital injection needed by the bank being small relative to its total size

[27] In the European Union this is one of the objectives of the BRRD, which allows the government to intervene in a bank's resolution when certain conditions are met.

(the ratio I/I_0 needs to be small). Figure 7 below illustrates the implication and shows parameters under which not involving the government leads to a higher welfare.

[Figure 7]

4.1.3 Capital Structure Regulation

The capital structure chosen by the bank is not necessarily aligned with the social optimum, creating a rationale for regulation. Differently from many banking models, bank equity has no social cost in our setup. Nevertheless, forcing the bank to be financed only with equity is not socially optimal. The reason is that, in the absence of government intervention, issuing bonds reduces the bank manager's incentives to pretend that θ is high, and thus goes against the Myers and Majluf (1984) effect. Bonds are thus part of the socially optimal capital structure. Moreover, because the bank captures only part of the surplus from restructuring, it may issue too few bonds. Under publicly subsidized restructuring, deposits also go against the Myers and Majluf (1984) effect. However, substituting one dollar of deposits with one dollar of bonds still reduces delays, because this creates more than one dollar of future repayments. The bank captures all the benefits from restructuring in that case, but deposits are subsidized by deposit insurance, so that the bank may still rely too little on bonds (in fact, it never issues any). The following implication summarizes these insights:

Implication 5. *Under private restructuring, and when $mR_0 < (1-m)I$ so that delays are positive, substituting one unit of deposits with one unit of bonds reduces restructuring delays for all types. If $D_0 \geq \hat{D}$ this unambiguously increases social welfare.*

Under publicly subsidized restructuring, if $(1-m)I \leq mI_0$ the bank's unregulated capital structure is socially optimal. If instead $(1-m)I > mI_0$, the bank chooses to rely only on deposits, whereas the social optimum is to have at least enough bonds to have $m(D_0 + R_0) = (1-m)I$ if $(1-m)I \leq \frac{mI_0}{1-h[1-\mathbb{E}(\theta)]}$, and $B_0 = I_0$ otherwise.

The model thus generates a novel rationale for minimum requirements on bonds, both with and without government intervention. The reason is that bonds, as long as they are renegotiable, create an incentive for the bank to be more truthful about its financial situation, which makes it easier to restructure. The existing requirements on AT1 securities as well as "TLAC" and "MREL" are typically rationalized by the possibility for a resolution authority to convert these instruments into equity or simply write them down, thus reducing the bank's indebtedness while protecting the depositors and avoiding a formal default. The model provides an additional rationale for these securities, which is that the bank can call them or negotiate with their holders (see Footnote 2). Moreover, the argument extends to any liability of the bank that can be renegotiated.

4.2 Possible Extensions

We kept the ingredients of the model relatively simple, so as to better illustrate the surplus and signaling effects, arrive at closed-form solutions for the restructuring delays, and study the optimal capital structure. However, the way we solve the bargaining game as well as formula (9) for the restructuring delay are quite general and could be used to study some policy-relevant extensions. In particular, we think that considering the signs of the signaling and surplus effects of a particular policy can be useful in several applications. We illustrate below some policy questions that may be addressed in the same setup in future research.

Restructuring under the threat of bank runs. In the model deposits are fully insured, whereas bonds are long-term and hence not "runnable". In reality, negotiations around a troubled bank need to take into account the presence of uninsured or simply nervous depositors who may run on the bank. A simple way to model this would be to assume that in each period there is a probability that depositors run on the bank, in which case the shareholders and uninsured creditors receive zero. This probability should depend on the bank's capital structure and on public beliefs about the bank's type, which themselves depend on the bank's actions. While solving this model would require a paper in itself, our analysis already provides some guidance on the impact of bank runs: the threat of a bank run means that shareholders and creditors may lose everything if they don't agree to restructure the bank, which speeds up restructuring. At the same time, making an early offer may signal to depositors that the bank is very weak, which may trigger a run. This is a signaling effect that will on the contrary lengthen the process. The delay and whether the bank will be able to restructure will depend on the balance between these two effects, which can be affected both by the bank's capital structure choice and possible government policies.

CoCos/Prompt Corrective Action. The model assumes that the bank can continue operating for a long time. An interesting policy to consider would be to give a deadline to the restructuring. For instance, the bank may be resolved by the regulator if no restructuring took place before some time $\bar{t}$. This could correspond to the FDIC's policy of "prompt corrective action".

Compared to the baseline model, such a policy gives all types $\theta \in [\Delta^{-1}(\bar{t}), \theta^*]$ an incentive to restructure earlier, so as to avoid resolution. However, this also implies that by waiting more the types below $\Delta^{-1}(\bar{t})$ can be pooled with stronger types than without the deadline. Hence, lower quality banks may wait longer to restructure.

Finally, the government may be tempted to force the bank to renegotiate immediately with its bondholders, so as to avoid costly delays. This amounts to setting $\bar{t} = 0$. If so, the bank cannot signal its type, and we have a pooling equilibrium in which all types $\theta \in [0, \tilde{\theta}]$ make the same offer R.[28] The variables $\tilde{\theta}$ and R are determined simultaneously by the fact that bondholders are indifferent between accepting and rejecting the offer, and that a bank with type $\tilde{\theta}$ breaks even by offering R:

$$\int_0^{\tilde{\theta}} \frac{[1-(1-\theta)h]R_0}{F(\tilde{\theta})} f(\theta)d\theta = \int_0^{\tilde{\theta}} \frac{[1-(1-\theta)(1-m)h]R}{F(\tilde{\theta})} f(\theta)d\theta - I \tag{41}$$

$$(1-(1-\tilde{\theta})(1-m))(X-R) = \tilde{\theta}(X-R_0). \tag{42}$$

Importantly, for general distributions, $\tilde{\theta}$ may not be positive. Indeed, the bank faces a problem a la Myers and Majluf (1984), and is reluctant to issue new claims as this communicates negative information to investors. If there is no tool to separate the different types, the outcome can be a complete absence of restructuring, which is typically inefficient here.

Supervision and Stress-Tests. Given that delays in restructuring are due to asymmetric information, the model gives an important rationale for communicating supervisory information to

[28] If we allow bondholders to randomize between accepting and rejecting an offer, we can build a separating equilibrium as in Giammarino (1989) in which the bank makes the same offers as in our model, and an offer $R(\theta)$ is accepted with probability $p(\theta) = e^{-\beta\Delta(\theta)}$. Although there is no delay, the equilibrium payoffs are exactly the same as in the original model. Put differently, delays can be seen as a more realistic way of modeling the probability that offers are rejected.

investors, for instance through stress-tests.[29] Importantly, in a fully separating equilibrium, the distribution of types F itself does not matter. To have an impact on the equilibrium delay, the disclosure of supervisory information should affect the support of investors' beliefs about θ. In particular, revealing that the bank's type exceeds some threshold $\tilde{\theta}$ reduces the equilibrium delay for all types above $\tilde{\theta}$. Indeed, $\dot{\Delta}(\theta)$ will be the same as in the original model, but the zero of the function $\Delta(\theta)$ is in $\theta = \tilde{\theta}$ instead of $\theta = 0$. Hence, for all types above $\tilde{\theta}$ the delay is reduced by $\Delta(\tilde{\theta})$.

5 Conclusion

This paper is a step towards understanding the complexities of negotiations towards restructuring the debt of a distressed bank, and how changing the resolution regime can either speed up or slow down the negotiation process.

Our model identifies two key forces at play, which we call the surplus effect and the signaling effect. The surplus effect is the fact that the resolution regime defines the surplus to be gained by reaching a private agreement, and increasing this surplus speeds up negotiations. The signaling effect is the fact that the resolution regime affects how sensitive the different parties' payoffs are to the bank's quality, and thus how much the shareholders stand to gain if they can pretend that the bank is of lower or higher quality than it really is. Ideally, a good resolution regime should both leave little payoff to shareholders and bondholders if they do not agree on a debt restructuring, and minimize the dependency of their payoffs on the bank's quality.

However, there can be a tension between these two objectives. For instance, we show that allowing the government to subsidize an agreement, e.g., by participating in a recapitalization, can both increase the surplus and increase the shareholders' incentives to pretend the bank is of high quality, so as to extract more subsidies from the government. Government involvement can actually slow down the bargaining process.

It is clear in our framework that the details of the tools available to the bank and the government matter, and that different forms of debt restructurings, bail-ins, and bail-outs may have different

[29] See for instance Goldstein and Sapra (2014) on this more general issue.

implications for the likelihood of reaching an agreement. In principle, many variants of the model can be considered to understand which forms of resolution may be more conducive to a private solution. Regardless of the exact variant considered, the surplus effect and the signaling effect play an important role in explaining the outcome.

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A Proofs

This section contains the proofs of the main results in the paper. Proofs that are repetitive or of less economic interest are relegated to the Online Appendix (proofs of Propositions 2, 4, 5, and 6).

A.1 Proof of Lemma 1

For any $\theta \geq 0$, we write

$$\dot{R}_{max}(\theta) = -\frac{m(Z - D_0 - R_0)}{[1-(1-m)(1-\theta)]^2} \tag{A.1}$$

$$\dot{R}_{min}(\theta) = -\frac{h[I(1-m) - mR_0]}{[1-h(1-m)(1-\theta)]^2} \tag{A.2}$$

$\dot{R}_{max}(\theta)$ is negative by (H2). If moreover $I(1-m)-mR_0 \leq 0$ we obtain that $\dot{R}_{max}(\theta)-\dot{R}_{min}(\theta) < 0$. If instead $I(1-m) - mR_0 > 0$ then $\dot{R}_{max}(\theta) - \dot{R}_{min}(\theta)$ increases in h. In $h = 1$ this difference is equal to

$$\frac{I(1-m) - m(Z - D_0)}{[1-(1-m)(1-\theta)]^2}. \tag{A.3}$$

Condition (H2) implies that this expression is negative, showing that $\dot{R}_{max}(\theta) - \dot{R}_{min}(\theta) < 0$ for any $h \leq 1$.

Hence, both when $I(1-m) - mR_0 \leq 0$ and when $I(1-m) - mR_0 > 0$, we obtain that $R_{max}(\theta)-R_{min}(\theta)$ is continuous and decreasing in θ for $\theta \geq 0$. We are going to show that $R_{max}(1)-R_{min}(1) < 0$ and $R_{max}(0) - R_{min}(0) > 0$, implying the existence of a unique $\theta^* \in (0,1)$ such that $R_{max}(\theta^*) - R_{min}(\theta^*) = 0$. We have

$$R_{max}(1) - R_{min}(1) = -I < 0. \tag{A.4}$$

Moreover,

$$R_{max}(0) - R_{min}(0) = \frac{(Z - D_0)(1-h(1-m)) - I - (1-h)R_0}{1-h(1-m)}. \tag{A.5}$$

The denominator is linear in h. To complete the proof, we just need to prove it is positive for both $h = 0$ and $h = 1$. In $h = 1$ the denominator is equal to $m(Z - D_0) - I$, which is positive by (H2). In $h = 0$, it is equal to $Z - D_0 - I - R_0$. Note that bondholders promised R_0 expect to get at least $[1 - h(1 - \mathbb{E}(\theta))]R_0$, hence the market value of this debt, B_0, is greater than this quantity. Moreover, $I_0 \geq D_0 + B_0$. Hence, we have:

$$R_0 \leq \frac{I_0 - D_0}{1 - h(1 - \mathbb{E}(\theta))}. \tag{A.6}$$

In addition, (H2) gives $Z > I + \frac{I_0}{\mathbb{E}(\theta)}$. Using both inequalities, we obtain:

$$\begin{aligned} Z - D_0 - I - R_0 &> I + \frac{I_0}{\mathbb{E}(\theta)} - D_0 - I - \frac{I_0 - D_0}{1 - h(1 - \mathbb{E}(\theta))} && \text{(A.7)} \\ &= \frac{(1 - \mathbb{E}(\theta))[(1 - h)I_0 + h\mathbb{E}(\theta)D_0]}{\mathbb{E}(\theta)[1 - h(1 - \mathbb{E}(\theta))]} > 0. && \text{(A.8)} \end{aligned}$$

This proves that (A.5) is positive also for $h = 0$ and completes the proof.

A.2 Proof of Lemma 2

Follows directly from equation (7).

A.3 Proof of Lemma 3

(i) Assume type θ prefers (R, Δ) to (R', Δ'), with $\Delta > \Delta'$. This means that

$$e^{-\beta\Delta}[p(\theta)(Z - D_0 - R)] + [1 - e^{-\beta\Delta}]\theta[Z - D_0 - R_0] \geq e^{-\beta\Delta'}[p(\theta)(Z - D_0 - R')] + [1 - e^{-\beta\Delta'}]\theta[Z - D_0 - R_0]. \tag{A.9}$$

This condition can be rewritten as

$$\left(e^{-\beta\Delta'} - e^{-\beta\Delta}\right)(Z - D_0 - R_0)\frac{\theta}{p(\theta)} \geq e^{-\beta\Delta'}(Z - D_0 - R') - e^{-\beta\Delta}(Z - D_0 - R). \tag{A.10}$$

As $\Delta' < \Delta$, the left-hand side is positive and (H4) implies it strictly increases in θ. Hence, the inequality will also hold strictly for any $\theta' > \theta$.

(ii) This point is proven analytically in Appendix A.1. Here we provide a more general proof by contradiction. Take $\theta' > \theta$ and assume that $R_{max}(\theta') > R_{max}(\theta)$. We can then pick R and R' such that $R_{max}(\theta') > R' > R_{max}(\theta) > R$. As $R' > R_{max}(\theta)$, type θ prefers (R, Δ) to $(R', 0)$ for any $\Delta > 0$. Then point (i) implies that θ' also prefers (R, Δ) to $(R', 0)$. However, clearly for Δ large enough the benefit from offering (R, Δ) can be made arbitrarily small, whereas $(R', 0)$ gives a strictly positive benefit to θ'. Hence, for a large enough Δ, θ' prefers $(R', 0)$ to (R, Δ), which contradicts (i).

(iii) Take $\theta' > \theta$ and assume, by contradiction, that $\Delta^*(\theta') < \Delta^*(\theta)$. By definition θ prefers $(R^*(\theta), \Delta^*(\theta))$ to $(R^*(\theta'), \Delta^*(\theta'))$. As $\Delta^*(\theta) > \Delta^*(\theta')$ and $\theta' > \theta$, by point (i) it must be the case that θ' strictly prefers $(R^*(\theta), \Delta^*(\theta))$ to $(R^*(\theta'), \Delta^*(\theta'))$, a contradiction. Hence, Δ^* is increasing. This immediately implies that R^* has to be decreasing, otherwise the equilibrium offers of higher types would be unambiguously dominated by the offers of lower types.

(iv) Denote $\overline{\theta} \in [0, 1]$ a type making an offer, and denote $(\overline{R}, \overline{\Delta})$ this offer. By contradiction, consider some type $\theta < \overline{\theta}$ that doesn't make an offer and hence gets zero surplus from restructuring. This implies that for any R and for a high enough $\Delta > \overline{\Delta}$ type θ prefers (R, Δ) to $(\overline{R}, \overline{\Delta})$. Indeed, as Δ goes to infinity the payoff from such an offer goes to zero. Then point (i) implies that $\overline{\theta}$ would also prefer making offer (R, Δ) and obtaining an arbitrarily small payoff to making offer $(\overline{R}, \overline{\Delta})$, a contradiction.

A.4 Proof of Proposition 1

Step 1: There exists $\bar{\theta} \in [0, 1]$ such that in equilibrium all types $\theta < \bar{\theta}$ make an offer and all types $\theta > \bar{\theta}$ don't make an offer.

This step follows directly from Lemma 3, point (iv). If the set of types making an offer is non-empty, denote $\bar{\theta}$ the supremum of this set, and then point (iv) implies that all types $\theta < \bar{\theta}$ make an offer, while by definition of the supremum no type $\theta > \bar{\theta}$ above does. It is not necessary at this stage to clarify whether type $\bar{\theta}$ makes an offer, but we will see below that this type makes an offer with an infinite delay. Hence, we adopt the convention that $\bar{\theta}$ does not maker an offer, and the set of types making an offer is hence the interval $[0, \bar{\theta})$.

Step 2: Under condition (H3), for all $\theta \in [0, \bar{\theta}]$, $R^*(\theta) = R_{min}(\theta)$.

By contradiction. We consider two possibilities: Case 1 - $\exists \theta \in [0, \bar{\theta}]$ s.t. $R^*(\theta) > R_{min}(\theta)$; Case 2 - $\forall \theta \in [0, \bar{\theta}]$, $R^*(\theta) \leq R_{min}(\theta)$ and $\exists \theta' \in [0, \bar{\theta}]$ s.t. $R^*(\theta') < R_{min}(\theta')$.

Case 1. By continuity, a type $\theta' < \theta$ exists such that $R^*(\theta) > R_{min}(\theta')$. Consider (R', Δ') with $R' \in (R_{min}(\theta'), R^*(\theta))$ and Δ' such that type θ' is indifferent between $(R^*(\theta'), \Delta^*(\theta'))$ and (R', Δ'). By Lemma 3, we have $R^*(\theta) \leq R^*(\theta')$.

First, we show that for type θ, (R', Δ') would be a strictly profitable deviation if accepted by bondholders: If $\Delta' \leq \Delta^*(\theta)$, this is obvious as $R' < R^*(\theta)$. If $\Delta' > \Delta^*(\theta)$, equilibrium requires that θ' weakly prefers $(R^*(\theta'), \Delta^*(\theta'))$ to $(R^*(\theta), \Delta^*(\theta))$. As (R', Δ') was chosen such that θ' is indifferent between (R', Δ') and $(R^*(\theta'), \Delta^*(\theta'))$, this implies that θ' weakly prefers (R', Δ') to $(R^*(\theta), \Delta^*(\theta))$. Since $\theta > \theta'$, Lemma 3 implies that θ then strictly prefers (R', Δ') to $(R^*(\theta), \Delta^*(\theta))$.

Second, we show that for types below θ', (R', Δ') is a strictly unprofitable deviation, even if the offer is accepted: As $R' < R^*(\theta)$ we also have $R' < R^*(\theta')$. Type θ' being indifferent between $(R^*(\theta'), \Delta^*(\theta'))$ and (R', Δ'), we need $\Delta' > \Delta^*(\theta')$. Using Lemma 3 this implies that all types below θ' strictly prefer $(R^*(\theta'), \Delta^*(\theta'))$ to (R', Δ'). Equilibrium requires that deviating to $(R^*(\theta'), \Delta^*(\theta'))$ be weakly unprofitable for those types, which concludes the proof.

We have shown that deviating to (R', Δ') is strictly unprofitable for types below θ', and strictly profitable for θ, if the offer is accepted. The most pessimistic belief following deviation (R', Δ') that still satisfies the Intuitive Criterion is thus some $\theta'' \in [\theta', \theta)$. Under (H3), $R_{min}(\theta') \geq R_{min}(\theta'')$. Since $R' > R_{min}(\theta')$, we also have $R' > R_{min}(\theta'')$, so that even the most pessimistic belief for bondholders leads them to accept offer (R', Δ'). Since this offer is accepted, offering (R', Δ') is a profitable deviation for θ, a contradiction.

Case 2. In this case, bondholders necessarily make an expected loss when accepting offer $R^*(\theta')$, which is not compatible with equilibrium.

Step 3: $\bar{\theta} = \theta^*$.

By contradiction.

Assume $\bar{\theta} < \theta^*$ so $R_{min}(\bar{\theta}) < R_{max}(\bar{\theta})$. By continuity, some $\theta' \in (\bar{\theta}, \theta^*)$ exists such that $R_{min}(\bar{\theta}) < R_{max}(\theta')$. Deviation $(R_{min}(\bar{\theta}), \Delta^*(\bar{\theta}))$ is thus profitable for θ' if accepted, and equilibrium implies it is accepted. Hence, the deviation is profitable for θ', a contradiction.

Assume $\bar{\theta} > \theta^*$ and take $\theta \in (\theta^*, \bar{\theta})$. According to Step 2, we have $R^*(\theta) = R_{min}(\theta)$. Since $\theta > \theta^*$ we have $R_{min}(\theta) > R_{max}(\theta)$, hence θ is better off deviating to not making an offer, a contradiction.

Step 4: Solving for $\Delta^*(\cdot)$.

In the main text, we prove that Δ^* must satisfy first-order condition (14) and that $\Delta^*(0) = 0$, which gives expression (9). We now check that the second-order condition holds. Define:

$$U(\hat{\theta}, \theta) = [1 - e^{-\beta\Delta^*(\hat{\theta})}]\bar{E}(R_0, \theta) + e^{-\beta\Delta^*(\hat{\theta})}E(\hat{\theta}, \theta). \tag{A.11}$$

Differentiating with respect to $\hat{\theta}$ gives:

$$\begin{aligned}
U_1(\hat{\theta}, \theta) &= e^{-\beta\Delta^*(\hat{\theta})}\left[E_1(\hat{\theta}, \theta) + \beta\dot{\Delta}(\hat{\theta})[E(\hat{\theta}, \theta) - \bar{E}(R_0, \theta)]\right] && \text{(A.12)}\\
&= e^{-\beta\Delta^*(\hat{\theta})}\left[E_1(\hat{\theta}, \theta) - \frac{E_1(\hat{\theta}, \hat{\theta})}{[E(\hat{\theta}, \hat{\theta}) - \bar{E}(R_0, \hat{\theta})]}[E(\hat{\theta}, \theta) - \bar{E}(R_0, \theta)]\right] && \text{(A.13)}\\
&= \left[e^{-\beta\Delta^*(\hat{\theta})}\frac{E_1(\hat{\theta}, \theta)E_1(\hat{\theta}, \hat{\theta})}{[E(\hat{\theta}, \hat{\theta}) - \bar{E}(R_0, \hat{\theta})]}\right] \times \left[\frac{[E(\hat{\theta}, \hat{\theta}) - \bar{E}(R_0, \hat{\theta})]}{E_1(\hat{\theta}, \hat{\theta})} - \frac{[E(\hat{\theta}, \theta) - \bar{E}(R_0, \theta)]}{E_1(\hat{\theta}, \theta)}\right]. && \text{(A.14)}
\end{aligned}$$

The expression in the first bracket is positive. Indeed, all terms in the numerator are positive for all θ and $\hat{\theta}$, and, by definition of θ^*, the denominator is positive for $\hat{\theta} \in [0, \theta^*]$. Hence the sign of $U_1(\hat{\theta}, \theta)$ is that of the expression in the second bracket. We have:

$$\begin{aligned}
\frac{E(\hat{\theta}, \theta) - \bar{E}(R_0, \theta)}{E_1(\hat{\theta}, \theta)} &= \frac{p(\theta)(Z - D_0 - R_{min}(\hat{\theta})) - \theta(Z - D_0 - R_0)}{p(\theta)(-\dot{R}_{min}(\hat{\theta}))} && \text{(A.15)}\\
&= -\frac{(Z - D_0 - R_{min}(\hat{\theta}))}{\dot{R}_{min}(\hat{\theta})} - \frac{\theta(Z - D_0 - R_0)}{[1 - (1 - \theta)(1 - m)](-\dot{R}_{min}(\hat{\theta}))} && \text{(A.16)}
\end{aligned}$$

Rearranging terms, we obtain

$$\frac{[E(\hat{\theta}, \hat{\theta}) - \bar{E}(R_0, \hat{\theta})]}{E_1(\hat{\theta}, \hat{\theta})} - \frac{[E(\hat{\theta}, \theta) - \bar{E}(R_0, \theta)]}{E_1(\hat{\theta}, \theta)} = \frac{Z - D_0 - R_0}{\dot{R}_{min}(\hat{\theta})}\left(\frac{\hat{\theta}}{p(\hat{\theta})} - \frac{\theta}{p(\theta)}\right). \tag{A.17}$$

Since $\dot{R}_{min}(\hat{\theta}) < 0$ and $Z - D_0 - R_0 > 0$, (A.14) implies that the sign of $U_1(\hat{\theta}, \theta)$ is that of

$$\frac{\hat{\theta}}{p(\hat{\theta})} - \frac{\theta}{p(\theta)}. \tag{A.18}$$

Condition (H4) implies that $\theta/p(\theta)$ increases in θ, so that $U_1(\hat{\theta}, \theta)$ is positive for $\hat{\theta} < \theta$ and negative for $\hat{\theta} > \theta$. Hence, the first-order condition $U_1(\theta, \theta) = 0$ gives an absolute maximum of $U_1(\hat{\theta}, \theta)$ for $\hat{\theta} \in [0, \theta^*]$.

Step 5: Deviations to off-equilibrium offers.

We define off-equilibrium beliefs compatible with the intuitive criterion such that deviating to any off-equilibrium offer (R, Δ) is unprofitable.

For any off-equilibrium offer (R, Δ) which, if accepted, would be profitable for some types, we define $\hat{\theta}$ the lowest such type. We assume that, upon observing (R, Δ), investors believe the bank's type to be $\hat{\theta}$. This belief satisfies the intuitive criterion. We check that given this belief deviating to (R, Δ) is never profitable.

If $R < R_{min}(\theta^*) = R_{max}(\theta^*)$, deviation (R, Δ) is profitable for type θ^*. Hence, $\hat{\theta} \leq \theta^*$. Since R_{min} is decreasing, we have $R_{min}(\theta^*) \leq R_{min}(\hat{\theta})$, and hence $R < R_{min}(\hat{\theta})$. This implies that (R, Δ) is rejected, and hence is not a profitable deviation.

If $R \in [R_{min}(\theta^*), R_{min}(0)]$, a type $\theta \in [0, \theta^*]$ exists such that $R = R_{min}(\theta)$. If $\Delta > \Delta^*(\theta)$, (R, Δ) is less profitable than the equilibrium offer $(R^*(\theta), \Delta^*(\theta))$ and thus cannot be a profitable deviation for any type. If $\Delta < \Delta^*(\theta)$ then offer (R, Δ), if accepted, is strictly profitable for type θ. This implies $\hat{\theta} < \theta$. But if so, bondholders reject plan R because $R = R_{min}(\theta)$, which is lower than $R_{min}(\hat{\theta})$ as R_{min} is decreasing. Hence, (R, Δ) is not a profitable deviation.

If $R > R_{min}(0)$, (R, Δ) is equilibrium-dominated by $(R_{min}(0), 0)$, if the latter offer is accepted. We showed in the main text that $\Delta^*(0) = 0$, so that $(R_{min}(0), 0)$ is an equilibrium offer, which is necessarily accepted. Hence, (R, Δ) is dominated by an equilibrium offer and cannot be a profitable deviation.

Expression for $\Delta^*(\theta)$: Consider $\theta \in [0, \theta^*)$. We have

$$\begin{aligned} \beta\dot{\Delta}^*(\theta) &= \frac{E_1(\theta,\theta)}{E(\theta,\theta) - \bar{E}(R_0,\theta)} \\ &= \frac{-p(\theta)h[mR_0 - (1-m)I]}{[1-(1-m)(1-\theta)h]^2[p(\theta)(Z - D_0 - R_{min}(\theta)) - \theta(Z - D_0 - R_0)]}. \end{aligned} \tag{A.19}$$

This expression can be reorganized as:

$$\beta\dot{\Delta}^*(\theta) = -\frac{h(1-m)}{1-(1-\theta)(1-m)h} + hm\frac{(Z-D_0)(1-m)(1-\theta) - R_0}{a(1-\theta)^2 + b(1-\theta) + c} \tag{A.20}$$

$$\text{with } a = -m(1-m)h(Z - D_0) \tag{A.21}$$

$$b = (1-m)hI + m(Z - D_0) + (1-h)[(1-m)I - mR_0] \tag{A.22}$$

$$c = -I. \tag{A.23}$$

Note that $a(1-\theta)^2 + b(1-\theta) + c = [1-(1-\theta)(1-m)h][E(\theta,\theta) - \bar{E}(R_0,\theta)]$. This polynomial has two roots θ_1 and θ_2, with:

$$\theta_1 = 1 + \frac{b + \sqrt{b^2 - 4ac}}{2a} \tag{A.24}$$

$$\theta_2 = 1 + \frac{b - \sqrt{b^2 - 4ac}}{2a} \tag{A.25}$$

We need to check that $b^2 - 4ac > 0$. We can write

$$b^2 - 4ac = [I(1-m) + m(Z - D_0) - m(1-h)R_0]^2 - 4hIm(1-m)(Z - D_0) \tag{A.26}$$

The second derivative of this expression with respect to h is $2m^2R_0^2 > 0$. In $h = 1$ the first derivative with respect to h is equal to $-2m(1-m)I(Z - D_0 - R_0) - 2m(Z - D_0)(I(1-m) - mR_0) < 0$. Hence $b^2 - 4ac$ is always decreasing in h. In $h = 1$ we obtain that $b^2 - 4ac = [(1-m)I - m(Z - D_0)]^2 > 0$. Hence $b^2 - 4ac$ is always positive.

Note that $\theta_2 > \theta_1$, as $a < 0$. Moreover, we prove that $\theta_1 \leq 0$. This is equivalent to $2a + b + \sqrt{b^2 - 4ac} \geq 0$. If $2a + b \geq 0$ this is true. If $2a + b \leq 0$ then $\theta_1 \leq 0$ is equivalent to

$\sqrt{b^2 - 4ac} \geq -(2a+b)$, which is equivalent to $a+b+c \geq 0$. We have:

$$a + b + c = [m(Z - D_0) - I][1 - h(1-m)] + (1-h)[(1-m)I - mR_0]. \tag{A.27}$$

Since $D_0 \leq I_0$, Assumption (H2) implies that $I \leq m(Z - D_0)$, and the second term is positive by (H3), thus $a+b+c \geq 0$. This concludes the proof that $\theta_1 < 0$. Following a symmetric reasoning, one easily shows that $\theta_2 > 0$. To conclude, we have shown that $[1-h(1-\theta)(1-m)][E(\theta,\theta) - \bar{E}(R_0,\theta)]$ is a second-degree polynomial in θ, with two roots θ_1 and θ_2, the former negative and the latter positive.

Remember that $R_{max}(\theta^*)$ is such that $\bar{E}(R_{max}(\theta^*, p(\theta^*) = \bar{E}(R_0, \theta^*$. Moreover, θ^* is such that $R_{max}(\theta^*) = R_{min}(\theta^*)$. We thus have $\bar{E}(R_{max}(\theta^*, p(\theta^*) = \bar{E}(R_{min}(\theta^*, p(\theta^*) = E(\theta^*, \theta^*) = \bar{E}(R_0, \theta^*)$. This shows that θ^* is a positive root of $[E(\theta,\theta) - \bar{E}(R_0,\theta)]$. Hence, $\theta_2 = \theta^*$.

Given the functional form (A.20), for $\theta \in [0, \theta^*)$ a primitive is given by:

$$\begin{aligned}
\beta\tilde{\Delta}^*(\theta) &= -\ln[1-(1-\theta)(1-m)h] + \frac{1}{2}\ln[a(1-\theta)^2 + b(1-\theta) + c] \\
&+ \kappa \ln\left(-\frac{2a(1-\theta) + b + \sqrt{b^2-4ac}}{2a(1-\theta) + b - \sqrt{b^2-4ac}}\right) && \text{(A.28)} \\
\text{with } \kappa &= \frac{I(1-m) - mR_0 + m(Z-D_0) - hmR_0}{2} \frac{1}{\sqrt{b^2-4ac}}. && \text{(A.29)}
\end{aligned}$$

Using simple properties of second order polynomials, this expression can be rearranged as:

$$\begin{aligned}
\beta\tilde{\Delta}^*(\theta) &= -\ln[1-(1-\theta)(1-m)h] + \frac{1}{2}\ln[-a(\theta-\theta_1)(\theta^*-\theta)] \\
&+ \kappa \ln\left(\frac{\theta-\theta_1}{\theta^*-\theta}\right)
\end{aligned} \tag{A.30}$$

Alternatively, we can express it as:

$$\begin{aligned}
\beta\tilde{\Delta}^*(\theta) &= -\frac{1}{2}\ln[1-(1-\theta)(1-m)h] + \frac{1}{2}\ln[E(\theta,\theta) - E_0(\theta)] \\
&+ \kappa \ln\left(\frac{\theta-\theta_1}{\theta^*-\theta}\right)
\end{aligned} \tag{A.31}$$

As shown in the text, we must have $\Delta^*(0) = 0$. Hence, $\Delta^*(\theta) = \tilde{\Delta}(\theta) - \tilde{\Delta}(0)$ and we obtain:

$$\beta\Delta^*(\theta) = -\ln\left(\frac{1-(1-\theta)(1-m)h}{1-(1-m)h}\right) + \frac{1}{2}\ln\left(\frac{-(\theta-\theta_1)(\theta^*-\theta)}{\theta_1\theta^*}\right) + \kappa\ln\left(\frac{-\theta^*(\theta-\theta_1)}{\theta_1(\theta^*-\theta)}\right) \quad (A.32)$$
$$= -\ln\left(\frac{1-(1-\theta)(1-m)h}{1-(1-m)h}\right) + \left(\kappa+\frac{1}{2}\right)\ln\left(\frac{\theta-\theta_1}{-\theta_1}\right) - \left(\kappa-\frac{1}{2}\right)\ln\left(\frac{\theta^*-\theta}{\theta^*}\right) \quad (A.33)$$

For future reference, using this last expression and $[1-(1-\theta)(1-m)h][E(\theta,\theta) - \bar{E}(R_0,\theta)] = -a(\theta^*-\theta)(\theta-\theta_1)$, we obtain:

$$e^{-\beta\Delta^*(\theta)}[E(\theta,\theta) - E_0(\theta)] = \frac{-a}{1-(1-m)h}[-\theta_1(\theta^*-\theta)]^{\kappa+\frac{1}{2}}[\theta^*(\theta-\theta_1)]^{\frac{1}{2}-\kappa}. \quad (A.34)$$

A.5 Proof of Proposition 3

By contradiction, we assume that the bank chooses a capital structure that does not satisfy (H3), and then show that this is suboptimal.

Step 1: The most profitable pooling equilibrium has $\bar{\theta} = \theta^*$.

In order to show that any structure leading to a pooling equilibrium is suboptimal, it is sufficient to show that this is the case when focusing on the most profitable pooling equilibrium. Using Proposition 2, any pooling equilibrium can be characterized by the highest type $\bar{\theta}$ making an offer, and the pooling offer $(R_{max}(\bar{\theta}), \bar{\Delta})$. Hence, the equilibrium is fully characterizes by $\bar{\theta}$ and $\bar{\Delta}$. Using (21), we can compute the profit for the bank for a capital structure leading to a pooling equilibrium, and denote it $\bar{V}(\bar{\theta}, \bar{\Delta})$. We will show that for any $\bar{\theta} > \theta^*$ and $\bar{\Delta} > 0$, we have $\bar{V}(\bar{\theta}, \bar{\Delta}) \leq \bar{V}(\theta^*, 0)$.

Note that $\bar{V}(\bar{\theta}, \bar{\Delta})$ is obviously lower than $\bar{V}(\bar{\theta}, 0)$, so it is enough to show $\bar{V}(\bar{\theta}, 0) \leq \bar{V}(\theta^*, 0)$.

Moreover, using (22) we have for any $\bar{\theta} > \theta^*$:

$$\frac{\partial\bar{V}(\bar{\theta},0)}{\partial\bar{\theta}} = f(\bar{\theta})[\bar{C}(R_{max}(\bar{\theta}), p(\bar{\theta})) + \bar{E}(R_{max}(\bar{\theta}), p(\bar{\theta})) - \bar{E}(R_0, \bar{\theta}) - \bar{C}(R_0, \bar{\theta})) - I]$$
$$+ \frac{\partial R_{max}(\bar{\theta})}{\partial\bar{\theta}} \int_0^{\bar{\theta}} [\bar{C}_1(R_{max}(\bar{\theta}), p(\theta)) + \bar{E}_1(R_{max}(\bar{\theta}), p(\theta))] dF(\theta)$$
$$< 0. \quad (A.35)$$

The first term is negative because $\bar{E}(R_{max}(\bar{\theta}), p(\bar{\theta})) - \bar{E}(R_0, \bar{\theta}) = 0$, by definition of $R_{max}(\bar{\theta})$, and $\bar{\theta} > \theta^*$ implies $R_{max}(\bar{\theta}) < R_{min}(\bar{\theta})$ and hence $\bar{C}(R_{max}(\bar{\theta}), p(\bar{\theta})) - \bar{C}(R_0, \bar{\theta}) - I < 0$. The reason is that when $\bar{\theta} > \theta^*$, further broadening the set of types for which restructuring occurs is inefficient for shareholders and bondholders, leading to lower expected profits ex ante. The second term is negative because $R_{max}(\cdot)$ is weakly decreasing (Lemma 3), and $\bar{C}_1(R, p(\theta)) + \bar{E}_1(R, p(\theta)) = (1-\theta)(1-m)(1-h) > 0$, reflecting that higher repayments imply higher expected bailout transfers. Therefore, $\bar{V}(\bar{\theta}, 0)$ is decreasing in $\bar{\theta}$. Hence, the pooling equilibrium with the highest profit has $\bar{\Delta} = 0$ and $\bar{\theta} = \theta^*$.

Step 2. Maximization program. We are now going to maximize $\bar{V}(\theta^*, 0)$ in D_0 and R_0, taking into account that D_0 and R_0 determine θ^*, B_0, and $\bar{R} = R_{max}(\theta^*)$. Using (21), $\bar{V}(\theta^*, 0)$ writes as:

$$\begin{aligned} \bar{V}(\theta^*, 0) &= \mathbb{E}(\theta)Z - I_0 + \int_0^{\theta^*} [m(1-\theta)Z - I] dF(\theta) \\ &+ \int_0^{\theta^*} (1-\theta)(1-m)[D_0 + (1-h)\bar{R}] dF(\theta) + \int_{\theta^*}^1 (1-\theta)[D_0 + (1-h)R_0] dF(\theta). \end{aligned} \tag{A.36}$$

Using (19), when offering R_0 to bondholders the bank can raise B_0 with:

$$B_0 = \int_0^{\theta^*} [(1-(1-\theta)(1-m)h)\bar{R} - I] dF(\theta) + \int_{\theta^*}^1 [1-(1-\theta)h] R_0 dF(\theta). \tag{A.37}$$

The bank maximizes $\bar{V}(\theta^*, 0)$ in D_0 and R_0 under the following constraints: (i) Equity is positive; (ii) The capital structure leads to pooling; (iii) Deposits are positive; (iv) Bonds are positive. Condition (ii) implies condition (iv). This gives us the following Lagrangian:

$$\mathcal{L} = \bar{V}(\theta^*, 0) + \lambda[I_0 - D_0 - B_0] + \mu[mR_0 - (1-m)I] + \nu D_0, \tag{A.38}$$

to be maximized in D_0 and R_0, taking into account that B_0 is determined by (A.37), θ^* by $R_{max}(\theta^*) = R_{min}(\theta^*)$, and $\bar{R}$ by $\bar{R} = R_{max}(\theta^*)$.

Step 3. First-order conditions. We first differentiate $\mathcal{L}$ with respect to D_0. We have:

$$\frac{\partial \mathcal{L}}{\partial D_0} = \frac{\partial \bar{V}(\theta^*,0)}{\partial D_0} - \lambda\left[1+\frac{\partial B_0}{\partial D_0}\right] + \nu \tag{A.39}$$

$$\text{with } \frac{\partial \bar{V}(\theta^*,0)}{\partial D_0} = (1-m)\int_0^{\theta^*}(1-\theta)dF(\theta)\left[1+(1-h)\frac{\partial \bar{R}}{\partial D_0}\right] + \int_{\theta^*}^1 (1-\theta)dF(\theta) + \frac{\partial \theta^*}{\partial D_0}\times 0 \tag{A.40}$$

$$\text{and } \frac{\partial B_0}{\partial D_0} = \frac{\partial \theta^*}{\partial D_0}\times 0 + \frac{\partial \bar{R}}{\partial D_0}\int_0^{\theta^*}[1-(1-\theta)(1-m)h]dF(\theta). \tag{A.41}$$

Note that differentiating (A.36) and (A.37) with respect to θ^* gives 0.[30] When differentiating with respect to R_0 we obtain:

$$\frac{\partial \mathcal{L}}{\partial R_0} = \frac{\partial \bar{V}(\theta^*,0)}{\partial R_0} - \lambda\frac{\partial B_0}{\partial R_0} + \mu m \tag{A.42}$$

$$\text{with } \frac{\partial \bar{V}(\theta^*,0)}{\partial R_0} = (1-m)(1-h)\frac{\partial \bar{R}}{\partial R_0}\int_0^{\theta^*}(1-\theta)dF(\theta) + (1-h)\int_{\theta^*}^1 (1-\theta)dF(\theta) + \frac{\partial \theta^*}{\partial R_0}\times 0 \tag{A.43}$$

$$\text{and } \frac{\partial B_0}{\partial R_0} = \frac{\partial \bar{R}}{\partial R_0}\int_0^{\theta^*}[1-(1-\theta)(1-m)h]dF(\theta) + \int_{\theta^*}^1[1-(1-\theta)h]dF(\theta). \tag{A.44}$$

Thus, we obtain the following two first-order conditions:

$$\begin{aligned}
\frac{\partial \mathcal{L}}{\partial D_0} &= (1-m)\int_0^{\theta^*}(1-\theta)dF(\theta)\left[1+(1-h)\frac{\partial \bar{R}}{\partial D_0}\right] + \int_{\theta^*}^1(1-\theta)dF(\theta) \\
&- \lambda\left[1+\frac{\partial \bar{R}}{\partial D_0}\int_0^{\theta^*}[1-(1-\theta)(1-m)h]dF(\theta)\right] + \nu = 0, \qquad \text{(A.45)}\\
\frac{\partial \mathcal{L}}{\partial R_0} &= (1-m)(1-h)\frac{\partial \bar{R}}{\partial R_0}\int_0^{\theta^*}(1-\theta)dF(\theta) + (1-h)\int_{\theta^*}^1(1-\theta)dF(\theta) \\
&- \lambda\left[\frac{\partial \bar{R}}{\partial R_0}\int_0^{\theta^*}[1-(1-\theta)(1-m)h]dF(\theta) + \int_{\theta^*}^1[1-(1-\theta)h]dF(\theta)\right] + \mu m = 0. \qquad \text{(A.46)}
\end{aligned}$$

Step 4. Study of $\bar{R}$. θ^* and $\bar{R}$ are at the intersection of the two curves $R_{min}(\theta)$ and $R_{max}(\theta)$, with R_{min} increasing and R_{max} decreasing in θ. From (6) and (3), $R_{min}(\theta)$ increases in R_0 and is constant in D_0, while $R_{max}(\theta)$ is decreasing in D_0 and increasing in R_0. This implies that $\bar{R}$ increases in R_0 and decreases in D_0: $\frac{\partial \bar{R}}{\partial R_0} \geq 0$ and $\frac{\partial \bar{R}}{\partial D_0} \leq 0$.

Step 5. Main inequality to prove. We now go back to the study of the Lagrangian. We want to prove that $\mu > 0$, that is, the pooling constraint is binding. By contradiction, assume that

[30] This is because $\bar{R} = R_{max}(\theta^*)$ so that $\bar{E}(\bar{R}, p(\theta^*)) = \bar{E}(R_0, \theta^*)$, and $\bar{R} = R_{min}(\theta^*)$ so that $\bar{C}(\bar{R}, p(\theta^*)) - I = \bar{C}(R_0, \theta^*)$.

$\mu = 0$. From (A.46), the first-order condition with respect to R_0, and since $\frac{\partial \bar{R}}{\partial R_0} \geq 0$, we deduce that $\lambda > 0$, and hence the bank has no equity. From (A.46) we obtain that:

$$\lambda = (1-h) \frac{(1-m)\frac{\partial \bar{R}}{\partial R_0} \int_0^{\theta^*} (1-\theta) dF(\theta) + \int_{\theta^*}^1 (1-\theta) dF(\theta)}{\frac{\partial B_0}{\partial R_0}} \tag{A.47}$$

The goal is to show that we cannot have $\nu \geq 0$, and hence generate a contradiction. We plug (A.47) into (A.45), use (A.41), and multiply both sides by $\frac{\partial B_0}{\partial R_0} \geq 0$. We obtain that $\nu < 0$ is equivalent to the following inequality:

$$\begin{aligned} & \tfrac{\partial B_0}{\partial R_0}(1-m) \textstyle\int_0^{\theta^*} (1-\theta) dF(\theta) \left[1 + (1-h)\tfrac{\partial \bar{R}}{\partial D_0}\right] + \tfrac{\partial B_0}{\partial R_0} \textstyle\int_{\theta^*}^1 (1-\theta) dF(\theta) \\ > \quad & \left[1 + \tfrac{\partial B_0}{\partial D_0}\right] \left[\tfrac{\partial \bar{R}}{\partial R_0}(1-m)(1-h) \textstyle\int_0^{\theta^*} (1-\theta) dF(\theta) + (1-h) \textstyle\int_{\theta^*}^1 (1-\theta) dF(\theta)\right] \end{aligned} \tag{A.48}$$

Intuitively, we want to show that R_0 should be chosen as low as possible, so that the constraint (H3) binds. Since the equity constraint binds, in order to lower B_0 by one unit, the bank has to increase D_0 by one unit. If R_0 and $\bar{R}$ also decreased by one unit as a result, this change would increase the expected subsidies received from the government, and lead to a higher profit. The difficulty is that R_0 and $\bar{R}$ decrease by more than one unit. Condition (A.48) means that this effect is always dominated, which we now prove analytically.

Step 6. Proof that inequality (A.48) holds.

We can rewrite inequality (A.48) as follows:

$$0 < (1-m) \int_0^{\theta^*} (1-\theta) dF(\theta) A + \int_{\theta^*}^1 (1-\theta) dF(\theta) B > 0 \tag{A.49}$$

$$\text{with } A = \left[1 + (1-h)\frac{\partial \bar{R}}{\partial D_0}\right] \frac{\partial B_0}{\partial R_0} - \left[1 + \frac{\partial B_0}{\partial D_0}\right] \frac{\partial \bar{R}}{\partial R_0}(1-h) \tag{A.50}$$

$$\text{and } B = \frac{\partial B_0}{\partial R_0} - (1-h)\left[1 + \frac{\partial B_0}{\partial D_0}\right] \tag{A.51}$$

In this form we separate the impact for values of θ below and above θ^*. We can plug the expressions (A.41) and (A.44) for $\frac{\partial B_0}{\partial D_0}$ and $\frac{\partial B_0}{\partial R_0}$ in order to obtain:

$$\begin{aligned}
A &= \left[1+(1-h)\frac{\partial \bar{R}}{\partial D_0}\right]\left[\frac{\partial \bar{R}}{\partial R_0}\int_0^{\theta^*}[1-(1-\theta)(1-m)h]dF(\theta)+\int_{\theta^*}^1[1-(1-\theta)h]dF(\theta)\right] \\
&- \frac{\partial \bar{R}}{\partial R_0}(1-h)\left[1+\frac{\partial \bar{R}}{\partial D_0}\int_0^{\theta^*}[1-(1-\theta)(1-m)h]dF(\theta)\right], \qquad \text{(A.52)} \\
B &= \frac{\partial \bar{R}}{\partial R_0}\int_0^{\theta^*}[1-(1-\theta)(1-m)h]dF(\theta)+\int_{\theta^*}^1[1-(1-\theta)h]dF(\theta) \\
&- (1-h)\left[1+\frac{\partial \bar{R}}{\partial D_0}\int_0^{\theta^*}[1-(1-\theta)(1-m)h]dF(\theta)\right]. \qquad \text{(A.53)}
\end{aligned}$$

Note that neither $\frac{\partial \bar{R}}{\partial D_0}$ nor $\frac{\partial \bar{R}}{\partial R_0}$ depend on the distribution F, as $\bar{R}$ is fully determined by the condition $\bar{R} = R_{max}(\bar{\theta}) = R_{min}(\bar{\theta})$, and neither R_{max} nor R_{min} depend on F. Using the expression above, we can study under which distribution F the left-hand side of (A.49) is the lowest. Pick a given $\hat{\theta}$ below θ^*, and differentiate (A.49) with respect to $f(\hat{\theta})$. We obtain:

$$\begin{aligned}
& (1-m)(1-\hat{\theta})A+(1-m)\int_0^{\theta^*}(1-\theta)dF(\theta)\frac{\partial A}{\partial f(\hat{\theta})}+\int_{\theta^*}^1(1-\theta)dF(\theta)\frac{\partial B}{\partial f(\hat{\theta})} \qquad \text{(A.54)} \\
&= (1-m)(1-\hat{\theta})A+[1-(1-\hat{\theta})(1-m)h]\left[\frac{\partial \bar{R}}{\partial R_0}\int_0^{\theta^*}(1-\theta)dF(\theta)+\left[\frac{\partial \bar{R}}{\partial R_0}-(1-h)\frac{\partial \bar{R}}{\partial D_0}\right]\int_{\theta^*}^1(1-\theta)dF(\theta)\right], \\
\text{using } \frac{\partial A}{\partial f(\hat{\theta})} &= \frac{\partial \bar{R}}{\partial R_0}[1-(1-\hat{\theta})(1-m)h] \qquad \text{(A.55)} \\
\text{and } \frac{\partial B}{\partial f(\hat{\theta})} &= \left(\frac{\partial \bar{R}}{\partial R_0}-(1-h)\frac{\partial \bar{R}}{\partial D_0}\right)[1-(1-\hat{\theta})(1-m)h]. \qquad \text{(A.56)}
\end{aligned}$$

Similarly, if we pick $\hat{\theta}$ above θ^* and differentiate (A.49) with respect to $f(\hat{\theta})$ we obtain:

$$\begin{aligned}
& (1-\hat{\theta})B+(1-m)\int_0^{\theta^*}(1-\theta)dF(\theta)\frac{\partial A}{\partial f(\hat{\theta})}+\int_{\theta^*}^1(1-\theta)dF(\theta)\frac{\partial B}{\partial f(\hat{\theta})} \qquad \text{(A.57)} \\
&= (1-\hat{\theta})B+[1-(1-\hat{\theta})h]\left[\int_{\theta^*}^1(1-\theta)dF(\theta)+(1-m)\int_0^{\theta^*}(1-\theta)dF(\theta)\left[1+(1-h)\frac{\partial \bar{R}}{\partial D_0}\right]\right], \\
\text{using } \frac{\partial A}{\partial f(\hat{\theta})} &= \left(1+(1-h)\frac{\partial \bar{R}}{\partial D_0}\right)[1-(1-\hat{\theta})h] \qquad \text{(A.58)} \\
\text{and } \frac{\partial B}{\partial f(\hat{\theta})} &= 1-(1-\hat{\theta})h. \qquad \text{(A.59)}
\end{aligned}$$

Both (A.54) and (A.57) are linear in $\hat{\theta}$. While the sign of the slope is unclear, this linearity implies that the marginal impact of a distribution putting more weight on $\hat{\theta}$ is the strongest in either $\hat{\theta} = 0$, or $\hat{\theta} = \theta^*$, or $\hat{\theta} = 1$. This implies that the distribution F that minimizes the left-hand side of inequality (A.49) is a distribution that puts all the weight on either: (i) $\hat{\theta} = 0$; (ii) $\hat{\theta} = \theta^* - \epsilon$, for ϵ small and positive; (iii) $\hat{\theta} = \theta^* + \epsilon$, for ϵ small and positive; (iv) $\hat{\theta} = 1$. We now compute the value of the left-hand side of (A.49) in these four cases.

(i) If the distribution puts all the weight in 0 then the left-hand side of (A.49) is equal to $(1-m)A$, with $A = hm\frac{\partial \bar{R}}{\partial R_0} > 0$.

(ii) If the distribution puts all the weight in $\theta^* - \epsilon$, then as $\epsilon \to 0$ the left-hand side of (A.49) tends to $(1-m)(1-\theta^*)A$, with:

$$A = h\frac{\partial \bar{R}}{\partial R_0}(1 - (1-\theta^*)(1-m)h), \tag{A.60}$$

which is strictly positive as $\frac{\partial \bar{R}}{\partial R_0} \geq 0$.

(iii) If the distribution puts all the weight in $\theta^* + \epsilon$, then as $\epsilon \to 0$ the left-hand side of (A.49) tends to $(1-\theta^*)B$ with $B = h\theta^* > 0$.

(iv) If the distribution puts all the weight in 1 then the left-hand side of (A.49) is equal to zero.

This shows that for non-degenerate distributions the left-hand side of (A.49) is necessarily strictly positive, so that (A.49) and hence (A.48) both hold. This implies that $\nu < 0$, a contradiction. This proves that the optimal solution cannot have $\mu = 0$. Hence, the pooling constraint binds, and the optimal capital structure cannot be such that a pooling equilibrium obtains with $mR_0 > (1-m)I$.

Finally, note that if $mR_0 = (1-m)I$, there exists a pooling equilibrium but it gives the exact same outcome as the separating equilibrium: as $R_{min}(\theta)$ is constant in θ, all types make the same offer after a zero delay and there is no incentive to misreport one's type.

A.6 Proof of Corollary 1

Differentiating (15) and (17) with respect to D_0, the signaling and surplus effects of increasing deposits are determined by:

$$\begin{aligned} \frac{\partial E_1(\theta,\theta)}{\partial D_0} &= -\frac{\partial \dot{R}^*(\theta)}{\partial D_0} \times [1-(1-\theta)(1-m)] = 0, & \text{(A.61)} \\ \frac{\partial [E(\theta,\theta) - \bar{E}(R_0,\theta)]}{\partial D_0} &= -m(1-\theta) < 0. & \text{(A.62)} \end{aligned}$$

Using expression (9), $\Delta^*(\theta)$ thus increases with D_0. Moreover, θ^* being defined by $E(\theta^*, \theta^*) - \bar{E}(R_0, \theta^*) = 0$, equation (A.62) implies that θ^* decreases with D_0.

For bonds, since the equilibrium is separating equation (19) reduces to:

$$B_0 = [1 - (1 - \mathbb{E}(\theta))h]R_0. \tag{A.63}$$

In particular, the derivative of any variable with respect to B_0 has the same sign as the derivative with respect to R_0. We can compute the surplus effect and the signaling effects of R_0, which go in opposite directions:

$$\frac{\partial E_1(\theta, \theta)}{\partial R_0} = \frac{-hm[1 - (1 - \theta)(1 - m)]}{[1 - h(1 - \theta)(1 - m)]^2} < 0, \tag{A.64}$$

$$\frac{\partial [E(\theta, \theta) - \bar{E}(R_0, \theta)]}{\partial R_0} = \frac{-m(1 - \theta)(1 - h)}{1 - h(1 - \theta)(1 - m)} < 0. \tag{A.65}$$

Condition (A.65) implies in particular that θ^* decreases in R_0 and hence in B_0.

Combining the two effects, we have:

$$\begin{aligned}
\frac{\partial \dot{\Delta}^*(\theta)}{\partial R_0} &= \frac{1}{\beta[E(\theta, \theta) - \bar{E}(R_0, \theta)]^2} \left(\frac{\partial E_1(\theta, \theta)}{\partial R_0} [E(\theta, \theta) - \bar{E}(R_0, \theta)] - \frac{\partial [E(\theta, \theta) - \bar{E}(R_0, \theta)]}{\partial R_0} E_1(\theta, \theta) \right) \\
&= -\frac{hm[1 - (1 - \theta)(1 - m)][m(1 - \theta)(Z - D_0) - I]}{\beta[1 - (1 - \theta)(1 - m)h]^2 [E(\theta, \theta) - \bar{E}(R_0, \theta)]^2}. \qquad \text{(A.66)}
\end{aligned}$$

This expression has the sign of $-[m(1 - \theta)(Z - D_0) - I]$. Thus, it is negative for $\theta \leq \frac{m(Z - D_0) - I}{m(Z - D_0)}$ and positive otherwise. Assumption (H2) guarantees that $\frac{m(Z - D_0) - I}{m(Z - D_0)} > 0$. Since $\frac{\partial \dot{\Delta}(\theta)}{\partial R_0} < 0$ for any $\theta \leq \frac{m(Z - D_0) - I}{m(Z - D_0)}$, we deduce that there exists $\tilde{\theta} > 0$ such that $\frac{\partial \Delta(\theta)}{\partial R_0} \leq 0$ for $\theta \leq \tilde{\theta}$ and $\frac{\partial \Delta(\theta)}{\partial R_0} \geq 0$ otherwise (the same applies to derivatives with respect to B_0). Moreover, (15) implies that $\frac{m(Z - D_0) - I}{m(Z - D_0)}$ is lower than θ^*. Since $\Delta(\theta)$ becomes infinite in θ^* and θ^* decreases in B_0, necessarily $\tilde{\theta}$ is lower than θ^*.

Finally, we prove that replacing one unit of deposit with one unit of bonds reduces the delay. We have shown that D_0 has no signaling effect whereas B_0 and hence R_0 reduce delay via the signaling effect. To complete the proof, it is sufficient to show that the proposed substitution increases the surplus, and hence will reduce the delay via the surplus effect. We have

$$
\begin{aligned}
\frac{\partial[E(\theta,\theta)-\bar{E}(R_0,\theta)]}{\partial B_0}-\frac{\partial[E(\theta,\theta)-\bar{E}(R_0,\theta)]}{\partial D_0} &= \frac{\partial[E(\theta,\theta)-\bar{E}(R_0,\theta)]}{\partial B_0}-\frac{\partial[E(\theta,\theta)-\bar{E}(R_0,\theta)]}{\partial D_0} && \text{(A.67)}\\
&= \frac{m(1-\theta)}{[1-h(1-\theta)(1-m)][1-(1-\mathbb{E}(\theta))h]}A, && \text{(A.68)}\\
\text{with } A &= ([1-h(1-\theta)(1-m)][1-(1-\mathbb{E}(\theta))h]-m(1-\theta)(1-h)) && \text{(A.69)}
\end{aligned}
$$

The quantity A is linear in m. It is obviously positive in $m=0$ and equal to $\mathbb{E}h+\theta(1-h)$ and hence also positive in $m=1$. Hence, A is always positive. This proves that replacing one unit of D_0 with one unit of B_0 increases the surplus from restructuring, so that $E(\theta,\theta)-\bar{E}(R_0,\theta)]$ decreases. Since moreover $E_1(\theta,\theta)$ decreases, this implies that $\dot{\Delta}(\theta)$ decreases for any θ, and hence $\Delta(\theta)$ decreases.

A.7 Proof of Corollary 2

Using (37) and (38) it is easy to show that we have $\partial\Delta^{**}/\partial B_0 \leq \partial\Delta^{**}/\partial D_0 \leq 0$, which proves 1. and 2. The third point directly follow from (32).

A.8 Proof of Lemma 4 and Implications 1 to 5

A.8.1 Proof of Lemma 4

For a given θ, conditionally on restructuring taking place the impact on social welfare is $m(1-\theta)Z-I$, which is positive if and only if $\theta \leq \theta^{**}$. This proves the first point. For the second point, recall from the proof of Lemma 1 that $R_{max}(\theta)-R_{min}(\theta)$ always decreases in θ. Moreover, $R_{max}(\theta^*)-R_{min}(\theta^*)=0$. Thus, $\theta^* \leq \theta^{**}$ if and only if $R_{max}(\theta^{**})-R_{min}(\theta^{**})<0$. We have:

$$
R_{max}(\theta^{**})-R_{min}(\theta^{**})=\frac{mI(Z-D_0)+(mZ-I)R_0}{mZ-I(1-m)}-\frac{(mZ-hI)R_0+mIZ}{mZ-(1-m)hI}. \qquad \text{(A.70)}
$$

We then compute that $R_{max}(\theta^{**})-R_{min}(\theta^{**})\leq 0$ and hence $\theta^* \leq \theta^{**}$ if and only if $D_0 \geq \hat{D}$. The second point of the Lemma follows.

A.8.2 Proof of Implication 1

Using (15), (17), and (7), we have:

$$\frac{\partial[E(\theta,\theta)-\bar{E}(R_0,\theta)]}{\partial h} = \frac{-(1-\theta)(1-(1-m)(1-\theta))(I(1-m)-mR_0)}{(1-h(1-\theta)(1-m))^2} < 0, \tag{A.71}$$
$$\frac{\partial[E(\theta,\theta)-\bar{E}(R_0,\theta)]}{\partial h} = p(\theta)\frac{[I(1-m)-mR_0][1+h(1-m)(1-\theta)]}{(1-h(1-\theta)(1-m))^3} > 0. \tag{A.72}$$

Using (9) then implies that $\Delta^*(\theta)$ always increases in h. The impact of h on social welfare then directly follows from Lemma 4. That h has no impact under publicly subsidized restructuring comes from (OA.11), the explicit expression of $\Delta^{**}(\theta)$.

A.8.3 Proof of Implication 2

- Case $D_0 = I_0$: This is a corner solution in which the bank only uses deposits. After a marginal increase in h, the bank's capital structure will still be at this corner solution. The only effect of h is then the short-run effect shown in Implication 1, and h increases the restructuring delay $\Delta^*(\theta)$.

- Case $B_0 = I_0$: This is a corner solution in which the bank only uses bonds. After a marginal increase in h, the bank's capital structure will still be at this corner solution. We have:

$$\begin{aligned} B_0 &= \int_0^{\theta^*}[\bar{C}(R^*(\theta),p(\theta))-I]dF(\theta)+\int_{\theta^*}^1\bar{C}(R_0,\theta)dF(\theta) && \text{(A.73)}\\ &= \int_0^1\bar{C}(R_0,\theta)dF(\theta) && \text{(A.74)}\\ &= (1-(1-\mathbb{E}(\theta))h)R_0, && \text{(A.75)}\end{aligned}$$

where the expression of B_0 simplifies due to $R^*(\theta)$ being set at $R_{min}(\theta)$, which is precisely such that $\bar{C}(R^*(\theta),p(\theta))-I=\bar{C}(R_0,\theta)$. We deduce that when $B_0=I_0$ we have:

$$R_0 = \frac{I_0}{(1-(1-\mathbb{E}(\theta))h)}, \tag{A.76}$$

and thus R_0 increases in h. When $\theta > \tilde{\theta}$, Corollary 1 states that this increase in R_0 also increases the delay $\Delta^*(\theta)$. This goes in the same direction as the direct effect of h in Implication 1. Hence, an increase in h necessarily leads to a longer delay in this case.

- Case $mR_0 = (1-m)I$: This is a corner solution in which the separating constraint is binding. After a marginal increase in h, the bank's capital structure will still be at this corner solution. With the separating constraint binding the delay is zero, hence the delay and social welfare are unaffected by the change in h.

A.8.4 Proof of Implication 3

Regarding the first point: When $D_0 = R_0 = 0$ and $h = 1$ we find:

$$\beta\Delta^*(\theta) = \beta\Delta^{**}(\theta) = \frac{(1-m)I}{mZ-(1-m)I}\ln\left(\frac{[1-(1-\theta)(1-m)][mZ-I]}{m[m(1-\theta)Z-I]}\right). \tag{A.77}$$

The delays in both cases are equal because this is a case in which restructuring has no externality on the government, and hence government involvement has no effect. We know from Corollaries 1 and 2 that $\Delta^*(\theta)$ increases in D_0 while $\Delta^{**}(\theta)$ decreases in D_0. Hence, increasing D_0 while $R_0 = 0$ and $h = 1$ necessarily makes the delay higher in the case without government than in the case with government.

Regarding the second point: we know from (17) and (7) that $\Delta^*(\theta) = 0$ when $h = 0$, whereas h has no impact on $\Delta^{**}(\theta)$. Moreover, $\Delta^*(\theta)$ is continuous in h. The result follows.

A.8.5 Proof of Implication 4

This Implication follows directly from Proposition 6.

A.8.6 Proof of Implication 5

The first point follows from the fact that substituting one unit of deposit with one of unit of bonds reduces the delay (Corollary 1), while Lemma 4 guarantees that when $D_0 > \hat{D}$ reducing the delay has a positive impact on welfare.

For the second point: When $(1-m)I \leq mI_0$ the unregulated bank chooses $D_0 = I_0$, which leads to a pooling equilibrium in which all types in $[0, \theta^{**}]$ restructure immediately, which is the first best. Instead when $(1-m)I > mI_0$ the delay is positive, and a change in the capital structure that reduces the delay for all types is necessarily welfare-improving. From the expression (OA.11) for $\Delta^{**}(\theta)$, we see that a change in the capital structure reduces the delay if and only if $D_0 + R_0$ increases. Increasing B_0 by one unit increases R_0 by more than one unit, hence substituting one unit of D_0 with one unit of B_0 increases $D_0 + R_0$ and reduces the delay up to the point where $(1 - m)I = m(R_0 + D_0)$, in which case the delay becomes null.

B Figures

Parameters used in the figures. Figures 2 and 3 use the following "baseline" parameters: $Z = 3$, $I_0 = 0.1$, $I = 0.5$, $m = 0.75$, $h = 0.75$, $\beta = 1$, $\tilde{\theta} \hookrightarrow \mathcal{U}[0, 1]$, under private restructuring. The capital structure is the optimal one for these parameters: $D_0 = 0$, $B_0 = 0.1$, so that $R_0 = 0.159$. Figures 4 and 7 use the baseline parameters except that h and I_0 both take 100 equally spaced values between 0.01 and 1.00. Figure 5 uses the baseline parameters and plots the cases of private and publicly subsidized restructuring. The capital structure is either $D_0 = 0, B_0 = 0.1$ (optimal structure under private restructuring) or $D_0 = 0.1, B_0 = 0$ (optimal structure under publicly subsidized restructuring). Figure 6 uses the baseline parameters, private restructuring, and lets h vary from 0.1 to 0.75. On the left panel the capital structure is $D_0 = 0$, $B_0 = 0.1$, so that $R_0 = 0.159$, the optimum for $h = 0.75$. On the right panel the capital structure is the optimal one for each h: $D_0 = 0.1$ and $B_0 = 0$ for $h = 0.1$ and $h = 0.25$; $D_0 = 0$, $B_0 = 0.1$, $R_0 = 0.1329$ for $h = 0.5$, and $D_0 = 0$, $B_0 = 0.1$ and $R_0 = 0.159$ for $h = 0.75$.

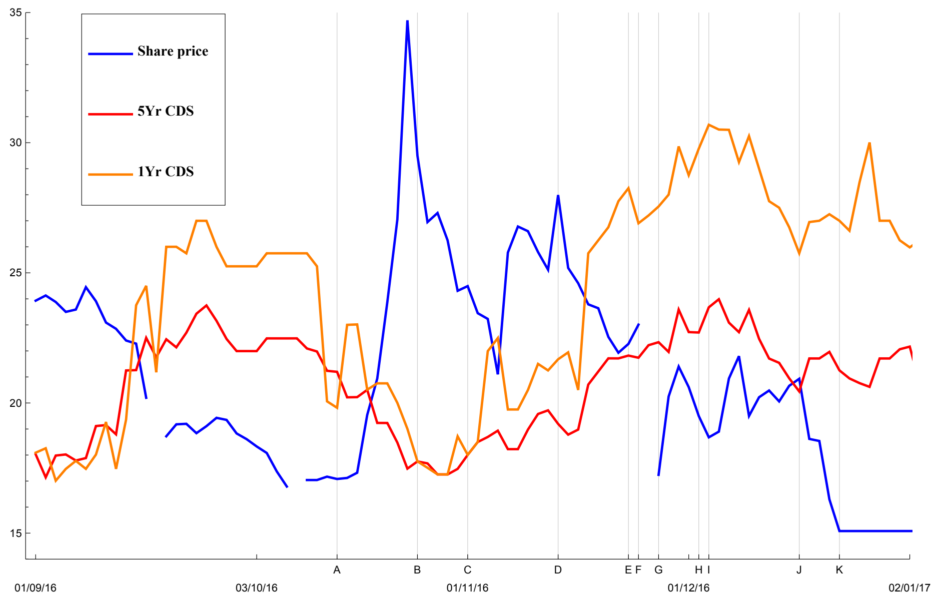

Figure 1: **Monte dei Paschi di Siena.** This graph plots the share price, 1-year and 5-year CDS premia for Monte dei Paschi di Siena between September 2016 and January 2017. CDS premia are multiplied by 1/20 for better readability.

A. 13 October 2016: Former Intesa Sanpaolo CEO Corrado Passera proposes a new private rescue plan of MPS.

B. 25 October 2016: Announcement of a EUR 5 bn "capital strengthening transaction" and of the transfer of a bad loans portfolio to a securitization vehicle.

C. 1 November 2016: Withdrawal of the 13 October proposal.

D. 14 November 2016: Announcement of a debt-to-equity swap for the end of November. Announcement of agreement to sell the bad loans vehicle, conditionally on the capital strengthening transaction being successful.

E. 23 November 2016: Capital strengthening transaction approved by the ECB.

F. 24 November 2016: Shareholders' meeting agrees to the capital strengthening transaction.

G. 28 November 2016: Start of the tender offer for the swap announced on 14 November. The offer is conditional on MPS' sale of its bad loans vehicle and capital strengthening transaction being successful.

H. 2 December 2016: Preliminary results of the tender offer communicated. Italy in talks with the European Commission on participating in the capital strengthening transaction.

I. 5 December 2016: Matteo Renzi resigns after "No" vote in referendum. Private investors reconsider their participation in the capital strengthening exercise.

J. 16 December 2016: New debt-to-equity swap offer announced.

K. 22 December 2016: MPS confirms the failure of the capital strengthening transaction. Rescue of the bank by the Italian government.

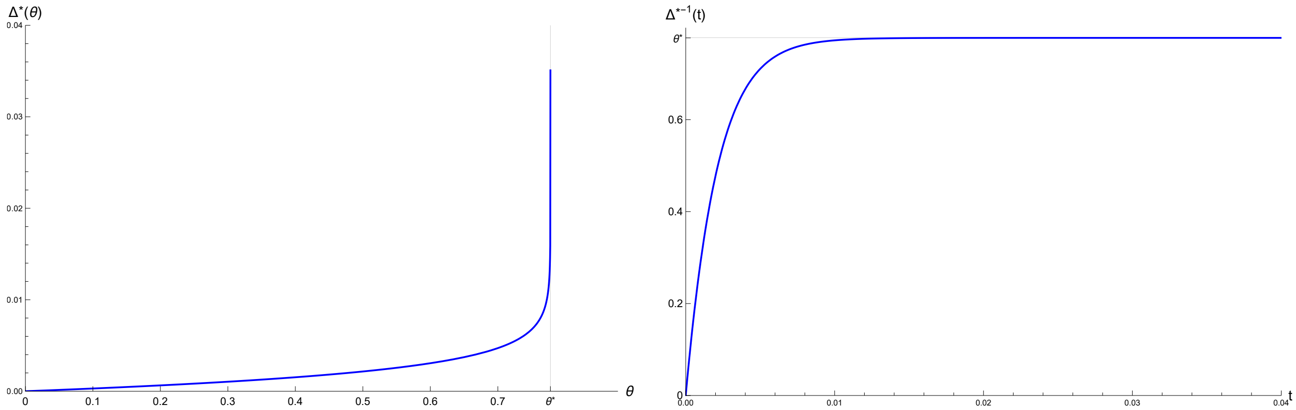

Figure 2: **Equilibrium delay $\Delta(\theta)$ for a given type θ (left panel), and equilibrium belief $\Delta^{-1}(t)$ for an observed delay t (right panel).**

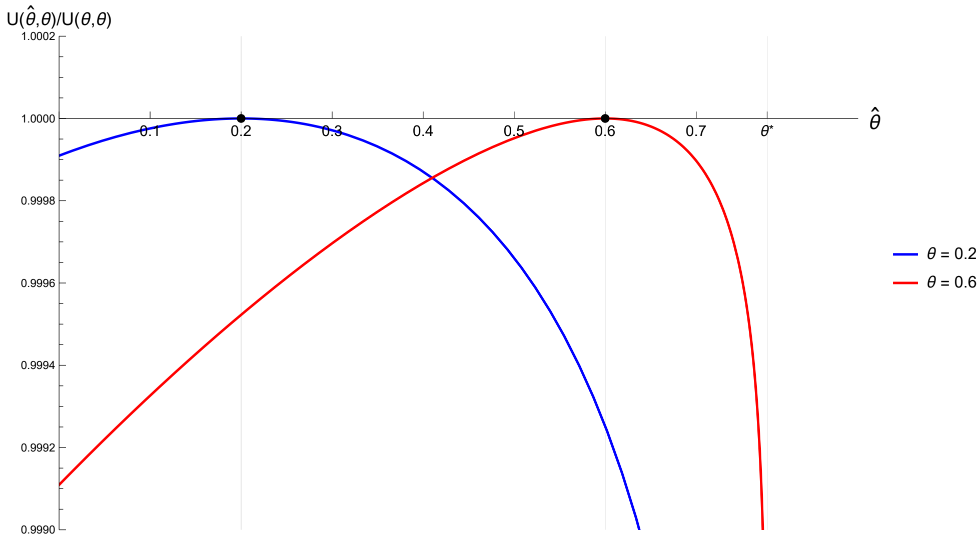

Figure 3: **Manager's incentives to report truthfully.** This graph plots the ratio $U(\hat{\theta}, \theta)/U(\theta, \theta)$ as a function of $\hat{\theta}$, for different values of θ, where $U(\hat{\theta}, \theta)$ is the expected payoff of a manager of type θ behaving as type $\hat{\theta}$ (see (A.11)). $U(\hat{\theta}, \theta)$ is always maximized in $\hat{\theta} = \theta$.

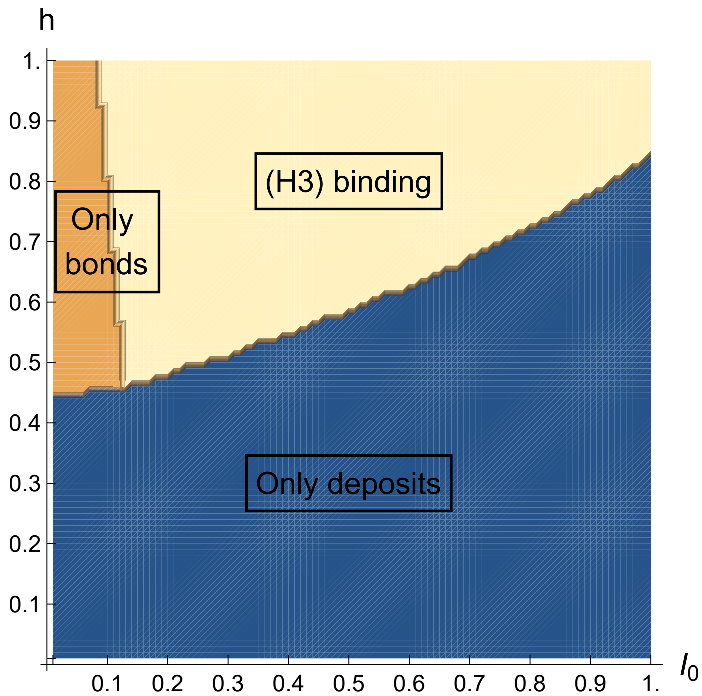

Figure 4: **Optimal capital structure.** This graph plots the optimal capital structure chosen by the bank as a function of I_0 and h.

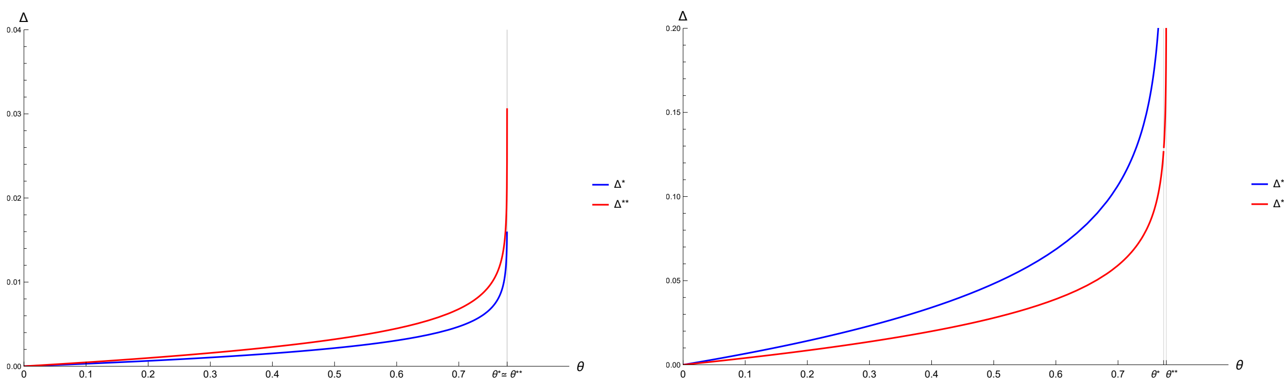

Figure 5: **Government involvement and equilibrium delay.** This graph plots the equilibrium delay under publicly subsidized restructuring $\Delta^*(\theta)$ and the equilibrium delay under private restructuring $\Delta^{**}(\theta)$, for a capital structure with bonds only (left panel) and with deposits only (right panel).

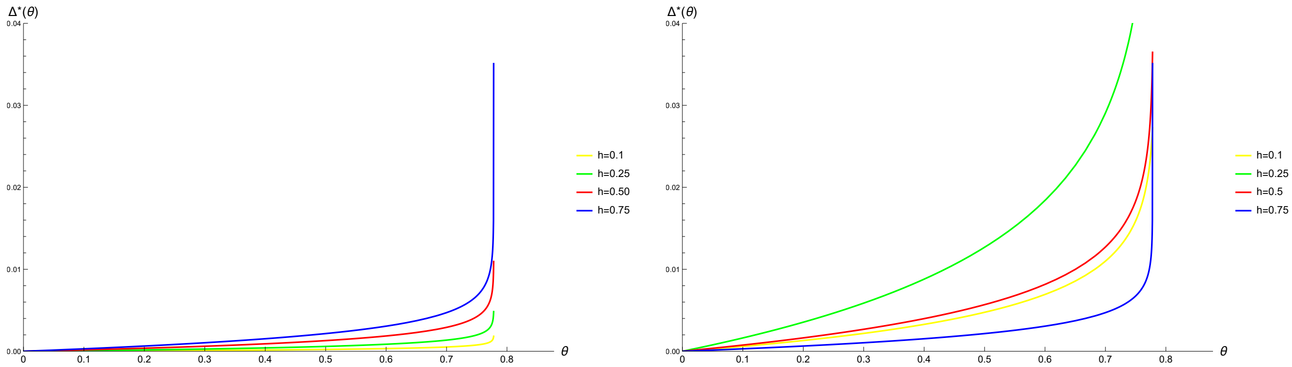

Figure 6: **Haircut h and equilibrium delay.** This graph plots the equilibrium delay under private restructuring $\Delta^*(\theta)$ for different values of h, either keeping the capital structure constant (left panel) or using the optimal capital structure for each h (right panel).

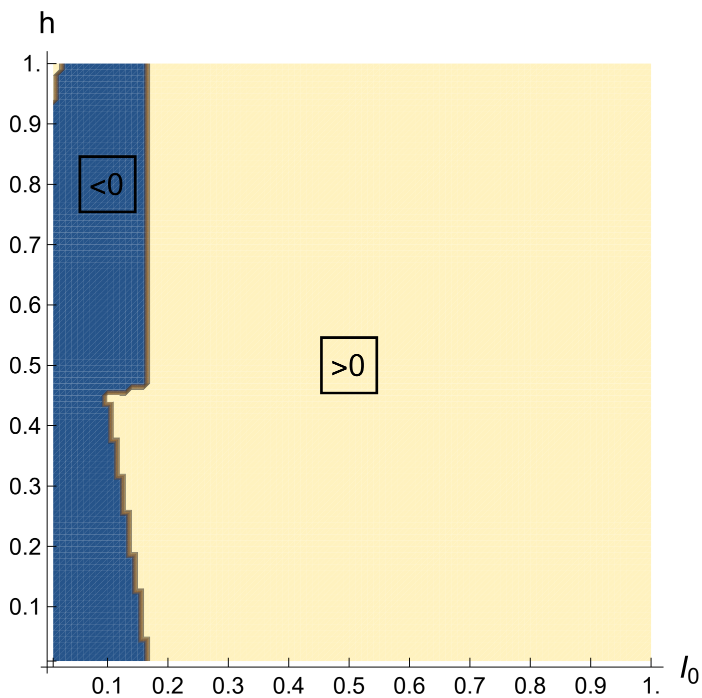

Figure 7: **Impact of government involvement on welfare.** This graph plots the sign of the difference between welfare $\mathcal{W}$ achieved under publicly subsidized restructuring and private restructuring, as a function of I_0 and h. The "> 0" region is where publicly subsidized restructuring achieves a higher welfare.

Online Appendix to "Financial Restructuring and Resolution of Banks"

JEAN-EDOUARD COLLIARD and DENIS GROMB

This Online Appendix provides additional proofs omitted from the main appendix.

OA.1 Proof of Proposition 2

Proof of the first bullet point. We prove that the strategies given in the Proposition indeed form an equilibrium.

Step 1: Beliefs following off-equilibrium moves.

Let $\hat{\theta}(R, \Delta)$ denote bondholders' belief following an off-equilibrium move (R, Δ). We define beliefs that satisfy the intuitive criterion.

If $R \geq R_{max}(\theta^*)$, no type finds the offer (if accepted) strictly profitable. We assume $\hat{\theta}(R, \Delta) = 0$ which the Intuitive Criterion does not constrain, since no type will consider this strategy irrespective of how bondholders respond.

If $R < R_{max}(\theta^*)$, the offer (if accepted) is strictly profitable for a set of types. Denote $\bar{\theta}$ the supremum of this set. R_{max} being continuous, $R < R_{max}(\theta)$ for some types $\theta > \theta^*$. Types above θ^* don't make offers in equilibrium, hence if an offer at $R < R_{max}(\theta)$ is accepted this would be a profitable deviation for them. This implies that $\bar{\theta} > \theta^*$. We assume the belief $\hat{\theta}(R, \Delta)$ to be the average between θ^* and $\bar{\theta}$. By Lemma 3, since $\bar{\theta}$ prefers (R, Δ) to not making an offer, this is also true for type $\hat{\theta}(R, \Delta) < \bar{\theta}$. Hence, this belief satisfies the Intuitive Criterion.

Step 2: No profitable deviation.

Consider a deviation (R, Δ) by type θ. If $R \geq R_{max}(\theta^*)$, the deviation is not strictly profitable irrespective of Δ. If $R < R_{max}(\theta^*)$ then $\hat{\theta}(R, \Delta) > \theta^*$. We have $R < R_{max}(\theta^*) = R_{min}(\theta^*)$. Moreover, since $R_{min}(\cdot)$ is increasing, $R_{min}(\theta^*) < R_{min}(\hat{\theta}(R, \Delta))$. Hence, $R < R_{min}(\hat{\theta}(R, \Delta))$ and the bondholders reject the offer.

Proof of the second bullet point.

Step 1: The highest type making an offer is some $\bar{\theta}$, with $\bar{\theta} \geq \theta^*$.

By contradiction. Assume $\bar{\theta} < \theta^*$. Consider a deviation consisting in offering $R_{max}(\theta^*)$ after $\Delta = 0$. $R_{max}(\cdot)$ being decreasing, the offer, if accepted, is profitable for all types in $(\bar{\theta}, \theta^*]$ but for none in $(\theta^*, 1]$. If $(R_{max}(\theta^*), 0) = (R^*(\theta), \Delta(\theta))$ for some type $\theta \in [0, \bar{\theta}]$, bondholders accept the offer a contradiction. Otherwise, under the Intuitive Criterion, bondholders must believe asset quality to be some $\hat{\theta} < \theta^*$. We have $R_{max}(\theta^*) = R_{min}(\theta^*)$. Moreover, $R_{min}(.)$ being increasing, $R_{min}(\theta^*) > R_{min}(\hat{\theta})$. Hence, the bondholders accept offer $(R_{max}(\theta^*), 0)$, which makes the deviation profitable for type $\hat{\theta}$, a contradiction.

Step 2: If $\bar{\theta} = \theta^*$ then $R^*(\theta) = R_{max}(\theta^*)$ and $\Delta^*(\theta) = 0$ for all $\theta \in [0, \theta^*]$.

By contradiction.

Assume $R^*(\theta) > R_{max}(\theta^*)$ for some $\theta \in [0, \theta^*]$. Consider a deviation consisting in offering $(R_{max}(\theta^*), 0)$. $R_{max}(\cdot)$ being decreasing, the offer, if accepted, is profitable for type θ but for none in $(\theta^*, 1]$. If $(R_{max}(\theta^*), 0) = (R^*(\theta'), \Delta^*(\theta'))$ for some type $\theta' \in [0, \theta^*]$, bondholders accept the offer. Otherwise, under the Intuitive Criterion, bondholders must believe asset quality to be some $\hat{\theta}$ in $[0, \theta^*]$. For any type $\hat{\theta} \in [0, \theta^*]$, bondholders will accept the offer because, $R_{min}(\cdot)$ being increasing, $R_{min}(\hat{\theta}) \leq R_{min}(\theta^*) = R_{max}(\theta^*)$. Hence, the deviation would be profitable for type θ, a contradiction.

Assume $R^*(\theta) < R_{max}(\theta^*)$ for some $\theta \in [0, \theta^*]$. Then by continuity of $R_{max}(.)$, there are some types above θ^* that prefer offering $(R^*(\theta), \Delta^*(\theta))$ to their equilibrium strategy, a contradiction.

Finally, assume $R^*(\theta) = R_{max}(\theta^*)$ for all $\theta \in [0, \theta^*]$ and $\Delta^*(\theta) > 0$. Then any type $\theta \in [0, \theta^*]$ deviating to $(R_{max}(\theta^*), 0)$ would see his offer accepted and have a profitable deviation, a contradiction.

This proves that the equilibrium in the first bullet point is the only one with $\bar{\theta} = \theta^*$. From now on, we consider the case $\bar{\theta} > \theta^*$.

Step 3: There exists $\underline{\theta} < \theta^*$ such that for all $\theta \in [\underline{\theta}, \bar{\theta}]$, $(R^*(\theta), \Delta^*(\theta)) = (\bar{R}, \bar{\Delta})$.

As $\bar{\theta} > \theta^*$, $R_{max}(\bar{\theta}) < R_{min}(\bar{\theta})$ and equilibrium requires $R^*(\bar{\theta}) \leq R_{max}(\bar{\theta})$ so $R^*(\bar{\theta}) < R_{min}(\bar{\theta})$. Hence, offer $(R^*(\bar{\theta}), \Delta^*(\bar{\theta}))$ can be accepted only if it's pooled with the offers of some types θ with $R_{min}(\theta) \leq R^*(\bar{\theta})$. Since moreover $R^*(\bar{\theta}) < R_{max}(\bar{\theta})$ and $R_{max}(\bar{\theta}) \leq R_{max}(\theta^*)$, we have $R_{min}(\theta) \leq R_{max}(\theta^*)$. This last inequality implies that $\theta < \theta^*$, since R_{min} and R_{max} cross in θ^*. Denoting $\underline{\theta}$ the lowest type making offer $(R^*(\bar{\theta}), \Delta^*(\bar{\theta}))$, we thus have $\underline{\theta} < \theta^*$. We then have $R^*(\underline{\theta}) = R^*(\bar{\theta})$ and $\Delta^*(\underline{\theta}) = \Delta^*(\bar{\theta})$. The monotonicity of R^* and Δ^* (Lemma 3) implies that all $\theta \in [\underline{\theta}, \bar{\theta}]$ make the same offer, which completes the proof.

Step 4: $\bar{R} = R_{max}(\bar{\theta}) < R_{max}(\theta^*)$.

Equilibrium implies $\bar{R} \leq R_{max}(\bar{\theta})$, otherwise $\bar{\theta}$ would not make the pooling offer. If $\bar{R} < R_{max}(\bar{\theta})$, by continuity of $R_{max}(.)$ there would exist $\theta > \bar{\theta}$ such that θ strictly prefers making the offer $(\bar{R}, \bar{\Delta})$ to making no offer, which contradicts the definition of $\bar{\theta}$. Hence, $\bar{R} = R_{max}(\bar{\theta})$. Moreover, $R_{max}(\cdot)$ being strictly decreasing, $\bar{\theta} > \theta^*$ implies $R_{max}(\bar{\theta}) < R_{max}(\theta^*)$.

Step 5: For all $\theta \in [0, \bar{\theta}]$**,** $(R^*(\theta), \Delta^*(\theta)) = (\bar{R}, \bar{\Delta})$.

Since the offer $(\bar{R}, \bar{\Delta})$ is accepted, there exists $\theta \in (\underline{\theta}, \bar{\theta})$ such that $\bar{R} > R_{min}(\theta)$. There exists $R \geq \bar{R}$ such that θ is indifferent between $(R, \Delta^*(0))$ and $(\bar{R}, \bar{\Delta})$. By contradiction, if $\underline{\theta} > 0$, $\Delta^*(0) < \bar{\Delta}$ and hence $R > \bar{R}$. By Lemma 3, all types in $(\underline{\theta}, \theta)$ strictly prefer to deviate to $(R, \Delta^*(0))$ if this offer is accepted. Moreover, according to the Intuitive Criterion, upon observing $(R, \Delta^*(0))$,the bondholders must believe the type to be some $\hat{\theta} < \theta$. Since $R_{min}(.)$ is increasing, $R_{min}(\theta) > R_{min}(\hat{\theta})$. Moreover, θ was such that $\bar{R} > R_{min}(\theta)$, hence $R > R_{min}(\hat{\theta})$. Hence, the bondholders accept $(R, \Delta^*(0))$ and this deviation is strictly profitable for all types in $(\underline{\theta}, \theta)$, a contradiction. This concludes the proof that any equilibrium has all types in $[0, \bar{\theta}]$ make the same offer.

OA.2 Proof of Proposition 4

The proof follows the same steps as the proof of Proposition 1, and many steps are almost identical.

To save on notations, we denote $(\mathcal{O}, \Delta)$ an offer (R, I_C, D, I_G, Δ). Similarly, $(\mathcal{O}', \Delta')$ is an alternative offer $(R', I'_C, D', I'_G, \Delta')$ and $(\mathcal{O}^{**}, \Delta^{**})$ and equilibrium offer $(R^{**}, I_C^{**}, D^{**}, I_G^{**}, \Delta^{**})$. We also denote $P = R + D$, $P' = R' + D'$, and $P^{**} = R^{**} + D^{**}$.

We start by establishing the following Lemma, which is an adaptation of Lemma 3 to the case of publicly subsidized restructuring.

Lemma 5. *Under (H4): (i) If type $\theta \in [0,1]$ weakly prefers the pair $(\mathcal{O}, \Delta)$ to $(\mathcal{O}', \Delta')$ and $\Delta > \Delta'$, then any $\theta' > \theta$ strictly prefers $(\mathcal{O}, \Delta)$ to $(\mathcal{O}', \Delta')$; (ii) $P_{max}(.)$ is weakly decreasing; (iii) $P^{**}(.)$ is weakly decreasing and $\Delta^{**}(.)$ weakly increasing; (iv) If type $\theta \in [0,1]$ makes an offer after a finite delay in equilibrium, then any type $\theta' < \theta$ also makes an offer after a finite delay.*

Proof of the Lemma.

(i) Assume type θ prefers $(\mathcal{O}, \Delta)$ to $(\mathcal{O}', \Delta')$, with $\Delta > \Delta'$. This means that

$$e^{-\beta\Delta}[p(\theta)(Z-P)]+[1-e^{-\beta\Delta}]\theta[Z-D_0-R_0] \geq e^{-\beta\Delta'}[p(\theta)(Z-P')]+[1-e^{-\beta\Delta'}]\theta[Z-D_0-R_0]. \quad \text{(OA.1)}$$

This condition can be rewritten as

$$\left(e^{-\beta\Delta'} - e^{-\beta\Delta}\right)(Z - D_0 - R_0)\frac{\theta}{p(\theta)} \geq e^{-\beta\Delta'}(Z - P') - e^{-\beta\Delta}(Z - P). \quad \text{(OA.2)}$$

As $\Delta' < \Delta$, the left-hand side is positive and (H4) implies it strictly increases in θ. Hence, the inequality will also hold strictly for any $\theta' > \theta$.

(ii) This point is proven analytically in the main text.

(iii) Take $\theta' > \theta$ and assume, by contradiction, that $\Delta^{**}(\theta') < \Delta^{**}(\theta)$. By definition θ prefers $(\mathcal{O}^{**}(\theta), \Delta^{**}(\theta))$ to $(\mathcal{O}^{**}(\theta'), \Delta^{**}(\theta'))$. As $\Delta^{**}(\theta) > \Delta^{**}(\theta')$ and $\theta' > \theta$, by point (i) it must be the case that θ' strictly prefers $(\mathcal{O}^{**}(\theta), \Delta^{**}(\theta))$ to $(\mathcal{O}^{**}(\theta'), \Delta^{**}(\theta'))$, a contradiction. Hence, Δ^{**} is increasing. This immediately implies that P^{**} has to be decreasing, otherwise the equilibrium offers of higher types would be unambiguously dominated by the offers of lower types.

(iv) Denote $\overline{\theta} \in [0,1]$ a type making an offer, and denote $(\overline{\mathcal{O}}, \overline{\Delta})$ this offer. By contradiction, consider some type $\theta < \overline{\theta}$ that doesn't make an offer and hence gets zero surplus from restructuring. This implies that for any $\mathcal{O}$ and for a high enough $\Delta > \overline{\Delta}$ type θ prefers $(\mathcal{O}, \Delta)$ to $(\overline{\mathcal{O}}, \overline{\Delta})$. Indeed, as Δ goes to infinity the payoff from such an offer goes to zero. Then point (i) implies that $\overline{\theta}$ would also prefer making offer $(\mathcal{O}, \Delta)$ and obtaining an arbitrarily small payoff to making offer $(\overline{R}, \overline{\Delta})$, a contradiction.

Proof of the Proposition:

Step 1: There exists $\bar{\theta} \in [0,1]$ such that in equilibrium all types $\theta < \bar{\theta}$ make an offer and all types $\theta > \bar{\theta}$ don't make an offer.

This step follows directly from Lemma 5, point (iv). If the set of types making an offer is non-empty, denote $\bar{\theta}$ the supremum of this set, and then point (iv) implies that all types $\theta < \bar{\theta}$ make an offer, while by definition of the supremum no type $\theta > \bar{\theta}$ above does. It is not necessary at this stage to clarify whether type $\bar{\theta}$ makes an offer, but we will see below that this type makes an offer with an infinite delay. Hence, we adopt the convention that $\bar{\theta}$ does not maker an offer, and the set of types making an offer is hence the interval $[0, \bar{\theta})$.

Step 2: Under condition (H3), for all $\theta \in [0, \bar{\theta}]$, $P^{**}(\theta) = P_{min}(\theta)$, $R^{**}(\theta) = R_{min}(\theta)$, and $D^{**}(\theta) = D_{min}(\theta)$.

By contradiction. We consider two possibilities: Case 1 - $\exists \theta \in [0, \bar{\theta}]$ s.t. $P^{**}(\theta) > P_{min}(\theta)$; Case 2 - $\forall \theta \in [0, \bar{\theta}]$, $P^{**}(\theta) \leq P_{min}(\theta)$ and $\exists \theta' \in [0, \bar{\theta}]$ s.t. $R^{**}(\theta') < P_{min}(\theta')$.

Case 1. By continuity, a type $\theta' < \theta$ exists such that $P^{**}(\theta) > P_{min}(\theta')$. Consider $(\mathcal{O}', \Delta')$ with $P' \in (P_{min}(\theta'), P^{**}(\theta))$ and Δ' such that type θ' is indifferent between $(\mathcal{O}^{**}(\theta'), \Delta^{**}(\theta'))$ and (R', Δ'). By Lemma 5, we have $P^{**}(\theta) \leq P^{**}(\theta')$.

First, we show that for type θ, $(\mathcal{O}', \Delta')$ would be a strictly profitable deviation if accepted by bondholders: If $\Delta' \leq \Delta^{**}(\theta)$, this is obvious as $P' < P^{**}(\theta)$. If $\Delta' > \Delta^{**}(\theta)$, equilibrium requires that θ' weakly prefers $(\mathcal{O}^{**}(\theta'), \Delta^{**}(\theta'))$ to $(\mathcal{O}^{**}(\theta), \Delta^{**}(\theta))$. As $(\mathcal{O}', \Delta')$ was chosen such that θ' is indifferent between $(\mathcal{O}', \Delta')$ and $(\mathcal{O}^{**}(\theta'), \Delta^{**}(\theta'))$, this implies that θ' weakly prefers $(\mathcal{O}', \Delta')$ to $(\mathcal{O}^{**}(\theta), \Delta^{**}(\theta))$. Since $\theta > \theta'$, Lemma 5 implies that θ then strictly prefers $(\mathcal{O}', \Delta')$ to $(\mathcal{O}^{**}(\theta), \Delta^{**}(\theta))$.

Second, we show that for types below θ', $(\mathcal{O}', \Delta')$ is a strictly unprofitable deviation, even if the offer is accepted: As $P' < P^{**}(\theta)$ we also have $P' < P^{**}(\theta')$. Type θ' being indifferent between $(\mathcal{O}^{**}(\theta'), \Delta^{**}(\theta'))$ and $(\mathcal{O}', \Delta')$, we need $\Delta' > \Delta^{**}(\theta')$. Using Lemma 5 this implies that all types below θ' strictly prefer $(\mathcal{O}^{**}(\theta'), \Delta^{**}(\theta'))$ to $(\mathcal{O}', \Delta')$. Equilibrium requires that deviating to $(\mathcal{O}^{**}(\theta'), \Delta^{**}(\theta'))$ be weakly unprofitable for those types, which concludes the proof.

We have shown that deviating to $(\mathcal{O}', \Delta')$ is strictly unprofitable for types below θ', and strictly profitable for θ, if the offer is accepted. The most pessimistic belief following deviation $(\mathcal{O}', \Delta')$ that still satisfies the Intuitive Criterion is thus some $\theta'' \in [\theta', \theta)$. Under (H3-G), $P_{min}(\theta') \geq P_{min}(\theta'')$. Since $P' > P_{min}(\theta')$, we also have $P' > P_{min}(\theta'')$, so that even the most pessimistic belief for bondholders leads them to accept offer $(\mathcal{O}', \Delta')$. Since this offer is accepted, offering $(\mathcal{O}', \Delta')$ is a profitable deviation for θ, a contradiction.

Case 2. In this case, either the government or the bondholders necessarily make an expected loss when accepting offer $\mathcal{O}^{**}(\theta')$, which is not compatible with equilibrium.

We have shown that in equilibrium $P^{**}(\theta) = P_{min}(\theta)$. Since P_{min} is strictly decreasing, when observing an equilibrium offer $\mathcal{O}^{**}(\theta)$ the bondholders and the government can correctly infer the type θ of the bank. Hence, the bondholders will require $R^{**}(\theta) \geq R_{min}(\theta)$, the government $D^{**}(\theta) \geq D_{min}(\theta)$, while $R^{**}(\theta) + D^{**}(\theta) = P_{min}(\theta) = R_{min}(\theta) + D_{min}(\theta)$. Hence, it has to be that $R^{**}(\theta) = R_{min}(\theta)$ and $D^{**}(\theta) = D_{min}(\theta)$. Note that $R_{min}(\theta)$ and $D_{min}(\theta)$ are defined for given $I_C^{**}(\theta)$ and $I_G^{**}(\theta)$, which can be any reals summing to I.

Step 3: $\bar{\theta} = \theta^*$.

By contradiction.

Assume $\bar{\theta} < \theta^{**}$ so $P_{min}(\bar{\theta}) < P_{max}(\bar{\theta})$. By continuity, some $\theta' \in (\bar{\theta}, \theta^{**})$ exists such that $P_{min}(\bar{\theta}) < P_{max}(\theta')$. Deviating by offering D' and R' such that $P' = P_{min}(\bar{\theta}) = P^{**}(\bar{\theta})$ after delay $\Delta^{**}(\bar{\theta})$ is thus profitable for θ' if accepted, and equilibrium implies it is accepted. Hence, the deviation is profitable for θ', a contradiction.

Assume $\bar{\theta} > \theta^{**}$ and take $\theta \in (\theta^{**}, \bar{\theta})$. According to Step 2, we have $P^{**}(\theta) = P_{min}(\theta)$. Since $\theta > \theta^{**}$ we have $P_{min}(\theta) > P_{max}(\theta)$, hence θ is better off deviating to not making an offer, a contradiction.

Step 4: Solving for $\Delta^{**}(\cdot)$.

We know that $R^{**}(\theta) + D^{**}(\theta) = P_{min}(\theta)$. This gives us:

$$
\begin{aligned}
E(\hat{\theta}, \theta) &= [1-(1-\theta)(1-m)](Z - P_{min}(\hat{\theta})) && \text{(OA.3)} \\
&= [1-(1-\theta)(1-m)]Z - \frac{1-(1-\theta)(1-m)}{1-(1-\hat{\theta}(1-m))}[I + \hat{\theta}(R_0 + D_0)]. && \text{(OA.4)}
\end{aligned}
$$

The expression for Δ^{**} follows from the first-order condition exactly as in the case without government. Equation (A.14) remains true and we need to show the expression is positive if and only if $\hat{\theta} \leq \theta$. We have:

$$
E_1(\hat{\theta}, \theta) = \frac{1-(1-\theta)(1-m)}{[1-(1-\hat{\theta})(1-m)]^2}[I(1-m) - m(R_0 + D_0)] > 0, \tag{OA.5}
$$

which shows that the first bracket of (A.14) is always positive.

Then we compute:

$$
\frac{E(\hat{\theta}, \theta) - E_0(\theta)}{E_1(\hat{\theta}, \theta)} = \frac{[1-(1-\hat{\theta})(1-m)][m(1-\theta)(1-(1-\hat{\theta})(1-m))Z - (1-(1-\theta)(1-m))I - m(\hat{\theta}-\theta)(R_0 + D_0)]}{[1-(1-\theta)(1-m)][(1-m)I - m(R_0 + D_0)]}. \tag{OA.6}
$$

After simplification we finally obtain:

$$
\begin{aligned}
&\frac{E(\hat{\theta},\hat{\theta}) - E_0(\hat{\theta})}{E_1(\hat{\theta},\hat{\theta})} - \frac{E(\hat{\theta},\theta) - E_0(\theta)}{E_1(\hat{\theta},\theta)} && \text{(OA.7)} \\
&= \frac{1-(1-\hat{\theta})(1-m)}{1-(1-\theta)(1-m)} \frac{m(\theta-\hat{\theta})(Z - D_0 - R_0)}{(1-m)I - m(R_0 + D_0)}. && \text{(OA.8)}
\end{aligned}
$$

We thus obtain that $U_1(\hat{\theta}, \theta)$ is strictly positive if $\hat{\theta} < \theta$, null in $\hat{\theta} = \theta$, and strictly negative if $\hat{\theta} > \theta$. This shows that making the offer $\mathcal{O}^{**}(\theta)$ after delay $\Delta^{**}(\theta)$ is indeed optimal for type θ.

Using (36) and (OA.6) in $\hat{\theta} = \theta$, we have:

$$
\Delta^{**}(\theta) = \int_0^{\theta} \frac{(1-m)I - m(D_0 + R_0)}{\beta[m(1-x)Z - I][1-(1-x)(1-m)]} dx. \tag{OA.9}
$$

We can rewrite this expression as:

$$\Delta^{**}(\theta) = \frac{(1-m)I - m(D_0+R_0)}{\beta} \int_0^{\theta} \left(\frac{mZ}{[mZ-(1-m)I][m(1-x)Z-I]} + \frac{(1-m)}{[mZ-(1-m)I][1-(1-x)(1-m)]} \right) dx. \tag{OA.10}$$

We can then integrate this expression and finally obtain:

$$\Delta^{**}(\theta) = \frac{1}{\beta} \frac{(1-m)I - m(D_0+R_0)}{mZ-(1-m)I} \ln\left(\frac{[1-(1-\theta)(1-m)][mZ-I]}{m[m(1-\theta)Z-I]} \right). \tag{OA.11}$$

Step 5: Deviations to off-equilibrium offers.

We define off-equilibrium beliefs compatible with the intuitive criterion such that deviating to any off-equilibrium offer is unprofitable.

For any off-equilibrium offer $(\mathcal{O}, \Delta)$ which, if accepted, would be profitable for some types, we define $\hat{\theta}$ the lowest such type. We assume that, upon observing $(\mathcal{O}, \Delta)$, investors believe the bank's type to be $\hat{\theta}$. This belief satisfies the intuitive criterion. We check that given this belief deviating to $(\mathcal{O}, \Delta)$ is never profitable.

If $P < P_{min}(\theta^{**}) = R_{max}(\theta^{**})$, deviation $(\mathcal{O}, \Delta)$ is profitable for type θ^{**}. Hence, $\hat{\theta} \leq \theta^{**}$. Since P_{min} is decreasing, we have $P_{min}(\theta^{**}) \leq P_{min}(\hat{\theta})$, and hence $P < P_{min}(\hat{\theta})$. This implies that either the government or the bondholders expect to make a loss when accepting this offer. Hence, $(\mathcal{O}, \Delta)$ is rejected and cannot be a profitable deviation.

If $P \in [P_{min}(\theta^{**}), P_{min}(0)]$, a type $\theta \in [0, \theta^{**}]$ exists such that $P = P_{min}(\theta)$. If $\Delta > \Delta^{**}(\theta)$, $(\mathcal{O}, \Delta)$ is less profitable than the equilibrium offer $(\mathcal{O}^{**}(\theta), \Delta^{**}(\theta))$ and thus cannot be a profitable deviation for any type. If $\Delta < \Delta^{**}(\theta)$ then offer $(\mathcal{O}, \Delta)$, if accepted, is strictly profitable for type θ. This implies $\hat{\theta} < \theta$. But if so, either the bondholders or the government reject offer $\mathcal{O}$ because $P = P_{min}(\theta)$, which is lower than $P_{min}(\hat{\theta})$ as R_{min} is decreasing. Hence, $(\mathcal{O}, \Delta)$ is not a profitable deviation.

If $P > P_{min}(0)$, $(\mathcal{O}, \Delta)$ is equilibrium-dominated by immediately making an offer with $D = D_{min}(0)$ and $R = R_{min}(0)$, if such an offer is accepted. The proof in the main text that $\Delta^* = 0$ also applies to the case of publicly subsidized restructuring, so that $\Delta^{**}(0) = 0$. Hence, offering $D = D_{min}(0)$ and $R = R_{min}(0)$ after a zero delay is an equilibrium offer, which is necessarily accepted. Hence, $(\mathcal{O}, \Delta)$ is dominated by an equilibrium offer and cannot be a profitable deviation.

OA.3 Proof of Proposition 5

The proof closely follows the steps of the proof of Proposition 2.

Proof of the first bullet point. We prove that the strategies given in the Proposition indeed form an equilibrium.

Step 1: Beliefs following off-equilibrium moves.

Let $\hat{\theta}(\mathcal{O}, \Delta)$ denote bondholders' belief following an off-equilibrium move $(\mathcal{O}, \Delta)$. We define beliefs that satisfy the intuitive criterion.

If $P \geq P_{max}(\theta^{**})$, no type finds the offer (if accepted) strictly profitable. We assume $\hat{\theta}(\mathcal{O}, \Delta) = 0$, which the Intuitive Criterion does not constrain, since no type will consider this strategy irrespective of how bondholders respond.

If $P < P_{max}(\theta^{**})$, the offer (if accepted) is strictly profitable for a set of types. Denote $\bar{\theta}$ the supremum of this set. P_{max} being continuous, $P < P_{max}(\theta)$ for some types $\theta > \theta^{**}$. Types above θ^{**} don't make offers in equilibrium, hence if an offer at $P < P_{max}(\theta)$ is accepted this would be a profitable deviation for them. This implies that $\bar{\theta} > \theta^{**}$. We assume the belief $\hat{\theta}(\mathcal{O}, \Delta)$ to be the average between θ^{**} and $\bar{\theta}$. By Lemma 5, since $\bar{\theta}$ prefers $(\mathcal{O}, \Delta)$ to not making an offer, this is also true for type $\hat{\theta}(\mathcal{O}, \Delta) < \bar{\theta}$. Hence, this belief satisfies the Intuitive Criterion.

Step 2: No profitable deviation.

Consider a deviation $(\mathcal{O}, \Delta)$ by type θ. If $P \geq P_{max}(\theta^{**})$, the deviation is not strictly profitable irrespective of Δ. If $P < P_{max}(\theta^{**})$ then $\hat{\theta}(\mathcal{O}, \Delta) > \theta^{**}$. We have $P < P_{max}(\theta^{**}) = P_{min}(\theta^{**})$. Moreover, since $P_{min}(\cdot)$ is increasing, $P_{min}(\theta^{**}) < P_{min}(\hat{\theta}(\mathcal{O}, \Delta))$. Hence, $P < P_{min}(\hat{\theta}(\mathcal{O}, \Delta))$ and hence either the bondholders or the government reject the offer.

Proof of the second bullet point.

Step 1: The highest type making an offer is some $\bar{\theta}$, with $\bar{\theta} \geq \theta^{**}$.

By contradiction. Assume $\bar{\theta} < \theta^{**}$. Consider a deviation consisting in offering (D, I_G, R, I_C)

such that $I_G + I_C = I$ and $D + R = P_{max}(\theta^{**})$, after $\Delta = 0$. $P_{max}(\cdot)$ being decreasing, the offer, if accepted, is profitable for all types in $(\bar{\theta}, \theta^{**}]$ but for none in $(\theta^{**}, 1]$. If $(P_{max}(\theta^{*}), 0) = (P^{**}(\theta), \Delta^{**}(\theta))$ for some type $\theta \in [0, \bar{\theta}]$, bondholders accept the offer, a contradiction. Otherwise, under the Intuitive Criterion, bondholders must believe asset quality to be some $\hat{\theta} < \theta^{**}$. We have $P_{max}(\theta^{**}) = P_{min}(\theta^{**})$. Moreover, $P_{min}(.)$ being increasing, $P_{min}(\theta^{**}) > P_{min}(\hat{\theta})$. Hence, it is possible to choose (D, I_G, R, I_C) such that $D + R = P_{max}(\theta^{**})$, $D \geq D_{\min}(\hat{\theta})$, and $R \geq R_{min}(\hat{\theta})$.[31] This offer is accepted by both the bondholders and the government. This makes the deviation profitable for type $\hat{\theta}$, a contradiction.

Step 2: If $\bar{\theta} = \theta^{**}$ then $P^{**}(\theta) = P_{max}(\theta^{**})$ and $\Delta^{**}(\theta) = 0$ for all $\theta \in [0, \theta^{**}]$.

By contradiction.

Assume $P^{**}(\theta) > P_{max}(\theta^{**})$ for some $\theta \in [0, \theta^{**}]$. Consider a deviation consisting in offering $(\mathcal{O}, \Delta)$ with $P = P_{max}(\theta^{**})$ and $\Delta = 0$. $P_{max}(\cdot)$ being decreasing, the offer, if accepted, is profitable for type θ but for none in $(\theta^{**}, 1]$. If $(\mathcal{O}, \Delta) = (\mathcal{O}^{**}(\theta'), \Delta^{**}(\theta'))$ for some type $\theta' \in [0, \theta^{**}]$, the bondholders and the government accept the offer. Otherwise, under the Intuitive Criterion, bondholders must believe asset quality to be some $\hat{\theta}$ in $[0, \theta^{**}]$. For any type $\hat{\theta} \in [0, \theta^{**}]$, $P_{min}(\cdot)$ being increasing, $P_{min}(\hat{\theta}) \leq P_{min}(\theta^{**}) = P_{max}(\theta^{**})$. Hence, it is possible to design the offer (D, I_G, R, I_C) such that $D \geq D_{min}(\hat{\theta})$ and $R \geq R_{min}(\hat{\theta})$, so that the bondholders and the government accept the offer. Hence, the deviation would be profitable for type θ, a contradiction.

Assume $P^{**}(\theta) < P_{max}(\theta^{**})$ for some $\theta \in [0, \theta^{**}]$. Then by continuity of $P_{max}(.)$, there are some types above θ^{**} that prefer offering $(\mathcal{O}^{**}(\theta), \Delta^{**}(\theta))$ to their equilibrium strategy, a contradiction.

Finally, assume $P^{**}(\theta) = P_{max}(\theta^{**})$ for all $\theta \in [0, \theta^{**}]$ and $\Delta^{**}(\theta) > 0$. Then any type $\theta \in [0, \theta^{**}]$ deviating to immediately offer (D, I_G, R, I_C) with $D = D_{min}(\theta^{**})$ and $R = R_{min}(\theta^{**})$, such that $D + R = P_{min}(\theta^{**}) = P_{max}(\theta^{**})$, would see his offer accepted and have a profitable deviation, a contradiction.

This proves that the equilibrium in the first bullet point is the only one with $\bar{\theta} = \theta^{**}$. From now on, we consider the case $\bar{\theta} > \theta^{**}$.

[31] Pick for instance $I_G = 0$, $I_C = I$, and bind the two inequalities on D and R.

Step 3: There exists $\underline{\theta} < \theta^{**}$ such that for all $\theta \in [\underline{\theta}, \bar{\theta}]$, $(P^{**}(\theta), \Delta^{**}(\theta)) = (\bar{P}, \bar{\Delta})$.

As $\bar{\theta} > \theta^{**}$, $P_{max}(\bar{\theta}) < P_{min}(\bar{\theta})$ and equilibrium requires $P^{**}(\bar{\theta}) \leq P_{max}(\bar{\theta})$, so $P^{**}(\bar{\theta}) < P_{min}(\bar{\theta})$. Hence, an offer with $P = P^{**}(\bar{\theta})$ and $\Delta = \Delta^{**}(\bar{\theta})$) can be accepted only if it's pooled with the offers of some types θ with $P_{min}(\theta) \leq P^{**}(\bar{\theta})$. Since moreover $P^{**}(\bar{\theta}) < P_{max}(\bar{\theta})$ and $P_{max}(\bar{\theta}) \leq P_{max}(\theta^{**})$, we have $P_{min}(\theta) \leq P_{max}(\theta^{**})$. This last inequality implies that $\theta < \theta^{**}$, since P_{min} and P_{max} cross in θ^{**}. Denoting $\underline{\theta}$ the lowest type making an offer with $P = P^{**}(\bar{\theta})$ and $\Delta = \Delta^{**}(\bar{\theta})$), we thus have $\underline{\theta} < \theta^{**}$. We then have $P^{**}(\underline{\theta}) = P^{**}(\bar{\theta})$ and $\Delta^{**}(\underline{\theta}) = \Delta^{**}(\bar{\theta})$. The monotonicity of P^{**} and Δ^{**} (Lemma 5) implies that all $\theta \in [\underline{\theta}, \bar{\theta}]$ make the same offer, which completes the proof.

Step 4: $\bar{P} = P_{max}(\bar{\theta}) < P_{max}(\theta^{**})$.

Equilibrium implies $\bar{P} \leq P_{max}(\bar{\theta})$, otherwise $\bar{\theta}$ would not make the pooling offer. If $\bar{P} < P_{max}(\bar{\theta})$, by continuity of $P_{max}(.)$ there would exist $\theta > \bar{\theta}$ such that θ strictly prefers making an offer with $P = \bar{P}$ and $\Delta = \bar{\Delta}$ to making no offer, which contradicts the definition of $\bar{\theta}$. Hence, $\bar{P} = P_{max}(\bar{\theta})$. Moreover, $P_{max}(\cdot)$ being strictly decreasing, $\bar{\theta} > \theta^{**}$ implies $P_{max}(\bar{\theta}) < P_{max}(\theta^{**})$.

Step 5: For all $\theta \in [0, \bar{\theta}]$, $(P^{**}(\theta), \Delta^{**}(\theta)) = (\bar{P}, \bar{\Delta})$.

Since the offer $(\bar{\mathcal{O}}, \bar{\Delta})$ is accepted, there exists $\theta \in (\underline{\theta}, \bar{\theta})$ such that $\bar{P} > P_{min}(\theta)$. There exists $P \geq \bar{P}$ such that θ is indifferent between offering a payment P in offer $(\mathcal{O}, \Delta^{**}(0))$, and offering $(\bar{\mathcal{O}}, \bar{\Delta})$. By contradiction, if $\underline{\theta} > 0$, $\Delta^{**}(0) < \bar{\Delta}$ and hence $P > \bar{P}$. By Lemma 5, all types in $(\underline{\theta}, \theta)$ strictly prefer to deviate to offering P after $\Delta^{*}(0)$ if this offer is accepted. Moreover, according to the Intuitive Criterion, upon observing $(\mathcal{O}, \Delta^{**}(0))$,the bondholders must believe the type to be some $\hat{\theta} < \theta$. Since $P_{min}(.)$ is increasing, $P_{min}(\theta) > P_{min}(\hat{\theta})$. Moreover, θ was such that $\bar{P} > P_{min}(\theta)$, hence $P > P_{min}(\hat{\theta})$. Hence, the bondholders accept $(\mathcal{O}, \Delta^{**}(0))$ and this deviation is strictly profitable for all types in $(\underline{\theta}, \theta)$, a contradiction. This concludes the proof that any equilibrium has all types in $[0, \bar{\theta}]$ make the same offer.

OA.4 Proof of Proposition 6

We solve for the optimal capital structure inducing a pooling equilibrium, then for the optimal capital structure inducing a separating equilibrium. When the parameters are such that both are possible we compare these two possibilities.

OA.4.0.1 Optimal capital structure inducing a pooling equilibrium

Assume we have $(1-m)I \leq m(R_0 + D_0)$ so that a pooling equilibrium obtains, in which all banks of type $\theta \in [0, \bar{\theta}]$ make the same offer $\bar{\mathcal{O}} = (\bar{D}, \bar{I}_G, \bar{R}, \bar{I}_C)$. The bank gets:

$$\bar{V} = \int_0^{\bar{\theta}} \bar{E}(\bar{D}, \bar{R}, p(\theta))dF(\theta) + \int_{\bar{\theta}}^1 \bar{E}(D_0, R_0, \theta)dF(\theta) - (I_0 - D_0 - B_0), \tag{OA.12}$$

where B_0 satisfies:

$$B_0 = \int_0^{\bar{\theta}} [[1 - (1-\theta)(1-m)h]\bar{R} - \bar{I}_C]dF(\theta) + \int_{\bar{\theta}}^1 [1 - (1-\theta)h]R_0 dF(\theta). \tag{OA.13}$$

We can then rewrite:

$$\begin{aligned} \bar{V} &= \int_0^{\bar{\theta}} [1 - (1-\theta)(1-m)][Z - P_{max}(\bar{\theta})]dF(\theta) + \int_{\bar{\theta}}^1 \theta(Z - D_0 - R_0)dF(\theta) - I_0 + D_0 \\ &+ \int_0^{\bar{\theta}} [[1 - (1-\theta)(1-m)h]\bar{R} - \bar{I}_C]dF(\theta) + \int_{\bar{\theta}}^1 [1 - (1-\theta)h]R_0 dF(\theta). \end{aligned} \tag{OA.14}$$

Note that $\bar{\theta}$ and $P_{max}(\bar{\theta})$ do not depend on $\bar{R}$ and $\bar{I}_C$. Among all the possible pooling equilibrium offers $\bar{\mathcal{O}}$ for a given $\bar{\theta}$ and $P_{max}(\bar{\theta})$, we assume an equilibrium in which the bank makes the most profitable offer. From the previous equation, we see that this is the offer that maximizes the ex post surplus of bondholders in the restructuring stage, as this surplus is ultimately captured by the bank through a higher B_0 (whereas the bank has no tool to extract ex ante any surplus that would be left to the government ex post).

The optimal pooling equilibrium thus maximizes in $(\bar{D}, \bar{I}_G, \bar{R}, \bar{I}_C)$, for a given $\bar{\theta}$, the ex-post surplus of bondholders:

$$\int_0^{\bar\theta}[[1-(1-\theta)(1-m)h]\bar R-\bar I_C]dF(\theta) \tag{OA.15}$$

under the constraint that the government accepts the offer:

$$\int_0^{\bar\theta}[\bar G(\bar D,\bar R,p(\theta))-\bar I_G]dF(\theta)\geq\int_0^{\bar\theta}\bar G(D_0,R_0,\theta)dF(\theta) \tag{OA.16}$$

$$\Leftrightarrow\quad \int_0^{\bar\theta}[[1-(1-\theta)(1-m)]\bar D-(1-m)(1-\theta)(1-h)\bar R-\bar I_G]dF(\theta)\geq\int_0^{\bar\theta}[\theta D_0-(1-\theta)(1-h)R_0]dF(\theta),$$

and $P_{max}(\bar\theta)=\bar R+\bar D$, $\bar I_C+\bar I_G=I$, and $\bar D,\bar I_G,\bar R,\bar I_C$ are all positive. We easily obtain that at an optimal offer the government has zero surplus, so that (OA.16) holds with an equality. Using this equality and replacing $\bar D=P_{max}(\bar\theta)-\bar R$, we can rewrite the ex-post surplus of bondholders as:

$$\int_0^{\bar\theta}[[1-(1-\theta)(1-m)h]\bar R-\bar I_C]dF(\theta)=\int_0^{\bar\theta}[P_{max}(\bar\theta)[1-(1-\theta)(1-m)]-I]dF(\theta)-\int_0^{\bar\theta}[\theta D_0-(1-\theta)(1-h)R_0]dF(\theta). \tag{OA.17}$$

Note that this last expression does not depend on $\bar D,\bar I_G,\bar R,\bar I_C$. We conclude that, for a given $\bar\theta$, any offer with $P_{max}(\bar\theta)=\bar R+\bar D$, $\bar I_C+\bar I_G=I$, $\bar D,\bar I_G,\bar R,\bar I_C$ all positive, and such that the government has zero surplus (equation (OA.16) binds), is optimal.

Since at an optimal offer the surplus of bondholders is given by (OA.17), we can replace this surplus in (OA.14) and write the bank's ex ante profit as:

$$\begin{aligned}
\bar V &= Z\int_0^{\bar\theta}[1-(1-\theta)(1-m)]dF(\theta)-P_{max}(\bar\theta)\int_0^{\bar\theta}[1-(1-\theta)(1-m)]dF(\theta)-I_0+D_0\\
&+\int_{\bar\theta}^1\theta(Z-D_0-R_0)dF(\theta)+P_{max}(\bar\theta)\int_0^{\bar\theta}[1-(1-\theta)(1-m)]dF(\theta)-F(\bar\theta)I\\
&-\int_0^{\bar\theta}[\theta D_0-(1-\theta)(1-h)R_0]dF(\theta)+\int_{\bar\theta}^1[1-(1-\theta)h]R_0dF(\theta) && \text{(OA.18)}\\
&= \mathbb{E}(\theta)Z+\int_0^{\bar\theta}[m(1-\theta)Z-I]dF(\theta)-I_0\\
&+[1-\mathbb{E}(\theta)][D_0+(1-h)R_0]. && \text{(OA.19)}
\end{aligned}$$

In the end, $\bar{V}$ is simply equal to the total expected surplus created by the bank, plus the expected costs to the government (which are transfers to the bank and bondholders). The pooling equilibrium that maximizes the bank's surplus thus has $\bar{\theta} = \theta^{**}$, which also maximizes total surplus. Since θ^{**} is independent of R_0 and D_0, in the end the bank's optimal structure under pooling simply maximizes the payments made by the government $D_0 + (1-h)R_0$, under the constraints that: (i) the bank's equity $I_0 - D_0 - B_0$ is positive; (ii) the capital structure satisfies the pooling condition; (iii) D_0 is positive; (iv) R_0 is positive.

To express constraint (i), we compute B_0 using (OA.13), using (OA.17), $\bar{\theta} = \theta^{**}$, and the fact that $P_{max}(\theta^{**}) = P_{min}(\theta^{**})$. Rearranging terms, we obtain:

$$\begin{aligned}
B_0 &= \int_{\theta^{**}}^{1} [1-(1-\theta)h]R_0 dF(\theta) + \int_0^{\theta^{**}} [\theta + (1-\theta)(1-h)]R_0 dF(\theta) - \int_0^{\theta^{**}} \theta(D_0 + R_0) dF(\theta) \\
&+ \int_0^{\theta^{**}} \frac{\theta^{**}(R_0+D_0)[1-(1-\theta)(1-m)] - I(1-m)(\theta^{**}-\theta)}{1-(1-\theta^{**})(1-m)} dF(\theta) && \text{(OA.20)} \\
&= R_0[1-(1-\mathbb{E}(\theta))h] + \int_0^{\theta^{**}} \frac{(\theta^{**}-\theta)[m(R_0+D_0) - I(1-m)]}{1-(1-\theta^{**})(1-m)} dF(\theta). && \text{(OA.21)}
\end{aligned}$$

Note in particular that as $(1-m)I \leq m(R_0 + D_0)$ we have $B_0 \geq 0$.

We can now express the maximization program defining the optimal capital structure via the following Lagrangian:

$$\mathcal{L} = D_0 + (1-h)R_0 + \lambda[I_0 - D_0 - B_0] + \mu[m(D_0+R_0) - (1-m)I] + \nu D_0 + \rho R_0. \qquad \text{(OA.22)}$$

The first-order conditions with respect to D_0 and R_0 give:

$$\begin{aligned}
1 - \lambda\left(1 + \frac{\partial B_0}{\partial D_0}\right) + \mu m + \nu &= 0 && \text{(OA.23)} \\
(1-h) - \lambda\frac{\partial B_0}{\partial R_0} + \mu m + \rho &= 0. && \text{(OA.24)}
\end{aligned}$$

Using (OA.21), we have:

$$\frac{\partial B_0}{\partial R_0} = 1 - h + \mathbb{E}(\theta)h + \int_0^{\theta^{**}} \frac{m(\theta^{**} - \theta)}{1 - (1 - \theta^{**})(1 - m)} dF(\theta). \tag{OA.25}$$

Since the multipliers have to be positive and $\frac{\partial B_0}{\partial D_0} \geq 0$, condition (OA.23) above implies that λ cannot be equal to zero. Hence we have $\lambda > 0$ and $I_0 = D_0 + B_0$: the capital structure uses no equity. There are two possible solutions, denoted P-1 and P-2, depending on whether the pooling constraint is binding.

Solution P-1 Assume that $\mu > 0$, so that the pooling constraint is binding. Equation (OA.21) then simplifies to

$$B_0 = R_0[1 - (1 - \mathbb{E}(\theta))h], \tag{OA.26}$$

and D_0 and R_0 are given by $I_0 = D_0 + B_0$ (no equity) and $m(D_0 + R_0) = (1 - m)I$ (pooling constraint binding). Solving for D_0 and R_0, we obtain:

$$D_0 = \frac{mI_0 - (1 - m)[1 - h(1 - \mathbb{E}(\theta))]I}{hm[1 - \mathbb{E}(\theta)]} \tag{OA.27}$$

$$R_0 = \frac{(1 - m)I - mI_0}{hm[1 - \mathbb{E}(\theta)]}. \tag{OA.28}$$

Solving for λ and μ, we obtain:

$$\lambda = \frac{h}{1 + \frac{\partial B_0}{\partial D_0} - \frac{\partial B_0}{\partial R_0}} = \frac{1}{1 - \mathbb{E}(\theta)} > 0 \tag{OA.29}$$

$$\mu = \frac{1}{m} \frac{\mathbb{E}(\theta) + \frac{\partial B_0}{\partial D_0}}{1 - \mathbb{E}(\theta)} > 0. \tag{OA.30}$$

We thus have a first solution, denoted P-1, to the maximization program. It requires that D_0 and R_0 are both positive, which gives the condition:

$$mI_0 \leq (1 - m)I \leq \frac{mI_0}{1 - h(1 - \mathbb{E}(\theta))}. \tag{OA.31}$$

Intuitively, the bank wants to use as many deposits as possible, since they maximize the payments from the government. However, since I_0 is smaller than $\frac{(1-m)I}{m}$ using only deposits would not be sufficient for the capital structure to imply pooling, so the bank uses just enough bonds to be on the pooling side. This is possible if I_0 is not too small, as otherwise even with bonds only pooling would not obtain.

Solution P-2: Assume that $\mu = 0$, the pooling constraint is not binding. It is easy to show that if $\nu = 0$ and $\rho = 0$ then (OA.23) and (OA.24) cannot be both satisfied, because $\frac{\partial B_0}{\partial D_0}$ and $\frac{\partial B_0}{\partial R_0}$ are independent of D_0 and R_0. $\rho > 0, \nu > 0$ is impossible, as then we cannot have zero equity. If $\rho = 0$ and $\nu > 0$, we use (OA.23) and (OA.24) to solve for ν and find:

$$\nu = \frac{1-h}{\frac{\partial B_0}{\partial R_0}} \left(1 + \frac{\partial B_0}{\partial D_0}\right) - 1. \tag{OA.32}$$

ν is strictly positive if and only if:

$$(1-h)\left(1 + \tfrac{\partial B_0}{\partial D_0}\right) > \tfrac{\partial B_0}{\partial R_0} \tag{OA.33}$$

$$\Leftrightarrow \quad 1 - h + (1-h)\int_0^{\theta^{**}} \tfrac{m(\theta^{**}-\theta)}{1-(1-\theta^{**})(1-m)} dF(\theta) > 1 - h + h\mathbb{E}(\theta) + \int_0^{\theta^{**}} \tfrac{m(\theta^{**}-\theta)}{1-(1-\theta^{**})(1-m)} dF(\theta), \tag{OA.34}$$

which is false. Hence, we cannot have $\rho = 0$ and $\nu > 0$.

Finally, we consider the case $\rho > 0, \nu = 0$, so that $R_0 = 0$ and $D_0 = I_0$. We compute that:

$$\lambda = \frac{1}{1 + \frac{\partial B_0}{\partial D_0}} > 0, \tag{OA.35}$$

$$\rho = -(1-h) + \frac{\frac{\partial B_0}{\partial R_0}}{1 + \frac{\partial B_0}{\partial D_0}}. \tag{OA.36}$$

The proof that $\rho > 0$ is the same as the proof that $\nu < 0$ in the previous case (equations OA.33 and OA.34). Finally, we need the pooling constraint $m(R_0 + D_0) > (1-m)I$ to be satisfied, which gives the condition:

$$mI_0 \geq (1-m)I. \tag{OA.37}$$

Intuitively, this is a case in which I_0 is so large that the bank can remain on the pooling side by using only deposits. Since deposits also maximize the payments from the government, there is no reason to use bonds or equity.

Conclusion: When $(1-m)I \leq mI_0$, the optimal capital structure compatible with a pooling equilibrium is $D_0 = I_0, R_0 = 0$: the bank uses only deposits (solution P-2). When $mI_0 < (1-m)I \leq \frac{mI_0}{1-h(1-\mathbb{E}(\theta))}$, the optimal capital structure compatible with a pooling equilibrium is D_0 and R_0 given by (OA.27) and (OA.28): the bank uses no equity and just enough bonds to induce a pooling equilibrium (solution P-1). When $(1-m)I > \frac{mI_0}{1-h(1-\mathbb{E}(\theta))}$ no capital structure exists that induces a pooling equilibrium.

OA.4.0.2 Optimal capital structure inducing a separating equilibrium

Assume we have $(1-m)I \geq m(R_0 + D_0)$ and a separating equilibrium obtains. The bank gets:

$$V = \int_0^1 \bar{E}(D_0, R_0, \theta) dF(\theta) + \int_0^{\theta^{**}} e^{-\beta\Delta^{**}(\theta)} \left[\bar{E}(D^{**}(\theta), R^{**}(\theta), p(\theta)) - \bar{E}(D_0, R_0, \theta)\right] dF(\theta) - (I_0 - D_0 - B_0). \tag{OA.38}$$

In addition we have:

$$\begin{aligned} \bar{C}(D^{**}(\theta), R^{**}(\theta), p(\theta)) - I_C^{**}(\theta) &= \bar{C}(D_0, R_0, \theta), && \text{(OA.39)} \\ \bar{G}(D^{**}(\theta), R^{**}(\theta), p(\theta)) - I_G^{**}(\theta) &= \bar{G}(D_0, R_0, \theta), && \text{(OA.40)} \\ B_0 &= \int_0^1 C_0(\theta) dF(\theta) = [1 - h[1 - \mathbb{E}(\theta)]]R_0. && \text{(OA.41)} \end{aligned}$$

We can use these equations as well as (37)to reexpress (OA.38) as:

$$V = \mathbb{E}(\theta)Z - I_0 + \int_0^{\theta^{**}} e^{-\beta\Delta^{**}(\theta)}[m(1-\theta)Z - I]dF(\theta) + [1 - \mathbb{E}(\theta)][D_0 + (1-h)R_0]. \tag{OA.42}$$

Intuitively, the bank's payoff is the total surplus absent restructuring, plus the total surplus with restructuring weighted by the probability that restructuring takes place for each type, plus the expected payments extracted from the government.

The bank's optimal structure in the separating case maximizes (OA.42) under the constraint that the bank's equity is positive, the capital structure satisfies the separating condition, and D_0

and R_0 are both positive. However, note that the expression (OA.42) is not necessarily concave in D_0 and R_0, due to how these variables enter Δ. In particular, increasing R_0 or D_0 reduces the delay more when $R_0 + D_0$ is already high. To find the optimal capital structure, we first use a Lagrangian to find necessary conditions for all the maxima of V^{sep}. We define the Lagrangian:

$$\begin{aligned}\mathcal{L} &= \int_0^{\theta^{**}} e^{-\beta\Delta^{**}(\theta)}[m(1-\theta)Z - I]dF(\theta) + [1-\mathbb{E}(\theta)][D_0 + (1-h)R_0] \qquad \text{(OA.43)}\\ &+ \lambda[I_0 - D_0 - [1 - h(1-\mathbb{E}(\theta))]R_0] + \mu[(1-m)I - m(D_0+R_0)] + \nu D_0 + \rho R_0.\end{aligned}$$

To obtain the first-order conditions we need to differentiate the expected gain from restructuring with respect to D_0 and R_0, using the explicit expression of $\Delta^{**}(\theta)$. We obtain:

$$\frac{\partial}{\partial D_0}\left(\int_0^{\theta^{**}} e^{-\beta\Delta^{**}(\theta)}[m(1-\theta)Z - I]dF(\theta)\right) = \frac{\partial}{\partial R_0}\left(\int_0^{\theta^{**}} e^{-\beta\Delta^{**}(\theta)}[m(1-\theta)Z - I]dF(\theta)\right) = \phi(D_0+R_0), \qquad \text{(OA.44)}$$

$$\text{with } \phi(x) = \int_0^{\theta^{**}} \frac{m[m(1-\theta)Z - I]}{mZ-(1-m)I} \ln\left(\frac{[1-(1-\theta)(1-m)][mZ-I]}{m[m(1-\theta)Z-I]}\right)\left(\frac{[1-(1-\theta)(1-m)][mZ-I]}{m[m(1-\theta)Z-I]}\right)^{-\frac{(1-m)I-mx}{mZ-(1-m)I}} dF(\theta). \qquad \text{(OA.45)}$$

The quantity $\phi(D_0 + R_0) \geq 0$ is the marginal gain the bank obtains when it decreases the delay in restructuring by increasing R_0 and D_0. We first prove that $\phi(D_0 + R_0) < \mathbb{E}(\theta)$, which will be important in the rest of the proof. Consider (OA.45) and observe that:

$$\text{(H2) implies} \qquad \frac{[1-(1-\theta)(1-m)][mZ-I]}{m[m(1-\theta)Z-I]} \geq 1 \qquad \text{(OA.46)}$$

$$m(R_0+D_0) \leq I(1-m) \text{ implies} \qquad -\frac{(1-m)I - m(R_0+D_0)}{mZ-(1-m)I} \leq 0 \qquad \text{(OA.47)}$$

$$\text{hence} \qquad \left(\frac{[1-(1-\theta)(1-m)][mZ-I]}{m[m(1-\theta)Z-I]}\right)^{-\frac{(1-m)I-m(D_0+R_0)}{mZ-(1-m)I}} \leq 1. \qquad \text{(OA.48)}$$

This implies that:

$$\phi(D_0+R_0) \leq \int_0^{\theta^{**}} \frac{m[m(1-\theta)Z-I]}{mZ-(1-m)I} \ln\left(\frac{[1-(1-\theta)(1-m)][mZ-I]}{m[m(1-\theta)Z-I]}\right) dF(\theta). \qquad \text{(OA.49)}$$

A sufficient condition to have $\phi(D_0 + R_0) < \mathbb{E}(\theta)$ is to have, for any $\theta \in (0, \theta^{**}]$:[32]

$$\frac{m[m(1-\theta)Z - I]}{mZ - (1-m)I} \ln\left(\frac{[1-(1-\theta)(1-m)][mZ - I]}{m[m(1-\theta)Z - I]}\right) < \theta. \tag{OA.50}$$

Using the inequality $\ln(1+x) < x$ for $x > 0$, we can write:

$$\ln\left(\frac{[1-(1-\theta)(1-m)][mZ - I]}{m[m(1-\theta)Z - I]}\right) = \ln\left(1 + \frac{\theta[mZ - (1-m)I]}{m[m(1-\theta)Z - I]}\right) < \frac{\theta[mZ - (1-m)I]}{m[m(1-\theta)Z - I]}. \tag{OA.51}$$

The left-hand side of (OA.50) is thus strictly smaller than:

$$\frac{m[m(1-\theta)Z - I]}{mZ - (1-m)I} \frac{\theta[mZ - (1-m)I]}{m[m(1-\theta)Z - I]} = \theta, \tag{OA.52}$$

which gives the desired inequality.. This concludes the proof that $\phi(D_0 + R_0)$ is always strictly lower than $\mathbb{E}(\theta)$.

We now compute the first-order conditions of the program with respect to D_0 and R_0:

$$\begin{aligned} \phi(D_0 + R_0) + 1 - \mathbb{E}(\theta) - \lambda - \mu m + \nu &= 0 && \text{(OA.53)} \\ \phi(D_0 + R_0) + [1 - \mathbb{E}(\theta)](1-h) - \lambda[1 - h(1 - \mathbb{E}(\theta))] - \mu m + \rho &= 0 && \text{(OA.54)} \end{aligned}$$

Solution S-1: We first assume $\lambda = 0$, so that the bank has a positive amount of equity. Then necessarily $\mu > 0$, the separating constraint is binding. It is easily deduced from (OA.53) and (OA.54) that $\rho > \nu$. Since we cannot have $\rho > 0$ and $\nu > 0$ and bind the separating constraint, the only remaining possibility is $\nu = 0$ and $\rho > 0$. So we have $R_0 = 0$, $D_0 = \frac{1-m}{m} I$. We compute $\mu = \frac{\phi(D_0) + 1 - \mathbb{E}(\theta)}{m} > 0$ and $\rho = h(1 - \mathbb{E}(\theta)) > 0$. Finally, we need to check that the positive equity constraint is satisfied, which gives:

$$(1-m)I < mI_0. \tag{OA.55}$$

Intuitively, the bank wants to stay in the separating region. However, I_0 is so large that even by using only deposits the bank would violate the separating constraint. The bank then chooses to

[32] We could have $\phi(D_0 + R_0) = \mathbb{E}(\theta)$ if the distribution F is degenerate and $\Pr(\theta = 0) = 1$. We dismiss this case as non-generic.

choose exactly the right amount of equity to bind the separating constraint.

Solution S-2: We now assume $\lambda > 0$, so that the bank has no equity.

Assume $\mu > 0$. Since both the positive equity and the separating constraints are binding, these two constraints define D_0 and R_0, which generically are not null. Hence we have $\nu = \rho = 0$. Using (OA.53) and (OA.54) we solve for μ and obtain $\mu = \frac{\phi(D_0+R_0)-\mathbb{E}(\theta)}{m}$. We know that this quantity is negative, so that there cannot be a solution with $\lambda > 0$ and $\mu > 0$.

We now assume $\mu = 0$, so that the separating constraint is slack. It is impossible to have $\rho > 0$ and $\nu > 0$ and zero equity. If $\rho = 0$ and $\nu = 0$ we obtain from (OA.53) and (OA.54) that $\phi(D_0 + R_0) = \mathbb{E}(\theta)$, which is impossible. If $\rho = 0$ and $\nu > 0$ we obtain that:

$$\nu = \frac{h(1-\mathbb{E}(\theta))}{1-h(1-\mathbb{E}(\theta))}(\phi(D_0 + R_0) - \mathbb{E}(\theta)) < 0, \tag{OA.56}$$

so that there can be no such solution.

The last possibility to consider is $\rho > 0$ and $\nu = 0$, so that $R_0 = 0, D_0 = I_0$. We obtain $\lambda = \phi(I_0) + 1 - \mathbb{E}(\theta) > 0$ and $\rho = h(1 - \mathbb{E})(\mathbb{E}(\theta) - \phi(I_0)) > 0$. Finally, we need to check that the separating constraint is indeed slack, which gives:

$$(1-m)I > mI_0. \tag{OA.57}$$

Intuitively this is a case in which the initial investment to make is small, so that by using deposits only the bank keeps the separating constraint slack, implying a positive delay. The bank could use less deposits and more bonds to reduce the delay. However, the fact that $\phi(D_0+R_0) < \mathbb{E}(\theta)$ implies that the marginal gain of reducing delay through such a substitution is lower than the marginal reduction in the payments given by the government.

Conclusion: When $(1-m)I < mI_0$ the necessary conditions for a maximum characterize only one potential solution, S-1, which is $D_0 = I_0, R_0 = 0$. Since the objective function is bounded above, it has a maximum, so S-1 is the unique maximum in this case. Similarly, when $(1-m)I > mI_0$ the necessary conditions characterize only one solution, S-2, which is also to set $D_0 = I_0$ and $R_0 = 0$. This is again the unique maximum.

OA.4.0.3 Optimal capital structure

Finally, we need to compare the pooling solutions to the separating solutions.

When $(1-m)I \leq mI_0$, we need to compare the solution S-1 to the solution P-2. It is easy to see that the bank cannot have a higher payoff than the one given by P-2, as it involves no delay and maximizes government payments. Hence, the bank chooses P-2. When $mI_0 < (1-m)I \leq \frac{mI_0}{1-h[1-\mathbb{E}(\theta)]}$, we need to compare the separating solution S-2 to the pooling solution P-1. Note that the solution P-1 is actually the same as the case $\lambda > 0, \mu > 0$ in the separating program, which we know is dominated by solution S-2. So the bank chooses S-2. Finally, when $(1-m)I > \frac{mI_0}{1-h[1-\mathbb{E}(\theta)]}$ no pooling solution is possible, so that the optimal capital structure is given by S-2.

To summarize, the optimal capital structure is always $D_0 = I_0, R_0 = 0$, and no equity. When $(1-m)I > mI_0$ this leads to a separating equilibrium with a strictly positive delay, when $(1-m)I \leq mI_0$ this leads to a pooling equilibrium with zero delay.