Financial Restructuring and Resolution of Banks[*]

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Abstract

How do resolution frameworks affect the private restructuring of distressed banks? We model a distressed bank's shareholders and creditors negotiating its restructuring given asymmetric information about asset quality and externalities onto the government. This yields costly negotiation delays used to signal asset quality. We find that strict bail-in rules increase delays by worsening informational frictions and reducing bargaining surplus. We characterize optimal bail-in rules for the government. We then consider the government's possible involvement in negotiations. We find that, depending on conditions, this can lead to shorter or longer delays. Notably, the government may find it optimal to commit not to partake in negotiations.

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

JEL classification: G21, G28.

Introduction

In the wake of the financial crisis, many bank resolution regimes have been 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 in two dimensions. First, they aim to facilitate either the orderly wind down or the viable continuation of failing banks, notably large systemic banks, to avoid a negative economic impact. Second, they attempt to minimize the cost to taxpayers of bailing out distressed banks.

While resolution rules may promote an efficient treatment of failing banks, they constitute only a last resort. Before a bank fails, its private stakeholders, i.e., shareholders and creditors, can engage in a workout to reduce debt, increase maturity, 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.[1][2] The process of negotiation can however be less than smooth. The restructuring of Monte dei Paschi di Siena (MPS) in 2016 illustrates vividly 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.[3]

[Figure 1]

In the case of MPS, it was clear that, failing a restructuring, the bank could ultimately be resolved and its creditors bailed-in. More generally, resolution regimes do not only determine outcomes once a bank has failed. By affecting the outside option of a bank's different claimholders, they also affect the process of private restructuring before the bank actually fails.[4] This raises important questions. For instance, do stricter bail-in rules favor or hinder private restructuring?

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[1]See Senbet and Wang (2012)'s survey on the financial restructuring of non-financial firms.

[2]A prime example is the Liability Management Exercises European banks conducted during the crisis. The banks offered to buy back their subordinated hybrid bonds at a discount, to cut leverage. According to Vallée (2016), a total of EUR 87 bln of hybrid bonds were tendered, creating EUR 30 bln of capital gains for European banks.

[3]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.

[4]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).

Might tougher resolution regimes, in effect forced debt restructurings, substitute for voluntary ones? Or, on the contrary, are tough resolution regimes necessary to spur private parties to restructure a bank?

In this paper, we propose a model to study how bank resolution regimes may affect the restructuring of distressed banks. The model accounts for several specificities of banks, notably the externalities bank defaults impose onto the government. First, bank defaults force the government to reimburse insured deposits. Second, for large banks, they can imply social costs unless the government bails out uninsured creditors. These elements affect the bank restructuring process. Because the resolution regime dictates an allocation of losses between a failing bank's stakeholders, it also affects these parties' positions in prior restructuring negotiations, and the likelihood that an early, voluntary restructuring succeeds.

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, unsecured debt, and equity. 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 uninsured creditors 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 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 it may become too late to improve the performance of the bank's assets. When this happens, renegotiation is useless and stops.

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.[5]

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, i.e., to convey information to the creditors in a credible manner. 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. In our model, for higher quality banks, restructuring creates less value and thus 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.

We use this setup to study the resolution regime's impact on the renegotiation process. In our model, the resolution framework sets the allocation of losses between the bank's different stakeholders: shareholders, creditors, depositors and the government. Thus, it affects the outside options of the negotiating parties. If renegotiation breaks down, the bank manager does not make the investment, and default is more likely than if he did. In default, shareholders are wiped out, and the government reimburses depositors fully but applies a haircut to other, uninsured, creditors (a haircut of zero corresponds to a full bail-out of creditors, and a 100% haircut to no bail-out).

We show that the haircut has two effects on the delay in the restructuring process, and thus on its efficiency.

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[5]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.

First, larger 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.

Second, larger haircuts reduce the joint surplus restructuring creates for shareholders and creditors because they reduce the value of the increase in debt restructuring brings about. This *surplus effect* too implies that higher haircuts may slow down the restructuring process.

Therefore, both effects imply that stricter bail-in rules may lead to less timely restructuring and thus increase the risk of a negotiation breakdown, in which case no restructuring takes place. Conversely, restructuring delays are minimized by a full bailout policy.

Based on this analysis, the level of haircut that is optimal from the government's viewpoint balances the haircut's *surplus* and *signaling effects* on the private restructuring process, as well as the fact that were that process to break down, imposing losses on creditors and depleting the deposit insurance fund may be undesirable. We show conditions under which the optimal resolution regime can be a full bailout, a full bail-in, or a middle ground. We also show how the optimal resolution regime varies with key parameters.

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 onto the government. For one, acting as the insurer of deposits, the government is de facto a creditor of the bank and as such is affected by the restructuring's impact on the probability of default. Moreover, purely private restructurings fail to internalize the social cost of imposing losses on creditors and the cost of funds used in bailouts. 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).

The bargaining proceeds as follows. First, the manager choose a restructuring offer and its timing, but now, an offer includes not only new terms for the existing creditors but also a transfer from the government. If the offer is accepted by the creditors and the government, the game stops. Otherwise, the government can make a counter-offer to the shareholders and the creditors. The manager can then make a new counter-offer, etc.

We characterize the equilibrium outcomes and derive some new results. For instance, 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.

We also find that under conditions that we characterize, the government may ultimately be hurt by its own bargaining power in the negotiations. Indeed, a greater bargaining power means that shareholders derive less surplus, which leads to longer delays in negotiations via the surplus effect.

Our model can also be used to think about how other policy tools such as Total Loss Absorbing Capital (TLAC) requirements, "CoCos", or bank supervision impact bank debt restructuring.

Related literature. Much of the theory work on bank resolution rules focuses on the timing of resolution, motivated notably by the "prompt corrective action" principle implemented in the 1991 FDIC Improvement Act (Mailath and Mester (1994), Decamps *et al.* (2004), Freixas and Rochet (2013)). Much less is known about the effect of different loss allocation rules conditional on the bank being resolved, although the recent regulatory reforms on bail-in have sparked academic interest in the topic.[6] For instance, Walther and White (2016) study how a regulatory authority's decision to trigger a bail-in can convey negative information to markets, precipitating a run. As in our paper, ex-post optimal regulatory decisions can be harmful ex-ante in their model. In particular, the regulatory authority should commit to triggering bail-ins after the public release of negative

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

information. Bolton and Oehmke (2016) study the allocation of losses across a failing multinational bank's stakeholders. Segura and Vicente (2018) study the incentives for countries in a banking union to mutualize the costs of bailing-out banks, and propose a theory of an optimal resolution framework as a mechanism ensuring that all member countries agree to participate. Keister and Mitkov (2016) develops a model in which bank runs and bail-ins are part of the optimal contract the bank offers creditors, and bail-outs delay the privately optimal bail-in. In contrast, we do not consider the optimal bank-creditor contract ex ante, but focus on debt renegotiation ex post under asymmetric information. In particular, we obtain a different result regarding the impact of bail-outs, which do not delay the resolution of distress.

Also related is the recent literature on contingent convertible securities ("CoCos"), which can be seen as a way to commit to 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.

An extant literature studies the alternatives to bank liquidations, such as bail-outs (e.g., Gorton and Huang (2004), Diamond and Rajan (2005)), 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.

Our paper is also related to corporate finance theory work on debt restructuring.[7] Bulow and Shoven (1978) study debt renegotiation when dispersed creditors cannot partake in negotiations, which generates an inefficiency. Similarly, in our model, the bank's private restructuring exerts a positive externality on the government. 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. 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".

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[7]There is also a specific literature on delays in sovereign debt restructuring. Papers in this literature include Alesina and Drazen (1991), Pitchford and Wright (2012), and Lehar and Stauffer (2015).

The most related paper in this literature is Giammarino (1989), which 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. 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 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 possible extensions. Section 5 concludes. Proofs omitted in the text are in the 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 deposits and debt with face values D and R_0, the shortfall K being raised from equity. For simplicity, we assume it cannot raise more than I_0, i.e., $K \geq 0$.[8] 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

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[8]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_0 is that fly-by-night operators with no project would swamp the market (e.g., Rajan (1992)).

where $\beta > 0$. Asset quality is initially unknown and drawn from distribution $f(\cdot)$ with c.d.f. $F(\cdot)$ over $[0, 1]$. We assume that setting up the bank is efficient, i.e.,

$$Z \cdot \int_0^1 f(\theta)\theta d\theta \geq I_0. \tag{1}$$

Investment opportunity. 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 $p(\theta) = \theta + m \cdot (1 - \theta)$.[9] Note that $p(\theta) > \theta$, $p(\theta)$ increases with θ.

Resolution. If the assets yield cash-flow Z at time T, the bank repays deposits and debt and shareholders receive $(Z - D - R_0)$.[10] If they yield 0, the bank defaults and enters resolution.[11] Depositors are fully insured: they are made whole by a government transfer of D. As for creditors, 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 debt's face value being bailed in, i.e., to a haircut.[12]

Restructuring. In general, making the investment (if efficient) would require the bank to restructure its liabilities. To make the problem interesting, we assume that shareholders and creditors would gain from making the investment for some asset qualities θ (i.e., at least for $\theta = 0$) for all capital structures (i.e., even if $D = I_0$) and resolution frameworks (i.e., even if $h = 1$):

$$m(Z - I_0) > I. \tag{2}$$

Given this, we model the process of restructuring over time period $[0, T]$.

Friction-less negotiations 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.

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[9]I may be an opportunity cost for creditors. For instance, if liquidated immediately, some loans could generate I to be paid to creditors, but if rolled over, generate Z with probability $m(1 - \theta)$. By rolling over the loans, creditors would forgo an immediate payment I and extend their debt maturity with a new higher face value.

[10]Indeed, if $Z < D + R_0$, depositors and creditors would receive (together) at least Z when the assets generate cash-flow Z. From condition (1), the value of deposits and unsecured debt would exceed I_0 which we have ruled out.

[11]Since assets pay zero in default, the relative seniority of depositors and creditors plays no role.

[12]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.

First, the government does not partake in negotiations.[13] Thus restructuring may fail to internalize externalities onto the government. Second, 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.

We study the impact of those frictions in a model of the restructuring process in which the manager chooses not only a restructuring plan to offer creditors but also that offer's timing.

First, the manager chooses a restructuring plan whereby creditors contribute I and exchange their existing debt with face value R_0 against new debt with face value R.[14] We assume that creditors accept any offer making them at least as well off than in the status quo.[15]

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 negotiations end. Otherwise, the game continues until creditors accept an offer or negotiations end because cash-flow realizes. (For simplicity, the manager cannot make offers after one has been accepted.)

2 Private Restructuring

We study the private restructuring process between the bank manager and creditors as well as the bank's capital structure choice. 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 plan $R^*(\theta)$ offered and its timing $\Delta^*(\theta)$; it also specifies creditor beliefs for each possible plan-delay pair (R, Δ), i.e., a posterior distribution over asset qualities. Without loss of generality, we assume that if an offer is made in equilibrium, creditors accept it immediately, i.e., rejected offers are equivalent to "no offer".

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[13]Section 3 studies government involvement in the negotiations.

[14]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 debt may be bailed out, it is optimal for the bank to offer to replace existing debt with new debt.

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

2.1 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:

$$\bar{E}(R_0, \theta) = \theta(Z - D - R_0). \tag{3}$$

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

$$\bar{E}(R, p(\theta)) = p(\theta)[Z - D - R] = [1 - (1 - \theta)(1 - m)][Z - D - R]. \tag{4}$$

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

$$R \leq R_{max}(\theta) \equiv \frac{(p(\theta) - \theta)(Z - D) + \theta R_0}{p(\theta)} = \frac{m(1 - \theta)(Z - D) + \theta R_0}{[1 - (1 - \theta)(1 - m)]}. \tag{5}$$

Note that $R_{max}(\theta)$ is less than $(Z - D)$ and thus always feasible.[16]

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

$$\bar{C}(R_0, \hat{\theta}) = [1 - (1 - \hat{\theta})h]R_0. \tag{6}$$

That is, creditors 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 debt with new debt with face value R, their expected payoff is:

$$\bar{C}(R, p(\hat{\theta})) = [1 - (1 - p(\hat{\theta}))h]R - I = [1 - (1 - \hat{\theta})(1 - m)h]R - I. \tag{7}$$

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[16] $R_{max}(\theta)$ is a weighted average of $(Z - D)$ and R_0 which is less than $(Z - D)$, implying $R_{max}(\theta) \leq (Z - D)$. From condition (A1), the weight on R_0 increases with θ so $R_{max}(\theta)$ decreases with θ.

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 to rejecting the offer, i.e., $\bar{C}(R, p(\hat{\theta})) \geq \bar{C}(R_0, \hat{\theta})$, if:

$$R \geq R_{min}(\hat{\theta}) \equiv \frac{[1 - (1 - \hat{\theta})h]R_0}{[1 - (1 - p(\hat{\theta}))h]} + \frac{I}{[1 - (1 - p(\hat{\theta}))h]} = \frac{[1 - (1 - \hat{\theta})h]R_0}{[1 - (1 - \hat{\theta})(1 - m)h]} + \frac{I}{[1 - (1 - \hat{\theta})(1 - m)h]}. \tag{8}$$

Restructuring plan $R_{min}(\hat{\theta})$ is the most aggressive one creditors 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 creditors 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 creditors would set to lend I given the new repayment probability.[17]

As we will see, the equilibrium depends on whether the manager's incentive is to induce creditors to believe asset quality is high or low and on his ability to signal asset quality through delay. Starting with the manager's ability to signal high quality, note that it relies on a single-crossing condition.

Lemma 1. *The following single-crossing condition is satisfied:*

$$\frac{\partial}{\partial \theta}\left(\frac{p(\theta)}{\theta}\right) < 0. \tag{A1}$$

Next, we turn to the manager's incentive is to signal high or low asset quality. Focusing (for now) on the most aggressive offer, this depends on whether $R_{min}(\hat{\theta})$ decreases with $\hat{\theta}$.

$$\dot{R}_{min}(\hat{\theta}) = \frac{hmR_0}{[1 - (1 - \hat{\theta})(1 - m)h]^2} - \frac{h(1 - m)I}{[1 - (1 - \hat{\theta})(1 - m)h]^2}. \tag{9}$$

Thus, two opposite effects captured by expression (9)'s two terms drive how perceived asset quality $\hat{\theta}$ impacts $R_{min}(\hat{\theta})$. On one hand, if creditors believe $\hat{\theta}$ to be high, they value the existing debt 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 $mR_0 - (1 - m)I$.

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[17]Whether this funding is provided by existing creditors or new financiers is immaterial to our analysis.

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Lemma 2. *The most aggressive plan $R_{min}(\hat{\theta})$ creditors 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):*

$$mR_0 \leq (1-m)I \tag{A2}$$

We therefore characterize restructuring depending on whether condition (A2) holds. As we show later, the bank always chooses a capital structure satisfying (A2). We thus focus on this case first.

2.2 Separating Equilibrium

In this section, we assume condition (A2) to hold. Thus, the manager has an incentive to convey that asset quality is high to get better terms from creditors. 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. *Define $\theta^* \in (0,1)$ as the unique solution to $R_{min}(\theta) = R_{max}(\theta)$. Under condition (A2), the unique Perfect Bayesian Nash equilibrium satisfying the Intuitive Criterion is as follows.*

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

$$R^*(\theta) = R_{min}(\theta) \tag{10}$$

  and

$$\Delta^*(\theta) = \int_0^\theta \frac{E_1(x,x)}{\beta[E(x,x) - \bar{E}(R_0,x)]} dx \quad where \quad E(x,y) \equiv \bar{E}(R_{min}(x), p(y)). \tag{11}$$

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

The equilibrium has a simple structure: the higher the asset quality θ, the longer delay $\Delta^*(\theta)$ the manager waits before offering a more aggressive plan, i.e., a lower $R^*(\theta)$, which is also the most aggressive creditors will accept given that asset quality, i.e., $R^*(\theta) = R_{min}(\theta)$. For asset quality above a threshold θ^*, the manager makes no offer, i.e., delay is infinite.

As per expression (11), 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 fail. The reason is that delay being used to signal higher asset quality, which convinces creditors to extend better terms, i.e., $R^*(\theta)$ decreases with θ. Note also that $R_{min}(\theta)$ being strictly decreasing under condition (A2), 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 (A1), only types slightly below θ find the lower repayment worth the longer delay, i.e., deviation (R', Δ') profitable. Under the Intuitive Criterion, creditors must believe asset quality to be only slightly below θ, and so they break even with repayment R': they accept the offer, implying a profitable deviation for type θ.

Next, we derive equilibrium delays $\Delta^*(\theta)$. Say creditors believe that for asset quality $\theta \in [0, \theta^*)$, 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 creditors, which he can do by delaying his offer until $\Delta^*(\hat{\theta})$. With probability $(1 - e^{-\beta \Delta^*(\hat{\theta})})$, negotiations end before time $\Delta^*(\hat{\theta})$ and shareholders get the status quo payoff $\bar{E}(R_0, \theta)$. Otherwise, negotiations reach time $\Delta^*(\hat{\theta})$, creditors accept plan $R^*(\hat{\theta})$, and shareholders' payoff is $\bar{E}(R_{min}(\hat{\theta}), \theta)$. 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 creditors' beliefs, i.e., for all $\theta \in [0, 1]$, $U^E(\hat{\theta}, \theta)$ must be maximized for $\hat{\theta} = \theta$. Differentiating expression (A.5) 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 creditors' belief about asset quality would increase by $d\hat{\theta}$ so that, if negotiations continue, 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 negotiations end 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 equilibrium delays.

Figure 2 illustrates the equilibrium delay $\Delta(\theta)$ in an example.[18] Figure 3 compares, for an actual asset quality θ, the shareholders' expected payoff if creditors 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]

2.3 Pooling Equilibria

Now assume condition (A2) not to hold. In that case, the manager has an incentive to convey that asset quality is low to get better terms from creditors. However, as per the single-crossing property (A1), delay can only help higher asset quality banks separate from lower asset quality banks. Hence, no signalling is possible and pooling equilibria obtain under the Intuitive Criterion.

Proposition 2. *Define $\theta^* \in (0, 1)$ as the unique solution to $R_{min}(\theta) = R_{max}(\theta)$. If condition (A2) does not hold, the Perfect Bayesian Nash equilibria satisfying the Intuitive Criterion are as follows.*

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

---

[18]The parameters used to generate the figures are reported in A.12.

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

2.4 Optimal Capital Structure

We now study the manager's choice of a capital structure for the bank, i.e., of the mix of deposits, debt and equity to finance the bank's set up cost I_0 at $t = -1$. We show that the optimal capital structure satisfies condition (A2).

2.4.1 Surplus and Signaling Effects

Expression (11) 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 creditors. Parameter β reflects the possible loss of that surplus due to negotiations ending, which is the cost of delay. A larger surplus leads to shorter delays because the cost needed for higher asset quality banks to separate is reached after a shorter delay. We call this effect the *surplus effect.*

$$
\begin{aligned}
E(\theta, \theta) - \bar{E}(R_0, \theta) &= m(1-\theta)(Z - D - R(\theta)) - \theta(R(\theta) - R_0) \qquad (15) \\
&= [m(1-\theta)(Z-D) - I] + (1-\theta)(1-h)\frac{(1-m)I - mR_0}{1 - (1-\theta)(1-m)h} \qquad (16)
\end{aligned}
$$

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 $[m(1-\theta)(Z-D) - I]$, and it leads a higher debt level which implies a net increase in expected shortfall in default of

$$
(1-\theta)[(1-m)R(\theta) - R_0] = (1-\theta)\frac{(1-m)I - mR_0}{[1 - (1-\theta)(1-m)h]} > 0. \qquad (17)
$$

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 creditors. 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*.

$$E_1(\theta, \theta) = -[1 - (1-\theta)(1-m)]\dot{R}(\theta) \tag{18}$$

The expression for $E_1(\theta, \theta)$ captures the fact the shareholders benefit from creditors believing asset quality to be higher because of the lower face value R this implies.

2.4.2 Capital Structure

From expression (11) we can derive how equilibrium delays vary with the bank's capital structure.

Corollary 1. *Under condition (A2), capital structure affects restructuring negotiations as follows.*

- *The equilibrium delay $\Delta^*(\theta)$ increases and the equilibrium threshold θ^* decreases with D.*

- *The equilibrium delay $\Delta^*(\theta)$ decreases and the equilibrium threshold θ^* increases with R_0.*

Increasing D has no signaling effect (it does not affect $R(\hat{\theta})$) but reduces shareholders and creditors' 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 creditors' joint surplus is positive for a smaller range of asset qualities, i.e., θ^* decreases.

The intuition for the impact of R_0 is as follows. A higher asset quality as perceived by creditors matters in two ways. On 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 other hand, creditors 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 (A2), the Myers-Majluf problem dominates. Because a higher R_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.

We now study the bank's optimal capital structure and show that it satisfies condition (A2).

At $t = -1$, before the manager learns asset quality θ, he must finance the set-up cost I_0 from several sources: it raises D from depositors, D_u from creditors, and E from shareholders such that $D + D_u + K = I_0$. (Note that deposits being fully insured, D equals deposits' face value.)

The bank maximizes shareholders' expected payoff

$$\mathbb{E}\left[\bar{E}(R_0, \theta) + e^{-\beta\Delta(\theta)}\left(E(\theta, \theta) - \bar{E}(R_0, \theta)\right)\right] - (I_0 - D - D_u) \tag{19}$$

Proposition 3. *At $t = -1$, the manager optimally chooses a capital structure as follows.*

- *The optimal capital structure has no equity, and the optimal debt and deposit levels are such that condition (A2) holds with strict inequality.*

- *The equilibrium negotiation outcome is as in Proposition 1: restructuring takes place with strictly positive delays.*

Because all claims are fairly priced except that of the government, the objective can be written as the difference between the total surplus:

$$\mathbb{E}\left[\theta Z + e^{-\beta\Delta(\theta)}\left(m(1-\theta)Z - I\right)\right] \tag{20}$$

and the government's expected surplus

$$\mathbb{E}\left[-(1-\theta)[D + (1-h)R_0] + e^{-\beta\Delta(\theta)}\left(-(1-\theta)(1-m)[D + (1-h)R(\theta)] + (1-\theta)[D + (1-h)R_0]\right)\right]. \tag{21}$$

3   Restructuring with Government Involvement

Private restructurings exert externalities on the government through the public funds used for deposit insurance and creditor bailout payments and through the social cost of bail-ins. Which banks engage in restructuring negotiations and the pace at which they conduct them may not be optimal from the government's viewpoint. The government may thus gain from joining the negotiations, and possibly subsidizing the restructuring. We analyze this case now.

3.1 Bargaining with the Government

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 creditors 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 creditors and the government contribute I_C and I_G to the investment I, and the bank, if successful, pays R to creditors, D_0 to depositors, and $(D - D_0)$ to the government. If either the government or the creditors 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.

Denote by $\Delta^{**}(\theta)$ the equilibrium delay if asset quality is θ.

3.2 Restructuring Plans

The analysis follows closely that in the previous section, with the exception that the manager's offer must be accepted both by creditors and the government. The government's outside option, $\bar{G}(D_0, R_0, \theta)$, equals the expected repayments to depositors and creditors. To emphasize the symmetry between the government and creditors, we add the (constant) repayment to depositors D_0:

$$\bar{G}(D_0, R_0, \theta) = -(1 - \theta)[D_0 + (1 - h)R_0] + D_0 = \theta D_0 - (1 - \theta)(1 - h)R_0. \tag{22}$$

The payoffs of shareholders and creditors in the absence of restructuring are the same as in the previous section. We denote them $\bar{E}(D_0, R_0, \theta)$ and $\bar{C}(D_0, R_0, \theta)$. If the offers (I_G, D) and (I_C, R) are accepted, restructuring occurs. The shareholders obtain $\bar{E}(D, R, p(\theta))$, the creditors $\bar{C}(D, R, p(\theta)) - I_C$, and the government $\bar{G}(D, R, p(\theta)) - I_G$.

The government's payoff has two components. Given its role as a deposit insurer, the government is like a creditor with a claim D_0 on the bank, who can finance an investment I_G in exchange for

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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 highlight the parallel with the previous section, we define the counterparts to R_{max} and R_{min} in this case. Note that $\bar{E}(D, R, \theta)$ 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:

$$P_{max}(\theta) = \frac{m(1-\theta)Z + \theta(D_0 + R_0)}{1 - (1-\theta)(1-m)} \tag{23}$$

$$\dot{P}_{max}(\theta) = \frac{-m(Z - D_0 - R_0)}{[1 - (1-\theta)(1-m)]^2} < 0. \tag{24}$$

$P_{max}(\theta)$, the maximum total repayment type θ accepts, is akin to R_{max} in the previous section. It decreases with θ: higher types gain less in restructuring and ask for lower repayments. Similarly, consider offer (D, I_C, R, I_G) which creditors and the government are indifferent between accepting and rejecting if they believe the type is θ. That is, $\bar{C}(R, I_C, \theta) = C_0(\theta)$ and $\bar{G}(D, I_G, R, \theta) = G_0(\theta)$. Therefore $R + D = P_{min}(\theta)$, with:

$$P_{min}(\theta) = \frac{I + \theta(R_0 + D_0)}{1 - (1-m)(1-\theta)} \tag{25}$$

$$\dot{P}_{min}(\theta) = \frac{-[(1-m)I - m(R_0 + D_0)]}{[1 - (1-m)(1-\theta)]^2}. \tag{26}$$

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

$$m(R_0 + D_0) \leq (1-m)I \tag{A2-G}$$

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.

Proposition 4. *Define $\theta^{**} = 1 - I/(mZ)$. Under condition (A2-G), any Perfect Bayesian Nash equilibrium satisfying the Intuitive Criterion is as follows.*

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

$$R^{**}(\theta) + D^{**}(\theta) = P_{min}(\theta) \tag{27}$$

$$I_C^{**}(\theta) + I_G^{**}(\theta) = I, \tag{28}$$

and

$$\Delta^{**}(\theta) = \int_0^\theta \frac{E_1(x,x)}{\beta[E(x,x) - \bar{E}(R_0, x)]} dx \qquad where \quad E(x,y) \equiv \bar{E}(D^{**}(x), R^{**}(x), y). \tag{29}$$

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

This equilibrium resembles that in Proposition 1. The incremental delay necessary to signal a marginally higher type still depends on the ratio of E_1 to $(E - E_0)$, but the expressions are different and account for the manager now capturing restructuring's impact on the government.

Figure 6 plots $\Delta(\theta)$ in an example and compares the case with and without the possibility of involving the government.

[Figure 6]

If instead condition (A2-G) does not hold, we obtain a pooling equilibrium:

Proposition 5. *If condition (A2-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 offers (R^*, I_C^*) and (D^*, I_G^*) immediately, i.e., with $\Delta^*(\theta) = 0$, and with $R^* + D^* = P_{max}(\theta^{**})$. 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 offers (R^*, I_C^*) and (D^*, I_G^*) with $R^* + D^* < P_{max}(\theta^{**})$ after the same delay $\Delta^* \geq 0$, and types $\theta > \bar{\theta}$ make no offer.*

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3.3 Optimal Capital Structure

Under condition (A2-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 $[E(x,x) - E_0(x)]$ in (??), and a signaling effect, coming from the term $E_1(x,x)$. We have:

$$
\begin{aligned}
E(x,x) - E_0(x) &= m(1-\theta)Z - I & (30) \\
E_1(x,x) &= \frac{(1-m)I - m(D_0 + R_0)}{1 - (1-\theta)(1-m)} & (31)
\end{aligned}
$$

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 creditors and the government to accept an offer. Through this effect, replacing equity with debt at the margin lowers E_1 and hence reduces the delay. Second, a marginal increase in debt 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 debt at the margin also lowers E_1 and reduces delay.

Corollary 2. *Under condition (A2-G), capital structure affects restructuring negotiations as follows.*

- *The equilibrium delay $\Delta^*(\theta)$ decreases with D_0 and D_u.*

- *The impact of D_u on delays is stronger than the impact of D_0.*

- *The set of types that restructure $[0, \theta^{**}]$ is independent of capital structure.*

That deposits now have a signaling effect generate an optimal capital structure that is very different from that absent government involvement:

Proposition 6. *The bank's optimal capital structure is to use only deposits: $D_0 = I_0, D_u = 0$. This structure leads to a separating equilibrium if $(1-m)I \geq mI_0$, and to a pooling equilibrium otherwise.*

Intuitively, uninsured debt is more expensive than insured deposits, as it leads to lower payments by the government. Its only advantage is that each unit of uninsured debt 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 uninsured debt is suboptimal. Equity is also suboptimal, as it leads to no government payment and has no signaling effect.

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

4   Possible Extensions

The model can be extended to discuss policy questions.

TLAC. In our model, the bank has three types of liabilities: insured deposits, uninsured debt, and equity. Uninsured debt can be interpreted as "bailinable" debt. It is clear from Corollary 1 that it is easier to restructure the bank when it has more bailinable debt and less deposits. Indeed, if there is not enough bailinable debt to start with, renegotiating the debt will mostly be a positive externality on the deposit insurance fund, and may not create any surplus for the bank and its creditors. If the bank can choose its financing structure ex-ante, for a sufficiently low haircut it will have an incentive to choose a non-zero level of bailinable debt to make restructuring easier. However, since restructuring creates an externality on the government, the privately chosen level of bailinable debt may not be optimal, creating a rationale for "total loss absorbing capital" requirements.

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 negotiations. 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 creditors, 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.[19] The variables $\tilde{\theta}$ and R are determined simultaneously by the fact that creditors are indifferent between accepting and rejecting the offer, and that a bank with type $\tilde{\theta}$ breaks even by offering R:

$$\int_0^{\tilde{\theta}} \frac{[1 - (1-\theta)h]R_0}{F(\tilde{\theta})} f(\theta)d\theta = \int_0^{\tilde{\theta}} \frac{[1 - (1-\theta)(1-m)h]R}{F(\tilde{\theta})} f(\theta)d\theta - I \tag{32}$$

$$(1 - (1-\tilde{\theta})(1-m))(X - R) = \tilde{\theta}(X - R_0). \tag{33}$$

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. Given that delays in restructuring are due to asymmetric information, the model gives an important rationale for communicating supervisory information to investors, for instance through stress-tests.[20] 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 $\Delta(\tilde{\theta})$.

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[19]If we allow creditors 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.

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

5 Conclusion

This paper is a first 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 speed 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 creditors 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. We show in an example that government involvement can actually slow down the bargaining process. In addition, these two effects may have to be traded off against ex-post costs of resolution. For example, we show that when the government does not participate more bail-outs always lead to a quicker agreement between shareholders and creditors. However, such bail-outs can be suboptimal ex-post, so that the government chooses an intermediate level of bail-outs that trades off the probability of successful restructuring against bail-out costs.

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 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   Appendix

A.1   Proof of Lemma 1

Follows directly from $p(\theta) = \theta + m(1 - \theta)$.

A.2   Proof of Lemma 2

Follows directly from equation (9).

A.3   Proof of Proposition 1

If type θ makes an (accepted) offer in equilibrium, let it be denoted $(R^*(\theta), \Delta^*(\theta))$. The Intuitive Criterion pins down the creditors' beliefs following off-equilibrium offers which, if accepted, would profit at least one type: creditors must believe asset quality to be the lowest such that the deviation would be profitable. Without loss of generality, we assume that creditors believe the asset quality to be 0 following off-equilibrium offers which, if accepted by creditors, would profit no type.

Step 1: θ^* is unique and strictly less than 1.

Function $\phi(\cdot)$ defined by $\phi(\theta) \equiv \bar{E}(R_{min}(\theta), p(\theta)) - \bar{E}(R_0, \theta)$, i.e.,

$$\phi(\theta) = [1 - (1 - \theta)(1 - m)][Z - D - R_{min}(\theta)] - \theta[Z - D - R_0]. \tag{A.1}$$

is strictly decreasing because, under condition (A2),

$$\dot{\phi}(\theta) = -mX - [(1 - m)R_{min}(\theta) - R_0] - [1 - (1 - \theta)(1 - m)]\dot{R}_{min}(\theta) \tag{A.2}$$

$$= -mX - \frac{(1 - h)[(1 - m)I - mR_0]}{[1 - (1 - \theta)(1 - m)h]^2} < 0. \tag{A.3}$$

Hence θ^* is the unique solution to $\phi(\theta) = 0$ because, given condition (2), we have:

$$\phi(0) = m[Z - D - R_{min}(0)] > 0 \quad \text{and} \quad \phi(1) = R_0 - (R_0 + I) = -I < 0. \tag{A.4}$$

Step 2: In any equilibrium, type θ makes an offer if and only if $\theta \leq \bar{\theta}$ for some $\bar{\theta} \in [0, 1]$.

By contradiction. Assume an in equilibrium in which type θ makes (accepted) offer $(R^*(\theta), \Delta^*(\theta))$ but type $\theta' < \theta$ makes no offer. For type θ', playing $(R^*(\theta), \Delta^*(\theta))$ is a profitable deviation. Indeed, equilibrium requires that creditors accept the offer and $R^*(\theta) \leq R_{max}(\theta)$. Moreover, $R_{max}(\cdot)$ being decreasing, $R^*(\theta) < R_{max}(\theta')$ so that type θ' would make a profit, a contradiction.

Step 3: Under condition (A2), for all $\theta \in [0, \bar{\theta}]$, $R^*(\theta) = R_{min}(\theta)$.

By contradiction.

Case 1: $\forall \theta \in [0, \bar{\theta}]$, $R^*(\theta) \leq R_{min}(\theta)$ and $\exists \theta'$ s.t. $R^*(\theta') < R_{min}(\theta')$.

If so, creditors make a loss by accepting offer $R^*(\theta')$, which cannot be true in equilibrium.

Case 2: $\exists \theta$ s.t. $R^*(\theta) > R_{min}(\theta)$.

By continuity, a type $\theta' < \theta$ exists such that $R^*(\theta) > R_{min}(\theta')$. Consider (R', Δ') with $R_{min}(\theta') < R' < R^*(\theta) \leq R^*(\theta')$, the last inequality arising from the single-crossing condition (A1), and Δ' such that type θ' is indifferent between $(R^*(\theta'), \Delta^*(\theta'))$ and (R', Δ').

For type θ, (R', Δ') is a strictly profitable deviation (if accepted). 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 $(R^*(\theta), \Delta^*(\theta))$. Hence θ' weakly prefers (R', Δ') to $(R^*(\theta), \Delta^*(\theta))$. Hence, from single-crossing condition (A1), θ strictly prefers (R', Δ') to $(R^*(\theta), \Delta^*(\theta))$.

For types below θ', (R', Δ') is a strictly unprofitable deviation. Note that $R' < R(\theta')$ implies $\Delta' > \Delta(\theta')$. Type θ' being indifferent between $(R(\theta'), \Delta(\theta'))$ and (R', Δ'), single-crossing condition (A1) and $\Delta' > \Delta(\theta')$ imply that types below θ' strictly prefer $(R(\theta'), \Delta(\theta'))$ to (R', Δ'). Moreover, equilibrium requires that deviating to $(R(\theta'), \Delta(\theta'))$ be weakly unprofitable for those types.

Under the Intuitive Criterion, the most pessimistic belief possible following deviation (R', Δ') is some $\theta'' \in [\theta', \theta)$. Since $R' > R_{min}(\theta') \geq R_{min}(\theta'')$, creditors would accept offer (R', Δ'), which would thus be a profitable deviation for θ, a contradiction.

Step 4: $\bar{\theta} = \theta^*$.

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 if accepted, and

equilibrium implies it is accepted. Hence, the deviation is profitable for θ', a contradiction.

Step 5: Solving for $\Delta^*(\cdot)$.

In the main text, we prove that Δ^* must satisfy first-order condition (14), which gives expression (11). We now check that the second-order condition holds. Define:

$$U(\hat{\theta}, \theta) = [1 - e^{-\beta \Delta^*(\hat{\theta})}] \bar{E}(R_0, \theta) + e^{-\beta \Delta^*(\hat{\theta})} E(\hat{\theta}, \theta). \tag{A.5}$$

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

$$U_1(\hat{\theta}, \theta) = e^{-\beta \Delta^*(\hat{\theta})} \left[E_1(\hat{\theta}, \theta) - \frac{E_1(\hat{\theta}, \hat{\theta})}{[E(\hat{\theta}, \hat{\theta}) - \bar{E}(R_0, \hat{\theta})]} [E(\hat{\theta}, \theta) - \bar{E}(R_0, \theta)] \right] \tag{A.6}$$

$$= \left[e^{-\beta \Delta^*(\hat{\theta})} \frac{E_1(\hat{\theta}, \theta) E_1(\hat{\theta}, \hat{\theta})}{[E(\hat{\theta}, \hat{\theta}) - \bar{E}(R_0, \hat{\theta})]} \right] \times \left[\frac{[E(\hat{\theta}, \hat{\theta}) - \bar{E}(R_0, \hat{\theta})]}{E_1(\hat{\theta}, \hat{\theta})} - \frac{[E(\hat{\theta}, \theta) - \bar{E}(R_0, \theta)]}{E_1(\hat{\theta}, \theta)} \right] \tag{A.7}$$

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 numerator 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:

$$\frac{E(\hat{\theta}, \theta) - \bar{E}(R_0, \theta)}{E_1(\hat{\theta}, \theta)} = \frac{[1 - (1 - \theta)(1 - m)](Z - D - R_{min}(\hat{\theta})) - \theta(Z - D - R_0)}{[1 - (1 - \theta)(1 - m)](-\dot{R}_{min}(\hat{\theta}))} \tag{A.8}$$

$$= -\frac{(Z - D - R_{min}(\hat{\theta}))}{\dot{R}_{min}(\hat{\theta})} - \frac{\theta(Z - D - R_0)}{[1 - (1 - \theta)(1 - m)](-\dot{R}_{min}(\hat{\theta}))} \tag{A.9}$$

Hence, given that $(Z - D - R_0)$ and $-\dot{R}_{min}(\hat{\theta})$ are positive, the sign of $U_1(\hat{\theta}, \theta)$ is that of

$$\frac{\theta}{[1 - (1 - \theta)(1 - m)]} - \frac{\hat{\theta}}{[1 - (1 - \hat{\theta})(1 - m)]} \tag{A.10}$$

Hence it is that of $(\theta - \hat{\theta})$ and the first order condition gives an absolute maximum over $[0, \theta^*]$.

Step 6: Deviations to off-equilibrium offers.

We show that any deviation (R, Δ) differing from $(R^*(\theta), \Delta^*(\theta))$ for all $\theta \in [0, \theta^*]$ is unprofitable. Assume that (R, Δ), if accepted, is profitable for some types, the smallest of which is $\hat{\theta}$.

If $R < R_{min}(\theta^*) = R_{max}(\theta^*)$, deviation (R, Δ) is profitable for type θ^*. Hence $\hat{\theta} \leq \theta^*$ but

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creditors reject plan R because $R < R_{min}(\theta^*) \leq R_{min}(\hat{\theta})$. Hence, (R, Δ) is not a profitable deviation.

If $R \in [R_{min}(\theta^*), R_{min}(0)]$, a type θ exists such that $R = R_{min}(0)$. The existence of $\hat{\theta}$ requires $\Delta < \Delta(\theta)$, otherwise (R, Δ) is equilibrium-dominated by $(R(\theta), \Delta(\theta))$. Hence (R, Δ), if accepted, is strictly profitable for type θ, which implies $\hat{\theta} < \theta$. But if so, creditors reject plan R because $R = R_{min}(\theta) < R_{min}(\hat{\theta})$. Hence, (R, Δ) is not a profitable deviation.

If $R > R_{min}(0)$, (R, Δ) is equilibrium-dominated by $(R_{min}(0), 0)$, which is accepted. Hence, (R, Δ) is not a profitable deviation.

Expression for $\Delta(\theta)$: Integrating $\dot{\Delta}(\theta)$ yields a (cumbersome) analytical expression for $\Delta(\theta)$.

$$\dot{\Delta}(\theta) = h[(1-m)I - mR_0]\left[\frac{A}{1 - (1-\theta)(1-m)h} + \frac{B(1-\theta) + C}{a(1-\theta)^2 + b(1-\theta) + c}\right] \quad \text{(A.11)}$$

$$\text{with } a = -m(1-m)hX \quad \text{(A.12)}$$

$$b = (1-m)hI + mX + (1-h)[(1-m)I - mR_0] \quad \text{(A.13)}$$

$$c = -I \quad \text{(A.14)}$$

$$A = -\frac{h(1-h)(1-m)^2}{a + (1-m)hb + c(1-m)^2h^2} \quad \text{(A.15)}$$

$$B = -(1-m)(1-h) - A[b + c(1-m)h] \quad \text{(A.16)}$$

$$C = 1 - cA. \quad \text{(A.17)}$$

Given this functional form, a primitive is given by:

$$\tilde{\Delta}(\theta) = h[(1-m)I - mR_0]\left(\frac{A\ln[1 - (1-\theta)(1-m)h]}{(1-m)h} + \phi(\theta) + \frac{2aC - bB}{2a}\psi(\theta)\right), \quad \text{(A.18)}$$

where

$$\phi(\theta) = -\frac{B}{2a}\ln(|a(1-\theta)^2 + b(1-\theta) + c|), \quad \text{(A.19)}$$

and

$$\psi(\theta) = \begin{cases} \frac{-2}{\sqrt{4ac-b^2}}arctan\left(\frac{2a(1-\theta)+b}{\sqrt{4ac-b^2}}\right) & \text{if } 4ac > b^2 \\ \frac{1}{\sqrt{b^2-4ac}}\ln\left(\frac{2a(1-\theta)+b+\sqrt{4ac-b^2}}{2a(1-\theta)+b-\sqrt{4ac-b^2}}\right) & \text{if } 4ac < b^2. \end{cases} \quad \text{(A.20)}$$

Finally, $\Delta(\theta) = \tilde{\Delta}(\theta) - \tilde{\Delta}(0)$.

A.4 Proof of Proposition 2

Proof of the first bullet point.

Step 1: θ^* is unique and strictly less than 1.

Function $\phi(\cdot)$ defined by $\phi(\theta) \equiv R_{max}(\theta) - R_{min}(\theta)$ is strictly decreasing because $R_{max}(\cdot)$ is strictly decreasing and, if condition (A2) does not hold, $R_{min}(\cdot)$ is strictly increasing. Hence θ^* is the unique solution to $\phi(\theta) = 0$ because, given condition (2), we have:

$$\phi(0) = Z - D - R_{min}(0) > 0 \quad \text{and} \quad \phi(1) = -[R_{min}(1) - R_0] = -I < 0. \tag{A.21}$$

Step 2: Beliefs following off-equilibrium moves.

Let $\hat{\theta}(R, \Delta)$ denote creditors' belief following an off-equilibrium move (R, Δ). 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. If $R < R_{max}(\theta^*)$, the offer (if accepted) is profitable for all types in $\{\theta \ s.t. \ R < R_{max}(\theta)\}$. Since $R_{max}(\cdot)$ is continuous and strictly decreasing, the set is an interval the maximum of which is strictly above θ^*. We assume $\hat{\theta}(R, \Delta)$ to be the average between θ^* and the maximum. Thus, $\hat{\theta}(R, \Delta) > \theta^*$ and satisfies the Intuitive Criterion because it belongs to the set.

Step 3: 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 $\hat{\theta}(R, \Delta) > \theta^*$ and creditors reject the offer because $R_{min}(\cdot)$ being increasing, $R_{min}(\hat{\theta}(R, \Delta)) > R_{min}(\theta^*) = R_{max}(\theta^*) > R$.

Proof of the second bullet point.

Step 1: In any equilibrium, type θ makes an offer if and only if $\theta \leq \bar{\theta}$ for some $\bar{\theta} \in [0, 1]$.

Same proof as for Proposition 1.

Step 2: $\bar{\theta} \geq \theta^*$.

By contradiction. Assume $\bar{\theta} < \theta^*$. Consider a deviation to offering $R_{max}(\theta^*)$ immediately. $R_{max}(\cdot)$ 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 $\theta \in [0, \bar{\theta}]$, creditors accept the offer. Otherwise, under the Intuitive Criterion, creditors must believe asset quality to be in $(\bar{\theta}, \theta^*]$. For any type $\theta \in (\bar{\theta}, \theta^*]$, creditors will accept the offer because, $R_{min}(\cdot)$ being increasing, $R_{min}(\theta) \leq R_{min}(\theta^*) = R_{max}(\theta^*)$. Hence, the deviation would be profitable for any such type, a contradiction.

Step 3: If $\bar{\theta} = \theta^*$ then $R^*(\theta) = R_{max}(\theta^*)$ and $\Delta^*(\theta) = 0$ for all $\theta \in [0, \theta^*]$.

By contradiction. Assume $R^*(\theta) > R_{max}(\theta^*)$ or $\Delta^*(\theta) > 0$ for some $\theta \in [0, \theta^*]$. Consider a deviation to offering $R_{max}(\theta^*)$ immediately. $R_{max}(\cdot)$ 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 $\theta' \in [0, \theta^*]$, creditors accept the offer. Otherwise, under the Intuitive Criterion, creditors must believe asset quality to be in $[0, \theta^*]$. For any type $\theta' \in [0, \theta^*]$, creditors will accept the offer because, $R_{min}(\cdot)$ being increasing, $R_{min}(\theta') \leq R_{min}(\theta^*) = R_{max}(\theta^*)$. Hence, the deviation would be profitable for type θ, 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 4: There exists $\underline{\theta} < \theta^*$ such that for all $\theta \in [\underline{\theta}, \bar{\theta}]$, $(R^*(\theta), \Delta^*(\theta)) = (R^{pool}, \Delta^{pool})$.

For all $\theta \in (\theta^*, \bar{\theta}]$, $R_{max}(\theta) < R_{min}(\theta)$ and equilibrium requires $R^*(\theta) \leq R_{max}(\theta)$ so $R^*(\theta) < R_{min}(\theta)$. Hence, their offers can be accepted only if they are pooled with some types below θ^*. The monotonicity of R completes the proof.

Step 5: $R^{pool} \leq R_{max}(\bar{\theta}) < R_{max}(\theta^*)$.

Equilibrium implies $R^{pool} \leq R_{max}(\bar{\theta})$. Moreover, $R_{max}(\cdot)$ being strictly decreasing, $\bar{\theta} > \theta^*$ implies $R_{max}(\bar{\theta}) < R_{max}(\theta^*)$.

Step 6: For all $\theta \in [0, \bar{\theta}]$, $(R^*(\theta), \Delta^*(\theta)) = (R^{pool}, \Delta^{pool})$.

By contradiction. If the statement is not true, $R^*(0) > R^{pool}$ and $\Delta^*(0) < \Delta^{pool}$. Denote $\underline{\theta}$ the maximum over $\{\theta \in [0, \bar{\theta}] \ s.t. \ (R^*(\theta), \Delta^*(\theta)) \neq (R^{pool}, \Delta^{pool})\}$. We have $R^{pool} > R_{min}(\underline{\theta})$. By continuity of $R_{min}(\cdot)$, a type $\theta \in (\underline{\theta}, \bar{\theta})$ exists such that $R^{pool} > R_{min}(\theta)$. Consider $R < R^*(0)$ such that type θ is indifferent between $(R^{pool}, \Delta^{pool})$ and $(R, \Delta^*(0))$. Deviating to $(R, \Delta^*(0))$ (if creditors accept the offer) is profitable for type 0 but, from single-crossing condition (A1), not for any type above θ. The Intuitive Criterion implies that following this off-equilibrium move, creditors believe asset quality to be some $\hat{\theta} \leq \theta$. If so, they accept the offer because, $R_{min}(\cdot)$ being increasing, we have $R_{min}(\hat{\theta}) \leq R_{min}(\theta) < R$. Thus, the deviation is strictly profitable for type 0, a contradiction.

A.5   Proof of Corollary 1

The signaling and surplus effects of increasing deposits are determined by:

$$\frac{\partial E_1(\theta, \theta)}{\partial D} = -\frac{\partial \dot{R}(\theta)}{\partial D} \times [1 - (1 - \theta)(1 - m)] = 0 \tag{A.22}$$

$$\frac{\partial [E(\theta, \theta) - E_0(\theta)]}{\partial D} = -m(1 - \theta) < 0. \tag{A.23}$$

From expression (11), $\Delta^*(\theta)$ increases with D. Moreover, θ^* being defined by $E(\theta, \theta) = E_0(\theta)$, equation (A.23) implies that θ^* decreases with D. A similar reasoning completes the proof given that the signaling and surplus effects of increasing debt are given by:

$$\frac{\partial E_1(\theta, \theta)}{\partial R_0} = \frac{-hm[1 - (1 - \theta)(1 - m)]}{[1 - h(1 - \theta)(1 - m)]^2} < 0 \tag{A.24}$$

$$\frac{\partial [E(\theta, \theta) - E_0(\theta)]}{\partial R_0} = [1 - (1 - \theta)(1 - m)]\frac{\partial R(\theta)}{\partial R_0} + \theta > 0. \tag{A.25}$$

A.6   Proof of Proposition 3

A.6.1   Proof that the optimal capital structure is such that condition (A2) holds

By contradiction, we assume that the bank chooses a capital structure that does not satisfy (A2), and then show that this is suboptimal.

Step 1: Bank expected profit in the pooling equilibrium. In any equilibrium, for some $\bar{\theta} \geq \theta^*$, all types in $[0, \bar{\theta}]$ make the same offer R^{pool} immediately. Hence, the bank's expected profit is:

$$V^{pool} \equiv \int_0^{\bar{\theta}} \bar{E}(R^{pool}, \theta) dF(\theta) + \int_{\bar{\theta}}^1 E_0(\theta) dF(\theta) - K. \qquad (\text{A.26})$$

The creditors' break-even condition is:

$$D_u = \int_0^{\bar{\theta}} \bar{C}(R^{pool}, \theta) dF(\theta) + \int_{\bar{\theta}}^1 C_0(\theta) dF(\theta). \qquad (\text{A.27})$$

Using the equality $I_0 = K + D + D_u$ and plugging (A.27) into (A.26), we obtain:

$$V^{pool} = \int_0^{\bar{\theta}} [\bar{C}(R^{pool}, \theta) + \bar{E}(R^{pool}, \theta)] dF(\theta) + \int_{\bar{\theta}}^1 [C_0(\theta) + E_0(\theta)] dF(\theta) - I_0 + D, \qquad (\text{A.28})$$

which given that

$$\bar{C}(R, \theta) + \bar{E}(R, \theta) = [1 - (1 - \theta)(1 - m)](Z - D) + (1 - \theta)(1 - m)(1 - h)R - I \quad (\text{A.29})$$

$$C_0(\theta) + E_0(\theta) = \theta(Z - D) + (1 - \theta)(1 - h)R_0. \qquad (\text{A.30})$$

can be rewritten as:

$$
\begin{aligned}
V^{pool} &= \mathbb{E}(\theta)Z - I_0 + \int_0^{\bar{\theta}} [m(1 - \theta)Z - I] dF(\theta) \\
&+ \int_0^{\bar{\theta}} (1 - \theta)(1 - m)[D_0 + (1 - h)R^{pool}] dF(\theta) + \int_{\bar{\theta}}^1 (1 - \theta)[D + (1 - h)R_0] dF(\theta) \quad (\text{A.31})
\end{aligned}
$$

The first line is total surplus, which the bank would internalize if all claims (i.e., the creditors and the government's) were priced competitively. The second line reflects the fact that the government's claim is not: it is the government's transfers to depositors and creditors, which subsidize the bank.

Step 2: $\bar{\theta} = \theta^*$ is the most profitable pooling equilibrium.

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. In an

equilibrium characterized by $(\bar{\theta}, R^{pool}, \Delta^{pool})$ with $\bar{\theta} > \theta^*$, the bank's expected profit is:

$$
\begin{aligned}
V^{pool}(\bar{\theta}, R^{pool}, \Delta^{pool}) &= (1 - e^{-\beta\Delta^{pool}}) \int_0^{\bar{\theta}} [E_0(\theta) + C_0(\theta)]dF(\theta) \\
&+ e^{-\beta\Delta^{pool}} \int_0^{\bar{\theta}} [\bar{E}(R^{pool}, \theta) + \bar{C}(R^{pool}, \theta)]dF(\theta) \quad (A.32)
\end{aligned}
$$

Reflecting that higher repayments imply higher expected government bailout transfers, we have

$$
\begin{aligned}
\frac{\partial V^{pool}(\bar{\theta}, R^{pool}, \Delta^{pool})}{\partial R^{pool}} &= 0 + e^{-\beta\Delta^{pool}} \int_0^{\bar{\theta}} [\bar{C}_1(R^{pool}, \theta) + \bar{E}_1(R^{pool}, \theta)]dF(\theta) \\
&= e^{-\beta\Delta^{pool}} \int_0^{\bar{\theta}} [(1 - \theta)(1 - m)(1 - h)]dF(\theta) > 0. \quad (A.33)
\end{aligned}
$$

Therefore, $V^{pool}(\bar{\theta}, R^{pool}, \Delta^{pool}) \le V^{pool}(\bar{\theta}, R_{max}(\bar{\theta}), \Delta^{pool})$. Moreover, we have

$$
\begin{aligned}
\frac{\partial V^{pool}(\bar{\theta}, R_{max}(\bar{\theta}), \Delta^{pool})}{\partial \bar{\theta}} &= e^{-\beta\Delta^{pool}} f(\bar{\theta})[\bar{C}(R_{max}(\bar{\theta}), \bar{\theta}) + \bar{E}(R_{max}(\bar{\theta}), \bar{\theta}) - E_0(\bar{\theta}) - C_0(\bar{\theta})] \\
&+ e^{-\beta\Delta^{pool}} \frac{\partial R_{max}(\bar{\theta})}{\partial \bar{\theta}} \int_0^{\bar{\theta}} [\bar{C}_1(R_{max}(\bar{\theta}), \theta) + \bar{E}_1(R_{max}(\bar{\theta}), \theta)]dF(\theta). \\
&< 0. \quad (A.34)
\end{aligned}
$$

The first term is negative because $\bar{E}(R_{max}(\bar{\theta}), \bar{\theta}) - E_0(\bar{\theta}) = 0$, by definition of $R_{max}(\bar{\theta})$, and $\bar{\theta} > \theta^*$ implies $R_{max}(\bar{\theta}) < R_{min}(\bar{\theta})$ and hence $\bar{C}(R_{max}(\bar{\theta}), \bar{\theta}) - C_0(\bar{\theta}) < 0$. The reason is that for the higher $\bar{\theta} > \theta^*$, the more types for which restructuring occurs despite being inefficient for shareholders and creditors, leading to lower expected profits ex ante. The second term is negative because $R_{max}(\cdot)$ is strictly decreasing, and as we saw, $\bar{C}_1(\cdot, \theta) + \bar{E}_1(\cdot, \theta) > 0$ reflecting that higher repayments imply higher expected bailout transfers. Therefore, $V^{pool}(\bar{\theta}, R^{pool}, \Delta^{pool}) < V^{pool}(\theta^*, R_{max}(\theta^*), \Delta^{pool})$.

Moreover, because $\theta < \theta^*$ implies $R_{min}(\theta) < R_{min}(\theta^*)$ and $R_{max}(\theta) > R_{max}(\theta^*)$, we have

$$
\begin{aligned}
\frac{\partial V^{pool}(\theta^*, R_{max}(\theta^*), \Delta^{pool})}{\partial \Delta^{pool}} &= -\beta e^{-\beta\Delta^{pool}} \int_0^{\theta^*} [\bar{C}(R_{max}(\theta^*), \theta) - C_0(\theta)]dF(\theta) \\
&- \beta e^{-\beta\Delta^{pool}} \int_0^{\theta^*} [\bar{E}(R_{max}(\theta^*), \theta) - E_0(\theta)]dF(\theta) \\
&< 0. \quad (A.35)
\end{aligned}
$$

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Therefore, $V^{pool}(\bar{\theta}, R^{pool}, \Delta^{pool}) < V^{pool}(\theta^*, R_{max}(\theta^*), 0)$.

Step 3. Maximization program. When $\bar{\theta} = \theta^*$ the shareholders' expected payoff is:

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

Note that we have $R^{pool} = R_{min}(\theta^*) = R_{max}(\theta^*)$. When offering R_0 to uninsured creditors, the bank can raise D_u with:

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

The bank maximizes V^{pool} under the following constraints: (i) Equity is positive; (ii) The capital structure leads to pooling; (iii) Deposits are positive; (iv) Uninsured debt is positive. This gives us the following Lagrangian:

$$
\mathcal{L} = V^{pool} + \lambda[I_0 - D_0 - D_u] + \mu[mR_0 - (1-m)I] + \nu D_0 + \eta R_0,
\tag{A.38}
$$

to be maximized in D_0 and R_0.

Step 4. First-order conditions. We first differentiate $\mathcal{L}$ with respect to D_0. We have:

$$
\frac{\partial \mathcal{L}}{\partial D_0} = \frac{\partial V^{pool}}{\partial D_0} - \lambda\left[1 + \frac{\partial D_u}{\partial D_0}\right] + \nu
\tag{A.39}
$$

$$
\begin{aligned}
\frac{\partial V^{pool}}{\partial D_0} &= (1-m)\int_0^{\theta^*} (1-\theta)dF(\theta)\left[1 + (1-h)\frac{\partial R^{pool}}{\partial D_0}\right] + \int_{\theta^*}^1 (1-\theta)dF(\theta) \\
&+ \frac{\partial \theta^*}{\partial D_0}\underbrace{\left[m(1-\theta^*)Z - I + (1-\theta^*)(1-m)(D_0 + (1-h)R^{pool}) - (1-\theta^*)(D_0 + (1-h)R_0)\right]}_{=0}
\end{aligned}
\tag{A.40}
$$

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

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When differentiating with respect to R_0 we obtain:

$$\frac{\partial \mathcal{L}}{\partial R_0} = \frac{\partial V^{pool}}{\partial R_0} - \lambda \frac{\partial D_u}{\partial R_0} + \mu m + \eta \qquad (A.42)$$

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

$$\frac{\partial D_u}{\partial R_0} = \frac{\partial R^{pool}}{\partial R_0} \int_0^{\theta^*} [1 - (1-\theta)(1-m)h]dF(\theta) + \int_{\theta^*}^1 [1 - (1-\theta)h]dF(\theta). \qquad (A.44)$$

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

$$\begin{aligned}
\frac{\partial \mathcal{L}}{\partial D_0} &= (1-m)\int_0^{\theta^*} (1-\theta)dF(\theta)\left[1 + (1-h)\frac{\partial R^{pool}}{\partial D_0}\right] + \int_{\theta^*}^1 (1-\theta)dF(\theta) \\
&\quad - \lambda\left[1 + \frac{\partial R^{pool}}{\partial D_0}\int_0^{\theta^*}[1-(1-\theta)(1-m)h]dF(\theta)\right] + \nu = 0 \qquad (A.45) \\
\frac{\partial \mathcal{L}}{\partial R_0} &= (1-m)(1-h)\frac{\partial R^{pool}}{\partial R_0}\int_0^{\theta^*}(1-\theta)dF(\theta) + (1-h)\int_{\theta^*}^1 (1-\theta)dF(\theta) \qquad (A.46) \\
&\quad - \lambda\left[\frac{\partial R^{pool}}{\partial R_0}\int_0^{\theta^*}[1-(1-\theta)(1-m)h]dF(\theta) + \int_{\theta^*}^1[1-(1-\theta)h]dF(\theta)\right] + \mu m + \eta = 0 \qquad (A.47)
\end{aligned}$$

Step 5. Study of R^{pool}. R^{pool} and θ^* are jointly determined by the system of equations $R^{pool} = R_{max}(\theta^*)$ and $R^{pool} = R_{min}(\theta^*)$. We have already shown that θ^* and R^{pool} are uniquely defined (see Section A.4). Since R_{min} increases in θ and R_{max} decreases in θ it is also easy to show that R^{pool} increases in R_0 and decreases in D_0.

Step 6. 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 $\mu = 0$. Note that the constraint $mR_0 > (1-m)I$ implies $R_0 > 0$ and hence $\eta = 0$. Looking at (A.42), the first-order condition with respect to R_0, we deduce that $\lambda > 0$, and hence the bank has no equity. From (A.42) we obtain that:

$$\lambda = (1-h)\frac{(1-m)\frac{\partial R^{pool}}{\partial R_0}\int_0^{\theta^*}(1-\theta)dF(\theta) + \int_{\theta^*}^1(1-\theta)dF(\theta)}{\frac{\partial D_u}{\partial R_0}} \qquad (A.48)$$

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We plug this expression into (A.39), the first-order condition with respect to D_0. The goal is to show that we cannot have $\nu \geq 0$, and hence generate a contradiction. As $\frac{\partial D_u}{\partial R_0} \geq 0$, we need to show the following inequality:

$$
\begin{aligned}
&\frac{\partial D_u}{\partial R_0}(1-m)\int_0^{\theta^*}(1-\theta)dF(\theta)\left[1+(1-h)\frac{\partial R^{pool}}{\partial D_0}\right]+\frac{\partial D_u}{\partial R_0}\int_{\theta^*}^1(1-\theta)dF(\theta)\\
&> \left[1+\frac{\partial D_u}{\partial D_0}\right]\left[\frac{\partial R^{pool}}{\partial R_0}(1-m)(1-h)\int_0^{\theta^*}(1-\theta)dF(\theta)+(1-h)\int_{\theta^*}^1(1-\theta)dF(\theta)\right]
\end{aligned}
\qquad (A.49)
$$

Intuitively, we want to show that R_0 should be chosen as low as possible, so that the separating constraint binds. This is because increasing D_0 by one unit always leads to more transfers from the government than increasing R_0 by one unit, even taking into account the impact of both on R^{pool}. However, because the equity constraint is binding, if the bank decreases D_0 by one unit it has to increase D_u by one unit, which leads to a higher increase in R_0.

Step 7. Proof that inequality (A.49) holds.

We can rewrite inequality (A.49) as follows:

$$
(1-m)\int_0^{\theta^*}(1-\theta)dF(\theta)A+\int_{\theta^*}^1(1-\theta)dF(\theta)B>0
\qquad (A.50)
$$

$$
\text{with}\quad A=\left[1+(1-h)\frac{\partial R^{pool}}{\partial D_0}\right]\frac{\partial D_u}{\partial R_0}-\left[1+\frac{\partial D_u}{\partial D_0}\right]\frac{\partial R^{pool}}{\partial R_0}(1-h)
\qquad (A.51)
$$

$$
B=\frac{\partial D_u}{\partial R_0}-(1-h)\left[1+\frac{\partial D_u}{\partial D_0}\right]
\qquad (A.52)
$$

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

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

$$
\begin{aligned}
B &= \frac{\partial R^{pool}}{\partial R_0}\int_0^{\theta^*}[1-(1-\theta)(1-m)h]dF(\theta)+\int_{\theta^*}^1[1-(1-\theta)h]dF(\theta)\\
&\quad -(1-h)\left[1+\frac{\partial R^{pool}}{\partial D_0}\int_0^{\theta^*}[1-(1-\theta)(1-m)h]dF(\theta)\right]
\end{aligned}
\qquad (A.54)
$$

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Note that neither $\frac{\partial R^{pool}}{\partial D_0}$ nor $\frac{\partial R^{pool}}{\partial R_0}$ depend on the distribution F. Using the expression above, we can study under which distribution F the left-hand side of (A.50) is the lowest. Pick a given $\hat{\theta}$ below θ^*, and differentiate (A.50) with respect to $f(\hat{\theta})$. We obtain:

$$(1-m)(1-\hat{\theta})A+[1-(1-\hat{\theta})(1-m)h]\left[\frac{\partial R^{pool}}{\partial R_0}\int_0^{\theta^*}(1-\theta)dF(\theta)+\left[\frac{\partial R^{pool}}{\partial R_0}-(1-h)\frac{\partial R^{pool}}{\partial D_0}\right]\int_{\theta^*}^1(1-\theta)dF(\theta)\right] \quad \text{(A.55)}$$

Similarly, if we pick $\hat{\theta}$ above θ^* and differentiate (A.50) with respect to $f(\hat{\theta})$ we obtain:

$$-(1-\hat{\theta})B+[1-(1-\hat{\theta})h]\left[\int_{\theta^*}^1(1-\theta)dF(\theta)+(1-m)\int_0^{\theta^*}(1-\theta)dF(\theta)\left[1+(1-h)\frac{\partial R^{pool}}{\partial D_0}\right]\right] \quad \text{(A.56)}$$

Both (A.55) and (A.56) are linear in $\hat{\theta}$. This implies that the distribution F that minimizes the left-hand side of inequality (A.50) 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.50) in these four cases.

(i) If the distribution puts all the weight in 1 then the left-hand side of (A.50) is equal to zero.

(ii) If the distribution puts all the weight in 1 then the left-hand side of (A.50) is equal to $(1-m)A$, with $A=hm\frac{\partial R^{pool}}{\partial R_0}>0$.

(iii) If the distribution puts all the weight in $\theta^*-\epsilon$, then as $\epsilon\to 0$ the left-hand side of (A.50) tends to:

$$\frac{\partial R^{pool}}{\partial R_0}h(1-m)(1-\theta^*)\left[1-(1-\theta^*)(1-m)-\frac{\partial R^{pool}}{\partial D_0}[1-(1-\theta^*)(1-m)h]\right], \quad \text{(A.57)}$$

which is strictly positive as $\frac{\partial R^{pool}}{\partial R_0}\geq 0$ and $\frac{\partial R^{pool}}{\partial R_0}\leq 0$.

(iv) If the distribution puts all the weight in $\theta^*+\epsilon$, then as $\epsilon\to 0$ the left-hand side of (A.50)

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tends to $h\theta^*(1 - \theta^*) > 0$.

This shows that the left-hand side of (A.50) is necessarily strictly positive, so 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 $mR_0 > (1 - m)I$.

A.6.2 Proof that the optimal capital structure has no equity

We know that the optimal capital structure leads to a separating equilibrium. By contradiction, assume it involves a positive level of equity. In a separating equilibrium, the bank's profit writes as:

$$V^{sep} = \int_0^1 E_0(\theta)dF(\theta) + \int_0^{\theta^*} e^{-\beta\Delta(\theta)}[E(\theta,\theta) - E_0(\theta)]dF(\theta) - (I_0 - D - D_u). \tag{A.58}$$

In a separating equilibrium in case of restructuring the creditors of a bank of type θ are given $R_{min}(\theta)$ such that their payoff is $C_0(\theta)$. Thus, the amount of uninsured debt the bank can raise by offering R_0 is:

$$D_u = \int_0^1 C_0(\theta)dF(\theta). \tag{A.59}$$

Thus, we can rewrite V^{sep} as:

$$
\begin{aligned}
V^{sep} &= \int_0^1 [E_0(\theta) + C_0(\theta)]dF(\theta) + \int_0^{\theta^*} e^{-\beta\Delta(\theta)}[E(\theta,\theta) - E_0(\theta)]dF(\theta) - I_0 + D \\
&= \mathbb{E}(\theta)Z + \int_0^{\theta^*} e^{-\beta\Delta(\theta)}[m(1-\theta)Z - I]dF(\theta) - I_0 \\
&+ \int_0^1 (1-\theta)[(1-h)R_0 + D_0]dF(\theta) + \int_0^{\theta^*} (1-\theta)e^{-\beta\Delta(\theta)}\left[\frac{(1-h)[(1-m)I - mR_0]}{1 - (1-\theta)(1-m)h} - mD\right]dF(\theta)
\end{aligned}
\tag{A.60} \tag{A.61}
$$

The optimal capital structure maximizes V^{sep} under the following constraints: (i) equity is non-negative; (ii) the separating constraint (A2); (iii) deposits are non-negative; (iv) uninsured debt is non-negative. We obtain the following Lagrangian:

$$\mathcal{L} = V^{sep} + \lambda\left[I_0 - D_0 - \int_0^1 [1 - (1-\theta)h]R_0 dF(\theta)\right] + \mu[(1-m)I - mR_0] + \nu D_0 + \eta R_0. \tag{A.62}$$

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

$$\frac{\partial \mathcal{L}}{\partial D_0} = \frac{\partial V^{sep}}{\partial D_0} - \lambda + \nu = 0 \tag{A.63}$$

$$\frac{\partial \mathcal{L}}{\partial R_0} = \frac{\partial V^{sep}}{\partial R_0} - \lambda \int_0^1 [1 - (1-\theta)h]R_0 dF(\theta) - m\mu + \eta = 0. \tag{A.64}$$

with:

$$
\begin{aligned}
\frac{\partial V^{sep}}{\partial D_0} &= \int_0^1 (1-\theta)dF(\theta) - m\int_0^{\theta^*} e^{-\beta\Delta(\theta)}(1-\theta)dF(\theta) + \frac{\partial\theta^*}{\partial D_0} \times 0 \tag{A.65} \\
&\quad - \beta \int_0^{\theta^*} \frac{\partial\Delta(\theta)}{\partial D_0} e^{-\beta\Delta(\theta)}[E(\theta,\theta) - E_0(\theta)]dF(\theta) \\
\frac{\partial V^{sep}}{\partial R_0} &= (1-h)\int_0^1 (1-\theta)dF(\theta) - m(1-h)\int_0^{\theta^*} e^{-\beta\Delta(\theta)}\frac{(1-\theta)}{1-(1-\theta)(1-m)h}dF(\theta) + \frac{\partial\theta^*}{\partial R_0} \times 0 \tag{A.66} \\
&\quad - \beta\int_0^{\theta^*} \frac{\partial\Delta(\theta)}{\partial R_0} e^{-\beta\Delta(\theta)}[E(\theta,\theta) - E_0(\theta)]dF(\theta)
\end{aligned}
$$

In particular, since by Corollary 1 we have $\frac{\partial\Delta(\theta)}{\partial R_0} \leq 0$, we deduce that $\frac{\partial V^{sep}}{\partial R_0} \geq 0$.

We can now prove that equity is necessarily null. By contradiction, assume that we have $I_0 > D_0 + D_u$, so that $\lambda = 0$. Using (A.64) and the fact that $\frac{\partial V^{sep}}{\partial R_0} \geq 0$, it has to be the case that $\mu > 0$, and hence $(1-m)I = mR_0$. When this equality holds, we have $E_1(\theta,\theta) = 0$ for any θ, which implies that $\frac{\partial\Delta(\theta)}{\partial D_0} = 0$. Using (A.65), we thus have $\frac{\partial V^{sep}}{\partial D_0} > 0$, which contradicts (A.63). Hence, we necessarily have $I_0 = D_0 + D_u$: the optimal capital structure uses no equity.

A.6.3 Proof that the optimal capital structure leads to a positive delay

By contradiction, assume that the optimal capital structure leads to separation with zero delay, that is, $mR_0 = (1-m)I$, so that $\mu > 0$. This also implies that $R_0 > 0$ and hence $\eta = 0$. Moreover, generically it cannot be the case that $I_0 = D_u$ and simultaneously $mR_0 = (1-m)I$, so that we have $D_0 > 0$ and hence $\nu = 0$. We also have $\Delta(\theta) = 0$ for every θ. Using (A.63) and (A.63) we obtain that:

$$m\mu = \frac{\partial V^{sep}}{\partial R_0} - \frac{\partial V^{sep}}{\partial D_0}\int_0^1 [1 - (1-\theta)h]R_0 dF(\theta). \tag{A.67}$$

Using (A.65) and (??) and simplifying, we can write:

$$m\mu = -h(1-m)\mathbb{E}(\theta)(1-\mathbb{E}(\theta)) - h(1-h)m(1-m)\int_0^{\theta^*}\frac{(1-\theta)^2}{1-(1-\theta)(1-m)h}dF(\theta). \quad \text{(A.68)}$$

This expression implies $\mu < 0$, a contradiction. Hence, we necessarily have $mR_0 < (1-m)I$ and the delay is positive for every $\theta \in (0, \theta^*]$.

A.7 Proof of Proposition 4

The proof follows exactly the same steps as the proof of Proposition ??.

Proof that Lemma ?? still holds: Assume an equilibrium in which the manager makes no offer for some θ but makes an accepted offer (D, R, I_G, I_C) after delay Δ for some $\theta' > \theta$. Since $D + R \le P_{max}(\theta')$, we also have $D + R \le P_{max}(\theta)$. Hence, type θ is better off making the same offer as θ' than not making an offer, a contradiction. *Q.E.D.*

Lemma 3. *In an equilibrium under condition (A2-G), the manager of a bank with asset quality θ makes either (accepted) offer satisfying $R + D = P_{min}(\theta)$ or no offer.*

Proof: By contradiction. If type θ makes an offer, denote it $(D^{**}(\theta), I_G^{**}(\theta), R^{**}(\theta), I_C^{**}(\theta))$.

Case 1. Assume for all θ making an offer we have $D^{**}(\theta) + R^{**}(\theta) \le P_{min}(\theta)$, with a strict inequality for at least one type θ'. This means that $\bar{C}(R^{**}(\theta), I_C^{**}(\theta), \theta) + \bar{G}(D^{**}(\theta), I_G^{**}(\theta), R^{**}(\theta), \theta) \le C_0(\theta) + G_0(\theta)$ for all θ making an offer, with a strict inequality at least for θ'. This implies that either the creditors or the government are strictly better off rejecting the offer made by θ', which cannot be true in equilibrium.

Case 2. Assume a θ exists such that $D^{**}(\theta) + R^{**}(\theta) > P_{min}(\theta)$. By continuity of P_{min}, there exists $\theta' < \theta$ such that $D^{**}(\theta) + R^{**}(\theta) > P_{min}(\theta')$. Consider an offer (D', I_G', R', I_C') with $\bar{C}(R', I_C', \theta') = C_0(\theta')$ and $\bar{G}(D', I_G', R', \theta') = G_0(\theta')$. This implies in particular $P_{min}(\theta') = R' + D'$, so that $R' + D' < D^{**}(\theta) + R^{**}(\theta)$. Take Δ' such that type θ' is indifferent between making his

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equilibrium offer after delay $\Delta^{**}(\theta')$ and making the offer (D', I'_G, R', I'_C) after delay Δ'. Moreover, we know from the single-crossing property that $D^{**}(\theta) + R^{**}(\theta) \leq D^{**}(\theta') + R^{**}(\theta')$.

For type θ, offering (D', I'_G, R', I'_C) after delay Δ' is a strictly profitable deviation if the offer is accepted. If $\Delta' \leq \Delta^{**}(\theta)$, this is obvious because $R' + D' < D^{**}(\theta) + R^{**}(\theta)$. Suppose instead that $\Delta' > \Delta^{**}(\theta)$. Equilibrium requires that type θ' weakly prefers offering $(D^{**}(\theta'), I_G^{**}(\theta'), R^{**}(\theta'), I_C^{**}(\theta'))$ after delay $\Delta^{**}(\theta')$ to offering $(D^{**}(\theta), I_G^{**}(\theta), R^{**}(\theta), I_C^{**}(\theta))$ after delay $\Delta^{**}(\theta)$. Hence, θ' weakly prefers offering (D', I'_G, R', I'_C) after delay Δ' to offering $(D^{**}(\theta'), I_G^{**}(\theta'), R^{**}(\theta'), I_C^{**}(\theta'))$ after delay $\Delta^{**}(\theta')$ to offering $(D^{**}(\theta), I_G^{**}(\theta), R^{**}(\theta), I_C^{**}(\theta))$ after delay $\Delta^{**}(\theta)$. From the single-crossing condition, this is also the case for type θ.

For types below θ', offering (D', I'_G, R', I'_C) after delay Δ' is a strictly unprofitable deviation. Note that $R' + D' < R^{**}(\theta') + D^{**}(\theta')$ implies $\Delta' > \Delta^{**}(\theta')$. Type θ' being indifferent between his equilibrium offer and the deviation, the single-crossing property and $\Delta' > \Delta^{**}(\theta')$ imply that types below θ' strictly prefer offering $(D^{**}(\theta'), I_G^{**}(\theta'), R^{**}(\theta'), I_C^{**}(\theta'))$ after delay $\Delta^{**}(\theta')$ to offering (D', I'_G, R', I'_C) after delay Δ'. Since equilibrium requires that deviating to the equilibrium offer of θ' be weakly unprofitable for those types, we can conclude that they do not deviate to offering (D', I'_G, R', I'_C) after delay Δ'.

Under the Intuitive Criterion, after observing offer (D', I'_G, R', I'_C) and delay Δ' the creditors and the government must put a zero probability on the type of the manager being below θ'. To conclude the proof, we show that I'_C and I'_G can always be chosen in such a way that this implies that the offer is accepted by both the creditors and the government.

Consider the creditors. If they believe the type of the manager to be θ, they accept the offer (D', I'_G, R', I'_C) if and only if $\bar{C}(R', I'_C, \theta) \geq C_0(\theta)$. We have:

$$\bar{C}(R', I'_C, \theta) - C_0(\theta) = [1 - h(1 - m)(1 - \theta)]R' - I'_C - [1 - h(1 - \theta)]R_0 \qquad (A.69)$$

$$\frac{\partial[\bar{C}(R', I'_C, \theta) - C_0(\theta)]}{\partial \theta} = h[(1 - m)R' - R_0]. \qquad (A.70)$$

We know that $\bar{C}(R', I'_C, \theta') - C_0(\theta') = 0$ and that creditors believe the type of the manager to be above θ'. A sufficient condition for them to accept the offer is that $\bar{C}(R', I'_C, \theta) - C_0(\theta)$ increases in

θ, which is true if $(1-m)R' - R_0$. Using the definition of R', we have:

$$R' = \frac{I'_C + (1 - h(1-\theta'))R_0}{1 - h(1-\theta')(1-m)}. \tag{A.71}$$

The condition $(1-m)R' - R_0$ is then satisfied if and only if $(1-m)I'_C > mR_0$.

Consider now the government. If they believe the type of the manager to be θ, they accept the offer (D', I'_G, R', I'_C) if and only if $\bar{G}(D', I'_G, R', \theta) \geq G_0(\theta)$. We have:

$$\bar{G}(D', I'_G, R', \theta) - G_0(\theta) = [1 - (1-m)(1-\theta)]D' - \theta D_0 - I'_G$$

$$- (1-\theta)(1-m)(1-h)R' + (1-\theta)(1-h)R_0 \tag{A.72}$$

$$\frac{\partial[\bar{G}(D', I'_G, R', \theta) - G_0(\theta)]}{\partial\theta} = (1-h)[(1-m)R' - R_0] + (1-m)D' - D_0. \tag{A.73}$$

Using the same reasoning as for creditors, we need $\bar{G}(D', I'_G, R', \theta) - G_0(\theta)$ to be increasing in θ. If $(1-m)R' - R_0 > 0$ a sufficient condition is to also have $(1-m)D' - D_0 > 0$. Using the definition of D' we have:

$$D' = \frac{(1-\theta')(1-m)(1-h)R' + I'_G + \theta'D_0 - (1-\theta')(1-h)R_0}{1 - (1-\theta')(1-m)}. \tag{A.74}$$

Using $(1-m)R' > R_0$, we have:

$$(1-m)D' - D_0 > \frac{(1-m)I'_G - mD_0}{1 - (1-\theta')(1-m)}. \tag{A.75}$$

To conclude, if we choose I'_G and I'_C such that $(1-m)I'_G > mD_0$ and $(1-m)I'_C > mR_0$ then we know that the creditors and the government accept the offer (D', I'_G, R', I'_C) after a delay Δ', and this creates a strictly profitable deviation for type θ. Remember that we also need $I'_C + I'_G = I$. Assumption (??) requires that $(1-m)I > m(R_0 + D_0)$, which ensures that the appropriate I'_G and I'_C can be found. Hence, we can build a profitable deviation for θ. A contradiction. *Q. E. D.*

Proof of the remainder of the Proposition:

Step 1. As $\theta^{**} = 1 - (I/mZ)$ and $I < mZ$ we have $\theta^{**} \in (0,1)$. Importantly, notice that for

any offer (D, I_G, R, I_C) we have:

$$[\bar{E}(D, R, \theta) + \bar{C}(R, I_C, \theta) + \bar{G}(D, I_G, R, I_C, \theta)] - [E_0(\theta) + C_0(\theta) + G_0(\theta)] = m(1 - \theta)Z - I. \quad \text{(A.76)}$$

Hence, restructuring creates a social surplus if and only if $\theta \leq \theta^{**}$. This also implies that $P_{min}(\theta^{**}) = P_{max}(\theta^{**})$.

Step 2. Next, we need to show that the highest type $\bar{\theta}$ (from Lemma **??**) making an offer is θ^{**}.

By contradiction. Assume $\bar{\theta} < \theta^{**}$. There exists $\theta' \in (\bar{\theta}, \theta^{**})$ such that $P_{min}(\bar{\theta}) < P_{max}(\theta')$. If θ' makes the same offer as $\bar{\theta}$ after the same delay, it would be accepted. Since $P_{min}(\bar{\theta}) < P_{max}(\theta')$, type θ' is better off making this offer than not making any offer, a contradiction.

Step 3. We know that $R^{**}(\theta) + D^{**}(\theta) = P_{min}(\theta)$. This gives us:

$$\begin{aligned}
E(\hat{\theta}, \theta) &= [1 - (1 - \theta)(1 - m)](Z - P_{min}(\hat{\theta}) & \text{(A.77)} \\
&= [1 - (1 - \theta)(1 - m)]Z - \frac{1 - (1 - \theta)(1 - m)}{1 - (1 - \hat{\theta}(1 - m))}[I + \hat{\theta}(R_0 + D_0)]. & \text{(A.78)}
\end{aligned}$$

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

$$E_1(\hat{\theta}, \theta) = \frac{1 - (1 - \theta)(1 - m)}{[1 - (1 - \hat{\theta})(1 - m)]^2}[I(1 - m) - m(R_0 + D_0)] > 0, \quad \text{(A.79)}$$

which shows that the first bracket of (**??**) is always positive.

Then we compute:

$$\frac{E(\hat{\theta}, \theta) - E_0(\theta)}{E_1(\hat{\theta}, \theta)} = \frac{[1 - (1 - \hat{\theta})(1 - m)][m(1 - \theta)(1 - (1 - \hat{\theta})(1 - m))Z - (1 - (1 - \theta)(1 - m))I - m(\hat{\theta} - \theta)(R_0 + I)}{[1 - (1 - \theta)(1 - m)][(1 - m)I - m(R_0 + D_0)]}$$
$$\text{(A.80)}$$

After simplification we finally obtain:

$$\frac{E(\hat{\theta},\hat{\theta})-E_0(\hat{\theta})}{E_1(\hat{\theta},\hat{\theta})} - \frac{E(\hat{\theta},\theta)-E_0(\theta)}{E_1(\hat{\theta},\theta)} \tag{A.81}$$

$$= \frac{1-(1-\hat{\theta})(1-m)}{1-(1-\theta)(1-m)} \frac{m(\theta-\hat{\theta})(R_0+D_0)}{(1-m)I-m(R_0+D_0)}. \tag{A.82}$$

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 $(D^{**}(\theta), I_G^{**}(\theta), R^{**}(\theta), I_C^{**}(\theta))$ after delay $\Delta^{**}(\theta)$ is indeed optimal for type θ.

Step 4.

Analytical expression for $\Delta^{**}(\theta)$. Remember we have:

$$\Delta^{**}(\theta) = \int_0^\theta \frac{(1-m)I - m(D_0+R_0)}{\beta[m(1-x)Z-I][1-(1-x)(1-m)]} dx. \tag{A.83}$$

We can rewrite this expression as:

$$\Delta^{**}(\theta) = \frac{(1-m)I - m(D_0+R_0)}{\beta} \int_0^\theta \left(\frac{mZ}{[mZ-(1-m)I][m(1-x)Z-I]} + \frac{(1-m)}{[mZ-(1-m)I][1-(1-x)(1-m)]} \right) dx. \tag{A.84}$$

We can then integrate this expression and finally obtain:

$$\Delta^{**}(\theta) = \frac{1}{\beta} \frac{(1-m)I - m(D_0+R_0)}{mZ-(1-m)I} \ln\left(\frac{[1-(1-\theta)(1-m)][mZ-I]}{m[m(1-\theta)Z-I]} \right). \tag{A.85}$$

A.8 Proof of Proposition 5

TO BE WRITTEN. USE PROOF OF LEMMA 4 BELOW.

A.9 Proof of Lemma 4

Lemma 4. *When condition (A2-G) does not hold, the Perfect Bayesian Nash equilibria satisfying the D1 Criterion are such that a threshold $\bar{\theta} > \theta^{**}$ exists such that for all $\theta \leq \bar{\theta}$, the manager makes the same offer such that $R + D = P_{max}(\bar{\theta})$ immediately (or $R + D \leq P_{max}(1)$ if $\bar{\theta} = 1$), and makes no offer for all $\theta > \bar{\theta}$.*

1. **All types in $[0, \theta^{**}]$ necessarily make an offer in an equilibrium satisfying the Intuitive Criterion**. By contradiction, assume this is not the case and some $\theta < \theta^{**}$ does not make an offer. Assume that type θ deviates and makes the offer (D, I_G, R, I_C) with $(1-m)I_C < mR_0$ and $(1-m)I_G < mD_0$ (which is possible when assumption (**??**) is not satisfied) and:

$$R = \frac{I_C + (1 - h(1 - \theta^{**}))R_0}{1 - h(1 - \theta^{**})(1 - m)} \tag{A.86}$$

$$D = \frac{(1 - \theta^{**})(1 - m)(1 - h)R + I_G + \theta^{**}D_0 - (1 - \theta^{**})(1 - h)R_0}{1 - (1 - \theta^{**})(1 - m)}. \tag{A.87}$$

Since $D + R = P_{max}(\theta^{**})$ and P_{max} decreases in θ, under the intuitive criterion the creditors and the government must put zero probability on the offer coming from a type above θ^{**}. Moreover, the offer if such that $\bar{G}(D, I_G, R, I_C, \theta^{**}) = G_0(\theta^{**})$ and $\bar{C}(R, I_C, \theta^{**}) = C_0(\theta^{**})$. Hence, the offer is surely accepted if $\bar{G}(D, I_G, R, I_C, \theta) - G_0(\theta)$ and $\bar{C}(R, I_C, \theta) - C_0(\theta)$ are both decreasing in θ. The analysis of Section A.7 shows this is implied by $(1 - m)I_C < mR_0$ and $(1 - m)I_G < mD_0$. Hence, the offer (D, I_G, R, I_C) is accepted.

Finally, since $D + R = P_{max}(\theta^{**})$ and P_{max} decreases in θ we have $R + D < P_{max}(\theta)$. Hence, making the offer (D, I_G, R, I_C) immediately is a profitable deviation for θ.

2. **Cutoff type $\bar{\theta}$**: Lemma **??** still applies in this case. We deduce that there exists $\bar{\theta} \geq \theta^{**}$ such that type θ makes an offer in equilibrium if and only if $\theta \leq \bar{\theta}$.

3. **Pooling offer at the top**: All types θ in $(\theta^{**}, \bar{\theta}]$ necessarily have $R^{**}(\theta) + D^{**}(\theta) \leq P_{max}(\theta)$, and thus $R^{**}(\theta) + D^{**}(\theta) < P_{min}(\theta)$. Hence, their offers can be accepted only if they are pooled with some types below θ^{**}. The monotonicity of $R^{**}(\theta) + D^{**}(\theta)$ implies that there exists $\underline{\theta} < \theta^{**}$ such that all types in $[\underline{\theta}, \bar{\theta}]$ make the same offer $(D^{pool}, I_G^{pool}, R^{pool}, I_C^{pool})$ after the same delay Δ^{pool}.

5. **If $\bar{\theta} < 1$ then the pooling offer makes $\bar{\theta}$ indifferent**: If $\bar{\theta} < 1$ then $R^{pool} + D^{pool}$ must be equal to $P_{max}(\bar{\theta})$. Indeed, if $R^{pool} + D^{pool} > P_{max}(\bar{\theta})$ then type $\bar{\theta}$ is better off not making an offer, whereas if $R^{pool} + D^{pool} < RP_{max}(\bar{\theta})$ then for a sufficiently small ϵ the managers of type $\theta \in [\bar{\theta}, \bar{\theta} + \epsilon]$

are better off making the same offer and pooling with lower types than not making an offer, which contradicts the definition of $\bar{\bar{\theta}}$. If $\bar{\bar{\theta}} = 1$ then $D^{pool} + R^{pool}$ has to be lower than $P_{max}(1)$, but not necessarily equal.

6. **Zero delay in the pooling offer**: By contradiction, assume that $\Delta^{pool} > 0$. Consider a deviation from the pooling offer to (D', I'_G, R', I'_C) and zero delay, with $R' = R^{pool} + \epsilon$ and $D' = D^{pool} + \epsilon$, where ϵ is small and positive.

Assume that the pooling offer made after Δ^{pool} is accepted with probabilities p_C by creditors and p_G by the government, and the deviation offer is accepted with probabilities p'_C and p'_G. A manager of type θ has an incentive to deviate if and only if:

$$E_0(\theta) + p_C p_G e^{-\beta \Delta^{pool}} [\bar{E}(D^{pool}, R^{pool}, \theta) - E_0(\theta)] < E_0(\theta) + p'_C p'_G [\bar{E}(D', R', \theta) - E_0(\theta)] \quad \text{(A.88)}$$

$$\Leftrightarrow \qquad e^{-\beta \Delta^{pool}} \frac{\bar{E}(D^{pool}, R^{pool}, \theta) - E_0(\theta)}{\bar{E}(D', R', \theta) - E_0(\theta)} < \frac{p'_C p'_G}{p_C p_G}. \quad \text{(A.89)}$$

We have:

$$\frac{\partial}{\partial \theta} \frac{\bar{E}(D^{pool}, R^{pool}, \theta) - E_0(\theta)}{\bar{E}(D', R', \theta) - E_0(\theta)} = \frac{m(D' + R' - D^{pool} - R^{pool})(Z - D_0 - R_0)}{[\bar{E}(D', R', \theta) - E(\theta)]^2} > 0. \quad \text{(A.90)}$$

This implies that the set of mixed best responses (p_C, p_G, p'_C, p'_G) such that deviating is profitable decreases in θ. More intuitively, the incentives to deviate decrease with θ for all types θ in $[\underline{\theta}, \bar{\theta}]$. If $\bar{\theta} < 1$ we also know that types θ above $\bar{\theta}$ have no incentive to use such a deviation as $D' + R' > P_{max}(\theta)$. Thus, any belief satisfying the D1 Criterion thus puts a probability of 1 on the type of the deviator being $\theta = \underline{\theta}$ or lower.

R^{pool} has to be such that $R^{pool} > R_{min}(\mathbb{E}[\theta | \theta \in [\underline{\theta}, \bar{\theta}]])$. Thus, since R_{min} is increasing, for ϵ sufficiently small a creditor who believes the type of the deviator is $\underline{\theta}$ or less accepts the offer R'. Moreover, for ϵ sufficiently small a manager of type $\theta = \underline{\theta}$ prefers $(R', 0)$ over $(R^{pool}, \Delta^{pool})$. This means that we have a profitable deviation, which contradicts the assumption that $\Delta^{pool} > 0$.

7. **All types make the same pooling offer**: Finally, since $\Delta^{pool} = 0$ and $D^{**}(\theta) + R^{**}(\theta) \geq D^{pool} + R^{pool}$ for all $\theta < \underline{\theta}$, incentive compatibility imposes that $D^{**}(\theta) + R^{**}(\theta) = D^{pool} + R^{pool}$ for

all $\theta < \underline{\theta}$. Hence, all types in $[0, \bar{\theta}]$ make the same pooling offer immediately.

A.10 Proof of Corollary 2

Using (30) and (31) it is easy to show that we have $\partial \Delta^* / \partial D_u \leq \partial \Delta^* / \partial D_0 \leq 0$.

A.11 Proof of Proposition 6

A.11.1 Pooling Case

Assume we have $(1 - m)I > m(R_0 + D_0)$ and a pooling equilibrium obtains, in which all banks of type $\theta \in [0, \bar{\theta}]$ make the same offer $(D^{pool}, R^{pool}, I_G^{pool}, I_C^{pool})$. The bank gets:

$$V^{pool} = \int_0^{\bar{\theta}} \bar{E}(D^{pool}, R^{pool}, \theta) dF(\theta) + \int_{\bar{\theta}}^1 E_0(\theta) dF(\theta) - (I_0 - D_0 - D_u), \tag{A.91}$$

where D_u satisfies:

$$D_u = \int_0^{\bar{\theta}} [[1 - (1 - \theta)(1 - m)h]R^{pool} - I_C] dF(\theta) + \int_{\bar{\theta}}^1 [1 - (1 - \theta)h]R_0 dF(\theta). \tag{A.92}$$

We can then rewrite:

$$
\begin{aligned}
V^{pool} &= \int_0^{\bar{\theta}} [1 - (1 - \theta)(1 - m)][Z - P_{max}(\bar{\theta})] dF(\theta) + \int_{\bar{\theta}}^1 \theta(Z - D_0 - R_0) dF(\theta) - I_0 + D_0 \\
&+ \int_0^{\bar{\theta}} [[1 - (1 - \theta)(1 - m)h]R^{pool} - I_C] dF(\theta) + \int_{\bar{\theta}}^1 [1 - (1 - \theta)h]R_0 dF(\theta). \tag{A.93}
\end{aligned}
$$

Note that $\bar{\theta}$ and $P_{max}(\bar{\theta})$ do not depend on R^{pool} and I_C. Among all the possible pooling equilibrium offers (R^{pool}, I_C) and (D, I_G) for a given $\bar{\theta}$ and $P_{max}(\bar{\theta})$, we focus on the most profitable one for the bank. From the previous equation, we see that this is the offer that maximizes the ex post surplus of uninsured creditors in the restructuring stage, as this surplus is ultimately captured by the bank through a higher D_u (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 (R^{pool}, D, I_C, I_G), for a given $\bar{\theta}$, the ex-post surplus of creditors:

$$\int_0^{\bar{\theta}} [[1-(1-\theta)(1-m)h]R^{pool} - I_C]dF(\theta) \tag{A.94}$$

under the constraint that the government accepts the offer:

$$\int_0^{\bar{\theta}} [[1-(1-\theta)(1-m)]D_0 - (1-m)(1-\theta)(1-h)R^{pool} - I_G]dF(\theta) \geq \int_0^{\bar{\theta}} [\theta D_0 - (1-\theta)(1-h)R_0]dF(\theta), \tag{A.95}$$

and $P_{max}(\bar{\theta}) = R^{pool} + D$, $I_C + I_G = I$, and I_C, I_G, D, R^{pool} are all positive. We easily obtain that at an optimal offer the government has zero surplus, so that (A.95) holds with an equality. Using this equality and $P_{max}(\bar{\theta}) = R^{pool} + D$, we can rewrite:

$$\int_0^{\bar{\theta}} [[1-(1-\theta)(1-m)h]R^{pool} - I_C]dF(\theta) = \int_0^{\bar{\theta}} [P_{max}(\bar{\theta})[1-(1-\theta)(1-m)] - I]dF(\theta) - \int_0^{\bar{\theta}} [\theta D_0 - (1-\theta)(1-h)R_0]dF(\theta) \tag{A.96}$$

Plugging this equality into (A.93), we obtain:

$$
\begin{aligned}
V^{pool} &= Z\int_0^{\bar{\theta}} [1-(1-\theta)(1-m)]dF(\theta) - P_{max}(\bar{\theta})\int_0^{\bar{\theta}} [1-(1-\theta)(1-m)]ZdF(\theta) - I_0 + D_0 \\
&+ \int_{\bar{\theta}}^1 \theta(Z - D_0 - R_0)dF(\theta) + P_{max}(\bar{\theta})\int_0^{\bar{\theta}} [1-(1-\theta)(1-m)]dF(\theta) - F(\bar{\theta})I \\
&- \int_0^{\bar{\theta}} [\theta D_0 - (1-\theta)(1-h)R_0]dF(\theta) + \int_{\bar{\theta}}^1 [1-(1-\theta)h]R_0 dF(\theta) \tag{A.97} \\
&= \mathbb{E}(\theta)Z + \int_0^{\bar{\theta}} [m(1-\theta)Z - I]dF(\theta) - I_0 \\
&+ [1-\mathbb{E}(\theta)][D_0 + (1-h)R_0]. \tag{A.98}
\end{aligned}
$$

In the end, V^{pool} 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 creditors). The optimal pooling equilibrium has $\bar{\theta}$ maximizing the total surplus, so that we focus on $\bar{\theta} = \theta^{**}$. The total surplus created by the bank is then independent of the capital structure. The bank's optimal

structure under pooling then simply maximizes the payments made by the government, under the constraint that the bank's equity is positive, the capital structure satisfies the pooling condition, and D_0 and R_0 are both positive. Using (**??**) and (**??**) we have $D_u = [1 - h(1 - \mathbb{E}(\theta))]R_0$, so that we can maximize the following Lagrangian:

$$\mathcal{L} = D_0 + (1-h)R_0 + \lambda[I_0 - D_0 - [1 - h(1 - \mathbb{E}(\theta))]R_0] + \mu[m(D_0 + R_0) - (1-m)I] + \nu D_0 + \eta R_0. \quad \text{(A.99)}$$

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

$$1 - \lambda + \mu m + \nu = 0 \quad \text{(A.100)}$$

$$(1 - h) - \lambda[1 - h(1 - \mathbb{E}(\theta))] + \mu m + \eta = 0. \quad \text{(A.101)}$$

If $\lambda = 0$ these two conditions imply that either μ or ν and η have to be negative, which cannot be the case. Hence we have $\lambda > 0$ and $I_0 = D_0 + [1 - h(1 - \mathbb{E}(\theta))]R_0$: the capital structure uses no equity.

Solution P-1 Assume that $\mu > 0$, the pooling constraint is binding. If in addition $\nu = 0$ and $\eta > 0$ we need $mI_0 = (1-m)I$, a non-generic case we neglect. If $\eta = 0$ and $\nu > 0$ we need $mI_0 = (1-m)[1 - h(1 - \mathbb{E}(\theta))]I$, another non-generic case we neglect. Having $\nu > 0$ and $\eta > 0$ is impossible, as then the positive equity constraint cannot be binding.

The last possibility is to have $\nu = \eta = 0$. Then we compute that:

$$R_0 = \frac{(1-m)I - mI_0}{hm[1 - \mathbb{E}(\theta)]} \quad \text{(A.102)}$$

$$D_0 = \frac{mI_0 - (1-m)[1 - h(1 - \mathbb{E}(\theta))]I}{hm[1 - \mathbb{E}(\theta)]}. \quad \text{(A.103)}$$

We compute that $\lambda = \frac{1}{1 - \mathbb{E}(\theta)} > 0$ and $\mu = \frac{\mathbb{E}(\theta)}{m(1 - \mathbb{E}(\theta))} > 0$.

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:

$$mI_0 \le (1-m)I \le \frac{mI_0}{1 - h(1 - \mathbb{E}(\theta))}. \quad \text{(A.104)}$$

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 uninsured debt to be on the pooling side. This is possible if I_0 is not too small, as otherwise even with only uninsured debt pooling would not obtain, which is the condition $I_0 \geq \frac{(1-m)[1-h(1-\mathbb{E}(\theta))]I}{m}$.

Solution P-2: Assume that $\mu = 0$, the pooling constraint is not binding. It is easy to show that if $\nu = 0$ and $\eta = 0$ then (A.103) and (**??**) cannot be both satisfied. $\eta > 0, \nu > 0$ is impossible, as then we cannot have zero equity. If $\eta = 0$ and $\nu > 0$, we can use (A.103) and (**??**) to solve for ν and find a negative value, which is not possible.

Finally, we consider the case $\eta > 0, \nu = 0$, so that $R_0 = 0$ and $D_0 = I_0$. We compute that $\lambda = 1 > 0$ and $\eta = h\mathbb{E}(\theta) > 0$. Finally, we need the pooling constraint to be satisfied, which gives the condition:

For the pooling constraint to hold we need $mI_0 \geq (1-m)I$.

$$mI_0 \geq (1-m)I. \tag{A.105}$$

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 uninsured debt or equity.

A.11.2 Separating Case

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

$$V^{sep} = \int_0^1 E_0(\theta)dF(\theta) \int_0^{\theta^{**}} e^{-\beta\Delta^{**}(\theta)} \left[\bar{E}(D^{**}(\theta), R^{**}(\theta), \theta) - E_0(\theta) \right] dF(\theta) - (I_0 - D - D_u). \tag{A.106}$$

In addition we have:

$$\bar{C}(R^{**}(\theta), I_C^{**}(\theta), \theta) = C_0(\theta) \tag{A.107}$$

$$\bar{G}(D^{**}(\theta), I_G^{**}(\theta), R^{**}(\theta), \theta) = G_0(\theta) \tag{A.108}$$

$$D_u = \int_0^1 C_0(\theta) dF(\theta). \tag{A.109}$$

We can use these equations to reexpress (A.106) as:

$$V^{sep} = \mathbb{E}(\theta)Z - I_0 + \int_0^{\theta^{**}} e^{-\beta\Delta^{**}(\theta)}[m(1-\theta)Z - I]dF(\theta) + [1 - \mathbb{E}(\theta)][D_0 + (1-h)R_0]. \tag{A.110}$$

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 (A.110) 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 (A.110) is not 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 will We define the Lagrangian:

$$\mathcal{L} = \int_0^{\theta^{**}} e^{-\beta\Delta^{**}(\theta)}[m(1-\theta)Z - I]dF(\theta) + [1 - \mathbb{E}(\theta)][D_0 + (1-h)R_0] \tag{A.111}$$

$$+ \lambda[I_0 - D_0 - [1 - h(1 - \mathbb{E}(\theta))]R_0] + \mu[(1-m)I - m(D_0 + R_0)] + \nu D_0 + \eta R_0. \tag{A.112}$$

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:

$$\frac{\partial}{\partial D_0}\left(\int_0^{\theta^{**}} e^{-\beta\Delta^{**}(\theta)}[m(1-\theta)Z - I]dF(\theta)\right) = \frac{\partial}{\partial R_0}\left(\int_0^{\theta^{**}} e^{-\beta\Delta^{**}(\theta)}[m(1-\theta)Z - I]dF(\theta)\right) = \phi(D_0 + R_0) \tag{A.113}$$

with $\quad \phi(x) = \int_0^{\theta^{**}} \frac{m[m(1-\theta)Z - I]}{mZ - (1-m)I} \ln\left(\frac{[1-(1-\theta)(1-m)][mZ-I]}{m[m(1-\theta)Z-I]}\right) \left(\frac{[1-(1-\theta)(1-m)][mZ-I]}{m[m(1-\theta)Z-I]}\right)^{\frac{(1-m)I - mx}{mZ - (1-m)I}} dF(\theta). \tag{A.114}$

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 $\phi(x) \le \mathbb{E}(\theta)$ for any x, which will be important in the rest of the proof. Observe first that ϕ increases in x, and we have:

$$\lim_{+\infty} \phi = \int_0^{\theta^{**}} \frac{m[m(1-\theta)Z - I]}{mZ - (1-m)I} \ln\left(\frac{[1-(1-\theta)(1-m)][mZ - I]}{m[m(1-\theta)Z - I]}\right) dF(\theta). \tag{A.115}$$

A sufficient condition to have $\phi(x) \le \mathbb{E}(\theta)$ for any x is to have, for any $\theta \in [0, \theta^{**}]$:

$$\frac{m[m(1-\theta)Z - I]}{mZ - (1-m)I} \ln\left(\frac{[1-(1-\theta)(1-m)][mZ - I]}{m[m(1-\theta)Z - I]}\right) \le \theta. \tag{A.116}$$

Using the inequality $\ln(1+x) \le x$, we can write:

$$\ln\left(\frac{[1-(1-\theta)(1-m)][mZ - I]}{m[m(1-\theta)Z - I]}\right) = \ln\left(1 + \frac{\theta[mZ - (1-m)I]}{m[m(1-\theta)Z - I]}\right) \le \frac{\theta[mZ - (1-m)I]}{m[m(1-\theta)Z - I]}. \tag{A.117}$$

In order to show (A.116) it is thus sufficient to show that:

$$\frac{m[m(1-\theta)Z - I]}{mZ - (1-m)I} \frac{\theta[mZ - (1-m)I]}{m[m(1-\theta)Z - I]} \le \theta, \tag{A.118}$$

which is true (both sides are equal after simplification). This concludes the proof that $\phi(D_0 + R_0)$ is always lower than $\mathbb{E}(\theta)$.

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

$$\phi(D_0 + R_0) + 1 - \mathbb{E}(\theta) - \lambda - \mu m + \nu = 0 \tag{A.119}$$

$$\phi(D_0 + R_0) + [1 - \mathbb{E}(\theta)](1-h) - \lambda[1 - h(1 - \mathbb{E}(\theta))] - \mu m + \eta = 0 \tag{A.120}$$

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 (A.119) and (A.120) that $\eta > \nu$. Since we cannot have $\eta > 0$ and $\nu > 0$ and bind the separating constraint, the only remaining possibility is $\nu = 0$ and $\eta > 0$. So we have $R_0 = 0$, $D_0 = \frac{1-m}{m}I$. We compute $\mu = \frac{A(D_0) + 1 - \mathbb{E}(\theta)}{m} > 0$ and $\eta = h(1 - \mathbb{E}(\theta)) > 0$. Finally, we need to check that the positive equity

constraint is satisfied, which gives:

$$(1 - m)I < mI_0. \tag{A.121}$$

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 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 $\mu > 0$. Using (A.119) and (A.120) 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 $\eta > 0$ and $\nu > 0$ and zero equity. If $\eta = 0$ and $\nu = 0$ we obtain from (A.119) and (A.120) that $\phi(D_0 + R_0) = \mathbb{E}(\theta)$, which is impossible. If $\eta = 0$ and $\nu > 0$ we obtain that:

$$\nu = \frac{h(1 - \mathbb{E}(\theta))}{1 - h(1 - \mathbb{E}(\theta))}(\phi(D_0 + R_0) - \mathbb{E}(\theta)) < 0, \tag{A.122}$$

so that there can be no such solution.

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

$$(1 - m)I > mI_0. \tag{A.123}$$

Intuitively this is a case in which the initial investment to make is small, so that by using deposits only the bank keep the separating constraint slack, implying a positive delay. The bank could use less deposits and more uninsured debt to reduce the delay. However, the fact that $\phi(x) < \mathbb{E}(\theta)$ 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.

To conclude, 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.

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

When $(1-m)I[1-h(1-\mathbb{E}(\theta))] > mI_0$ no pooling solution is possible, so that the optimal capital structure is given by S-2. When $(1-m)I[1-h(1-\mathbb{E}(\theta))] \leq mI_0$ and $(1-m)I > mI_0$ 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 $(1-m)I \leq mI_0$ 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.

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.

A.12   Parameters used in the figures

Unless explicitly mentioned on the figure, Figures 2, 3, 4, 5, and 8 use the following parameters: $m = 0.5$, $Z = 3$, $D = 1.31$, $R_0 = 0.28$, $I = 0.75$, $\beta = 1$, $\eta = 1.25$, $h = 0.3$, and F is the cdf of the uniform distribution over $[0, 1]$. Fig. 8 uses $h = 0.75$ instead of $h = 0.3$.

Figures 6 and 7 use a different set of parameters: $m = 0.067$, $Z = 1$, $D = 0.38$, $R_0 = 0.17$, $I = 0.04$, $\beta = 1$, $\eta = 0$, $h = 0.3$, and $\alpha = 0.1$.
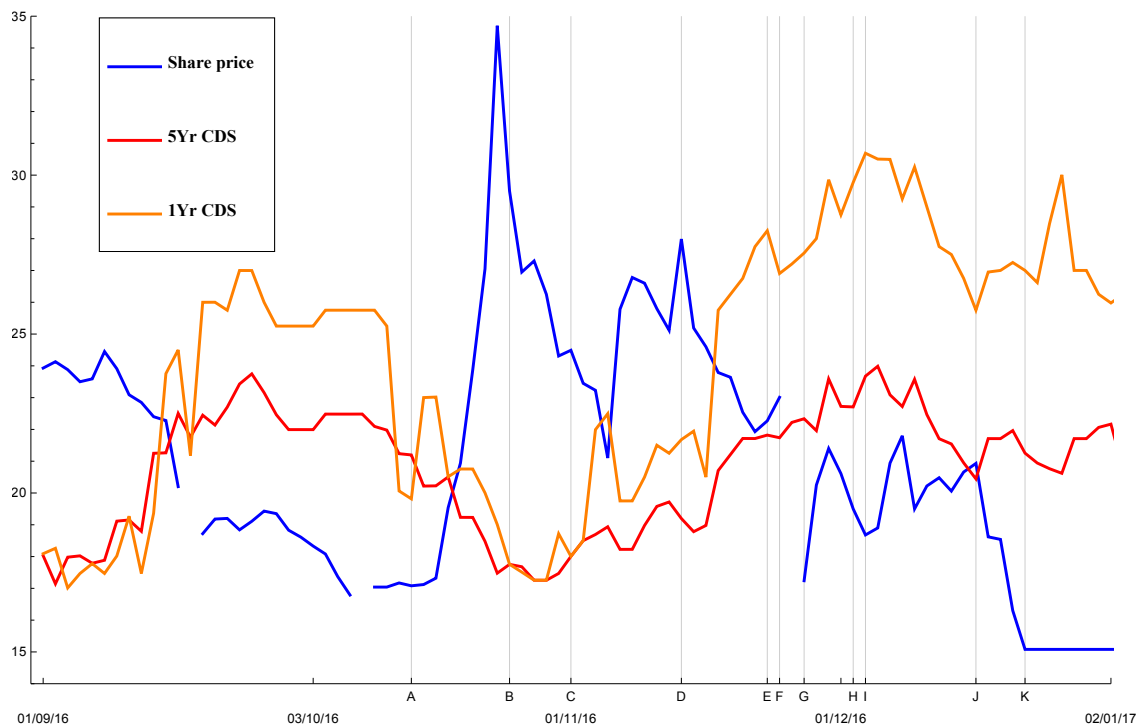
Figure 1: **Monte dei Paschi di Siena.** This graph plots the share price, 1-year and 5-year CDS premia for Monte dei Paschi di Siena between September 2016 and January 2017. CDS premia are multiplied by 1/20 for better readability.

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 bln "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.
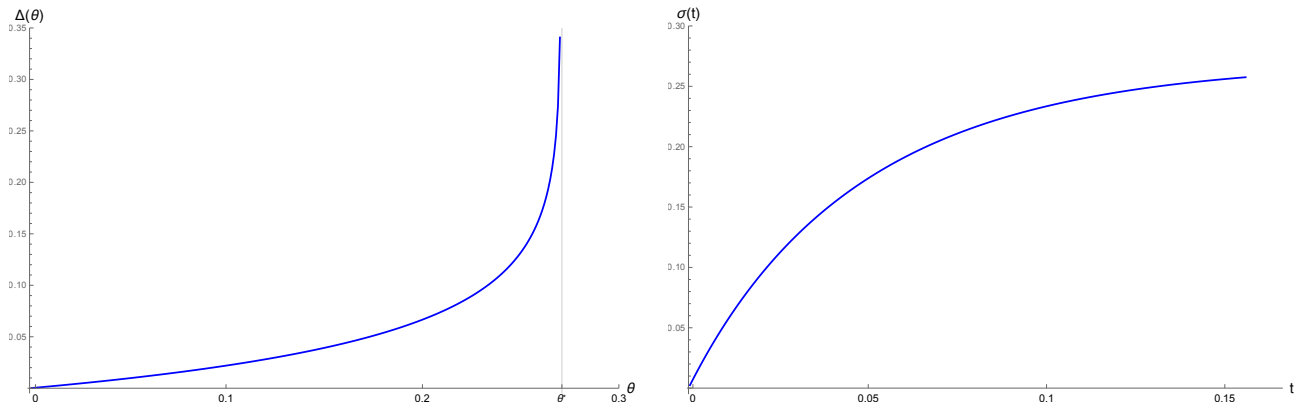
Figure 2: **Equilibrium delay $\Delta(\theta)$, and equilibrium belief $\sigma(t)$.**
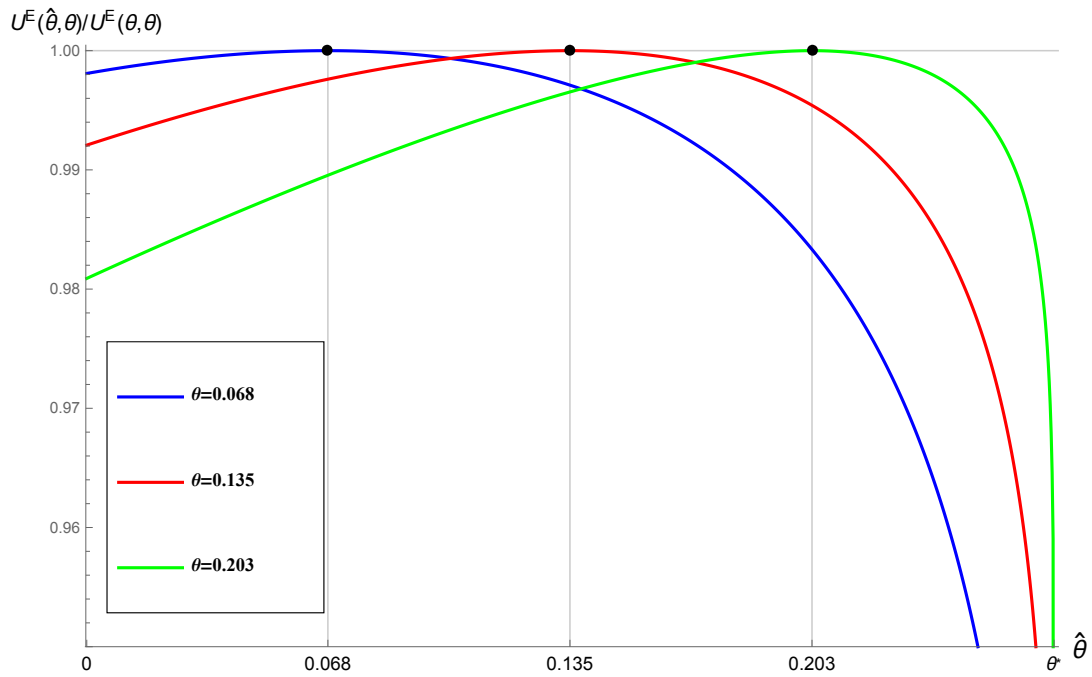

Figure 3: **Manager's incentives to report truthfully.** This graph plots the ratio $U^E(\hat{\theta},\theta)/U^E(\theta,\theta)$ as a function of $\hat{\theta}$, for different values of θ. $U^E(\hat{\theta},\theta)$ is always maximized in $\hat{\theta} = \theta$.
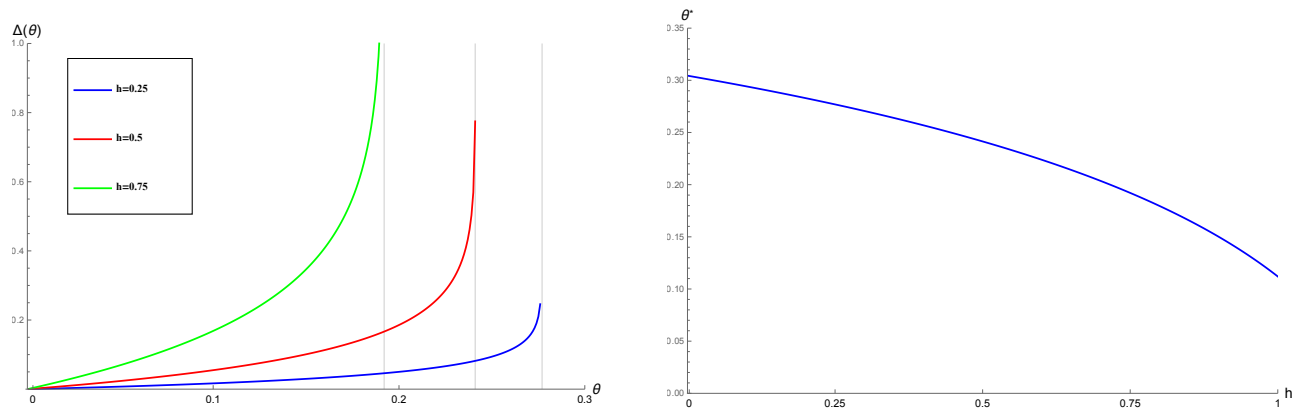
Figure 4: **Equilibrium delay and haircuts.** The left panel plots the equilibrium delay $\Delta(\theta)$ as a function of θ for different values of the haircut h. The right panel plots the maximum type making an offer, θ^*, as function of h.
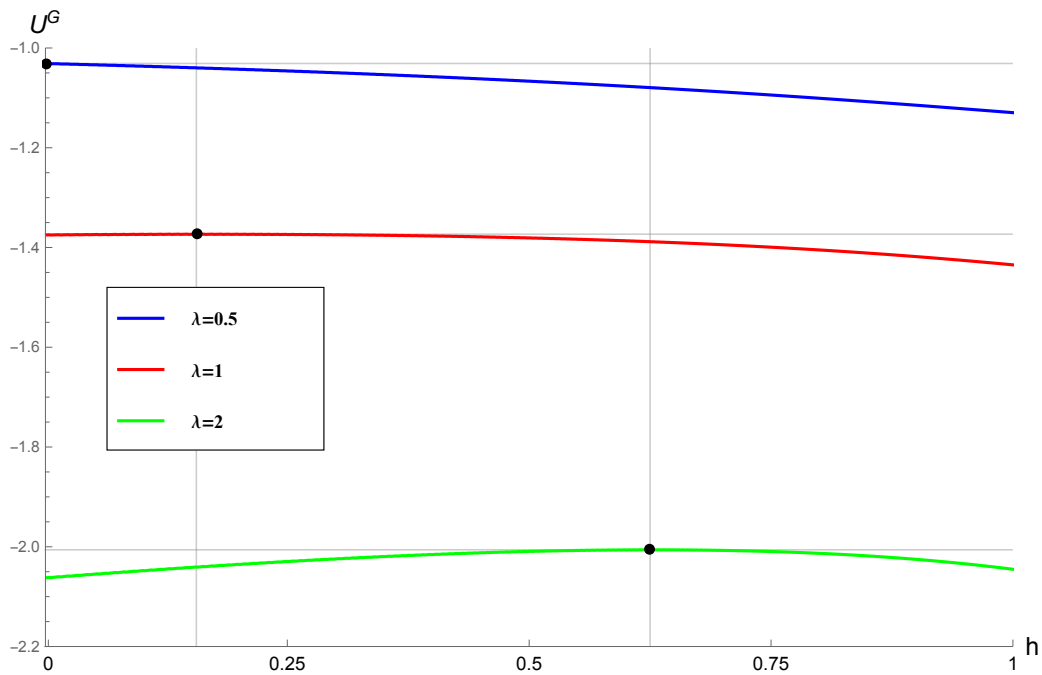
Figure 5: **Expected government payoff and haircuts.** This graph plots the expected government payoff U^G as a function of the haircut h, for different values of the cost of public funds λ.
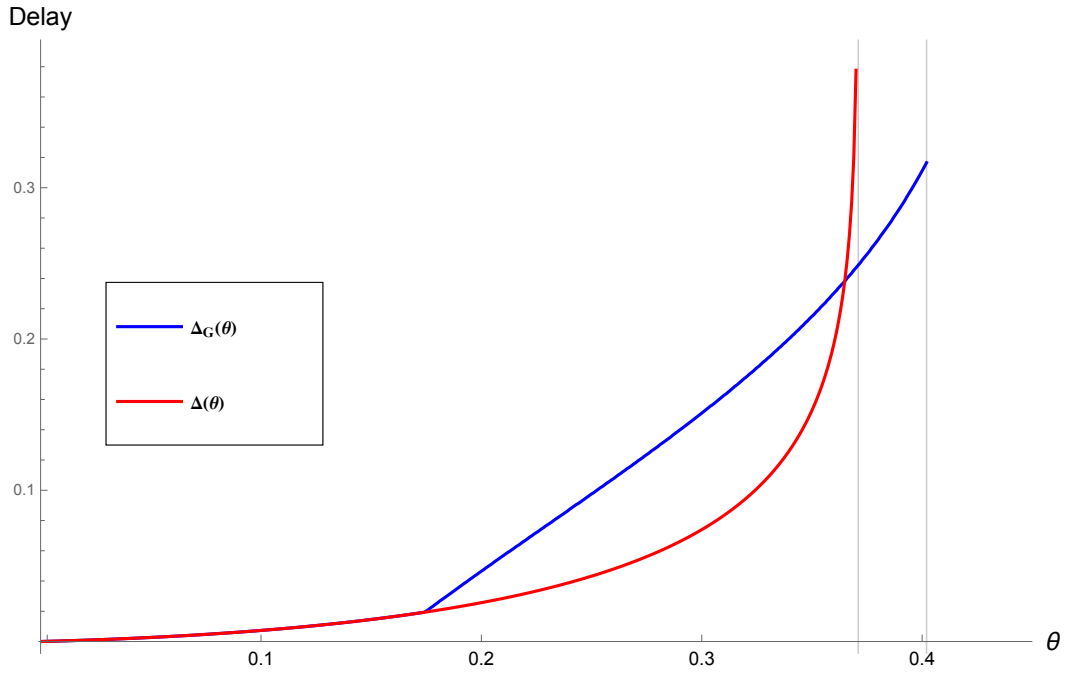
Figure 6: **Government involvement and equilibrium delay.** This graph plots the equilibrium delay with government involvement $\Delta_G(\theta)$ and the delay without government involvement $\Delta(\theta)$.
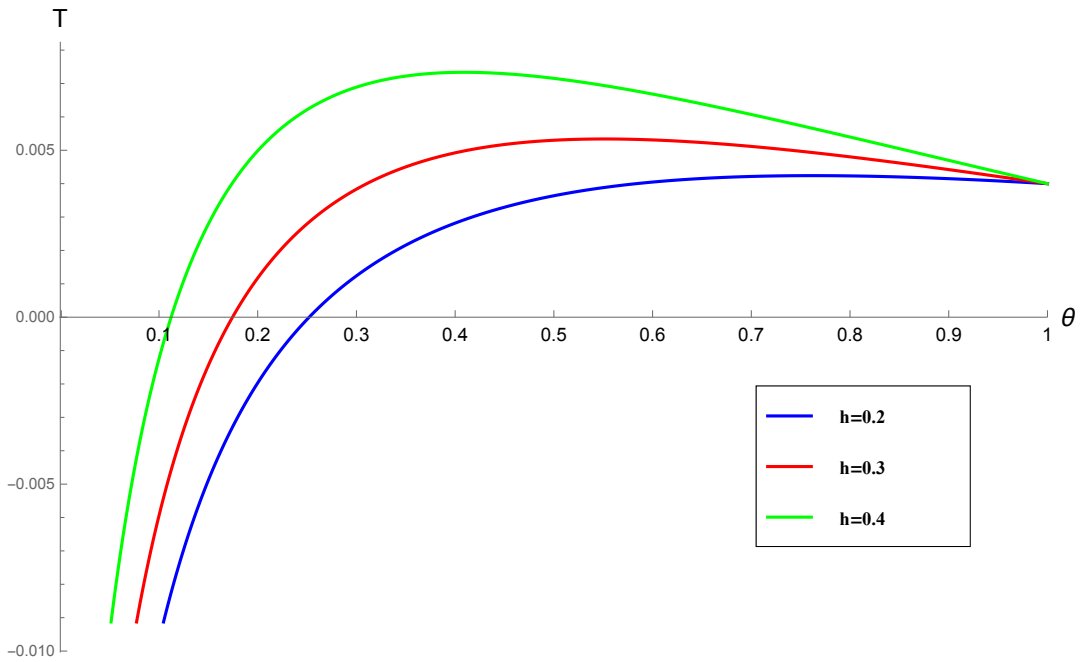

Figure 7: **Impact of haircuts on government transfers.** This graph plots $T(\theta)$ as a function of θ for different levels of the haircut h.
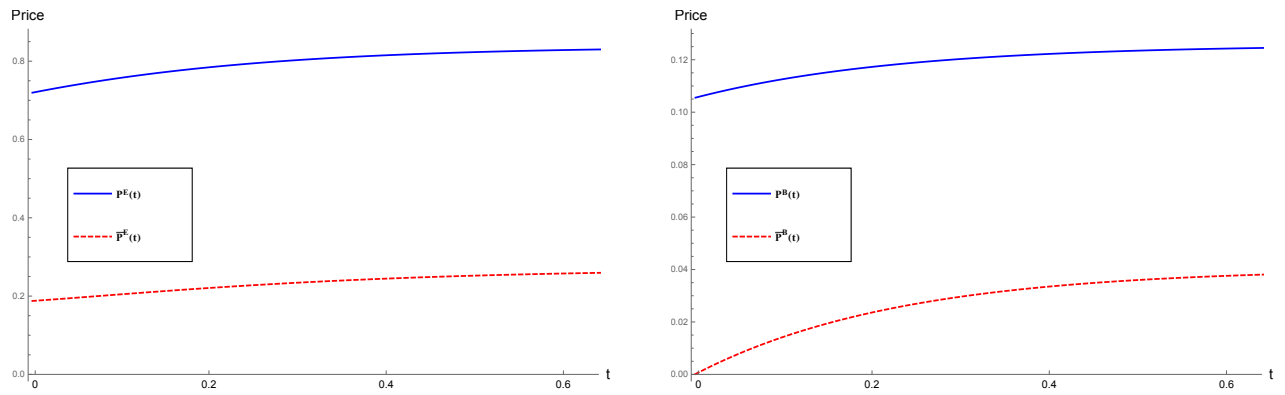
Figure 8: **Market value of equity and debt.** This graph plots the market values of equity and debt $P^E(t)$ and $P^C(t)$ over time, as well as $\bar{P}^E(t)$ and $\bar{P}^C(t)$. If restructuring occurs at time t, the equity value drops from $P^E(t)$ to $\bar{P}^E(t)$, and the debt value from $P^C(t)$ to $\bar{P}^C(t)$.