Financial Restructuring and Resolution of Banks*

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Abstract

We study how resolution frameworks for failing banks affect the incentives of private stakeholders to restructure the liabilities of a distressed bank before it fails. In our model, a distressed bank's shareholders and creditors can renegotiate its liabilities, but informational frictions hamper financial restructuring, resulting in delays and loss of value. The resolution framework affects this process. On the one hand, excessively lax bail-out rules can suppress private restructuring incentives by reducing the bargaining surplus. On the other hand, excessively strict bail-in rules can also lead to costly delays in restructuring: by making the value of debt more information-sensitive, they make information more valuable, thus worsening informational frictions. We then consider the government taking part directly in the negotiations to speed up the restructuring process. However, it must subsidize the bank's stakeholders, and we show that strict bail-in rules can in fact weaken its bargaining position.

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

JEL classification: G21, G28.

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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 (**?**). Such voluntary restructuring, 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 vividly illustrates 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.

In the case of MPS, it was clear that, failing a restructuring, the bank would be resolved and that this would involve some bail-in of the creditors. More generally, resolution regimes do not only determine outcomes once a bank has failed, but by affecting private parties' default options, also affect the process of private restructuring before the bank actually fails.[3] This raises important questions. For instance, do stricter bail-in rules favor or hinder private restructuring? 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 rules may affect the financial

[1] See **?**'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 **?**, a total of EUR 87 bln of hybrid bonds were tendered, creating EUR 30 bln of capital gains for European banks.

[3] 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., **?**, **?**.

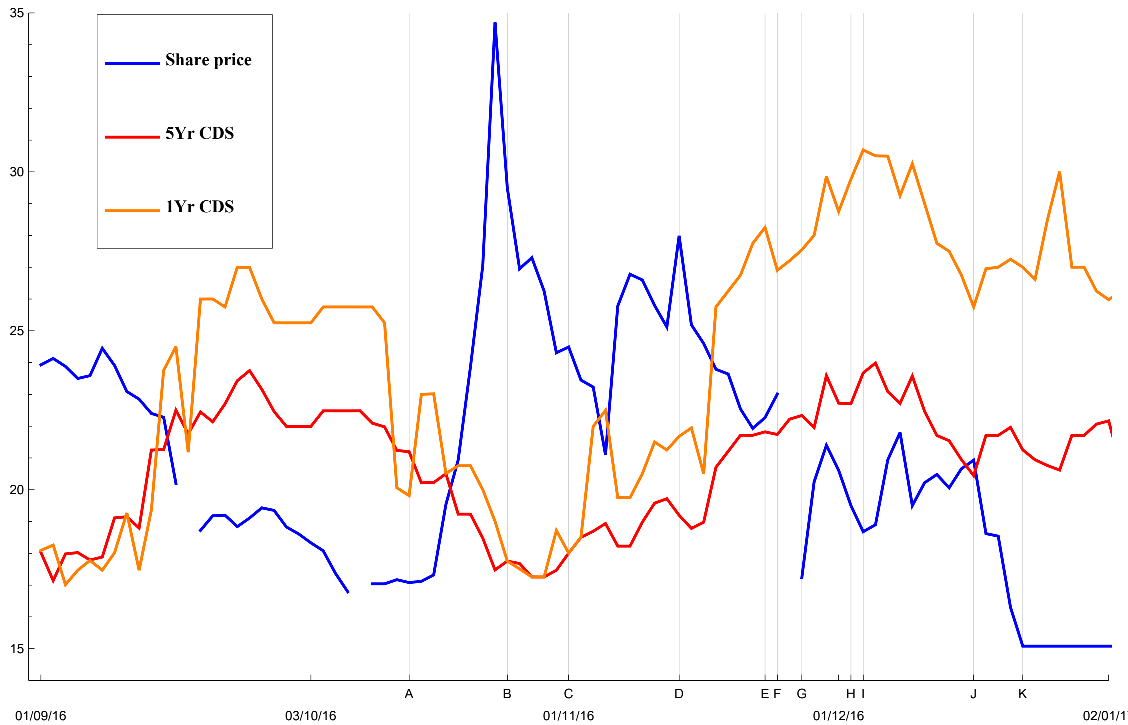

Figure 1: **Monte dei Paschi di Siena.** This graph plots the share price, 1-year and 5-year CDS premia for Monte dei Paschi di Siena between September 2016 and January 2017. CDS premia are multiplied by 1/20 for better readability.

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.

restructuring of banks. The model accounts for two specificities of banks. First, the default of large banks can have negative externalities, forcing government bailouts and motivating the use of special resolution regimes. Second, funding conditions can evolve very rapidly for banks, making speed critical to the restructuring process. These two elements interact. As 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 take a remedial action to increase the probability that the bank's assets pay off, but he does not, as this would mostly benefit the creditors. To try and avoid this cost of financial distress, the manager can approach the creditors to negotiate a restructuring of the bank's debt.

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 becomes useless and bargaining breaks down.

As a benchmark case, assume that the manager and the creditors are equally informed about the quality of the bank's assets. In principle, debt renegotiation can avoid inefficiencies. Indeed, under the efficient outcome, the total value of the bank is higher and so could be split in such a way that shareholders and creditors are all better off. Such financial restructuring can take different forms (see **?**). 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. Without frictions, such an offer is made and accepted immediately, and the bank recovers from financial distress.

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, so that an efficient outcome is no longer guaranteed. The manager has an incentive to claim that the bank's asset quality is poor to low-ball 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. Since that cost varies with the assets' value, so does the delay the manager is willing to accept. As a result, a separating equilibrium can arise in which the manager makes an offer after a delay that depends on the assets' value. Thus bank assets' 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 monitor the assets, 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. First, if the haircut is sufficiently low, creditors expect a generous bail-out and have little incentives to make concessions. In fact, shareholders and creditors may be better off not renegotiating at all, so as to extract more bail-out funds from the government. This *surplus effect* implies that higher haircuts may speed up the restructuring process. The second effect, however, goes in the opposite direction. If creditors expect a generous bail-out, the value of the debt claim they hold is not very sensitive to the assets' quality. As a result of this *signaling effect*, the manager has little to gain by delaying making an offer, as the deal he can extract improves only slowly with time. This implies that higher haircuts may slow down the restructuring process.

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 may be undesirable.

Next, we extend the model to allow the government to partake in negotiations. Indeed, by reaching an agreement, shareholders and creditors forgo part of the bail-out funding the government would provide otherwise. As they fail to internalize this positive externality onto the government, negotiations will tend to be excessively slow and, in some cases, even fail to converge. 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 bail-in rules still play an important role in this case, as they determine the creditors and the government's outside options. We show that, surprisingly perhaps, stricter bail-in rules may weaken the government's position. On the one hand, the perspective of being bailed-in makes creditors more willing to make concessions. On the other hand, since bail-ins cause a negative externality, the government is eager to reach an agreement and avoid an inefficient outcome.[4]

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 (**?**, **?**, **?**). 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.[5] For instance, **?** study how a government's decision to trigger a bail-in can convey negative information to markets, precipitating a run. **?** study the allocation of losses across a failing multinational bank's stakeholders. **?**, the most related paper, develops a model of bank runs in which 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

[4]The 2016 Monte dei Paschi di Siena negotiations illustrate well the government's eagerness to avoid a bail-in.

[5]See also recent policy-oriented pieces, e.g., **?**, **?**, **?** or **?**.

not always delay the resolution of distress, due to the signaling effect.

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 **?**'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., **?**, **?**), asset purchases by the government (**?**, **?**), or acquisition by stronger banks (**?**, **?**). A particularly related paper is **?**, 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 given bank.

Our paper is also related to corporate finance theory work on debt restructuring. **?** study bank 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. **?** study public debt restructurings, in which dispersed creditors can partake via exchange offers. Inefficiencies arise from their free-riding behavior, not from information frictions as in our model. In **?**, 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 **?**'s survey), where "signaling through delay" is key (e.g., **?**). 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. Empirical implications and extensions are covered in Sections 4 and 5. Section 6 concludes. Proofs omitted in the text are in the Appendix.

1 The Model

Bank in financial distress. We consider a bank with the following stylized balance sheet. On the asset side, the bank has risky assets that eventually yield a cash-flow $Z > 0$ with probability p, and 0 otherwise. Probability p, which captures the quality of the bank's assets, is random and follows a distribution $F(\cdot)$. On the liability side, the bank has D in deposits, that are fully insured by the government. We denote $X = Z - D > 0$ the bank's future cash-flow net of deposit repayment. In addition, the bank has uninsured liabilities with face value $R_0 < X$.

The bank is run by a manager acting on behalf of existing shareholders. The manager is privately informed about p, whereas other players only know its distribution $F(\cdot)$. This implies that any negotiations with other parties, notably creditors, will *a priori* occur under asymmetric information about the assets' quality, which we call the bank's type.

The probability that the bank's assets do not pay off can be reduced if the manager takes a remedial action (which for simplicity we will call "monitoring"). By incurring a non-pecuniary cost $c > 0$, the manager can increase the probability that the assets yield Z from p to $p + m$, with $m \in (0, 1)$. For consistency, we assume that the support of $F(.)$ is $[0, 1 - m]$ so that $p + m \leq 1$.

Monitoring involves a cost c and creates a surplus mX for shareholders and creditors. Yet, the shareholders' payoff only increases by $m(X - R_0)$. We assume that monitoring is efficient, but that the manager has no incentive to monitor, i.e., the bank faces a debt overhang problem:

$$mX > c > m(X - R_0). \tag{H1}$$

If possible, it would be optimal for creditors and shareholders to renegotiate the debt and set a new face value $R < R_0$ satisfying both the following shareholder incentive-compatibility condition:[6]

$$m(X - R) \geq c, \tag{IC}$$

[6] See **?** for an analysis of debt renegotiation under incentive constraints in the context of the debt overhang problem.

and the following creditor participation constraint:

$$[1 - h(1 - p - m)]R \geq [1 - h(1 - p)]R_0. \tag{IR}$$

The condition's right-hand side is the creditors' expected payoff under the status quo, i.e., absent renegotiation. It reflects the fact that the debt's face value R_0 is paid in full unless the bank defaults, which occurs with probability $(1-p)$, in which case a haircut h is applied. The condition's left-hand side has the same intuition but with the new face value R and default probability $(1-p-m)$ which renegotiation implies.

To keep the model simple, we assume throughout that for all p, at least one R exists that satisfies both constraints.[7] This assumption amounts to:[8]

$$\begin{aligned} c &\leq m(X - R_0) + m^2 hR_0 \\ \Leftrightarrow h \geq h_{\min} &= \frac{mR_0 - (mX - c)}{m^2 R_0}. \end{aligned} \tag{H2}$$

Restructuring. The manager can propose a restructuring plan for the bank. We consider two cases. In the first case, the government is not involved in the restructuring. The manager then makes a public offer to the uninsured creditors to write-down the debt from R_0 to R;[9] creditors are dispersed, and accept any offer improving their payoff relative to the status quo.[10]

The manager's main decision is how long to wait before making an offer. We consider a continuous time model. The manager can make an offer at any time $t > 0$. The delay in making the offer is observed by the other agents, who on this basis update their beliefs about the bank's type p. Waiting is costly: in each period dt, there is a probability βdt that it becomes too late

[7] An equivalent alternative would be to assume that in the renegotiation, the manager can commit to monitor the bank's assets, i.e., the incentive compatibility condition need not be satisfied.

[8] Condition (H2) is derived as follows. Condition (IC) can be rewritten as $mX - c \geq mR$. Hence, both conditions (IC) and (IR) can satisfied by the same R if and only if $[1 - h(1-p-m)](mX - c) \geq [1 - h(1-p)]mR_0$. Given assumption (H1), this condition tightens as p increases over $[0, 1-m]$, and is thus tightest for $p = 1 - m$, at which point it writes $mX - c \geq (1 - hm)mR_0$ or, equivalently, as in condition (H2).

[9] Within our model this is without loss of generality. Without bail-outs ($h = 1$), given that there are two states, one of which gives a zero payoff, all financial contracts are equivalent. When $h < 1$, since by assumption debt contracts open the possibility of a bail-out, it is optimal for the bank to offer to replace existing debt with a new debt contract. As a result, the optimal restructuring takes the form of a debt write-down.

[10] See **?** for a model of how exchange offers for senior debt can implement a debt write-down for dispersed creditors.

to take a remedial action and improve the assets' performance. When this happens, restructuring cannot create any surplus any more, and negotiations break down. Otherwise, the game continues until such time as the manager gets an offer accepted, and thus implemented, or negotiations break down.[11]

In the second case, the government partakes in the restructuring: the manager makes an offer to both the creditors and the government; the government can reject the offer and make a counter-proposal, and the bank and the government alternate making offers. As in **?**, each player has to wait a minimum time $t_0 = -(1/\beta)\ln(\delta)$ between receiving an offer and making a counter-offer. We denote $\alpha = \delta/(1+\delta)$ the bargaining power of the government in this game.

Resolution. Following the restructuring phase, be it successful or not, the bank's assets pay off and payments are made. If the assets yield a cash-flow 0, the bank defaults on its liabilities. A resolution regime specifies what happens then. In our baseline model, shareholders receive 0 and depositors are repaid in full by the government. In addition, the government may voluntarily bail-out the creditors, up to a fraction $1-h$ of par value, i.e., h is a haircut.[12]

We give the government a simple objective function. The losses borne by creditors have a negative externality (e.g., domino effect on other financial institutions) equal to η per unit.[13] However, the government also takes into account the cost of bailing out the creditors, in addition to reimbursing the depositors. Thus, if the bank owes R to its creditors and defaults, the government's payoff is $-[D+R+hR(\eta-1)]$. In particular, if $\eta > 1$, imposing zero haircut is optimal ex post, whereas if $\eta < 1$ the government is better off not reimbursing the creditors.

2 Restructuring without Government Involvement

We first consider the case in which the government does not partake directly in the bank restructuring process. It is only involved in any potential bail-out.

[11] For simplicity, we assume the manager cannot make further offers after an offer has been accepted.

[12] For instance, according to the European BRRD, a minimum 8% of the banks' liabilities must be bailed-in before the Single Resolution Fund can be used.

[13] We interpret these additional losses as having a genuine social cost. However, other interpretations are possible, such as political losses for the government.

2.1 Equilibrium Delay in Restructuring

The model is in effect a signaling game, in which the delay chosen by the manager signals the assets' quality p. We focus on fully separating perfect Bayesian Nash equilibria. In such equilibria, the bank's type p maps one-to-one into a delay $\Delta(p)$ before the manager makes an offer. If an offer is made after a delay t, the creditors infer the bank's type to be $p = \Delta^{-1}(t)$. Given the creditors' inference, the manager of a type p bank finds it optimal to wait $\Delta(p)$ before making an offer. Solving for an equilibrium consists in solving for the function $\Delta(\cdot)$.

If renegotiation breaks down, the debt's face value remains R_0 and the manager does not monitor. Thus the outside option of the shareholders and uninsured creditors for a given bank type p are:

$$E_0(p) = p(X - R_0), \tag{1}$$

$$C_0(p) = [1 - h(1-p)]R_0. \tag{2}$$

The shareholders' payoff is $X - R_0$ unless the bank defaults, which happens with probability $1 - p$, in which case they get zero. The creditors' expected payoff is R_0 unless the bank defaults, in which case they only receive a payment $(1 - h)R_0$ from the government's bailout.

In a separating equilibrium, if the manager makes an offer after a delay t, creditors infer the bank's type to be $p' = \Delta^{-1}(t)$. They will agree to reduce the debt's face value to R if and only if this is more than compensated by the lower default probability monitoring implies, i.e., if condition (IR) is satisfied.

It follows that the manager should offer to lower the debt's face value from R_0 to the value $R(p')$ which makes creditors indifferent between accepting and rejecting the offer, i.e., such that condition (IR) holds with equality:

$$R(p') = \left(1 - \frac{mh}{1-(1-p'-m)h}\right)R_0 \tag{3}$$

which corresponds to a debt write-down of

$$R_0 - R(p') = \frac{mh}{1-(1-p'-m)h}R_0 \tag{4}$$

The lower the perceived quality p' of the bank's assets, the larger the write-down creditors concede: if the creditors believe the bank's type to be worse, they view their outside option as being lower, and are thus willing to concede a larger write-down. This is true even though a lower bank type also implies a lower payoff post-restructuring for creditors. Indeed, holding repayment R constant, the ratio of creditor payoffs with and without monitoring is $E_0(p'+m)/E_0(p') = 1 + m/p'$, which is decreasing with p'.

To solve for the equilibrium, we need the shareholders and creditors' payoffs $E(p', p)$ and $C(p', p)$ when the manager makes a successful offer after a delay $\Delta(p')$ but the bank's type is p:

$$E(p', p) = (p + m)[X - R(p')] - c \quad (5)$$

$$C(p', p) = [1 - (1 - p - m)h]R(p'). \quad (6)$$

The shareholders' payoff is as in the status quo except for the higher probability of a payoff, the lower face value, and the cost of monitoring. The creditors' payoff is as in the status quo except for the lower default probability and the lower face value.

The expression for the shareholders' payoff, $E(p', p)$, sheds light on the manager's incentive to influence the creditors' belief about the assets' quality. Indeed, as argued above, to extract larger concessions from creditors, the manager ought to convince them that the assets' quality is low, i.e., we have $E_1(p', p) < 0$. [14]

We denote $V(p', p) = E(p', p) + C(p', p)$ the total payoff. We obtain:

$$V(p', p) = (p + m)X + (1 - p - m)(1 - h)R(p') - c. \quad (7)$$

Note that the total payoff after renegotiation increases with the perceived quality p' of the bank's assets: If creditors think default is likely, they accept a substantial write-down, which reduces the expected bail-out. In the absence of bail-outs ($h = 1$), the repayment $R(p')$ would be a mere transfer

[14] That larger concessions obtain for lower asset quality stems from the fact that the ratio of the creditors' payoffs with and without monitoring decreases with asset quality p. However, what matters for our analysis and results is that the manager wants to signal that that payoff ratio is high. Whether this amounts to signaling high or low quality does not. For instance, in a simple variation of the model in which the information asymmetry would be over the impact of monitoring, m, rather than over asset quality, p, the ratio being increasing in m would imply that the manager wants to convince creditors that m is large. Our results would be unaffected.

between shareholders and creditors and $V(p', p)$ would be independent of p'.

If the manager's strategy is to make an offer after a delay t, there is a probability $(1 - e^{-\beta t})$ that negotiations will break down before time t and the shareholders will receive $E_0(p)$, whereas otherwise the manager's offer is accepted and shareholders receive $E(\Delta^{-1}(t), p)$. For a type p bank, the shareholders' expected payoff is thus:

$$\left[1 - e^{-\beta t}\right] E_0(p) + e^{-\beta t} E(\Delta^{-1}(t), p). \tag{8}$$

Following the literature on bargaining under asymmetric information (e.g., **?**), we can write the manager's problem as that of choosing which type p' to pretend the bank to be, which he can do by waiting $\Delta(p')$. If the manager of a type p bank pretends it to be of type p', the shareholders' expected payoff is:

$$U^E(p', p) = \left[1 - e^{-\beta\Delta(p')}\right] E_0(p) + e^{-\beta\Delta(p')} E(p', p). \tag{9}$$

Using the revelation principle, a necessary condition for equilibrium is that $U^E(p', p)$ be maximized for $p' = p$. Differentiating this expression with respect to p', we obtain:

$$U_1^E(p', p) = e^{-\beta\Delta(p')} \left[E_1(p', p) - \beta\dot{\Delta}(p')(E(p', p) - E_0(p))\right]. \tag{10}$$

To understand the trade-off, we can also denote $\sigma = \Delta^{-1}$, $t' = \Delta(p')$, and rewrite (10) as:

$$\dot{\sigma}(t')U_1^E(\sigma(t'), p) = e^{-\beta t'} \left[\dot{\sigma}(t')E_1(\sigma(t'), p) - \beta(E(\sigma(t'), p) - E_0(p))\right]. \tag{11}$$

This condition means that by delaying his offer by an extra dt, the manager changes the creditors' inference about his type by $\dot{\sigma}(t')$, which changes the payoff he obtains from the renegotiation by $E_1(\sigma(t'), p)$. However, he must also take into account the cost of waiting, i.e., that the negotiation will break down with probability βdt, in which case shareholders lose $E(\sigma(t'), p) - E_0(p)$.

Using (5), this loss is equal to $p[R_0 - R(\sigma(t'))] + m[X - R(\sigma(t'))] - c$, and thus increases in p. High type managers expect to repay their debt with a high probability, so that losing the opportunity to renegotiate is costly to them. Conversely, low type managers know they have a low probability of repaying their debt anyway, and can afford taking the risk of a negotiation breakdown by waiting longer. This different sensitivity to the probability of a negotiation breakdown makes a separating equilibrium possible: high types obtain a small write-down after a short waiting time, while low types obtain a large write-down after a long waiting time. Hence, in equilibrium, waiting signals a lower type ($\dot{\sigma} \leq 0$) or, equivalently, higher types wait less ($\dot{\Delta} \leq 0$).

From condition (10) for $p' = p$, we obtain a condition which $\Delta(\cdot)$ must satisfy in equilibrium:

$$
\begin{aligned}
U_1^E(p,p) = 0 \quad &\Leftrightarrow \quad e^{-\beta\Delta(p)}\left[E_1(p,p) - \beta\dot{\Delta}(p)(E(p,p) - E_0(p))\right] = 0 \\
&\Leftrightarrow \quad \dot{\Delta}(p) = \frac{E_1(p,p)}{\beta[V(p,p) - E_0(p) - C_0(p)]}. \qquad (12)
\end{aligned}
$$

Moreover, we have:

$$
\begin{aligned}
V(p,p) - E_0(p) - C_0(p) \quad &= \quad mX - c - m(1-h)R(p) - (1-p)(1-h)[R_0 - R(p)] \qquad (13) \\
E_1(p,p) \quad &= \quad -(p+m)\dot{R}(p). \qquad (14)
\end{aligned}
$$

It is easily checked that $V(p,p) - E_0(p) - C_0(p)$ is positive and increasing in p. Indeed, our assumptions ensure that shareholders and creditors have (and can realize) strict gains from trade, i.e., the benefits of the reduced default probability exceed the cost of monitoring and the foregone government bailout. These gains are smaller for smaller values of p because the larger write-down implies larger foregone bailout funding. Since $E_1(p,p) < 0$, function $\dot{\Delta}(p)$ is indeed strictly negative, i.e., the manager of a bank with poorer assets waits longer to make an offer.

Note that in equilibrium, the shareholders of a bank of type $p = 1 - m$ obtain the least favorable deal. Hence, it must be that for this type, the manager does not wait to make an offer, as otherwise a deviation would surely be profitable. Denoting K an integration constant, we have:

$$
\begin{aligned}
\Delta(p) \quad &= \quad \int_0^p \dot{\Delta}(x)dx + K \qquad (15) \\
\Delta(1-m) \quad &= \quad \int_0^{1-m} \dot{\Delta}(x)dx + K = 0. \qquad (16)
\end{aligned}
$$

Hence the equilibrium delay is:

$$\forall p \in [0,(1-m)], \quad \Delta(p) = \int_p^{1-m} \frac{-E_1(x,x)}{\beta[V(x,x) - E_0(x) - C_0(x)]} dx. \tag{17}$$

This expression shows that two factors determine the equilibrium delay: the numerator, which captures the manager's marginal benefit from "lying-by-delaying", and the denominator, which captures his marginal expected loss implied by the risk of breakdown.

First, $E_1(p,p)$ is the sensitivity of the shareholders' payoff to the type the manager conveys via his choice of delay or, in other words, the manager's marginal incentive to lie about the bank's type. A higher value of $-B_1(p,p)$ thus leads to longer delays. We call this the *signaling effect*.

Second, the denominator is the surplus created by renegotiation, which is also the cost of waiting and taking the risk that negotiations will break down. If this surplus goes to zero, the delay goes to infinity, which means that the probability of a negotiation breakdown before an agreement is reached goes to one, i.e., no negotiation takes place. More generally, a greater surplus leads to shorter delays. We call this the *surplus effect*.

From this analysis, we obtain the following result.

Proposition 1. *A separating perfect Bayesian Nash equilibrium exists in which the following holds. The manager of a bank of type $p \in [0, 1-m]$ waits $\Delta(p)$ before making an offer to reduce the debt's face value to $R(p)$ which creditors accept, with $R(p)$ and $\Delta(p)$ defined by (3) and (17), respectively.*

Figure 2 illustrates the equilibrium delay $\Delta(p)$ in an example.[15] Figure 3 shows the shareholders' payoff $U^E(p', p)$ relative to $U^E(p,p)$ as a function of p', and confirms that in this example the definition of Δ induces truthful revelation.

From expression (17), we can derive properties of the delay $\Delta(\cdot)$.

Corollary 1. *The delay $\Delta(p)$ is strictly decreasing and convex in p.*

That $\Delta(p)$ is decreasing in p means that the riskiest banks are also those that will take the longest to restructure, and thus run the higher risk of failing. This simply comes from the need for a costly signal. The convexity of Δ implies that the information content of an extra delay dt

[15] All the parameters used to generate the figures are reported in A.12.

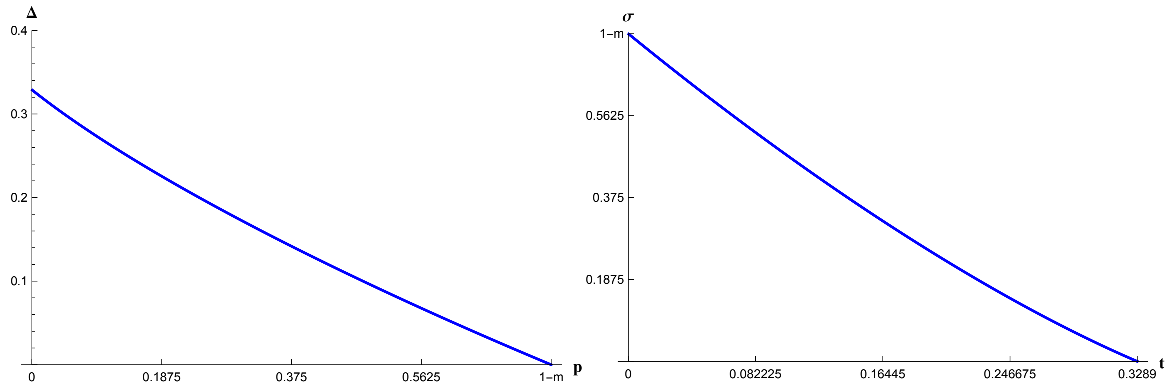

Figure 2: **Equilibrium delay $\Delta(p)$, and equilibrium belief $\sigma(t)$.**

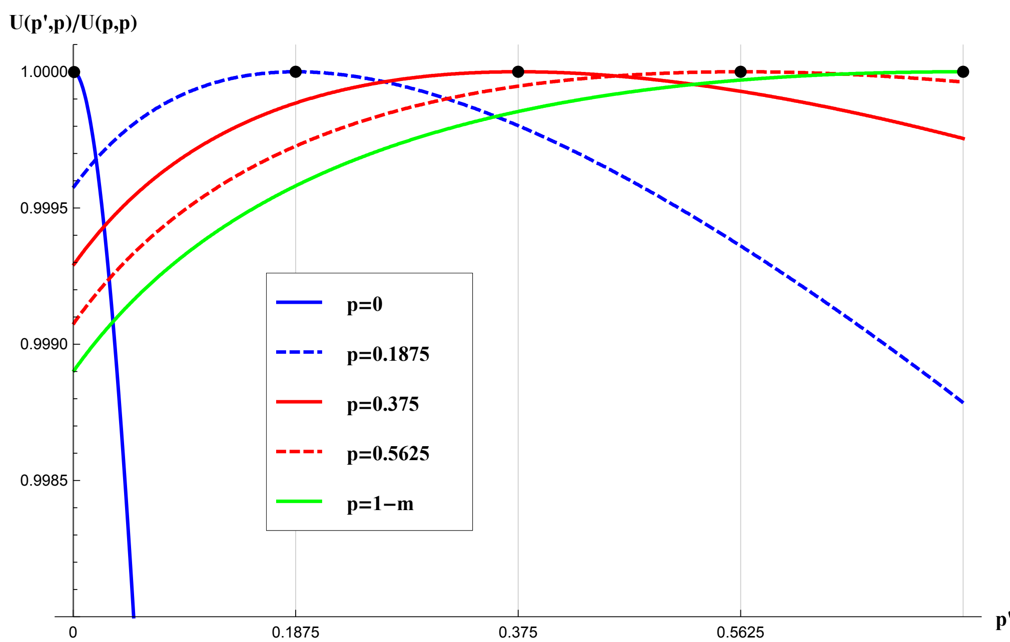

Figure 3: **Manager's incentives to report truthfully.** This graph plots the ratio $U^E(p',p)/U^E(p,p)$ as a function of p', for different values of p. $U^E(p',p)$ is always maximized in $p'=p$.

decreases over time. For large values of p, the delay is short and $\Delta(p)$ is relatively flat, which means that a short time is sufficient for many of the high types to reveal themselves. Conversely, for low values of p, the types differentiate themselves more slowly.

2.2 The Impact of Haircuts on Restructuring

Before deriving comparative statics results on $\Delta(p)$ with respect to the haircut h, we briefly look at two polar cases. First, assume that there are no bail-outs, which corresponds to a 100% haircut ($h = 1$). Then we obtain the following expression:

$$\Delta(p) = \int_p^{1-m} \frac{mR_0}{\beta(x+m)(mX-c)} dx = \frac{-mR_0 \ln(p+m)}{\beta(mX-c)}. \tag{18}$$

This value reflects the delay after which a type p banks negotiates with its creditors when restructuring is a purely private matter. The delay is decreasing in m and X, and increasing in c, reflecting that a larger surplus from renegotiation leads to a lower delay. The delay is also increasing in R_0. A larger outstanding debt implies that the bank can obtain larger concessions by misreporting its type, which have to be compensated by a longer delay.

Conversely, in the polar case in which creditors are bailed-out almost in full ($h \to 0$), $\Delta(p)$ goes to 0 for all values of p. Indeed, in this case the creditors are almost sure to obtain R_0, even if the bank defaults, so that there is little scope for renegotiating the debt in the first place. This implies that the manager has little to gain by misreporting the bank's type, which reduces the delay in making offers.

These polar cases illustrate that h has both a surplus effect and a signaling effect on $\Delta(p)$. To see this, we can write $\dot{\Delta}(p)$ explicitly as:

$$\begin{aligned} \dot{\Delta}(p) &= \frac{-(p+m)mh^2R_0}{\beta[1-h(1-p-m)]^2[mX-c+(1-p)(1-h)[R(p)-R_0]-m(1-h)R(p)]} \\ &= \frac{-(p+m)mh^2R_0}{\beta[1-h(1-p-m)][(mX-c)[1-h(1-p-m)]-m(1-h)R_0]}. \end{aligned} \tag{19}$$

Integrating with respect to p and using $\Delta(1-m) = 0$, we can solve explicitly for $\Delta(p)$ (see Appendix

A.3 for a proof):

$$\Delta(p) = \frac{m(X - R_0) - c}{\beta(mX - c)} \ln\left[\frac{(mX - c)[1 - h(1 - p - m)] - m(1 - h)R_0}{mX - c - mR_0(1 - h)}\right] - \frac{1}{\beta}\ln[1 - h(1 - m - p)]. \tag{20}$$

We obtain the following comparative statics with respect to h.

Corollary 2. *Both $-E_1(p,p)$ and $V(p,p) - E_0(p) - C_0(p)$ are increasing in h, so that $\dot{\Delta}(p)$ is not necessarily monotonic in h. More precisely, define the delay-minimizing haircut*

$$h^*(p) = \frac{[c - m(X - R_0)](1 + p + m)}{c - m(X - R_0) + (p + m)(mX - c)}. \tag{21}$$

If $m \leq 1/2$ and $m(X - R_0) - c \leq \frac{-m^3 R_0}{1-m}$, then for all $p \in [0, 1 - m]$ and $h \in [h_{\min}, 1]$, the delay $\Delta(p)$ increases with h.

If $m \leq 1/2$ and $m(X - R_0) - c > \frac{-m^3 R_0}{1-m}$, there exists $\bar{p} \in (0, 1 - m)$ such that for $p \geq \bar{p}$ and $h \in [h_{\min}, 1]$ the delay $\Delta(p)$ increases with h. For $p < \bar{p}$, the delay decreases with h for $h \in [h_{\min}, h^*(p)]$, and increases with h for $h \in [h^*(p), 1]$.

For any p, the delay $\Delta(p)$ is minimized in $h = \max(h^*(p), h_{\min})$, and $h^*(p)$ decreases with p.

In general, increasing the haircut has two effects on the delay to reach an agreement. First, as we saw, in the limit if h goes to 0 there is no delay. As the haircut h increases, the shareholders' payoff becomes more sensitive to the type they report because creditors are ready to concede lower repayments. Thus higher haircuts magnify the *signaling effect*, leading to longer delays. But higher haircuts have a second, countervailing effect. By reducing the part of the creditors' losses that is absorbed by the government, they increase the surplus shareholders and creditors can obtain in renegotiations.[16] Thus higher haircuts also magnify the *surplus effect*, leading to shorter delays. These two effects are general, and their combination can go either way. Figure 4 plots an example in which haircuts lead to longer delays, except for the lowest values of p, for which $h^*(p) > h_{\min}$.

[16] Actually, if (H2) is not satisfied, the surplus from renegotiation can be zero or negative for low values of h and p, in which case there is no agreement (infinite delay).

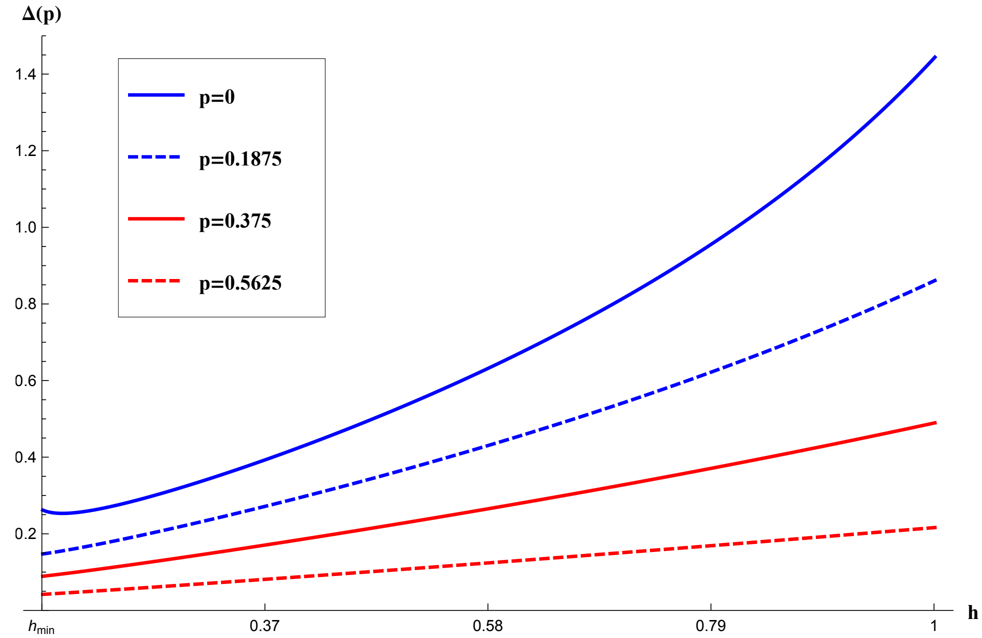

Figure 4: **Equilibrium delay and haircuts.** This graph plots the equilibrium delay $\Delta(p)$ as a function of the haircut h, for different values of p.

2.3 Optimal Haircut

Finally, we characterize the optimal haircut h from the government's perspective. The government's payoff is 0 if the bank can pay its creditors, and $-[D + R + (\eta - 1)hR]$ if it defaults, where R is the amount owed to creditors. Thus, denoting $G_0(p)$ the government's payoff in the absence of renegotiation, and $G(p', p)$ the government's payoff if renegotiation occurs and a type p bank reports type p', we have:

$$G_0(p) = -(1-p)[D + R_0 + hR_0(\eta - 1)] \tag{22}$$

$$G(p', p) = -(1-p-m)[D + R(p') + hR(p')(\eta - 1)]. \tag{23}$$

These values imply that in equilibrium, the surplus of the government created by renegotiation is:

$$G(p,p) - G_0(p) = mD + (1 + h(\eta - 1))[mR(p) + (1-p)(R_0 - R(p))]. \tag{24}$$

This expression is positive, reflecting that private renegotiations have a positive externality on the government. It also illustrates two effects. First, renegotiation solves the debt overhang problem, so that the default probability of the bank is reduced by m. Note that this would be beneficial for the government even if it did not care about (uninsured) creditors ($\eta = 0$ and $h = 1$) but only about depositors. In such a case, the government would still obtain a surplus of mD, corresponding to lower expected losses for the deposit insurance fund. Second, renegotiation reduces the face value of debt by $R_0 - R(p)$, which decreases both the externality in case of default and the amount needed to bail-out the creditors.

Denoting $U^G(p, h)$ the government's expected payoff in equilibrium for a given bank type p and haircut h, we can write:

$$U^G(p, h) = G_0(p) + e^{-\beta\Delta(p)}[G(p, p) - G_0(p)]. \tag{25}$$

The impact of h on the government's expected payoff can be decomposed as follows:

$$\begin{aligned} U_2^G(p, h) = \quad & \underbrace{(1-\eta)\left[R_0(1-p)(1-e^{-\beta\Delta(p)}) + e^{-\beta\Delta(p)}R(p)(1-p-m)\right]}_{\text{Ex-post effect}} \\ - \quad & \underbrace{e^{-\beta\Delta(p)}(1-p-m)(1-h(1-\eta))\frac{\partial R(p)}{\partial h}}_{\text{Write-down effect}} - \underbrace{\beta\frac{\partial \Delta(p)}{\partial h}e^{-\beta\Delta(p)}(G(p,p) - G_0(p))}_{\text{Delay effect}}. \end{aligned} \tag{26}$$

This expression illustrates three different effects. The first term captures an *ex post effect* of the haircut h. If $\eta < 1$ then externalities are lower than the cost of public funds and increasing the haircut makes the government better off, whereas if $\eta > 1$ a full bail-out is desirable ex-post. The second term reflects a positive *write-down effect* for the government: Increasing the haircut reduces the creditors' outside option, leading them to concede a larger write-down. The third term captures a *delay effect*: the haircut affects the delay and thus the probability with which renegotiation will occur. If $h < h^*$ then increasing h leads to a shorter delay and has a positive impact on the government's payoff, whereas if $h > h^*$ the opposite obtains.

Denote $h^{**}(p)$ the haircut that maximizes the government's expected payoff $U^G(p, h)$. We obtain

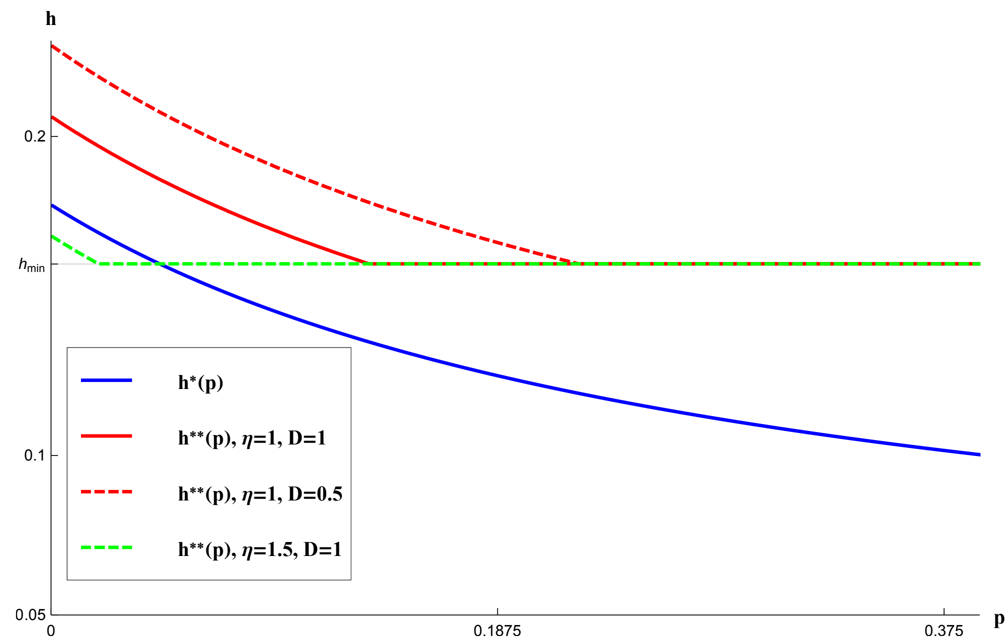

Figure 5: **Delay-minimizing and optimal haircuts.** This graph plots the delay-minimizing haircut $h^*(p)$, as well as the optimal haircut $h^{**}(p)$ for different values of the externality η and deposits D.

the following results:

Proposition 2. *If $\eta \leq 1$, then $h^{**}(p) > h^*(p)$: the optimal haircut is larger than the delay-minimizing haircut.*

A higher deposit level D increases $h^{**}(p)$ when $h^{**}(p) < h^*(p)$, and decreases $h^{**}(p)$ otherwise: more deposits make the optimal haircut closer to the delay-minimizing haircut.

Both results are intuitive. If haircuts mattered only through the *delay effect*, $h^{**}(p)$ would be equal to $h^*(p)$. The negative write-down effect gives an incentive to choose a higher haircut. Moreover, the ex-post effect of haircuts gives an incentive to increase h further if $\eta \leq 1$, and to decrease h otherwise. When $\eta < 1$, the last two effects go in the same direction and surely the optimal haircut is larger than $h^{**}(p)$. When the bank has more deposits, the government is more keen on reaching an agreement and not having to reimburse depositors. This makes the delay effect stronger without affecting the other two, so that $h^{**}(p)$ is closer to the delay-minimizing haircut. Interestingly, the optimal haircut is not necessarily decreasing in the externality η, because of the write-down effect: larger externalities make it more profitable to decrease the repayment $R(p)$,

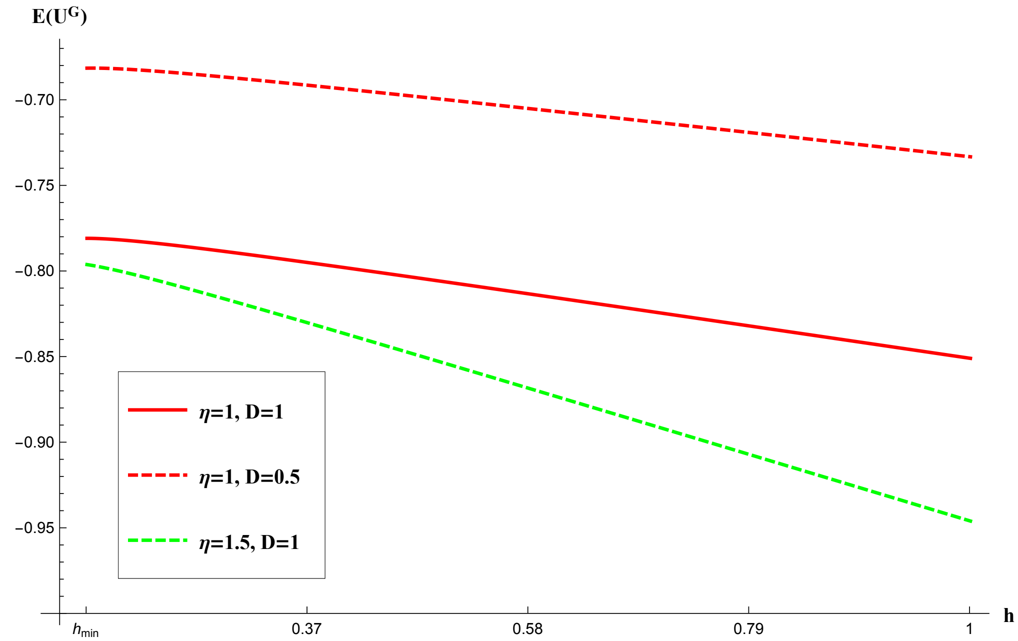

Figure 6: **Expected government payoff and haircuts.** This graph plots the expected government payoff $\mathbb{E}(U^G(p,p))$ as a function of the haircut h, for different values of the externality η and deposits D.

which is obtained by charging a higher haircut.

When $\eta > 1$, the government always prefers no haircut ex-post, which gives a rationale for tying the government's hands with a minimum haircut $\underline{h}$. In this case, the actual haircut equals $\underline{h}$ for any p. The level of $\underline{h}$ that maximizes the government's payoff will depend on the distribution $F(.)$. Importantly, in general it is not optimal to completely prevent bail-outs, even if $\eta \leq 1$, as this can lead to a very low probability of renegotiation.

Figure 6 plots $\mathbb{E}(U^G(p,p))$ for different values of h. In this example, the government always prefers the lowest possible haircut h_{min}. However, this comes from the facts that $h^{**}(p)$ is equal to h_{min} for all values of p except the lowest (Figure 5) and p is uniformly distributed in this example. It is not a necessary feature of the model that the optimal h is h_{min}.

3 Restructuring with Government Involvement

Private debt restructurings exert a positive externality onto the government by reducing the need for bailouts. As a result, restructurings are too slow and too likely to fail from the point of view of the government. Hence, the government may benefit from participating in negotiations and possibly subsidizing or intervening in the restructuring. This is the case we analyze now.

3.1 Equilibrium Restructuring Outcome

In practice, such subsidies may take different forms, e.g., debt guarantees, asset purchases, or capital injections. These are not equivalent in the model. We consider the simplest possible case, in which the government simply makes a cash transfer $T(p')$ to the shareholders.[17]

Assume the manager makes an offer after a delay Δ, so that the creditors and the government believe the bank's type to be $p' = \sigma(\Delta)$. The bank's optimal offer gives a payoff $C(p', p) = C_0(p')$ to the creditors, as before, and asks for a transfer T from the government. The government can reject this offer, and counter. Its counter-offer also gives $C(p', p) = C_0(p')$ to the creditors, and a transfer T' to the shareholders. The manager can then make a new counter-offer, etc. The subgame starting after the manager's first offer, which reveals the bank to be of type p', is a standard bargaining game, in which the government's bargaining power is given by α. Hence, $T(p')$ is such that:

$$E(p', p') + T(p') = E_0(p') + (1 - \alpha)[V(p', p') + G(p', p') - C_0(p') - E_0(p') - G_0(p')]. \tag{27}$$

The lumpsum transfer is such that the shareholders receive their outside option plus a share $1 - \alpha$ of the total surplus created by renegotiation. In contrast, without government intervention the bank shareholders only captured the surplus $V(p', p') - C_0(p') - E_0(p')$, but in full. Note that the creditors' payoff if they accept the offer is the same as before, so that $R(p')$ is still given by (3). The values $E(p', p)$, $C(p', p)$, and $G(p', p)$ thus also have the same definition as in the previous section.[18]

[17] This simplifies the analysis because as we will see, since $T(p')$ is a lump sum transfer, it does not affect the total surplus to be shared but only the probability of reaching an agreement.

[18] This property would not necessarily hold if the government subsidized the negotiations through other tools, e.g., a recapitalization.

We obtain that the transfer $T(p')$ from the government to the shareholders is defined as:

$$T(p') = (1-\alpha)[G(p',p') - G_0(p')] - \alpha[E(p',p') - E_0(p')] \tag{28}$$

$$= (1-\alpha)[[(1-p')(R_0 - R(p')) + mR(p')](1-h+\eta h) + mD] \tag{29}$$

$$- \alpha[mX - c - mR(p') + p'(R_0 - R(p'))].$$

Note that $T(p')$ can be negative. Indeed, say the government has all the bargaining power ($\alpha = 1$). Then it can capture the entire surplus, and ask for a transfer *from* the bank. Of course, the bank is then better off not involving the government in the negotiation, and make an offer to the creditors only. Thus, if the parameters are such that $T(p)$ as defined above is negative, the bank makes the same offer to the creditors as in the previous section, and the outcome is the same. However, it is clear from (28) that for a sufficiently small α the transfer from the government is surely positive, and the bank involves the government in negotiations.

Moreover, whether the manager actually makes an offer to the government depends on the bank's type. Observe that:

$$\frac{\partial[G(p,p) - G_0(p)]}{\partial p} = -(1-h+h\eta)[R_0 - R(p) + \dot{R}(p)(1-p-m)] \leq 0 \tag{30}$$

$$\frac{\partial[E(p,p) - E_0(p)]}{\partial p} = R_0 - R(p) - (p+m)\dot{R}(p) = \frac{m(1-p-m)h(1-h)R_0}{[1-h(1-p-m)]^2} \geq 0. \tag{31}$$

As a bank's type p increases, renegotiation gains decrease for the government but increase for the shareholders. From (28), this implies that T is decreasing in p: low-type banks get higher subsidies from the government than high-type banks. Thus, a threshold $\bar{p}_T \in [0, 1-m]$ for p exists (possibly equal to 0 or $1-m$) such that $T(p) \geq 0$ if and only if $p \leq \bar{p}_T$. We have:

Lemma 1. *Define two thresholds for the government's bargaining power:*

$$\alpha_1 = \frac{m[D + R_0 + hR_0(\eta - 1)]}{mZ - c + mh\eta R_0} \quad \text{and} \quad \alpha_2 = \frac{m[D(1-h(1-m)) + R_0(1-h+h\eta)]}{(1-h(1-m))(mZ-c) + hm\eta R_0}. \tag{32}$$

We have $0 < \alpha_1 < \alpha_2 < 1$. $T(p)$ *is increasing in* p*, positive for* $p \leq \bar{p}_T$ *and negative otherwise.* $\bar{p}_T = 1-m$ *for* $\alpha \leq \alpha_1$, $\bar{p}_T = 0$ *for* $\alpha \geq \alpha_2$*, and* $\bar{p}_T \in (0, 1-m)$ *for* $\alpha \in (\alpha_1, \alpha_2)$.

We follow the same reasoning as previously. Denoting $\Delta_G(p)$ the equilibrium delay when the government is involved in the negotiations, a type p bank pretending to be of type p' obtains the following payoff:

$$U^E(p',p) = \left[1 - e^{-\beta\Delta_G(p')}\right] E_0(p) + e^{-\beta\Delta_G(p')}[E(p',p) + \max(T(p'),0)] \tag{33}$$

and we obtain:

$$\Delta_G(p) = \begin{cases} \int_p^{\bar{p}_T} \frac{-[E_1(x,x)+\dot{T}(x)]}{\beta[E(x,x)+T(x)-E_0(x)]} dx + \Delta(\bar{p}_T) & \text{if } p \leq \bar{p}_T \\ \Delta(p) & \text{if } p \geq \bar{p}_T \end{cases} \tag{34}$$

We can express $\dot{\Delta}_G(p)$ explicitly:

$$\begin{aligned} E(p,p) + T(p) - E_0(p) &= (1-\alpha)[V(p,p) + G(p,p) - E_0(p) - C_0(p) - G_0(p)] && (35) \\ &= (1-\alpha)\left[m(X+D) - c + \frac{\eta h m R_0}{1 - h(1-p-m)}\right] && (36) \\ E_1(p,p) + \dot{T}(p) &= \frac{hmR_0}{(1-h(1-p-m))^2}[1 - h(1-m-p) + h\eta(1-\alpha)] && (37) \\ \forall p \leq \bar{p}_T, \dot{\Delta}_G(p) &= -\frac{hmR_0[1-h(1-m-p)+h\eta(1-\alpha)]}{\beta(1-\alpha)(1-h(1-p-m))[(m(X+D)-c)(1-h(1-p-m)) + \eta hmR_0]} && (38) \end{aligned}$$

We deduce:

Proposition 3. *A separating perfect Bayesian Nash equilibrium exists in which the following holds.*

For a bank of type $p \in [0, \bar{p}_T]$, the manager waits $\Delta_G(p)$ to make an offer for creditors to reduce the debt's face value to $R(p)$, and for the government to make a transfer $T(p)$ to the shareholders, with $R(p)$, $T(p)$, and $\Delta_G(p)$ defined by (3), (28), and (34), respectively.

For a bank of type $p \in (\bar{p}_T, (1-m)]$, the manager waits $\Delta_G(p)$ before making an offer to the creditors only for them to reduce the debt's face value to $R(p)$, with $R(p)$ and $\Delta_G(p)$ defined by (3) and (34), respectively.

The offer is accepted.

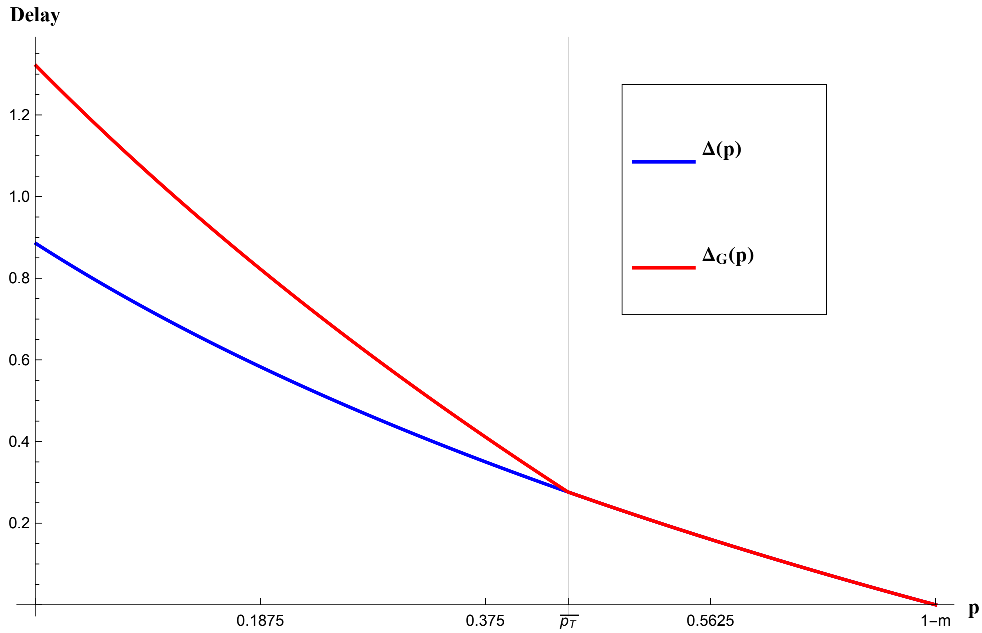

Figure 7: **Government involvement and equilibrium delay.** This graph plots the equilibrium delay with government involvement $\Delta_G(p)$ and the delay without government involvement $\Delta(p)$.

3.2 The Government's Impact on Restructuring

We derive implications on how government involvement in the negotiation affects the restructuring's outcome.

Corollary 3. *For types $p > \bar{p}_T$, government involvement in the negotiation has no effect. For types $p \leq \bar{p}_T$, government involvement increases the total surplus from the negotiation as well as the incentives to misreport, so that $\Delta_G(p)$ can be either lower or higher than without government involvement.*

This corollary is immediate from comparing (34) with (17). First, when the government partakes in negotiations, the different parties bargain about the total surplus from renegotiation rather than the shareholders and creditors' joint surplus. Thus renegotiation internalizes the externality, which shortens the delay via the surplus effect. Second, the bank gets an additional transfer $T(p')$, which is decreasing in p'. This reinforces the incentives to misreport the bank's situation as worse than it really is. This effect lengthens the delay via the signaling effect.

Corollary 4. *The impact of the government's bargaining power α is non-monotonic. If $\alpha \geq \alpha_2$, the manager does not make an offer to the government, and government involvement does not affect the outcome.*

For $\alpha < \alpha_2$, an increase in α reduces the share of the surplus that accrues to the bank, which lengthens the delay $\Delta_G(p)$, and reduces the bank's incentives to misreport, which goes in the other direction. As a result, a higher α can either lengthen or shorten the delay.

This corollary yields the surprising insight that the government may actually suffer from having too much bargaining power in the negotiation with the bank. Indeed, conditionally on the bank starting the negotiation process, the government is always better off ex post with a higher bargaining power. However, a high bargaining power may lead the bank to wait longer before making an offer, which may hurt the government ex ante.

Corollary 5. *Define:*

$$\alpha_3 = 1 - \frac{m+p}{\eta} \quad \text{and} \quad \alpha_4 = 1 - \frac{h(m+p)}{\eta} + \frac{1-h(1-m-p)}{2\eta} > \alpha_3. \tag{39}$$

If $\alpha \leq \alpha_3$, then $T(p)$ is increasing and $\dot{T}(p)$ decreasing in h. The impact of h on both T and $\dot{T}$ shortens the delay $\Delta_G(p)$.

If $\alpha \in (\alpha_3, \alpha_4)$, then $T(p)$ and $\dot{T}(p)$ are both decreasing in h. The impact of h on T and $\dot{T}$ may either shorten or lengthen the delay $\Delta_G(p)$.

If $\alpha \geq \alpha_4$, then $T(p)$ is decreasing and $\dot{T}(p)$ increasing in h. The impact of h on T and $\dot{T}$ lengthens the delay $\Delta_G(p)$.

Perhaps surprisingly, when $\alpha \leq \alpha_3$, the presence of a larger haircut on creditors actually weakens the bargaining position of the government, and leads to a larger transfer to the bank's shareholders. This is because haircuts affect both the creditors and the government's outside options. Indeed, when the haircut is larger the creditors obtain less absent renegotiation. They thus accept a lower repayment $R(p)$, which decreases the transfer the government makes to the shareholders. There is a second, less intuitive effect. When the haircut is larger, if $\eta > 1$ the government is hurt by haircuts ex post, as it is more efficient to bail-out the creditors than to suffer the externality. If so, larger

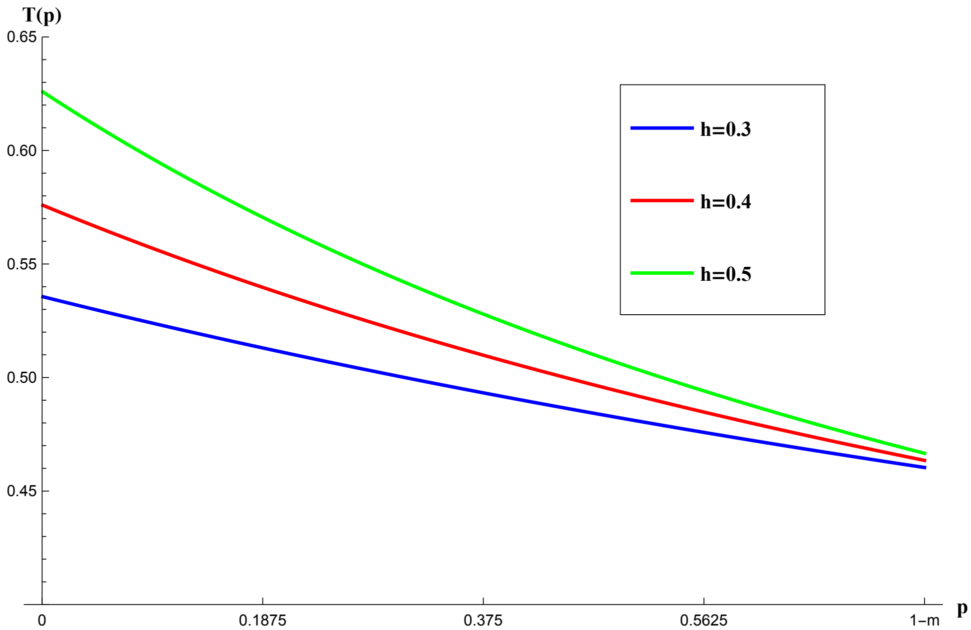

Figure 8: **Impact of haircuts on government transfers.** This graph plots $T(p)$ as a function of p for different levels of the haircut h.

haircuts make the government more willing to renegotiate, and haircuts weaken the government's bargaining position. Which effect dominates depends on α. If α is close to 1, the government has all the bargaining power and its outside option does not matter, so that the second effect is not present. If α is close to zero instead, the government has no bargaining power and the second effect is maximal. Figure 8 plots $T(p)$ in an example in which larger haircuts always increase transfers from the government.

To the extent that giving more surplus to the shareholders can help reach a quick agreement, the government may indirectly benefit from weakening its own bargaining position by using large haircuts. However, we also need to take into account the impact of h on the banks' incentives to misreport, which again can go both ways. Ultimately, we find that for low values of α the surplus and signaling effects of a higher haircut both shorten the delay, whereas for high values of α the opposite obtains.

4 Empirical Implications

Our model has implications for how the share price of a distressed bank should evolve over time, and how it is affected by the announcement of a restructuring. To see this, denote by $P^E(t)$ the market value of the bank if no announcement has yet been made after a delay of t, and $\bar{P}^E(t)$ its market value if a restructuring is accepted at time t. Similarly, denote by $P^C(t)$ and $\bar{P}^C(t)$ the value of the creditors' claims. For simplicity, we consider the framework of Section 2.

If at time t there still hasn't been a restructuring, shareholders and creditors expect that $p \leq \sigma(t)$. We thus have:

$$P^E(t) = \int_0^{\sigma(t)} \frac{[1 - e^{-\beta\Delta(p)}]p(X - R_0) + e^{-\beta\Delta(p)}(p + m)(X - R(p))}{F(\sigma(t))} f(p)dp \tag{40}$$

$$P^C(t) = \int_0^{\sigma(t)} \frac{[1 - e^{-\beta\Delta(p)}](1 - h(1 - p))R_0 + e^{-\beta\Delta(p)}(1 - h(1 - p - m))R(p)}{F(\sigma(t))} f(p)dp. \tag{41}$$

In case a restructuring is announced at time t, for any time $t' > t$ the value of the bank to the shareholders and creditors is:

$$\bar{P}^E(t) = [\sigma(t) + m](X - R(\sigma(t))) \tag{42}$$

$$\bar{P}^C(t) = [1 - h(1 - \sigma(t) - m)]R(\sigma(t)). \tag{43}$$

Since $\Delta(p)$ decreases in p, shareholders and creditors become more pessimistic about the soundness of the bank over time. Indeed, their expectation of p is $\mathbb{E}(p|p < \sigma(t))$. When a restructuring is announced, this expectation jumps upwards to $\sigma(t)$. We obtain the following:

Corollary 6. *The market prices of the bank's equity and debt decrease over time, conditionally on no restructuring being announced: $P^E(t)$ and $P^C(t)$ decrease in t.*

Both prices jump upwards when a restructuring is announced: $\bar{P}^E(t) > P^E(t)$ and $\bar{P}^C(t) > P^C(t)$.

Figure 9 illustrates the corollary. The second part is in line with the evidence in **?** that bank creditors receive restructuring offers positively. Note that in this model this obtains even though the creditors do not receive any rent in the restructuring (they receive exactly their outside option

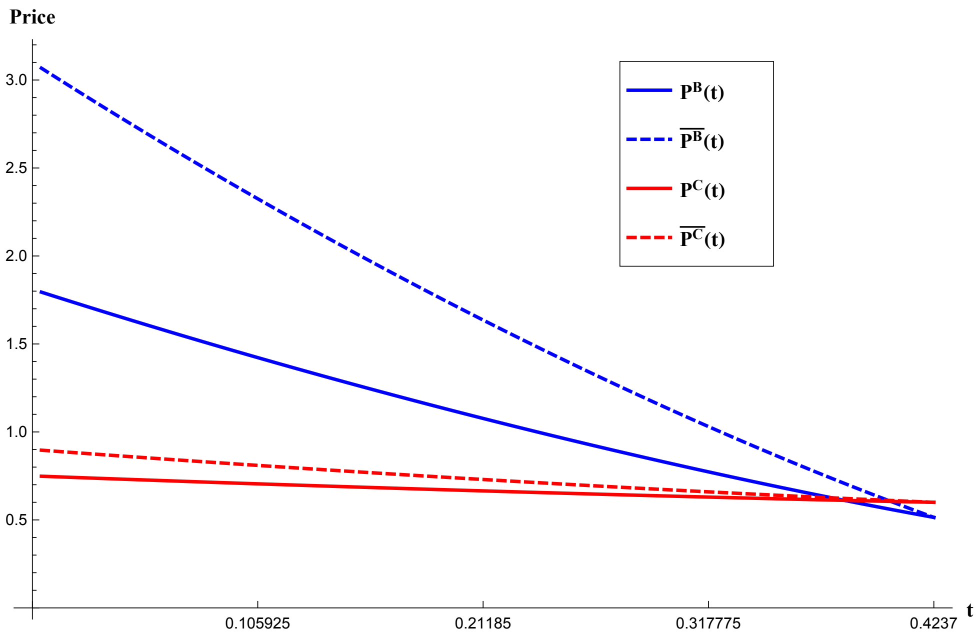

Figure 9: **Market value of equity and debt.** This graph plots the market values of equity and debt $P^E(t)$ and $P^C(t)$ over time, as well as $\bar{P}^E(t)$ and $\bar{P}^C(t)$. If restructuring occurs at time t, the equity value jumps from $P^E(t)$ to $\bar{P}^E(t)$, and the debt value from $P^C(t)$ to $\bar{P}^C(t)$.

$E_0(p)$). The jump upwards in the value of the creditors' claims is entirely driven by the positive signal that the restructuring sends about the soundness of the bank.

The first part of the corollary is a prediction that is quite specific to this model, and remains to be tested. Even in the absence of any restructuring event, prices should have a drift downwards in the model, because the delay in making a restructuring offer signals the weakness of the bank.

Recent papers have also looked at the impact of the European BRRD and the tightening of the resolution regime on market prices. In the model, we obtain the following prediction:

Corollary 7. *The market price of debt $P^C(t)$ is negatively affected by a larger haircut h. The market price of equity $P^E(t)$ can be affected either positively or negatively by a larger haircut h.*

The first point is consistent with recent papers such as **?** and **?**, and is quite intuitive: larger haircuts increase the creditors' losses in case of default. Since creditors have no bargaining power in this model, their payoff is always equal to $E_0(p)$, which decreases in h.

The effect on the price of the bank's equity is more ambiguous. The first effect of a larger haircut is to allow the bank to offer a lower $R(p)$ to creditors, which has a positive impact on the equity price. Creditors are more willing to renegotiate, as they have more to lose if they don't. The second effect is the impact of h on the delay $\Delta(p)$, which can be either positive or negative. In particular, if a larger h leads to a shorter delay (which happens for a given p when $h < h^*(p)$), we obtain the surprising result that the share price can increase when a tighter resolution regime is implemented. However, note that an important effect is missing from the model. Here the bank only has outstanding debt claims, and larger haircuts allow the bank to renegotiate payments downwards. If the bank could also issue new debt claims, haircuts would decrease their value and would hurt the shareholders' payoffs.

5 Possible extensions

The model can be extended in several ways to shed light on various policy questions.

TLAC/MREL. The bank in our model has three types of liabilities: equity, insured deposits, and uninsured debt. Uninsured debt can be interpreted as "bailinable" debt. It is clear in the model that it is easier to restructure the bank when it has more bailinable debt and less deposits. Indeed, if there is not sufficient 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. By adding an additional ex-ante stage at which the bank chooses its financing structure, one could study optimal capital requirements and "total loss absorbing capital" requirements. While the current model generates a relative advantage of bailinable debt over deposits, additional assumptions would be needed to fully understand the trade-off between the three sources of financing.

CoCos/Prompt Corrective Action. The model assumes that the bank can continue operating for a long time, even if it becomes clear after a sufficiently long delay that its assets are worth little. 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". Since the share price is monotonous in the delay, CoCos with a trigger based on the share price would have an equivalent effect in the model.

Compared to the baseline model, such a policy gives all types $p < \sigma(\bar{t})$ an incentive to restructure earlier, so as to avoid resolution. However, this also implies that by waiting more the types above $\sigma(\bar{t})$ can be pooled with weaker types than without the deadline. Hence, banks with a high p may wait longer to restructure. An interesting point to take into account in this trade-off is the fact that $\Delta(p)$ is convex. This means that as time passes an extra delay gives less and less information about the bank's type. Because of this effect, a high enough $\bar{t}$ comes at little cost.

Finally, it could be tempting in the model to set $\bar{t} = 0$, that is, to force the bank to renegotiate immediately with its creditors, who will then accept an offer R' corresponding to the average type of the bank. There is no cost associated with this policy in the model but, if the bank had to issue debt ex ante, not allowing creditors to learn about the bank's type ex post would be costly.

Bail-in rules. Bail-in rules are modeled in a crude way by assuming that the government will impose a fixed haircut h on outstanding debt in case a bail-out is necessary. One can use the model to study how alternative rules change the incentives to renegotiate the debt. For instance, an important incentive to delay restructuring in Section 2 is the externality of debt restructuring on the government: by agreeing to a write-down, uninsured creditors lose potential bailout benefits. An alternative rule that would alleviate this problem would be to lower the haircut if creditors agree to restructure, or to consider that by agreeing to restructure the creditors already suffered a haircut. Such a policy would lead to less delay via the surplus effect, but its signaling effect is not clear.

Supervision. Given that delays in restructuring the bank are due to asymmetric information, the model gives an important rationale for communicating supervisory information to investors, for instance through stress-tests.[19] 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 p. In particular, revealing that the bank's type is for sure lower than some threshold $\bar{p}$ reduces the equilibrium delay for all types below $\bar{p}$. Indeed, $\dot{\Delta}(p)$ will be the same as in the original model, but the zero of the function $\Delta(p)$ is in $p = \bar{p}$ instead of $p = 1 - m$.

[19] See for instance **?** on this more general issue.

Other forms of government intervention. The government may participate in the negotiation in ways other than just offering a lump-sum payment to the shareholders. In practice, governments intervene in a number of ways that are not equivalent in a framework with asymmetric information. For instance, if the government buys some of the bank's illiquid assets, the amount it has to buy to reach an agreement depends on the value p' reported by the manager, but the value of the transfer depends on the actual quality p of the bank's assets. Similarly, if the government injects equity into the bank, the impact on existing shareholders depends on the actual value of the bank's assets.

6 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, by affecting the negotiating parties' outside options, can either quicken or lengthen the negotiation process. It is clear in our framework that the details of the tools available to the bank and the government matter, and that different forms of debt restructurings, bail-ins, and bail-outs may have different 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, our model identifies the 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 quickens negotiations. The signaling effect is the fact that the resolution regime affects how sensitive the different parties' payoffs in the absence of an agreement 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 is a tension between these two objectives, and an optimal resolution regime needs to strike a balance between the surplus effect and the signaling effect.

A Appendix

A.1 Proof of Proposition 1

We prove that the following set of strategies and beliefs forms a perfect Bayesian Nash equilibrium:

Given the bank's type $p \in [0, 1-m]$, the manager waits $\Delta(p)$ before making an offer to reduce the debt's face value to $R(p)$.

If the creditors receive an offer after a delay $t \in [0, \Delta(0)]$, they expect p to be equal to $\Delta^{-1}(t)$ and accept an offer to reduce the debt's face value to R' if and only if $R' \geq R(\Delta^{-1}(t))$.

If the creditors receive an offer R' after a delay $t > \Delta(0)$, we allow them to have any expectation $\hat{\sigma}(t) \in [0, 1-m]$ about p. They accept the offer if and only if $R' \geq R(\hat{\sigma}(t))$.

1. We first need to prove that the bank manager's strategy is optimal. Given the creditors' strategy, it is clear that if the manager chooses a delay t, it is optimal to make the offer $R(\Delta^{-1}(t))$.

Waiting for $t > \Delta(0)$ can never be optimal, irrespective of the creditors' beliefs. Indeed, if the manager makes an offer $R' = R(\hat{\sigma}(t))$ after a delay $t > \Delta(0)$, he can obtain the same debt write-down after a shorter delay by waiting $\Delta(\hat{\sigma}(t)) < t$ instead.

Thus, we only need to prove that a type p manager prefers waiting for $t = \Delta(p)$ rather than any other $t' \in [0, \Delta(0)]$. This is equivalent to showing that reporting $p' = p$ maximizes $U^E(p', p)$ in p'.

We proved in the main text that $\dot{\Delta}(p)$ is such that $p' = p$ satisfies the first-order condition of the manager's maximization program. It remains to check that this solution is indeed a maximum. We have:

$$U_{11}^E(p', p) = -\beta e^{-\beta\Delta(p')}[E_1(p', p) - \beta\dot{\Delta}(E(p', p) - E_0(p))] \\ + e^{-\beta\Delta(p')}[E_{11}(p', p) - \beta\ddot{\Delta}(p')(E(p', p) - E_0(p)) - \beta\dot{\Delta}(p')E_1(p', p)]. \tag{A.1}$$

Using (12) and rearranging, we obtain:

$$\begin{aligned}
U_{11}^E(p,p) \leq 0 &\Leftrightarrow -E_{12}(p,p)[E(p,p) - E_0(p)] + E_1(p,p)E_2(p,p) - \dot{E}_0(p) \leq 0 \\
&\Leftrightarrow \dot{R}(p)[p(R_0 - R(p)) - c + m(X - R(p))] - (p+m)\dot{R}(p)(X - R) - (X - R_0) \leq 0 \\
&\Leftrightarrow -\dot{R}(p)[c + p(X - R_0)] - (X - R_0) \leq 0. \qquad \text{(A.2)}
\end{aligned}$$

The last inequality is true, which shows that reporting $p' = p$ maximizes $U^E(p', p)$ in p' (at least locally).

2. Second, we have to show that the creditors' strategy is optimal given their beliefs. Indeed, by definition of R in (3), when creditors believe that the bank's type is p' they accept an offer to write-down the repayment to R' if and only if $R' \geq R(p')$.

3. Finally, the creditors' beliefs have to be consistent with the bank manager's equilibrium behavior. For $t \in [0, \Delta(0)]$, the only thing we need is that $\Delta^{-1}(t)$ is well-defined. This is the case, as we showed in the text that Δ is a strictly decreasing function. On the equilibrium path, delays $t > \Delta(0)$ are never observed, so that any belief is consistent with a Bayesian Nash equilibrium.

A.2 Proof of Corollary 1

We proved in the main text that $\dot{\Delta}(p) < 0$. Differentiating (19) with respect to p gives:

$$\ddot{\Delta}(p) = \frac{mh^2R_0[(1-h)^2mR_0 - (mX - c)(1 - h(1-p-m))(1 - h(1+p+m))]}{\beta[1 - h(1-p-m)]^2[(mX - c)[1 - h(1-p-m)] - m(1-h)R_0]^2} \qquad \text{(A.3)}$$

We can rewrite the numerator as:

$$mh^2R_0[h^2(m+p)^2(mX - c) + (1-h)^2(c - m(X - R_0))]. \qquad \text{(A.4)}$$

Using (H1), this expression is positive.

A.3 Proof of Corollary 2

The first part of the corollary follows from differentiating (13) and (14) with respect to h.

For the second part, we first prove equation (20). Define $\mu = \frac{mR_0}{mX-c}$ and $\pi = 1-p-m$. Note that $\mu > 1$. We can rewrite (20) as:

$$\Delta(p) = \frac{1-\mu}{\beta}\ln\left[\frac{1-h\pi-\mu(1-h)}{1-\mu(1-h)}\right] - \frac{1}{\beta}\ln\left[1-h\pi\right]. \tag{A.5}$$

Differentiating with respect to p, we have:

$$\begin{aligned}\beta\dot{\Delta}(p) &= \frac{(1-\mu)h}{1-h\pi-\mu(1-h)} - \frac{h}{1-h\pi} \\ &= \frac{-\mu h^2(p+m)}{[1-h\pi-\mu(1-h)][1-h\pi]}.\end{aligned}$$

which is expression (19). We can also check that $\Delta(1-m)=0$.

To prove the second part of the corollary, we differentiate (A.5) with respect to h:

$$\frac{\partial\Delta(p)}{\partial h} = \frac{(1-\mu)(\mu-\pi)}{\beta(1-h\pi-\mu(1-h))} + \frac{\pi}{\beta(1-h\pi)} - \frac{\mu(1-\mu)}{1-\mu(1-h)}. \tag{A.6}$$

After rearranging and simplifying, this quantity is positive if and only if:

$$h(\mu-\pi)-(2-\pi)(\mu-1) \geq 0. \tag{A.7}$$

This quantity increases in h, and is null in $h = h^*(p)$. Thus, $\Delta(p)$ decreases in h for $h \leq h^*(p)$, and increases for $h \geq h^*(p)$. The condition $m \leq 1/2$ ensures that $h^*(p) \leq 1$ for any p. Moreover, differentiating $h^*(p)$ we observe that this quantity increases in p if and only if $mX - c + m(X - R_0) - c \leq 0$, which is not compatible with (H2) and $m \leq 1/2$. Hence, h^* decreases in p.

We then need to study when $h^*(p)$ is larger than $h_{\min}$. First, direct computations show that $h^*(1-m) < h_{\min}$ when $m \leq 1/2$. Second, we obtain that $h^*(0) \geq h_{\min}$ is equivalent to:

$$m(X-R_0)-c > \frac{-m^3R_0}{1-m}. \tag{A.8}$$

The Corollary follows, with the value $\bar{p}$ being such that $h^*(\bar{p}) = h_{\min}$.

A.4 Proof of Proposition 2

Consider the first point. We compute:

$$\frac{\partial R(p)}{\partial h} = \frac{-mR_0}{[1-h(1-p-m)]^2} < 0. \tag{A.9}$$

We then obtain that $\partial U^G(p,p)\partial h = 0$ is equivalent to:

$$\begin{aligned}\beta\frac{\partial \Delta(p)}{\partial h}e^{-\beta\Delta(p)}(G(p,p)-G_0(p)) &= (1-\eta)\left[R_0(1-p)(1-e^{-\beta\Delta(p)}) - e^{-\beta\Delta(p)}R(p)(1-p-m)\right] \\ &+ e^{-\beta\Delta(p)}\frac{mR_0(1-p-m)(1-h(1-\eta))}{(1-h(1-p-m))^2}. \end{aligned}\tag{A.10}$$

When $\eta \leq 1$ the right-hand side is positive, so that $\frac{\partial\Delta(p)}{\partial h} \geq 0$. Using Corollary 2, this shows that $h^{**}(p) \geq h^*(p)$.

Turning now to the second point, we simply observe that:

$$\frac{\partial U_2^G(p,h)}{\partial D} = -\beta m \frac{\partial \Delta(p)}{\partial h}e^{-\beta\Delta(p)}, \tag{A.11}$$

which has a sign opposite to $\frac{\partial\Delta(p)}{\partial h}$. Using again Corollary 2, this shows the second point.

A.5 Proof of Lemma 1

We have already shown that $T(p)$ decreases in p, and it is clear from (28) that $T(p)$ is decreasing in α. We just need to define α_1 as the value of α such that $T(1-m)=0$ and α_2 as the value such that $T(0)=0$. Using (29), we obtain the quantities given in the Lemma. The variation of T with respect to p and α implies that $\alpha_1 \leq \alpha_2$. From the analytical expressions of α_1 and α_2, is it clear that these quantities are both positive. Moreover, we have:

$$\alpha_1 \leq 1 \quad \Leftrightarrow \quad m(X-R_0)+mhR_0 \geq c \tag{A.12}$$

$$\alpha_2 \leq 1 \quad \Leftrightarrow \quad (mX-c)(1-h(1-m)) - m(1-h)R_0 \geq 0. \tag{A.13}$$

Both inequalities are implied by (H2).

A.6 Proof of Proposition 3

We prove that the following set of strategies and beliefs forms a perfect Bayesian Nash equilibrium:

Given the bank's type $p \in [0, 1-m]$, the manager waits $\Delta_G(p)$ before making an offer. If $p \geq \bar{p}_T$, the managers offers the creditors to reduce the debt's face value to $R(p)$. If $p > \bar{p}_T$, the manager makes a joint offer to the creditors to reduce the debt's face value to $R(p)$ and to the government to make a lumpsum transfer $T(p)$ to the shareholders. The restructuring is implemented if both the government and the creditors accept the offer.

If the creditors receive an offer after a delay $t \in [0, \Delta_G(0)]$, they expect p to be equal to $\Delta_G^{-1}(t)$ and accept an offer to reduce the debt's face value to R' if and only if $R' \geq R(\Delta_G^{-1}(t))$. If the creditors receive an offer R' after a delay $t > \Delta_G(0)$, we allow them to have any expectation $\hat{\sigma}(t) \in [0, 1-m]$ about p. They accept the offer if and only if $R' \geq R(\hat{\sigma}(t))$.

If the government receives an offer after a delay $t \in [0, \Delta_G(0)]$, it expects p to be equal to $\Delta_G^{-1}(t)$ and accepts to transfer T' to the shareholders if and only if $T' \leq T(\Delta_G^{-1}(t))$. If the government receives an offer T' after a delay $t > \Delta_G(0)$, we allow the government to have any expectation $\hat{\sigma}(t) \in [0, 1-m]$ about p. It accepts the offer if and only if $T' \leq T(\hat{\sigma}(t))$.

If the government rejects an offer by the bank, it can make a counter-offer after a minimum delay of t_0, and the game of alternating offers described in Section 1 follows. The equilibrium of this subgame is such that the government is indifferent between accepting and rejecting an offer $T(\Delta_G^{-1}(t))$.

1. The delay Δ_G was derived so as to maximize the manager's payoff $U^E(p', p)$ over $p' \in [0, 1-m]$ precisely in $p' = p$. As in Section 2, there is no incentive to wait for $t > \Delta_G(0)$.

2. The creditors' behavior is optimal given their beliefs, by definition of $R(p)$ in (3).

3. The alternating offers game that starts when the managers makes an offer to the government is a standard bargaining game under symmetric information, since in the proposed equilibrium the government's belief about the bank's type after receiving an offer is always a degenerate distribution.

The function T is precisely such that the government is indifferent. See for instance **?** or **?**. The government's behavior when it receives an offer is thus optimal given its beliefs about p.

4. The creditors and the government's beliefs about p if they receive an offer after a delay $t \in [0, 1-m]$ is consistent with the manager's behavior. The perfect Bayes Nash equilibrium concept does not impose any restriction on beliefs after observing a longer delay.

Finally, we report additional closed-form expressions, used in particular in the simulations:

$$\bar{p}^T = \frac{mR_0[1-h+h(1-\alpha)\eta] - (1-h(1-m))[\alpha(mX-c)-(1-\alpha)mD]}{h[\alpha(mX-c)-(1-\alpha)mD]}. \tag{A.14}$$

For $p \leq \bar{p}^T$, write $\hat{\Delta}_G(p)$ a primitive of $\dot{\Delta}_G(p)$:

$$\begin{aligned}\hat{\Delta}_G(p) = &-\frac{1}{\beta}\ln[1-h(1-p-m)] \\ &- \frac{mR_0-(1-\alpha)(m(X+D)-c)}{\beta(1-\alpha)[m(X+D)-c]}\ln[(1-h(1-p-m))(m(X+D)-c)+hmR_0\eta].\end{aligned} \tag{A.15}$$

We have:

$$\Delta_G(p) = \hat{\Delta}_G(p) + \Delta(\bar{p}_T) - \hat{\Delta}(\bar{p}_T) \tag{A.16}$$

A.7 Proof of Corollary 3

See the main text.

A.8 Proof of Corollary 4

We only need to prove the second part of the Corollary. Observe that:

$$\frac{\partial \dot{T}(p)}{\partial \alpha} = [(R_0 - R(p)) + \dot{R}(p)(1-p-m)]h(\eta-1) + \dot{R}(p). \tag{A.17}$$

This expression is increasing in η, and it is equal to $\frac{mh(1-h)R_0}{1-h(1-p-m)}$ when $\eta = 0$. Hence, it is always positive. This shows that the quantity $-[B_1(x,x)+\dot{T}(x)]$ in (34) decreases in α. From the expression of $T(p)$ in (28), it is obvious that $T(p)$ and hence $[E(p,p)+T(p)-E_0(p)]$ are decreasing in α.

A.9 Proof of Corollary 5

We differentiate $T(p)$ and $\dot{T}(p)$ with respect to h:

$$\frac{\partial T(p)}{\partial h} = \frac{mR_0[(1-\alpha)\eta - (m+p)]}{[1-h(1-m-p)]^2} \tag{A.18}$$

$$\frac{\partial \dot{T}(p)}{\partial h} = \frac{-mR_0[1-h(1-m-p) - 2h(m+p) + 2(1-\alpha)\eta}{[1-h(1-m-p)]^2}. \tag{A.19}$$

The first expression is decreasing in α and null in $\alpha = \alpha_3$. The second expression is increasing in α and null in $\alpha = \alpha_4$. The Corollary follows.

A.10 Proof of Corollary 6

To prove that $P^E(t)$ decreases in t it is sufficient to show that the value of the bank to shareholders increases in p. This is equivalent to:

$$\beta\dot{\Delta}(p)[p(X-R_0)-(p+m)(X-R(p))] + (X-R_0)(1-e^{-\beta\Delta(p)}) + e^{-\beta\Delta(p)}(X-R(p)-(p+m)\dot{R}(p)) \geq 0$$
$$\Leftrightarrow -\beta\dot{\Delta}(p)[p(R_0-R(p)) + m(X-R(p))] + (X-R_0) + e^{-\beta\Delta(p)}[R_0 - R(p) - (p+m)\dot{R}(p)] \geq 0. \tag{A.20}$$

We have $R_0 - R(p) \geq 0$, $X - R(p) \geq 0$, $X - R_0 \geq 0$, and it can be checked that $R_0 - R(p) - (p+m)\dot{R}(p) \geq 0$. Since $\dot{\Delta(p)} < 0$, inequality (A.20) holds. This implies both that $P^E(t)$ decreases in t and that $\bar{P}^E(t) \geq P^E(t)$.

The proof is direct for creditors. Indeed, they receive $C_0(p)$ regardless of whether restructuring takes place or not. Hence we have $P^C(t) = \mathbb{E}(C_0(p)|p \leq \sigma(t))$ and $\bar{P}^C(t) = C_0(\sigma(t))$. As $C_0(p)$ increases in p and $\sigma(t)$ decreases in t, we deduce that $P^C(t)$ decreases in t and $P^C(t) \leq \bar{P}^C(t)$.

A.11 Proof of Corollary 7

The result for creditors is a direct consequence of the fact that $C_0(p)$ decreases in h for any p.

To understand why the impact on the shareholders is ambiguous, we can write the derivative of the shareholders' payoff, conditional on a given p, with respect to h as:

$$e^{-\beta\Delta(p)}\left(-\beta\frac{\partial\Delta(p)}{\partial h}[p(R_0 - R(p)) + m(X - R(p))] - \frac{\partial R(p)}{\partial h}(p+m)\right). \tag{A.21}$$

We have $\frac{\partial R(p)}{\partial h} \leq 0$, so that the second effect is positive. The first effect depends on the sign of $\frac{\partial\Delta(p)}{\partial h}$, which depends on whether h is larger than $h^*(p)$. For $h \leq h^*(p)$, we know that $\frac{\partial\Delta(p)}{\partial h} \leq 0$ and the impact of h on the shareholders' payoff is positive.

A.12 Parameters used in the figures

We use the following parameters in all the figures: $X = 4$, $m = 0.25$, $k = 0.76$, $R_0 = 1$, $\beta = 1$, and F is the cdf of the uniform distribution over $[0, 1-m]$.

In addition, Figures 2 and 3 use $h = 0.3$.

Figure 4 uses four values of p: $0, (1-m)/3, (1-m)/2, 3(1-m)/4$.

Figures 5 and 6 use three values of the pair (η, D): $(1, 1), (1, 0.5)$, $(1.5, 1)$.

Figure 7 uses $h = 0.75$ and $\alpha = 0.8$.

Figure 8 uses $\alpha = 0.1$, and three values of h: 0.3, 0.4, and 0.5.

Figure 9 uses $h = 0.4$.