Financial Restructuring and Resolution of Banks*

Jean-Edouard Colliard Denis Gromb

April 24, 2019

Abstract

How do resolution frameworks affect the private restructuring of distressed banks? We model a distressed bank's shareholders and creditors negotiating a restructuring given asymmetric information about asset quality and externalities onto the government. This yields 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 this can lead to shorter or longer delays. Notably, the government may gin from committing not to partake in negotiations.

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

JEL classification: G21, G28.

*Correspondence: colliard@hec.fr and gromb@hec.fr. Both authors are at HEC Paris, Department of Finance, 1 rue de la Libération, 78351 Jouy-en-Josas, France. We are grateful to Darrell Duffie, Paolo Fulghieri, Andrew Gracie, Matthias Kahl, Fausto Panunzi, Thomas Philippon, Jessie Wang, Lucy White, participants to the 2017 DNB-Riksbank Macroprudential Conference, the 2017 BAFFI CAREFIN-Intesa Banking Conference, the 14th Annual Corporate Finance Conference at Washington University, the 4th CSEF Banking Conference in Naples, the 3rd annual Chicago Financial Institutions Conference, and seminar participants at the Copenhagen Business School, HEC Paris, Católica Lisbon School of Business and Economics, the University of Amsterdam, the University of Porto, the University of Vienna, for helpful comments and suggestions. We thank Chhavi Rastogi for excellent research assistance. Financial support from the Chair ACPR/Risk Foundation: Regulation and Systemic Risk is gratefully acknowledged.

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 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.[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?

[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 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 becomes useless and breaks down.

As a benchmark case, assume that the manager and the creditors are equally informed about the quality of the bank's assets. In principle, debt renegotiation can achieve the jointly efficient outcome with certainty: the total value of debt and equity being higher, the manager can exchange the existing debt against new claims such that shareholders and creditors are all 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, so that 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 patient in that he 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

[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.

its efficiency.

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,

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

the regulatory authority should commit to triggering bail-ins after the public release of negative 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

[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).

procedures imply less efficient ex ante bargaining, which is close to what we call the "surplus effect". 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. Sections 4 and 5 cover empirical implications and extensions. Section 6 concludes. Proofs omitted in the text are in the Appendix.

1 The Model

We develop a model of the restructuring and resolution of banks in financial distress. We assume universal risk-neutrality and no discounting.

Banks. We model a bank with a stylized balance sheet. On the asset side, risky assets (e.g., loans) of quality $\theta \in [0, 1]$ yield a cash-flow $Z > 0$ with probability θ or 0 otherwise. On the liability side are government-insured deposit D, unsecured liabilities with face value R_0, and equity.[8]

Resolution. If the assets yield Z, depositors and creditors are paid in full: defining $X = Z - D$, we assume $R_0 < X$. However if they pay 0, the bank defaults and enters resolution: depositors are made whole by the government, shareholders receive 0, and unsecured creditors are bailed-out by

[8] As the assets pay zero in case of default, the relative seniority of depositors and unsecured creditors plays no role.

the government with probability $(1-h)$, in which case they are made whole, but get 0 otherwise. Parameter h, the probability of a bail-in, is also equivalent to a fixed fraction h of the unsecured debt's face value being bailed in. Hence we refer to h as a haircut.[9]

Financial distress. The bank can improve its assets' quality at a cost: investing $I > 0$ reduces the probability that the assets yield 0 from $(1-\theta)$ to $m(1-\theta)$ with $m \in (0,1)$.[10] (Note that the lower the quality θ of the bank's assets, the greater the investment's impact). Yet shareholders do not capture the investment's full value: the reduced default probability creates a surplus $m(1-\theta)hR_0$ for creditors. If the surplus left for shareholders is negative, they will not bear the cost I even if the joint surplus would be positive. In that case, the bank faces a debt overhang problem.

We assume that such a situation can indeed arise, at least for banks of the lowest quality possible ($\theta = 0$) and absent bailouts ($h = 1$). In this situation, the surplus created for shareholders and creditors is simply $(mX - I)$ and that for creditors alone mR_0. Hence, assuming that the joint surplus is positive but less than that created for creditors is written:

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

Restructuring. In case of a debt overhang problem, it would be optimal for shareholders and creditors to engage in financial restructuring, i.e., renegotiate their claims, so that shareholders can also gain from the investment and both shareholders and creditors are better off. Absent frictions, restructuring would yield the jointly efficient outcome (Haugen and Senbet (1978)). Instead, we assume that the bank's manager (acting on its existing shareholders' behalf) knows θ while other players only know its distribution $F(\cdot)$ over $[0,1]$. Thus negotiations take place under asymmetric information about the assets' quality.

We consider a restructuring process in which the manager chooses the restructuring plan to offer creditors and when to offer it. First, the manager chooses a restructuring plan whereby creditors

[9]For instance, the European Bank Recovery and Resolution Directive (BRRD) requires that a minimum 8% of the banks' liabilities be bailed-in before the Single Resolution Fund (SRF), the EU-level fund aimed at resolving failing banks, can be used.

[10]One interpretation of I is as an opportunity cost for existing creditors. For instance, if liquidated immediately, some outstanding loans could generate I to be paid immediately to existing creditors, but if rolled over, generate Z with probability m. Rolling over the loans would involve creditors forgoing an immediate payment I and extending the maturity of their debt with a new higher face value.

contribute I and replace their debt R_0 with new debt R.[11] We assume that creditors accept any offer improving their payoff relative to the status quo.[12] We also assume that they extend better terms, i.e. lower R, for banks they believe to be of higher quality which we later show to require:

$$(1-m)I > mR_0 \tag{H2}$$

Second, the manager chooses the timing $t \in \mathbb{R}_+$ of his offer. As we will see, timing can be used to signal the bank's quality. Delaying the offer involves risks: in each time period dt, there is a probability βdt that the investment is no longer possible, so that restructuring can no longer create surplus, and negotiations break down. Otherwise, the game continues until the manager gets an offer accepted or negotiations break down. (For simplicity, the manager cannot make further offers after one has been accepted.)

Government. We assume that the government designs the resolution framework, i.e., sets h. Its aims are to avoid the negative economic impact of a bail-in (e.g., domino effect on other financial institutions) and to minimize the bailout cost to taxpayers. Thus, we assume that the government bears a cost $\eta \geq 0$ per dollar of face value of debt bailed in, and a cost $(1+\lambda)$ per dollar used in bailouts, with $\lambda \geq 0$ representing a shadow cost of public funds (e.g. due to distortionary taxation).[13] Therefore, if the bank owes R to its creditors and defaults, the government's payoff is

$$-\left[(1+\lambda)D + \eta h R + (1+\lambda)(1-h)R\right]. \tag{1}$$

2 Private Restructuring

We first study the case of purely private restructuring in which negotiations involve only the bank's manager (acting on the shareholders' behalf) and creditors, but not the government.

The model is a signaling game in which the manager uses his offer's delay to signal the assets'

[11]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 claims 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 assumed form.

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

[13]Here η is a genuine social cost but other interpretations are possible, e.g. political losses for the government.

quality θ. We focus on fully separating perfect Bayesian Nash equilibria: the bank's type θ maps one-to-one into a delay $\Delta(\theta)$. Solving for an equilibrium consists in solving for the function $\Delta(\cdot)$.

2.1 Optimal Restructuring Plans

To start with, we characterize the optimal restructuring plan the manager offers the creditors as a function of the perceived quality of the bank's assets.

We begin with payoffs in the absence of restructuring. These constitute the parties' outside options in the negotiations. If negotiations break down, the debt's face value remains R_0 and the investment is foregone. Thus, if the bank has assets of quality θ, the shareholders and uninsured creditors' expected payoffs are:

$$E_0(\theta) = \theta(X - R_0), \tag{2}$$

$$C_0(\theta) = [1 - (1 - \theta)h]R_0. \tag{3}$$

That is, the shareholders' payoff is $(X - R_0)$ provided the bank does not default, which occurs with probability θ, and zero otherwise; the creditors get paid R_0 in full unless the bank defaults, which occurs with probability $(1 - \theta)$, in which case they suffer a proportional haircut h.

Now consider the manager's optimal offer to creditors if they believe the bank to be of type $\hat{\theta}$. The value creditors ascribe to an offer to fund I against a new debt face value R is:

$$[1 - (1 - \hat{\theta})(1 - m)h]R - I. \tag{4}$$

That is, the creditors pay the cost I and in return get paid the new face value R in full unless the bank defaults, which occurs with probability $(1 - \theta)(1 - m)$, in which case they suffer a haircut h.

Hence, assuming the manager actually makes an offer, his optimal offer $R(\hat{\theta})$ makes creditors indifferent between accepting and rejecting it, i.e., the value they ascribe to it equals $C_0(\hat{\theta})$. Thus

$$R(\hat{\theta}) = \frac{[1 - (1 - \hat{\theta})h]R_0}{[1 - (1 - \hat{\theta})(1 - m)h]} + \frac{I}{[1 - (1 - \hat{\theta})(1 - m)h]} \tag{5}$$

The first term, which is smaller than R_0, corresponds to a write-down creditors concede on the existing debt to relax the debt overhang problem. The second term corresponds to the financing of I on competitive terms. (Whether this funding is provided by existing creditors or new financiers is immaterial to our analysis).

Consider a bank with assets of actual quality θ and quality $\hat{\theta}$ as perceived by the creditors. Assuming the bank's manager actually makes offer $R(\hat{\theta})$, in which case it is accepted by creditor, the shareholders and creditors' expected payoffs are:

$$E(\hat{\theta},\theta) = [1-(1-\theta)(1-m)][X-R(\hat{\theta})], \tag{6}$$

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

The shareholders' payoff is as in the status quo except for the lower default probability, $(1-\theta)(1-m)$, and the new face value, $R(\hat{\theta})$. The creditors' payoff is as in the status quo except for the lower default probability, the new face value and the investment cost.

Two points are in order regarding the shareholders' expected payoff $E(\hat{\theta},\theta)$. First, this is the expected payoff assuming the manager proposes a restructuring plan. However, he will do so only if this makes shareholders better off than under the status quo, a condition we can characterize.

Lemma 1. *For a bank of actual quality θ and quality $\hat{\theta}$ as perceived by creditors, a threshold $\theta^*(\hat{\theta}) \in [0,1)$ exists such that it is optimal for the manager to propose a restructuring plan with $R(\hat{\theta})$ if $\theta \in [0,\theta^*(\hat{\theta}))$ and not to propose a restructuring plan and to maintain the status quo otherwise.*

The shareholder's surplus $E(\hat{\theta},\theta) - E_0(\theta)$ decreases with θ because the investment is less useful for higher quality banks, as their lower default risk means that both the increase in cash flow and that in expected bailout are lower. Moreover, that surplus is negative for $\theta = 1$ since absent default risk, both increases equal zero, and shareholders only bear the investment cost I. Hence, we can define a unique $\theta^*(\hat{\theta}) \in [0,1)$ as the smallest θ such that $E(\hat{\theta},\theta) \leq E_0(\theta)$.

Second, the expression for $E(\hat{\theta},\theta)$ sheds light on the manager's incentive to influence the creditors' belief about the bank's quality. Indeed, whether the shareholders are better or worse off when creditors believe the bank's quality to be higher simply depends on whether this belief leads to a higher or lower $R(\hat{\theta})$, the debt's face value post-restructuring. We have:

$$\dot{R}(\hat{\theta}) = \frac{hmR_0}{[1-(1-\hat{\theta})(1-m)h]^2} - \frac{h(1-m)I}{[1-(1-\hat{\theta})(1-m)h]^2} \tag{8}$$

Thus, how the new face value $R(\hat{\theta})$ varies with the bank's perceived quality $\hat{\theta}$ results from two opposite effects each captured by a term in expression (8). On the one hand, if creditors perceive $\hat{\theta}$ to be high, they view the value of their existing claims as high, and are thus willing to concede only a smaller write-down against what they view as a small improvement to asset quality. On the other hand, for the same reason, the financing of I at competitive terms requires a smaller face value because the perceived default risk is smaller.

Which effects dominates and thus whether banks of higher perceived quality get better or worse terms in restructuring depends on the sign of $mR_0 - (1-m)I$.

Lemma 2. *Under assumption (H2), banks perceived by creditors to be of higher quality $\hat{\theta}$ get better terms in restructuring $R(\hat{\theta})$, i.e., $\dot{R}(\hat{\theta}) < 0$.*

2.2 Equilibrium Restructuring Delays

We can now derive the manager's equilibrium strategy given the actual quality of the bank's assets.

In a separating equilibrium, the highest-quality banks will simply not engage in restructuring. Indeed, for these banks, restructuring is creating no joint surplus for the shareholders and creditors, and in a separating equilibrium, creditors cannot be "fooled" into accepting a negative surplus.

Lemma 3. *A threshold $\theta^* \in [0,1)$ exists such that in any separating equilibrium, the manager does not propose a restructuring plan and maintains the status quo if and only if $\theta \in [\theta^*, 1]$.*

Now consider a bank of quality $\theta \in [0, \theta^*)$. Suppose that creditors believe that the manager of a bank of quality θ will delay making the optimal offer $R(\theta)$ by an amount of time $\Delta(\theta)$.

Consider the problem of the manager of a bank of actual quality θ. Following the literature on bargaining under asymmetric information (e.g., Ausubel *et al.* (2002)), it amounts to choosing which type $\hat{\theta}$ to pretend the bank to be, which the manager can do by delaying his offer by $\Delta(\hat{\theta})$. If so, there is a probability $(1 - e^{-\beta\Delta(\hat{\theta})})$ that negotiations break down before time $\Delta(\hat{\theta})$, in which case the shareholders get the status quo payoff $E_0(\theta)$. Conversely, if negotiations reach time $\Delta(\hat{\theta})$, which occurs with probability $e^{-\beta\Delta(\hat{\theta})}$, the manager's optimal offer $R(\hat{\theta})$ is accepted by the creditors, and the shareholders' expected payoff is $E(\hat{\theta}, \theta)$. Overall, the shareholders' expected payoff is:

$$U^E(\hat{\theta}, \theta) = [1 - e^{-\beta\Delta(\hat{\theta})}]E_0(\theta) + e^{-\beta\Delta(\hat{\theta})}E(\hat{\theta}, \theta). \tag{9}$$

A necessary condition for equilibrium is that the manager's action be optimal given the creditors' beliefs. Here this means that for all $\theta \in [0, 1]$, $U^E(\hat{\theta}, \theta)$ is maximized for $\hat{\theta} = \theta$. Differentiating the expression for $U^E(\hat{\theta}, \theta)$ with respect to $\hat{\theta}$, we obtain the following first order condition:

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

This condition captures the trade-off involved for the manager when, having reached time $\Delta(\hat{\theta})$, he is considering further delaying his offer. Without further delay, the manager would offer $R(\hat{\theta})$ and shareholders' expected payoff would be $E(\hat{\theta}, \theta)$. An extra delay $\dot{\Delta}(\hat{\theta})d\hat{\theta}$ would be needed to change the creditors' belief about the bank's quality by $d\hat{\theta}$. This marginal delay would have two effects. On the one hand, if negotiations continue, the payoff shareholders obtain from the renegotiation increases by $E_1(\hat{\theta}, \theta)d\hat{\theta}$. This is the marginal benefit of delaying the offer. On the other hand, the manager must also account for the fact that due to the longer delay, the likelihood that negotiations break down increases by $\beta\dot{\Delta}(\hat{\theta})d\hat{\theta}$, in which case shareholders get $E_0(\theta)$, hence an opportunity cost of $E(\hat{\theta}, \theta) - E_0(\hat{\theta})$. This is the marginal cost of delaying the offer.

For $\hat{\theta} = \theta$ to be optimal, the marginal benefit of delaying the offer must equal its marginal cost, i.e., we must have $U_1^E(\theta, \theta) = 0$ which can be written as:

$$\dot{\Delta}(\theta) = \frac{E_1(\theta, \theta)}{\beta[E(\theta, \theta) - E_0(\theta)]}. \tag{11}$$

Note that in equilibrium, the shareholders of a bank of the lowest quality possible, $\theta = 0$, obtain the least favorable terms. Hence, it must be that for this bank quality, the manager does not wait to make an offer (i.e., $\Delta(0) = 0$), as a deviation would otherwise be profitable. Given this, we have:

$$\forall \theta \in [0, \theta^*), \quad \Delta(\theta) = \int_0^\theta \frac{E_1(x,x)}{\beta[E(x,x) - E_0(x)]} dx. \tag{12}$$

This expression shows that two factors determine equilibrium delays.

First, the numerator, $E_1(\theta, \theta)$, reflects the sensitivity of the shareholders' payoff to the creditors' belief $\hat{\theta}$ about the bank's quality. The higher this sensitivity, the higher the shareholders' benefit from "lying-by-delaying". Hence a larger value of $E_1(\theta, \theta)$ leads to longer delays because it takes longer for higher quality banks to separate from lower quality banks. We say that a variable has a positive *signaling effect* on the delay when it increases the delay by increasing $E_1(\theta, \theta)$.

Second, the denominator, $[E(\theta, \theta) - E_0(\theta)]$, is the shareholders' gain from an immediate restructuring. Here, because shareholders extract all the surplus, that gain coincides with the joint surplus created for shareholders and creditors. The potential loss of that surplus due to negotiations breaking down is the cost of waiting. If this surplus goes to zero, the delay goes to infinity, and so the probability of a negotiation breakdown before an agreement is reached goes to one, i.e., no negotiation takes place. Conversely, a larger surplus leads to shorter delays because the cost needed for higher quality banks to separate is reached after a shorter delay. We say that a variable has a positive *surplus effect* on the delay when it increases the delay by decreasing $[E(\theta, \theta) - E_0(\theta)]$.

We can now characterize the separating equilibrium.

Proposition 1. *A separating perfect Bayesian Nash equilibrium exists in which the following holds.*

- *If the bank's quality is $\theta \in [0, \theta^*)$, the manager waits $\Delta(\theta)$ before making a restructuring offer $R(\theta)$ which creditors accept immediately, with $R(\theta)$ decreasing in θ and $\Delta(\theta)$ increasing in θ defined by (5) and (12), respectively.*

- *If the bank's quality is $\theta \in [\theta^*, 1]$, the manager makes no restructuring offer and does not make the investment.*

That $\Delta(\theta)$ is increasing in θ means that the best quality banks are also those that take the longest to restructure, and thus run the highest risk of the restructuring failing. This results from the need for a costly signal to separate from lower quality banks.

Figure 2 illustrates the equilibrium delay $\Delta(\theta)$ in an example.[14] Figure 3 shows the shareholders' payoff $U^E(\hat{\theta}, \theta)$ relative to $U^E(\theta, \theta)$ as a function of $\hat{\theta}$, and confirms that in this example the definition of Δ induces truthful revelation.

[Figures 2 and 3]

In the context of our model, we have:

$$
\begin{aligned}
E_1(\theta, \theta) &= -[1-(1-\theta)(1-m)]\dot{R}(\theta) && (13) \\
E(\theta, \theta) - E_0(\theta) &= m(1-\theta)(X-R) - \theta(R-R_0) && (14) \\
&= [m(1-\theta)X - I] + (1-\theta)(1-h)\frac{[(1-m)I - mR_0]}{1-(1-\theta)(1-m)h} && (15)
\end{aligned}
$$

The expression for $E_1(\theta, \theta)$ captures the fact the shareholders benefit from creditors believing the bank to be of higher quality because of the lower face value R this implies. The expression for $E(\theta, \theta) - E_0(\theta)$ illustrates that restructuring increases shareholder surplus through two effects, each captured by one term of the sum. First, restructuring increases the total value of the assets $[m(1-\theta)Z - I]$, of which shareholders capture $[m(1-\theta)X - I]$. Second, restructuring leads to an increase the debt's face value leading to an net increase in expected shortfall in case of default of

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

This increases shareholders' surplus in restructuring due to the corresponding proportional increase in expected bail-out payments.

From expression (12), we can derive properties of the equilibrium delay $\Delta(\cdot)$ and threshold θ^*.

Corollary 1. *Restructuring negotiation delays vary with the bank's characteristics as follows.*

- *The restructuring delay $\Delta(\theta)$ is strictly decreasing in payoff Z and strictly increasing in the amount of deposits D.*

- *The quality threshold θ^* above which no restructuring occurs is strictly increasing in payoff Z and strictly decreasing in the amount of deposits D.*

[14] All the parameters used to generate the figures are reported in A.16.

The intuition is that an increase in $X = Z - D$ has no signaling effect (because it does not affect $R(\hat{\theta})$) but increases the joint surplus restructuring creates for shareholders and creditors. This implies that the opportunity cost of waiting is higher and so shorter delays are sufficient for signaling the bank's quality. This also implies that the surplus is positive for a wider range of bank qualities, i.e., θ^* increases. The impact of Z and D derive from that of X.

Corollary 2. *The delay $\Delta(\theta)$ is strictly increasing and convex in θ.*

This can be seen from the expressions in (13): $E_1(\theta, \theta)$ increases with θ and $E(\theta, \theta) - E_0(\theta)$ decreases with θ. Both effects imply that $\dot{\Delta}(\theta)$ increases with θ. The convexity of $\Delta(\cdot)$ means that the information content of an extra delay declines over time. For low values of θ, the delay is short and $\Delta(\theta)$ is relatively flat, so that a short amount of time is sufficient for many of the low types to reveal themselves. Conversely, for high values of θ, the types differentiate themselves more slowly.

2.3 Resolution and Restructuring Outcomes

We now study how the resolution framework affects private restructuring negotiations between shareholders and creditors. Here the resolution framework amounts to the probability of a bail-in of creditors. Hence we study how the delay $\Delta(\theta)$ and the threshold θ^* vary with the haircut h.

In our model, haircuts have both a signaling effect and a surplus effects, both of which imply that higher haircuts lead to longer restructuring delays. First, $E_1(\theta, \theta)$, the sensitivity of the shareholders' expected payoff to creditors' beliefs, increases with h. Indeed, creditors' beliefs affect R and more so when h is high because, creditors being less insured against default, their claims are more information-sensitive. Second, $E(\theta, \theta) - E_0(\theta)$, the joint surplus restructuring creates for shareholders and creditors, decreases with h because the additional expected government bailout restructuring brings about decreases with h.

We can thus characterize the resolution framework's impact on purely private restructurings.

Corollary 3. *As the haircut h increases, equilibrium delays $\Delta(\theta)$ increase and the bank asset quality threshold θ^* above which no restructuring occurs decreases. As a result, successful restructuring is less likely. Thus, the haircut minimizing the delay is $h = 0$.*

Figure 4 plots equilibrium delays $\Delta(\theta)$ and threshold θ^* as functions of haircut h in an example.

[Figure 4]

2.4 Optimal Haircut

So far we have taken the resolution framework as a given. We conclude our analysis of purely private restructurings by examining the design of the resolution framework.

We characterize the optimal haircut h from the government's perspective. Denoting $G_0(\theta)$ the government's expected payoff under the status quo, and $G(\hat{\theta},\theta)$ that following successful restructuring of a bank with assets of actual quality θ and perceived quality $\hat{\theta}$, we have:

$$\begin{aligned} G_0(\theta) &= -(1-\theta)[hR_0\eta + (1+\lambda)(1-h)R_0 + (1+\lambda)D], \qquad (17)\\ G(\hat{\theta},\theta) &= -(1-\theta)(1-m)[hR(\hat{\theta})\eta + (1+\lambda)(1-h)R(\hat{\theta}) + (1+\lambda)D]. \qquad (18)\end{aligned}$$

Hence in equilibrium, the surplus of the government created by successful restructuring is:

$$G(\theta,\theta) - G_0(\theta) = (1-\theta)\left[m(1+\lambda)D - ((1-m)R(\theta) - R_0)(h\eta + (1-h)(1+\lambda))\right]. \qquad (19)$$

The first term inside the bracket, $m(1+\lambda)D$, is positive: it reflects the reduced use of public funds for reimbursing depositors due to the lower default probability restructuring brings about. The second term is itself a product of two terms. The second one, $((1-m)R(\theta) - R_0)$, is positive: it reflects the increase in expected debt shortfall resulting from restructuring. The first term of the product, $-(h\eta + (1-h)(1+\lambda))$, is negative: it captures the cost to the government implied by the increased expected debt shortfall. That cost is the sum of $h\eta$ and $(1-h)(1+\lambda)$, the social costs per dollar of debt shortfall caused by bail-ins and bail-outs, respectively.

The government's expected payoff in equilibrium for a given haircut h is therefore:

$$U^G = \int_0^1 G_0(x)f(x)dx + \int_0^{\theta^*} e^{-\beta\Delta(x)}[G(x) - G_0(x)]f(x)dx. \qquad (20)$$

The first term is the government expected payoff absent restructuring. The second term is its expected payoff due to restructuring taking into account that the probability of a restructuring for a bank of quality θ is $e^{-\beta\Delta(\theta)}$ for $\theta < \theta^*$ and zero for $\theta \geq \theta^*$. Therefore, the impact of h on the government's expected payoff can be decomposed as follows:

$$\frac{\partial U^G}{\partial h} = \int_0^1 \frac{\partial G_0(x)}{\partial h} f(x)dx + \int_0^{\theta^*} e^{-\beta\Delta(x)} \frac{\partial[G(x) - G_0(x)]}{\partial h} f(x)dx \tag{21}$$

$$-\beta \int_0^{\theta^*} e^{-\beta\Delta(x)} \frac{\partial \Delta(x)}{\partial h}[G(x) - G_0(x)]f(x)dx + \frac{\partial \theta^*}{\partial h} e^{-\beta\Delta(\theta^*)}[G(\theta^*) - G_0(\theta^*)]f(\theta^*).$$

This expression illustrates four different effects. The first term captures the haircut's effect on the government's expected payoff absent any restructuring. In our model,

$$\frac{\partial G_0(\theta)}{\partial h} = -(1-\theta)[\eta - (1+\lambda)]R_0, \tag{22}$$

so that this effect is positive for $\eta < (1+\lambda)$. The second term captures the haircut's impact on the gains from restructuring assuming they materialize. In our model,

$$\frac{\partial[G(\theta) - G_0(\theta)]}{\partial h} = -\frac{(1-\theta)[(1-m)I - mR_0]}{[1-(1-\theta)(1-m)h]^2}[\eta - (1+\lambda)(1-(1-\theta)(1-m))], \tag{23}$$

so that this effect is positive for $\eta < (1+\lambda)(1-(1-\theta)(1-m))$, which generally may depend on θ. The third term captures the haircut's impact on the delay in restructuring, and thus on the probability it materializes. In our model, as we saw, higher haircuts lead to longer delays:

$$\frac{\partial \Delta(\theta)}{\partial h} > 0. \tag{24}$$

Therefore this effect is negative provided restructuring generates a surplus for the government. The last term also captures the haircut's impact on the probability restructuring materializes but through the set of bank types $[0, \theta^*)$ that actually attempt to restructure. In our model, as we saw, higher haircuts lead to longer delays:

$$\frac{\partial \theta^*}{\partial h} < 0. \tag{25}$$

Therefore this effect is also negative provided restructuring generates a surplus for the government for a bank of quality θ^*.

Proposition 2. *The optimal resolution framework from the government's viewpoint is as follows.*

- *If* $\frac{mD}{(1-m)I - mR_0} > 1$*:*
  - *If* $\frac{\eta}{(1+\lambda)} \geq 1$*, full bailout (*$h = 0$*) is optimal from the government's viewpoint.*
  - *Otherwise, the optimal haircut can be strictly positive.*
- *If* $\frac{mD}{(1-m)I - mR_0} < 1$*:*
  - *If* $\frac{mD}{(1-m)I - mR_0} < \frac{\eta}{(1+\lambda)} < m$*, full bail-in (*$h = 1$*) is optimal from the government's viewpoint.*
  - *Otherwise, the optimal haircut can be strictly less than* 1*.*

The intuition is as follows. The first case corresponds to the government surplus being positive for $h = 0$. When the social cost of bail-ins is high ($\eta \geq (1+\lambda)$), all effects of the haircut on the government's objective go in the same direction: higher haircuts are detrimental. Indeed, lower haircuts maximize both the government's payoff absent restructuring and the surplus restructuring generates for the government. Moreover, the restructuring surplus is positive for low enough haircuts implying that making restructuring faster, and thus more likely, is also desirable, and this too is achieved by minimizing haircuts. As a result, a full bailout is optimal.

Things are different when the social cost of bail-ins is low ($\eta < (1+\lambda)$). In that case, higher haircuts have some positive effects: they increase the government's payoff absent restructuring, and may even increase the government's restructuring surplus for high quality banks. This has to be balanced against some negative effects: the surplus for low quality banks decreases, restructuring delays increase and the likelihood of restructuring decreases. Thus, a strictly positive haircut may be optimal depending on parameters and the distribution of asset qualities.

The second case corresponds to the government surplus being negative for $h = 0$. In that case, all four effects necessarily go in the same direction only if the government's status quo payoff increases with h and its restructuring surplus is negative and increasing in h for all values of θ and h. In that case, expected payoff is maximized but negative for $h = 1$, and thus delays are desirable.

We can now compare the ex ante and ex post optimal resolution frameworks from the government viewpoint. Indeed, the ex post optimal haircut maximizing the government's payoff (1) is $h = 0$ if $\eta \geq (1 + \lambda)$ and $h = 1$ otherwise. This points to an interesting time consistency issue.

Corollary 4. *Assume $m(D + R_0) > (1 - m)I$. Compared to the government's ex ante optimal haircut, its ex post optimal haircut is the same if $\eta \geq (1 + \lambda)$ and smaller if $\eta < (1 + \lambda)$. In the latter case, the government would benefit from committing ex ante to be "softer" with creditors than what would be optimal ex post.*

We can also characterize how the optimal resolution framework varies with some key model parameters.

Corollary 5. *If the optimal haircut is positive, it decreases with deposits D (holding X constant), increases with the cost of public funds λ but the effect of the social cost of bail-ins η is ambiguous.*

The intuition for these results stems from the interaction of each of these parameters with the four effects of haircuts on the government's expected payoff.

Consider deposits, holding X constant. Because deposits are fully insured irrespective of h, their level does not interact with haircuts in the government's status quo payoff or in its surplus from restructuring. Thus their only impact is that they increase the government's surplus from restructuring: the higher the deposits, the more valuable is the reduction of the default risk restructuring brings about. This implies that the cost of delays increases with D and to shorten delays accordingly requires decreasing h.

Consider the cost of public funds λ. A higher λ implies that increasing h is more beneficial to the government in terms of its status quo payoff and its restructuring surplus. These effects push towards higher haircuts being optimal. Moreover, as λ increases, the government's surplus from restructuring decreases: the higher λ, the more costly is the increase in the debt shortfall restructuring brings about. Thus the cost of delays decreases with λ, which also pushes towards higher haircuts being optimal.

Last, consider η, the cost of bail-ins. A higher η implies that increasing h is more costly to the government in terms of its status quo payoff and its restructuring surplus. These effects push towards lower haircuts being optimal. However, as η increases, the government's surplus from restructuring decreases: the higher η, the more costly is the increase in the debt shortfall restructuring brings about. Thus the cost of delays decreases with η, which also pushes towards higher haircuts being optimal. The net effect is thus ambiguous.

Figure 5 plots the government's expected payoff U^G for different values of haircut h.

[Figure 5]

3 Restructuring with Government Involvement

Private restructurings exert externalities on the government by impacting the public funds used to reimburse depositors and to bail out creditors, and the social cost of bail-ins. 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. 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 negotiations.

The bargaining proceeds as follows. First, the manager choose a restructuring offer and the time at which to make it. Denote by $\Delta_G(\theta)$ the equilibrium delay after which the manager of a bank with quality θ makes his first offer. Now, an offer consists not only of a new face value R for the existing creditors against the financing of I, but also includes a transfer T 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 denote by α the government's bargaining power in this bargaining game.

In the model, the government can subsidize negotiations in only two ways: it can make a transfer to the shareholders paid either only when the bank avoids default or unconditionally. We focus on the former case. It covers different observed means in which governments subsidize banks such as debt guarantees or capital injections, all of which are equivalent in our setup.

We again look for a separating equilibrium. To ensure such an equilibrium exists, we impose the following (sufficient) condition that bears on the government's incentives to restructure the bank:

$$1 \geq \frac{mD}{(1-m)I - mR_0} \geq \frac{(1-h)mZ}{mZ-(1-m)hI}. \tag{HG}$$

Following a restructuring, a depositor bailout is less likely so the government makes a gain proportional to mD. At the same time, the bank's debt is higher, implying that the government makes a loss due to associated with bail-outs and bail-ins in case of default proportional to $(1-m)I - mR_0$. The first inequality in (HG) thus means that for the government, the additional default costs loom larger than the savings for the deposit insurance fund. As we will show, this implies that the government prefers the bank not to be restructured when $\eta = 0$ and $h = 0$. The second inequality compares the incentives to restructure for the government when $\eta = 0$ and $h = 0$ to the total surplus from restructuring. In particular, as we will show, the inequality means that a bank quality θ exists such that restructuring increases the government's payoff and creates a social surplus.

3.2 Optimal Restructuring Plans

We proceed by backward induction. Assume the manager made his initial offer after a delay $\Delta_G(\hat{\theta})$, so that the creditors and the government believe the bank's quality to be $\hat{\theta}$.

Irrespective of whether the manager or the government gets to make an offer, the optimal offer makes creditors indifferent between the offer and the status quo. Hence, if an offer with a transfer T is accepted, the shareholders, the government and the creditors receive respectively

$$E(\hat{\theta},\theta) + (1-(1-\theta)(1-m))T \tag{26}$$

$$G(\hat{\theta},\theta) - (1+\lambda)(1-(1-\theta)(1-m))T \tag{27}$$

$$C(\hat{\theta},\theta) \tag{28}$$

where $E(\hat{\theta},\theta)$, $G(\hat{\theta},\theta)$ and $C(\hat{\theta},\theta)$ are as in Section 2. In particular, $C(\hat{\theta},\theta) = C_0(\theta)$.

In a separating equilibrium, the manager's first offer reveals the bank's quality θ. Hence the subsequent subgame is a standard Rubinstein bargaining game under symmetric information and thus converges immediately. Hence, on the equilibrium path, the manager makes an offer $(R(\hat{\theta}), T(\hat{\theta}))$ with $R(\hat{\theta})$ defined in equation (5) and $T(\hat{\theta})$ defined by:

$$(1-\alpha)[G(\hat{\theta},\hat{\theta})-(1+\lambda)(1-(1-\hat{\theta})(1-m))T(\hat{\theta})-G_0(\hat{\theta})] = (1+\lambda)\alpha[E(\hat{\theta},\hat{\theta})+(1-(1-\hat{\theta})(1-m))T(\hat{\theta})-E_0(\hat{\theta})], \tag{29}$$

which the creditors and the government accept immediately, where $E_0(\theta)$ and $G_0(\theta)$ are as in Section 2. To understand how the transfer $T(\hat{\theta})$ is determined, the previous equation can be rewritten as:

$$\begin{aligned} E(\hat{\theta},\hat{\theta}) + (1-(1-\hat{\theta})(1-m))T(\hat{\theta}) = E_0(\hat{\theta}) \quad &+ \quad \frac{1-\alpha}{1+\alpha\lambda}[G(\hat{\theta},\hat{\theta}) - G_0(\hat{\theta}) + E(\hat{\theta},\hat{\theta}) - E_0(\hat{\theta}) \\ &- \quad \lambda(1-(1-\hat{\theta})(1-m))T(\hat{\theta})]. \end{aligned} \tag{30}$$

That is, the transfer $T(\hat{\theta})$ is such that the shareholders' payoff equals their outside option $E_0(\hat{\theta})$ plus a share of the total surplus created by restructuring for the shareholders, creditors and the government. That surplus accounts for the cost of public funds government transfers imply.

Hence for any bank quality θ the government's transfer $T(\theta)$ to the shareholders is given by:

$$[1-(1-\theta)(1-m)]T(\theta) = \frac{1-\alpha}{1+\lambda}[G(\theta,\theta) - G_0(\theta)] - \alpha[E(\theta,\theta) - E_0(\theta)]. \tag{31}$$

3.3 Equilibrium Restructuring Outcome

For such a bargaining outcome to be possible in equilibrium, the shareholders' payoff must exceed their payoff absent restructuring but also their payoff from negotiating with creditors without involving the government. We consider these conditions in turn.

First, the shareholders of a bank of quality θ must receive a payoff exceeding their payoff absent restructuring, $E_0(\theta)$. Using equation (30) this amounts to:

$$G(\theta,\theta) - G_0(\theta) + E(\theta,\theta) - E_0(\theta) - \lambda[1-(1-\theta)(1-m)]T(\theta) \geq 0. \tag{32}$$

In our model, this is written as:

$$m(1-\theta)Z - I \geq (1-\theta)h\frac{\eta}{1+\lambda}\frac{(1-m)I - mR_0}{1-(1-m)(1-\theta)h}. \tag{33}$$

The reflects that bargaining with the government can be successful only if it creates a positive total surplus. This is the case if the improvement in quality of the bank's assets (the LHS) exceeds the social costs of the higher expected debt shortfall restructuring brings about (the RHS).

Second, the shareholders must prefer involving the government to negotiating only with the creditors. From equation (26), this amounts to the government's transfer $T(\theta)$ being positive. This need not be the case as equation (31) illustrates: given a high enough bargaining power, the government would receive a transfer *from* the shareholders and, as a result, would not be involved it in negotiations by the manager. For this not to be the case, the government's bargaining power must instead be small enough. Specifically, using equation (31), $T(\theta) \geq 0$ is equivalent to

$$\alpha \leq \bar{\alpha}(\theta) \equiv \frac{G(\theta,\theta) - G_0(\theta)}{G(\theta,\theta) - G_0(\theta) + (1+\lambda)(E(\theta,\theta) - E_0(\theta))}. \tag{34}$$

Equation (34) shows that irrespective of its bargaining power, unless the government derives a positive surplus from restructuring a bank of quality θ, it will not make a positive transfer to its shareholders. Said differently, $\bar{\alpha}(\theta) \in (0,1)$ requires $G(\theta,\theta) - G_0(\theta) \geq 0$, which can be written as:

$$\frac{mD}{(1-m)I - mR_0} \geq \frac{h\eta + (1-h)(1+\lambda)}{(1+\lambda)[1-(1-\theta)(1-m)h]}. \tag{35}$$

This condition means that in a restructuring, the government's savings for the deposit insurance fund exceed the social losses the higher debt implies.

We can now characterize when the manager involves the government in the restructuring negotiations: it does so if the bank's quality θ satisfies conditions (33), (34), and (35).

Lemma 4. *Denote by Θ_η the set of bank qualities θ such that in equilibrium the manager makes an offer $(R(\theta), T(\theta))$ to the creditors and the government, which is accepted.*

- *Absent social costs of default ($\eta = 0$), there exist $\underline{\theta}, \overline{\theta}$ with $\underline{\theta} \leq \overline{\theta}$ such that $\theta \in \Theta_0$ if and only* *if $\theta \in [\underline{\theta}, \overline{\theta}]$ and $\alpha \leq \bar{\alpha}(\theta)$, with $\bar{\alpha}(\theta)$ defined in (34).*

- *The higher the social costs of default, the fewer the banks finding it optimal to involve the government in restructuring negotiations: as η increases, Θ_η shrinks as η increases, i.e., for any (η, η') with $\eta' > \eta$, $\Theta_{\eta'} \subset \Theta_\eta$.*

- *If the social costs of default are high enough, the government is never involved in restructuring negotiations: $\Theta_\eta = \emptyset$ for η large enough.*

As per the lemma, the manager will not involve the government in negotiations if θ is too large, as restructuring does not create surplus, if θ is too low, as the government prefers no restructuring to occur, nor if α is too large, as the government captures too much of the surplus. For higher η, restructuring is more costly for the government because of the additional expected debt shortfall it implies, making government involvement less likely.

We can now characterize the delays in restructuring as a function of bank quality. The equilibrium delays are derived along the same lines as in Section 2. For a bank of actual quality θ and of quality $\hat{\theta}$ as perceived by creditors and the government, the shareholders' expected payoff is:

$$U^E(\hat{\theta}, \theta) = [1 - e^{-\beta \Delta_G \hat{\theta})}]E_0(\theta) + e^{-\beta \Delta_G(\hat{\theta})}[E(\hat{\theta}, \theta) + [1 - (1-\theta)(1-m)] \max(T(\hat{\theta}), 0)] \tag{36}$$

and we obtain:

$$\dot{\Delta}_G(\theta) = \begin{cases} \dfrac{E_1(\theta, \theta) + [1 - (1-\theta)(1-m)]\dot{T}(\theta)}{\beta[E(\theta, \theta) + [1 - (1-\theta)(1-m)]T(\theta) - E_0(\theta)]} & \text{if } \theta \in \Theta_\eta \\ \\ \dot{\Delta}(\theta) & \text{otherwise.} \end{cases} \tag{37}$$

where $\Delta(\theta)$ and $\dot{\Delta}(\theta)$ are as in Section 2.

Lemma 5. *For any $\theta \in \Theta_\eta$ we have $\dot{\Delta}_G(\theta) > 0$. This implies that for the manager of bank of quality θ who makes an offer in equilibrium either to the creditors and the government or only to* *the creditors, the delay in making his offer is given by:*

$$\Delta_G(\theta) = \int_0^\theta \dot{\Delta}_G(x)dx. \tag{38}$$

We can now characterize the separating equilibrium.

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

- *For banks of quality $\theta \in \Theta_\eta$, the manager waits $\Delta_G(\theta)$, which increases with θ, before making restructuring offers $R(\theta)$ to the creditors and $T(\theta)$ to the government, both of which are accepted immediately, with $\Delta_G(\theta)$, $R(\theta)$, and $T(\theta)$ defined by (38), (31) and (5).*

- *For banks of quality $\theta \notin \Theta_\eta$ and $\theta \leq \theta^*$, the manager makes no offer to the government and waits $\Delta_G(\theta) = \Delta(\theta)$ before making a restructuring offer $R(\theta)$ to the creditors only, which is accepted immediately.*

- *For banks of quality $\theta \notin \Theta_\eta$ and $\theta > \theta^*$, the manager makes no restructuring offer and does not make the investment.*

3.4 The Government's Impact on Restructuring

We derive implications on how the possibility for the bank's manager of involving the government in the negotiation affects the restructuring's outcome.

Corollary 6. *The possibility to involve the government in restructuring has the following impact.*

- *Government involvement weakly widens the set of bank qualities for which the bank engages in restructuring negotiations, and does so strictly if the social cost of bail-ins η and the government's bargaining power α are small enough.*

- *For banks of quality $\theta \in \Theta_\eta$, government involvement increases the total surplus from the negotiation and has a negative surplus effect on the delay. Government involvement has a positive signaling effect on the delay if haircuts h are sufficiently small, and a negative one if haircuts h are sufficiently large, and the social costs of bail-ins η and the government's bargaining power α are small.*

The first point reflects that as a bank manager can always choose to not involve the government, the set of bank qualities for the manager engages in restructuring negotiations cannot be smaller than for private restructuring. When η is small, restructuring creates a surplus for the government, much of which is captured by shareholders when α is small: hence government involvement leads to managers of a strictly broader set of bank qualities to engage in restructuring negotiations.

The second point derives from the comparison of equations (12) and (37). First, government involvement means that restructuring negotiations pertain to the total restructuring surplus, including the government's surplus. Internalizing externalities on the government shortens the restructuring delays via the surplus effect. Second, the transfer $T(\hat{\theta})$ shareholders receive also delays via the signaling effect. For small haircuts h, the government's surplus is larger for higher quality banks, and so the government's transfer is larger for such banks. This makes the shareholder's surplus more sensitive to the creditors and the government's belief about the bank's quality, which lengthens the delay needed for higher quality banks to separate. In this case, both effects go in different directions and the overall impact of government involvement is ambiguous. Instead, for large haircuts h and small social costs of bail-ins η, the government's surplus is smaller for banks of higher quality θ. If, in addition, the bank's bargaining power α is small, this implies that the transfer $T(\theta)$ to shareholders is lower for higher quality banks. This makes the shareholder's surplus less sensitive to the creditors and the government's belief, which shortens restructuring delays. In this case, the signaling and surplus effect go in the same direction and government involvement unambiguously leads to shorter restructuring delays.

This result shows that due to the signaling effect the government may be better off committing not to participate in any negotiations about the restructuring of the bank. A necessary condition for this to happen is that reporting a better type allows the bank to get more subsidies from the government. This is the case in particular when the haircut is small, i.e., bail-outs are common.

Figure 6 illustrates this point by plotting $\Delta_G(\theta)$ and $\Delta(\theta)$ in an example. For banks of low quality θ, the two delay functions coincide, as the government will not make a positive transfer to shareholders. For banks of intermediate quality θ, the signaling effect of government involvement is positive, and dominates the negative surplus effect: government involvement leads to longer delays.

Last, for banks of high enough quality θ, the surplus effect dominates: government involvement leads to shorter delays and to more banks engaging in restructuring negotiations.

[Figure 6]

We can now study how key model parameters affects the restructuring outcomes through the signaling effect and the surplus effect we have identified. We first characterize how the government's bargaining power impacts the restructuring process.

Corollary 7. *The government's bargaining power in negotiations has the following impact.*

- *If the government's bargaining power is too high ($\alpha \geq \bar{\alpha}(\theta)$), the manager does not involve the government in the restructuring negotiations, and his to do so has no impact.*
- *If $\theta \in \Theta_\eta$, a threshold $\bar{\eta}$ exists such that:*
  - *For $\eta \leq \bar{\eta}$, an increase in α has a negative surplus effect and a positive signaling effect, and thus unambiguously leads to longer restructuring delay $\Delta_G(\theta)$.*
  - *For $\eta > \bar{\eta}$, an increase in α has a negative surplus effect but a negative signaling effect, and thus has an ambiguous impact on restructuring delay $\Delta_G(\theta)$.*

This result yields the surprising insight that the government may suffer from having too much bargaining power. 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.

We also characterize the impact of the resolution framework on bank restructuring negotiations in which the government can be involved.

Corollary 8. *The haircut h has the following impact.*

- *A higher haircut h has a positive surplus effect on the delay. In particular, $T(\theta)$ increases in h if $\eta < (1+\lambda)[1-(1-\theta)(1-m)]$.*
- *A threshold $\tilde{\alpha} \in (0,1)$ exists such that:*

- *For $\alpha \leq \tilde{\alpha}$, a higher haircut h has a positive signaling effect and thus an increase in haircut h unambiguously leads to longer restructuring delay $\Delta_G(\theta)$*
- *For $\alpha > \tilde{\alpha}$, a higher haircut has a negative signaling effect and thus an increase in haircut h has an ambiguous impact on restructuring delay $\Delta_G(\theta)$.*

The first point comes from the total restructuring surplus decreasing with the haircut. The restructuring implies that the bank gets additional financing, which when η is positive implies a greater loss associated with bail-ins in case of default. Through this channel, haircuts increase restructuring delays.

The signaling effect is more subtle. The positive signaling effect comes from the fact that a higher haircut makes the total restructuring surplus decrease less quickly with θ. When α is low, the shareholders capture a large share of this surplus, and this effect implies that transfers increase more quickly in θ, making reporting a higher quality more tempting. This effect goes in the same direction as the surplus effect, and implies that delays increase with the haircut.

However, there is also a negative signaling effect. When haircut h increases, the shareholders' restructuring surplus $E(\theta, \theta) - E_0(\theta, \theta)$ also decreases less quickly with θ, and so a smaller transfer is needed to get them to agree to a restructuring. When α is large, transfers are such that the shareholders get a surplus close to this private surplus, and this effect dominates.

When the government is involved in negotiations, the optimal haircut from the government's viewpoint is affected by more effects than in Proposition 2. First, surprisingly, when the social cost of bail-ins η is small, larger haircuts lead the government to make larger transfers (see Figure 7). Indeed, they make restructuring more valuable for the government, which is then willing to subsidize the process more: larger haircuts lead to greater transfers, which are costly to the government, but speed up negotiations via the surplus effect. Second, as discussed above, the haircut also has a signaling effect via the transfers. This implies in particular that larger haircuts may not always lead to longer delays when the government is involved in the negotiations, in contrast to Proposition 2.

[Figure 7]

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 $\theta \geq \Delta^{-1}(t)$. Using the convention that for $\theta > \theta^*$ we have $\Delta(\theta) = +\infty$, we can write:

$$P^E(t) = \int_{\Delta^{-1}(t)}^{1} \frac{[1 - e^{-\beta\Delta(\theta)}]E_0(\theta) + e^{-\beta\Delta(\theta)}E(\theta,\theta)}{1 - F(\Delta^{-1}(t))} f(\theta)d\theta \quad (39)$$

$$P^C(t) = \int_{\Delta^{-1}(t)}^{1} \frac{[1 - e^{-\beta\Delta(\theta)}]C_0(\theta) + e^{-\beta\Delta(\theta)}C(\theta,\theta)}{1 - F(\Delta^{-1}(t))} f(\theta)d\theta. \quad (40)$$

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:

$$\bar{P}^E(t) = E(\Delta^{-1}(t), \Delta^{-1}(t)) \quad (41)$$

$$\bar{P}^C(t) = C(\Delta^{-1}(t), \Delta^{-1}(t)) = C_0(\Delta^{-1}(t)). \quad (42)$$

Since $\Delta(\theta)$ increases with θ, shareholders and creditors become more optimistic over time about the bank's quality. Indeed, their expectation of θ is $\mathbb{E}(\theta|\theta > \Delta^{-1}(t))$. When a restructuring is announced, this expectation jumps downwards to $\Delta^{-1}(t)$. We obtain the following:

Corollary 9. *The market prices of the bank's equity and debt increase over time, conditionally on no restructuring being announced: $P^E(t)$ and $P^C(t)$ increase in t. Both prices react negatively to the announcement of a restructuring: $\bar{P}^E(t) < P^E(t)$ and $\bar{P}^C(t) < P^C(t)$.*

Figure 8 illustrates the corollary. An interesting implication is that markets appear to react negatively to restructuring offers, even though such offers create economic surplus. This is entirely driven by the negative signal that the restructuring sends about the soundness of the bank.

Recent papers have also examined the impact of the European BRRD and the tightening of the resolution regime on market prices. Here, we obtain the following prediction.

Corollary 10. *The market price of debt $P^C(t)$ and the market price of equity $P^E(t)$ are both negatively affected by a larger haircut h.*

This corollary is consistent with recent papers such as Neuberg *et al.* (2016) and Schafer *et al.* (2016), and is quite intuitive: larger haircuts increase the creditors' losses in case of default. Since creditors have no bargaining power in our model, their payoff is always equal to $C_0(\theta)$, which decreases with h. A consequence is that the creditors ask for a larger repayment, so that $R(\theta)$ increases. As a larger h also slows down negotiations and makes a restructuring less likely (Corollary 3), the bank's shareholders are also negatively affected by higher haircuts.

5 Possible extensions

The model can be extended in several ways to shed light on various 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.[15] 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:

$$\int_0^{\tilde{\theta}} \frac{[1-(1-\theta)h]R_0}{F(\tilde{\theta})} f(\theta) d\theta = \int_0^{\tilde{\theta}} \frac{[1-(1-\theta)(1-m)h]R}{F(\tilde{\theta})} f(\theta) d\theta - I \tag{43}$$

$$(1-(1-\tilde{\theta})(1-m))(X-R) = \tilde{\theta}(X-R_0). \tag{44}$$

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.[16] 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 $\Delta(\tilde{\theta})$.

[15] 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.

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

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 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.

References

Acharya, V. V., Amihud, Y. and Litov, L. (2011a). Creditor rights and corporate risk-taking. *Journal of Financial Economics*, **102** (1), 150–166.

—, Sundaram, R. K. and John, K. (2011b). Cross-country variations in capital structures: The role of bankruptcy codes. *Journal of Financial Intermediation*, **20** (1), 25–54.

— and Yorulmazer, T. (2008). Cash-in-the-market pricing and optimal resolution of bank failures. *The Review of Financial Studies*, **21** (6), 2705.

Admati, A. R. and Perry, M. (1987). Strategic delay in bargaining. *The Review of Economic Studies*, **54** (3), 345–364.

Alesina, A. and Drazen, A. (1991). Why are stabilizations delayed? *The American Economic Review*, **81** (5), 1170–1188.

Ausubel, L. M., Cramton, P. and Deneckere, R. J. (2002). Bargaining with incomplete information. In R. Aumann and S. Hart (eds.), *Handbook of Game Theory with Economic Applications*, vol. 3, *50*, 1st edn., Elsevier, pp. 1897–1945.

Bignon, V. and Vuillemey, G. (2018). *The Failure of a Clearinghouse: Empirical Evidence*. Working paper.

Bolton, P. and Oehmke, M. (2016). *Bank Resolution and the Structure of Global Banks*. Working paper.

Bulow, J. I. and Shoven, J. B. (1978). The bankruptcy decision. *The Bell Journal of Economics*, **9** (2), 437–456.

Cramton, P. (1992). Strategic delay in bargaining with two-sided uncertainty. *Review of Economic Studies*, **59** (1), 205–225.

Cramton, P. C. (1984). Bargaining with incomplete information: An infinite-horizon model with two-sided uncertainty. *The Review of Economic Studies*, **51** (4), 579–593.

Decamps, J.-P., Rochet, J.-C. and Roger, B. (2004). The three pillars of Basel II: optimizing the mix. *Journal of Financial Intermediation*, **13** (2), 132 – 155, bank Capital Adequacy Regulation under the New Basel Accord.

Dermine, J. (2016). *The Single Resolution Mechanism in the European Union: Good Intentions and Unintended Evil*. Working paper.

Diamond, D. W. and Rajan, R. G. (2005). Liquidity shortages and banking crises. *The Journal of Finance*, **60** (2), 615–647.

Flannery, M. J. (2014). Contingent capital instruments for large financial institutions: A review of the literature. *Annual Review of Financial Economics*, **6**, 225–240.

Freixas, X. and Rochet, J. (2013). Taming Systemically Important Financial Institutions. *Journal of Money, Credit and Banking*, **45**, 37–58.

Gertner, R. and Scharfstein, D. (1991). A theory of workouts and the effects of reorganization law. *The Journal of Finance*, **46** (4), 1189–1222.

Giammarino, R. M. (1989). The resolution of financial distress. *The Review of Financial Studies*, **2** (1), 25–47.

Goldstein, I. and Sapra, H. (2014). Should banks' stress test results be disclosed? an analysis of the costs and benefits. *Foundations and Trends(R) in Finance*, **8** (1), 1–54.

GORTON, G. and HUANG, L. (2004). Liquidity, efficiency, and bank bailouts. *American Economic Review*, **94** (3), 455–483.

GRACIE, A. (2016). Ending too big to fail: Getting the job done. Speech given by Andrew Gracie at Deloitte, London, on 26 May 2016.

HAUGEN, R. A. and SENBET, L. W. (1978). The Insignificance of Bankruptcy Costs to the Theory of Optimal Capital Structure. *Journal of Finance*, **33** (2), 383–393.

HUERTAS, T. (2016). *European Bank Resolution: Making it work!* CEPS Papers 11262, Centre for European Policy Studies.

KAHL, M. (2002). Economic distress, financial distress, and dynamic liquidation. *The Journal of Finance*, **57** (1), 135–168.

KEISTER, T. and MITKOV, Y. (2016). *Bailouts, Bail-ins and Banking Crises*. Working paper.

LANDIER, A. and UEDA, K. (2009). *The Economics of Bank Restructuring; Understanding the Options*. IMF Staff Position Notes 2009/12, International Monetary Fund.

LEHAR, A. (2015). *Restructuring failure and optimal capital structure*. Working paper.

— and STAUFFER, R. (2015). *Learning and Optimal Delay in Bargaining over Sovereign Debt Restructuring*. Working paper.

MAILATH, G. and MESTER, L. (1994). A positive analysis of bank closure. *Journal of Financial Intermediation*, **3** (3), 272–299.

MYERS, S. C. and MAJLUF, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics*, **13** (2), 187 – 221.

NEUBERG, R., GLASSERMAN, P., KAY, B. and RAJAN, S. (2016). *The Market-Implied Probability of European Government Intervention in Distressed Banks*. Working paper.

PEROTTI, E. and SUAREZ, J. (2002). Last bank standing: What do I gain if you fail? *European Economic Review*, **46** (9), 1599–1622.

PHILIPPON, T. and SALORD, A. (2017). Bail-ins and bank resolution in europe: A progress report. ICMB/CEPR Report.

— and SCHNABL, P. (2013). Efficient recapitalization. *The Journal of Finance*, **68** (1), 1–42.

— and SKRETA, V. (2012). Optimal interventions in markets with adverse selection. *American Economic Review*, **102** (1), 1–28.

PITCHFORD, R. and WRIGHT, M. L. J. (2012). Holdouts in sovereign debt restructuring: A theory of negotiation in a weak contractual environment. *The Review of Economic Studies*, **79** (2), 812–837.

SCHAFER, A., SCHNABEL, I. and WEDER DI MAURO, B. (2016). *Bail-in Expectations for European Banks: Actions Speak Louder than Words*. Working paper.

SEGURA, A. and VICENTE, S. (2018). *Bank Resolution and Public Backstop in an Asymmetric Banking Union*. Working paper.

SENBET, L. W. and WANG, T. Y. (2012). Corporate Financial Distress and Bankruptcy: A Survey. *Foundations and Trends(R) in Finance*, **5** (4), 243–335.

TIROLE, J. (2012). Overcoming adverse selection: How public intervention can restore market functioning. *American Economic Review*, **102** (1), 29–59.

Vallée, B. (2016). *Contingent Capital Trigger Effects: Evidence from Liability Management Exercises.* Working paper.

Walther, A. and White, L. (2016). *Rules vs. Discretion in Bank Resolution.* Working paper.

A Appendix

A.1 Proof of Lemma 1

For a bank of actual quality θ and perceived quality $\hat{\theta}$, the manager will make offer $R(\hat{\theta})$ to creditors if and only if the surplus generated for shareholders is positive. The shareholders' surplus is:

$$E(\hat{\theta}, \theta) - E_0(\theta) = [1 - (1-\theta)(1-m)][X - R(\hat{\theta})] - \theta(X - R_0) \tag{A.1}$$

which decreases with the bank's quality θ as

$$\frac{\partial[E(\hat{\theta}, \theta) - E_0(\theta)]}{\partial\theta} = -mX - [(1-m)R(\hat{\theta}) - R_0] < 0, \tag{A.2}$$

and negative for the highest bank quality possible, $\theta = 1$, as

$$E(\hat{\theta}, 1) - E_0(1) = -[R(\hat{\theta}) - R_0] < 0. \tag{A.3}$$

Hence a unique $\theta^*(\hat{\theta}) \in [0, 1)$ exists such that $E(\hat{\theta}, \theta) - E_0(\theta) \leq 0$ if and only if $\theta \geq \theta^*(\hat{\theta})$.

A.2 Proof of Lemma 3

In a separating equilibrium, the bank's actual quality θ coincides with that perceived by creditors. Hence the manager will make offer $R(\theta)$ to creditors if and only if the surplus generated for shareholders is positive. The shareholders' surplus is:

$$E(\theta, \theta) - E_0(\theta) = [1 - (1-\theta)(1-m)][X - R(\theta)] - \theta(X - R_0) \tag{A.4}$$

which decreases with the bank's quality θ as

$$\begin{aligned} \frac{\partial[E(\theta, \theta) - E_0(\theta)]}{\partial\theta} &= -mX - [(1-m)R(\theta) - R_0] - [1 - (1-\theta)(1-m)]\dot{R}(\theta) && \text{(A.5)} \\ &= -mX - \frac{(1-h)[(1-m)I - mR_0]}{[1 - (1-\theta)(1-m)h]^2} < 0 && \text{(A.6)} \end{aligned}$$

and negative for the highest bank quality possible, $\theta = 1$, as

$$E(1,1) - E_0(1) = -[R(1) - R_0] = -I < 0 \tag{A.7}$$

Hence a unique $\theta^* \in [0,1)$ exists such that $E(\theta,\theta) - E_0(\theta) \leq 0$ if and only if $\theta \geq \theta^*$.

A.3 Proof of Proposition 1

We have shown that given the manager's strategy, the creditors' beliefs satisfy Bayes rule and we need to show that the manager's strategy is optimal given the creditors' beliefs.

Consider first a bank of quality in $[\theta^*, 1]$. Its manager has no incentive to mimic that of a bank with quality in $[0, \theta^*]$ it would issue debt below its fair value, so creditors would make a profit, to finance an investment which, by definition of θ^*, would generate a negative surplus. Hence the shareholders' gain from such a deviation would be negative. Mimicking a bank with another quality in $[\theta^*, 1]$ would lead not affect the outcome and would thus not be strictly beneficial to shareholders.

Consider now a bank of quality in $[0, \theta^*]$. Its manager has no incentive to mimic that of a bank with quality in $[\theta^*, 1]$ because he would forgo shareholders' restructuring surplus which is positive, by definition of θ^*. Last we must show that mimicking that of a bank with another quality in $[0, \theta^*]$. we have already shown that the equilibrium delay satisfies the first-order condition, so we must now show that the second order condition holds. From equations (10) and (11) we have

$$\begin{aligned} U_1^E(\hat{\theta}, \theta) &= e^{-\beta\Delta(\hat{\theta})} \left[E_1(\hat{\theta}, \theta) - \frac{E_1(\hat{\theta}, \hat{\theta})}{[E(\hat{\theta}, \hat{\theta}) - E_0(\hat{\theta})]} [E(\hat{\theta}, \theta) - E_0(\theta)] \right] & \text{(A.8)} \\ &= \left[e^{-\beta\Delta(\hat{\theta})} \frac{E_1(\hat{\theta}, \theta) E_1(\hat{\theta}, \hat{\theta})}{[E(\hat{\theta}, \hat{\theta}) - E_0(\hat{\theta})]} \right] \times \left[\frac{[E(\hat{\theta}, \hat{\theta}) - E_0(\hat{\theta})]}{E_1(\hat{\theta}, \hat{\theta})} - \frac{[E(\hat{\theta}, \theta) - E_0(\theta)]}{E_1(\hat{\theta}, \theta)} \right] & \text{(A.9)} \end{aligned}$$

The expression in the first bracket is positive. Indeed, all terms in the numerator are positive for all θ and $\hat{\theta}$, and the numerator is positive given $\hat{\theta} \in [0, \theta^*]$ by definition of θ^*. Hence the sign of

$U_1^E(\hat{\theta},\theta)$ is that of the expression in the second bracket. We have:

$$\frac{E(\hat{\theta},\theta)-E_0(\theta)}{E_1(\hat{\theta},\theta)} = \frac{[1-(1-\theta)(1-m)](X-R(\hat{\theta}))-\theta(X-R_0)}{[1-(1-\theta)(1-m)](-\dot{R}(\hat{\theta}))} \tag{A.10}$$

$$= -\frac{(X-R(\hat{\theta}))}{\dot{R}(\hat{\theta})} - \frac{\theta(X-R_0)}{[1-(1-\theta)(1-m)](-\dot{R}(\hat{\theta}))} \tag{A.11}$$

Hence, given that $(X-R_0)$ and $-\dot{R}(\hat{\theta})$ are positive, the sign of $U_1^E(\hat{\theta},\theta)$ is that of

$$\frac{\theta}{[1-(1-\theta)(1-m)]} - \frac{\hat{\theta}}{[1-(1-\hat{\theta})(1-m)]} \tag{A.12}$$

Hence it is positive for $\hat{\theta}<\theta$ and negative for $\hat{\theta}>\theta$ and the first order condition does indeed give an absolute maximum over $[0,\theta^*]$.

Analytical expression for $\Delta(\theta)$. As it turns out, it is possible to integrate $\dot{\Delta}(\theta)$ and find a (cumbersome) analytical expression for $\Delta(\theta)$. First, we can express $\dot{\Delta}(\theta)$ as:

$$\dot{\Delta}(\theta) = h[(1-m)I-mR_0]\left[\frac{A}{1-(1-\theta)(1-m)h}+\frac{B(1-\theta)+C}{a(1-\theta)^2+b(1-\theta)+c}\right] \tag{A.13}$$

$$\text{with } a = -m(1-m)hX \tag{A.14}$$

$$b = (1-m)hI+mX+(1-h)[(1-m)I-mR_0] \tag{A.15}$$

$$c = I \tag{A.16}$$

$$A = -\frac{h(1-h)(1-m)^2}{a+(1-m)hb+c(1-m)^2h^2} \tag{A.17}$$

$$B = -(1-m)(1-h)-A[b+c(1-m)h] \tag{A.18}$$

$$C = 1-cA. \tag{A.19}$$

Given this functional form, a primitive is given by:

$$\tilde{\Delta}(\theta) = h[(1-m)I-mR_0]\frac{A}{(1-m)h}\left[\ln[1-(1-\theta)(1-m)h]+g(\theta)\right], \tag{A.20}$$

where $g(\theta)$ is given by:

$$g(\theta) = \begin{cases} \frac{B}{2a} \ln |a(1-\theta)^2 + b(1-\theta) + c|) + \frac{2aC - bB}{a\sqrt{4ac-b^2}} arctan\left(\frac{2a(1-\theta)+b}{\sqrt{4ac-b^2}}\right) & \text{if } 4ac > b^2 \\ \frac{B}{2a} \ln |a(1-\theta)^2 + b(1-\theta) + c|) - \frac{2aC - bB}{a\sqrt{b^2-4ac}} arctanh\left(\frac{2a(1-\theta)+b}{\sqrt{b^2-4ac}}\right) & \text{if } 4ac < b^2. \end{cases} \tag{A.21}$$

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

A.4 Proof of Corollary 1

The impact of Z and D derives from that of $X = Z - D$. For $\theta < \theta^*$, $\Delta(\theta)$ decreases with X. Indeed, an increase in X has no signaling effect but increases the restructuring surplus

$$\frac{\partial E_1(\theta,\theta)}{\partial X} = 0 \qquad \text{and} \qquad \frac{\partial[E(\theta,\theta) - E_0(\theta)]}{\partial X} = m(1-\theta) > 0, \tag{A.22}$$

which leads to shorter delays and to managers of banks with higher quality finding it optimal to engage in restructuring, i.e., $\Delta(\theta)$ decreases and θ^* increases with X.

A.5 Proof of Corollary 3

For $\theta < \theta^*$, $\Delta(\theta)$ increases with h. Indeed, an increase in h has a positive signaling and a negative surplus effect:

$$\frac{\partial E_1(\theta,\theta)}{\partial h} = \frac{[1-(1-\theta)(1-m)][(1-m)I - mR_0][1+(1-\theta)(1-m)h]}{[1-(1-\theta)(1-m)h]^3} > 0 \tag{A.23}$$

$$\frac{\partial[E(\theta,\theta) - E_0(\theta)]}{\partial h} = -\frac{(1-\theta)[(1-m)I - mR_0][1-(1-\theta)(1-m)]}{[1-(1-\theta)(1-m)h]^2} < 0. \tag{A.24}$$

Both effects lead to longer delays and the latter to managers of banks with higher quality finding it optimal not to engage in restructuring, i.e., $\Delta(\theta)$ increases and θ^* decreases with h.

A.6 Proof of Proposition 2

Condition $\dfrac{mD}{(1-m)I - mR_0} > 1$ implies that the government's restructuring surplus is positive for $h = 0$ and all $\theta \in [0, 1]$. Indeed, for $h = 0$ we have:

$$G(\theta,\theta) - G_0(\theta) = (1-\theta)(1+\lambda)[mD - ((1-m)R(\theta) - R_0)] = (1-\theta)(1+\lambda)[mD - ((1-m)I - mR_0)]. \tag{A.25}$$

Case 1: $\eta \geq (1+\lambda)$. Under a full bailout policy ($h = 0$), the government's payoff absent restructuring and its restructuring surplus are maximum because from (22) and (23), we have $\frac{G_0(\theta)}{\partial h} < 0$ and $\frac{\partial[G(\theta) - G_0(\theta)]}{\partial h} < 0$. Moreover, the government's restructuring surplus is positive for $h = 0$ and all $\theta \in [0, 1]$, and delays $\Delta(\theta)$ are minimum for all $\theta \in [0, 1]$ and the threshold θ^* is maximum. From (20), $h = 0$ is optimal.

Case 2: $\eta < (1 + \lambda)$. From (22), we have $\frac{G_0(\theta)}{\partial h} > 0$. From (23), we have $\frac{\partial[G(\theta)-G_0(\theta)]}{\partial h} > 0$ if and only if $\eta < (1 + \lambda)(1 - (1 - \theta)(1 - m))$.

Case 2.1: $\eta < m(1 + \lambda)$. In that case, $\frac{\partial[G(\theta)-G_0(\theta)]}{\partial h} > 0$ for all $\theta \in [0, 1]$. Moreover, $[G(\theta) - G_0(\theta)] > 0$ for all $\theta \in [0, 1]$ because as we saw, this holds for $h = 0$. Hence, the haircut's first and second effects are positive but the third and fourth are negative.

Case 2.2: $\eta \in (m(1 + \lambda), (1 + \lambda))$. In that case, $\frac{\partial[G(\theta)-G_0(\theta)]}{\partial h} > 0$ if and only if $\theta \in (\tilde{\theta}, 1]$ with $\tilde{\theta}$ defined by $\eta - (1 + \lambda)(1 - (1 - \tilde{\theta})(1 - m))$. Moreover, $[G(\theta) - G_0(\theta)] > 0$ for all $\theta \in [0, 1]$ because it is minimum at $\tilde{\theta}$ and takes the value

$$\begin{aligned}
G(\tilde{\theta},\tilde{\theta}) - G_0(\tilde{\theta}) &= (1-\tilde{\theta})\left[m(1+\lambda)D - \frac{(h\eta + (1-h)(1+\lambda))}{1-(1-\tilde{\theta})(1-m)h}((1-m)I - mR_0)\right] \\
&= (1-\tilde{\theta})\left[m(1+\lambda)D - \frac{(h\eta + (1-h)(1+\lambda))}{1-h+h[1-(1-\tilde{\theta})(1-m)]}((1-m)I - mR_0)\right] \\
&= (1-\tilde{\theta})\left[m(1+\lambda)D - \frac{(h\eta + (1-h)(1+\lambda))}{1-h+h\frac{\eta}{(1+\lambda)}}((1-m)I - mR_0)\right] \\
&= (1-\tilde{\theta})\left[m(1+\lambda)D - (1+\lambda)\frac{(h\eta + (1-h)(1+\lambda))}{h\eta + (1-h)(1+\lambda)}((1-m)I - mR_0)\right] \\
&= (1-\tilde{\theta})(1+\lambda)\left[mD - ((1-m)I - mR_0)\right] > 0
\end{aligned}$$

Hence the haircut's first effect is positive, the second is positive for $\theta \in (\tilde{\theta}, 1]$ only, the third and fourth ones are negative.

Condition $\dfrac{mD}{(1-m)I - mR_0} < 1$ implies that the government's restructuring surplus is negative for $h = 0$ and all $\theta \in [0, 1]$.

Case 1: $\eta \geq (1+\lambda)$. From (22) and (23), we have $\frac{G_0(\theta)}{\partial h} < 0$ and $\frac{\partial[G(\theta) - G_0(\theta)]}{\partial h} < 0$, which implies that the government's restructuring surplus is negative for all $h \in [0, 1]$ and all $\theta \in [0, 1]$. The first and second effects are negative but the third and fourth ones are positive.

Case 2: $\eta < (1+\lambda)$. From (22), we have $\frac{G_0(\theta)}{\partial h} > 0$. From (23), we have $\frac{\partial[G(\theta) - G_0(\theta)]}{\partial h} > 0$ if and only if $\eta < (1+\lambda)(1-(1-\theta)(1-m))$.

Case 2.1: $\eta \in (m(1+\lambda), (1+\lambda))$. In that case, $\frac{\partial[G(\theta) - G_0(\theta)]}{\partial h} > 0$ if and only if $\theta \in (\tilde{\theta}, 1]$ with $\tilde{\theta}$ defined by $\eta - (1+\lambda)(1-(1-\tilde{\theta})(1-m))$. Moreover, for some values of θ, the government surplus for $h = 1$ is less than that for $h = 0$. Indeed, for $h = 1$

$$G(\theta, \theta) - G_0(\theta) = (1-\theta)\left[m(1+\lambda)D - \eta\frac{((1-m)I - mR_0))}{[1-(1-\theta)(1-m)]}\right],$$

and for $h = 0$

$$G(\theta, \theta) - G_0(\theta) = (1-\theta)\left[m(1+\lambda)D - (1+\lambda)[(1-m)I - mR_0]\right].$$

Hence the difference has the same sign as

$$(1+\lambda) - \frac{\eta}{[1-(1-\theta)(1-m)]}$$

which is positive for $\theta = 1$ and negative for $\theta = 0$. Thus $h = 1$ need not be optimal.

Case 2.2: $\eta < m(1+\lambda)$. In that case, $\frac{\partial[G(\theta) - G_0(\theta)]}{\partial h} > 0$ for all $\theta \in [0, 1]$. Hence $h = 1$ is necessarily optimal if the government's surplus is negative for $h = 1$ and all $\theta \in [0, 1]$. That is the case if for all $\theta \in [0, 1]$

$$G(\theta, \theta) - G_0(\theta) = (1-\theta)\left[m(1+\lambda)D - \eta\frac{((1-m)I - mR_0))}{[1-(1-\theta)(1-m)]}\right] < 0$$

which amounts to

$$\frac{m(1+\lambda)D}{((1-m)I - mR_0))} < \eta.$$

In that case, all four effects are positive and $h = 1$ is optimal. Otherwise, the third and forth effects can be negative.

A.7 Proof of Corollary 5

We have:

$$\frac{\partial U^G}{\partial h} = \int_0^1 \frac{\partial G_0(x)}{\partial h} f(x)dx + \int_0^{\theta^*} e^{-\beta\Delta(x)} \frac{\partial[G(x) - G_0(x)]}{\partial h} f(x)dx \tag{A.26}$$

$$-\beta \int_0^{\theta^*} e^{-\beta\Delta(x)} \frac{\partial\Delta(x)}{\partial h}[G(x) - G_0(x)]f(x)dx + \frac{\partial\theta^*}{\partial h} e^{-\beta\Delta(\theta^*)}[G(\theta^*) - G_0(\theta^*)]f(\theta^*).$$

Note that holding X fixed, $\frac{\partial\Delta(\theta)}{\partial Y} = 0$ and $\frac{\partial\theta^*}{\partial Y} = 0$. Thus

$$\frac{\partial^2 U^G}{\partial Y \partial h} = \int_0^1 \frac{\partial^2 G_0(x)}{\partial Y \partial h} f(x)dx + \int_0^{\theta^*} e^{-\beta\Delta(x)} \frac{\partial^2[G(x) - G_0(x)]}{\partial Y \partial h} f(x)dx \tag{A.27}$$

$$-\beta \int_0^{\theta^*} e^{-\beta\Delta(x)} \frac{\partial\Delta(x)}{\partial h} \frac{\partial[G(x) - G_0(x)]}{\partial Y} f(x)dx + \frac{\partial\theta^*}{\partial h} e^{-\beta\Delta(\theta^*)} \frac{\partial[G(\theta^*) - G_0(\theta^*)]}{\partial Y} f(\theta^*).$$

For $Y = D$, we also have $\frac{\partial^2 G_0(x)}{\partial D \partial h} = 0$ and $\frac{\partial^2[G(x)-G_0(x)]}{\partial D \partial h} = 0$, we have

$$\begin{aligned}
\frac{\partial^2 U^G}{\partial D \partial h} &= -\beta \int_0^{\theta^*} e^{-\beta\Delta(x)} \frac{\partial\Delta(x)}{\partial h} \frac{\partial[G(x) - G_0(x)]}{\partial D} f(x)dx + \frac{\partial\theta^*}{\partial h} e^{-\beta\Delta(\theta^*)} \frac{\partial[G(\theta^*) - G_0(\theta^*)]}{\partial D} f(\theta^*) \\
&= -\beta \int_0^{\theta^*} e^{-\beta\Delta(x)} \frac{\partial\Delta(x)}{\partial h}(1-x)m(1+\lambda)f(x)dx + \frac{\partial\theta^*}{\partial h} e^{-\beta\Delta(\theta^*)}(1-\theta^*)m(1+\lambda)f(\theta^*)
\end{aligned}$$

which is negative since both terms are. For $Y = \eta$, the first two terms are negative but the last two are positive. For $Y = \lambda$, all four terms are positive.

A.8 Proof of Lemma 4

Consider the case $\eta = 0$. We need to study under which conditions θ simultaneously satisfies (33), (34), and (35). Condition (33) gives us:

$$\theta \leq \overline{\theta} = \frac{mZ - I}{mZ}. \tag{A.28}$$

Condition (35) can be rewritten as:

$$\theta \geq \frac{(1-h)[(1-m)I - mR_0] - mD[1-(1-m)h]}{h(1-m)mD} = \underline{\theta}. \tag{A.29}$$

The right-hand side of condition (HG) is equivalent to $\underline{\theta} \leq \overline{\theta}$.

Finally, since the numerator of $\bar{\alpha}(\theta)$ is $G(\theta,\theta) - G_0(\theta)$, condition $\theta > \underline{\theta}$ implies that $\bar{\alpha}(\theta) > 0$, so that we can always find a sufficiently small α.

By inspecting (33) and (35) it is obvious that increasing η makes these conditions less likely to hold, and surely they cannot hold if η is large enough. This is also the case for condition (34), but this is more easily checked by looking at equation (**??**), from which it is derived: it is clear from (**??**) that increasing η has a negative impact on $T(\theta)$, so that it is less likely that $T(\theta) \geq 0$, and (34) is more difficult to satisfy. Since η affects the three conditions in the same direction, the set Θ_η of values that satisfy all three conditions shrinks as η increases.

A.9 Proof of Lemma 5

We want to prove $E_1(\theta,\theta) + [1-(1-\theta)(1-m)]\dot{T}(\theta) \geq 0$. Using equation (**??**), we can write:

$$T(\theta) = \frac{1-\alpha}{1+\lambda} g_G(\theta) - \alpha g_E(\theta) \tag{A.30}$$

with

$$g_G(\theta) = \frac{G(\theta,\theta) - G_0(\theta)}{1-(1-\theta)(1-m)} \tag{A.31}$$

$$= (1-\theta)\frac{(1+\lambda)[mD-(1-h)[(1-m)R(\theta)-R_0]] - h\eta[(1-m)R(\theta)-R_0]}{1-(1-\theta)(1-m)} \tag{A.32}$$

$$g_E(\theta) = \frac{E(\theta,\theta) - E_0(\theta)}{1-(1-\theta)(1-m)} \tag{A.33}$$

$$= \frac{m[(1-\theta)X - R(\theta)] - \theta[(1-m)R(\theta)-R_0]}{1-(1-\theta)(1-m)}. \tag{A.34}$$

We need to differentiate T. We first consider $g_E(\theta)$. We have:

$$\frac{d[E(\theta,\theta)-E_0(\theta)]}{d\theta} = -mX - (1-h)\frac{(1-m)I - mR_0}{[1-(1-\theta)(1-m)h]^2} \leq 0. \tag{A.35}$$

Since the denominator of $g_E(\theta)$ increases in θ, this shows that $\dot{g_E}(\theta) \leq 0$.

Turning to $g'_G(\theta)$, note that we have:

$$\frac{\partial g_G(\theta)}{\partial \eta} = -h(1-\theta)\frac{(1-m)R(\theta)-R_0}{1-(1-\theta)(1-m)} \tag{A.36}$$

$$= -h[(1-m)I - mR_0]\frac{1-\theta}{[1-(1-\theta)(1-m)h][1-(1-\theta)(1-m)]} \tag{A.37}$$

$$\frac{\partial g'_G(\theta)}{\partial \eta} = h[(1-m)I - mR_0]\frac{1-h(1-\theta)^2(1-m)^2}{[1-(1-\theta)(1-m)h]^2[1-(1-\theta)(1-m)]^2} \geq 0. \tag{A.38}$$

Note that η does not appear in $g_E(\theta)$ or in $E_1(\theta,\theta)$. Hence, it is sufficient to show that $E_1(\theta,\theta) + [1-(1-\theta)(1-m)]\dot{T}(\theta) \geq 0$ when $\eta = 0$. Moreover, since $E_1(\theta,\theta) \geq 0$ and $-\alpha\dot{g_E}(\theta) \geq 0$, it is sufficient to consider the case $\alpha = 0$. When $\eta = 0$ and $\alpha = 0$, after some rewriting we obtain:

$$E_1(\theta,\theta) + [1-(1-\theta)(1-m)]\dot{T}(\theta) = [1-(1-\theta)(1-m)]\left(-\dot{R}(\theta) + \frac{1-\alpha}{1+\lambda}\dot{g_G}(\theta)\right) \tag{A.39}$$

$$= \frac{[1-h(1-\theta)(1-m)]^2[(1-m)I - mR_0 - mD]}{1-(1-\theta)(1-m)}, \tag{A.40}$$

which is positive under condition (HG).

We conclude that for any θ, α, and η, $E_1(\theta,\theta) + (1-(1-m)(1-\theta))\dot{T}(\theta) > 0$. Moreover, by definition a type $\theta \in \Theta_\eta$ is such that $E(\theta,\theta) + (1-(1-m)(1-\theta))T(\theta) > E_0(\theta)$, so that $\dot{\Delta}_G(\theta) > 0$.

We can thus apply the same method as in Section 2 and solve for $\Delta_G(\theta)$.

A.10 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 $\theta \in \Theta_\eta \cup [0, \theta^*]$, the manager waits $\Delta_G(p)$ before making an offer. If $\theta \notin \Theta_\eta$, the manager offers the creditors a new debt contract with face value $R(\theta)$. If $\theta \in \Theta_\eta$, the manager makes a joint offer to the creditors of a new debt contract $R(\theta)$ and to the government to make a transfer $T(\theta)$ to the shareholders, conditional on the bank surviving. The restructuring is implemented if both the government and the creditors accept the offer.

Denote $\theta^{\max} = \max(\theta^*, \max(\Theta_\eta))$ the highest type that restructures in equilibrium (either with or without making an offer to the government). If the creditors receive an offer after a delay $t \in [0, \Delta_G(\theta^{\max})]$, they expect θ to be equal to $\Delta_G^{-1}(t)$ and accept an offer R' if and only if $R' \geq R(\Delta_G^{-1}(t))$. If the creditors receive an offer R' after a delay $t > \Delta_G(\theta^{\max})$, we allow them to have any expectation $\hat{\sigma}(t) \in [0, \theta^{\max}]$ about θ. They accept the offer if and only if $R' \geq R(\hat{\sigma}(t))$.

If the government receives an offer after a delay $t \in [0, \Delta_G(\theta^{\max})]$, it expects θ 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 $t > \Delta_G(\theta^{\max})$, we allow the government to have any expectation $\hat{\sigma}(t) \in [0, \theta^{\max}]$ about θ. 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 $U^E(\hat{\theta}, \theta)$ over $\hat{\theta}$ precisely in $\hat{\theta} = \theta$. As in Section 2, there is no incentive to wait for $t > \theta^{\max}$.

2. The creditors' behavior is optimal given their beliefs, by definition of $R(\theta)$ in (5).

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 Admati and Perry (1987) or Cramton (1992). The government's behavior when it receives an offer is thus optimal given its beliefs about θ.

4. The creditors and the government's beliefs about θ if they receive an offer after a delay $t \in [0, \theta^{\max}]$ 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.

A.11 Proof of Corollary 6

Formally, the first point says that $(0, \theta^*) \subset \Theta_\eta \cup [0, \theta^*]$, which is obviously true. In order to prove that this inclusion is strict when η and α are close to zero, it is sufficient to show that $\bar{\theta} > \theta^*$. These two thresholds are defined by:

$$E(\theta^*, \theta^*) - E_0(\theta^*) = 0 \tag{A.41}$$

$$\frac{G(\bar{\theta}, \bar{\theta}) - G_0(\bar{\theta})}{1+\lambda} + E(\bar{\theta}, \bar{\theta}) - E_0(\bar{\theta}) = 0. \tag{A.42}$$

Since $G(\bar{\theta}, \bar{\theta}) - G_0(\bar{\theta}) > 0$, we have $E(\bar{\theta}, \bar{\theta}) - E_0(\bar{\theta}) < 0$. As in addition $E(\theta, \theta) - E_0(\theta)$ decreases in θ, we obtain $\bar{\theta} > \theta^*$.

The second point is obvious: the government is involved only when $T(\theta) > 0$, so that necessarily the surplus for the bank is greater than without government involvement, and the surplus effect is negative.

For the third point, government involvement has a positive signaling effect if and only if $\dot{T}(\theta) > 0$. Using the proof of Lemma 5, in order to show that $\dot{T}(\theta) > 0$ it is sufficient to show that $\dot{g_G}(\theta) \geq 0$. Since moreover $\dot{g_G}(\theta)$ increases in η, it is actually sufficient to prove the inequality when $\eta = 0$. In that case, we have:

$$\begin{aligned} \dot{g_G}(\theta) &= \frac{(1+\lambda)}{[1-h(1-m)(1-\theta)]^2[1-(1-\theta)(1-m)]^2} \\ &\times \left[(1-h)[(1-m)I - mR_0][1-h(1-m)^2(1-\theta)^2] - mD[1-h(1-m)(1-\theta)]^2\right]. \end{aligned} \tag{A.43}$$

Since $mD \leq (1-m)I - mR_0$, this quantity is indeed positive when h is sufficiently small. In this case, we obtain that $\dot{T}(\theta) > 0$, so that government involvement has a positive signaling effect which goes against the negative surplus effect.

When instead h is large, it is easy to show using (A.43) that $\dot{g_G}(\theta) < 0$ when $\eta = 0$ (consider $h = 1$). If in addition α is sufficiently small, then $\dot{T}(\theta)$ has the same sign as $\dot{g_G}(\theta)$. The signaling effect is thus positive and goes in the same direction as the surplus effect.

A.12 Proof of Corollary 7

The first part of the Corollary follows directly from Lemma 4.

For the second part of the Corollary, it is obvious from (30) that $E(\theta,\theta) - E_0(\theta) + [1-(1-\theta)(1-m)]T(\theta)$ decreases in α, so that α has a positive surplus effect on the delay.

For the signaling effect, we need to consider the impact of α on $\dot{T}(\theta)$. We have:

$$\frac{dT(\theta)}{d\alpha} = -\frac{G(\theta,\theta) - G_0(\theta) + (1+\lambda)[E(\theta,\theta) - E_0(\theta)]}{(1+\lambda)[1-(1-\theta)(1-m)]} \tag{A.44}$$

$$= \frac{(1-\theta)h\eta[(1-m)I - mR_0] - (1+\lambda)[1-(1-m)(1-\theta)h][m(1-\theta)Z - I]}{[1-(1-\theta)(1-m)][1-(1-m)(1-\theta)h]} \tag{A.45}$$

The parameter η is multiplied by a positive constant times $(1-\theta)/([1-(1-\theta)(1-m)][1-(1-m)(1-\theta)h])$, which is clearly decreasing in θ. Hence, $\frac{d\dot{T}(\theta)}{d\alpha}$ decreases in η, and is negative for η large enough. If η is equal to zero instead, the quantity above reduces to $-(1+\lambda)[m(1-\theta)Z-I]/[1-(1-\theta)(1-m)]$, which is clearly increasing in θ, in which case $\frac{d\dot{T}(\theta)}{d\alpha} \geq 0$.

This analysis shows that there exists $\bar{\eta}$ such that α has a positive signaling effect on the delay if $\eta \leq \bar{\eta}$ and a negative effect otherwise. Since the surplus effect is always positive, we conclude that α has a positive impact on the delay when $\eta \leq \bar{\eta}$.

A.13 Proof of Corollary 8

For the surplus effect, it is straightforward to use equations (30) and (33) to show that the shareholders' surplus is decreasing in h. To prove that $T(\theta)$ increases in h, we consider the impact of h

on $g_G(\theta)$ and $g_E(\theta)$ separately. After simple computations, we have:

$$\frac{dg_G(\theta)}{dh} = \frac{(1-\theta)[(1-m)I - mR_0]}{[1-(1-\theta)(1-m)][1-(1-\theta)(1-m)h]^2}[(1+\lambda)[1-(1-\theta)(1-m)] - \eta] \tag{A.46}$$

$$\frac{dg_E(\theta)}{dh} = -\frac{dR(\theta)}{dh}[1-(1-\theta)(1-m)]. \tag{A.47}$$

The first expression is positive when $\eta \leq (1+\lambda)[1-(1-\theta)(1-m)]$, and the second one negative. Using (A.30), this implies that $T(\theta)$ increases in h.

For the signaling effect, we use (A.30) to rewrite $T(\theta)$:

$$T(\theta) = \frac{1-\alpha}{1+\lambda}[g_G(\theta) + (1+\lambda)g_E(\theta)] - g_E(\theta). \tag{A.48}$$

Let us first consider the term $-g_E(\theta)$ and show that $\frac{d^2 g_E(\theta)}{d\theta dh} \geq 0$. Using (A.34) we have:

$$\frac{dg_E(\theta)}{dh} = -\frac{dR(\theta)}{dh} \tag{A.49}$$

$$\frac{d^2 g_E}{dh d\theta} = -\frac{d\dot{R}(\theta)}{dh} = \frac{d}{dh}\frac{h[(1-m)I - mR_0]}{[1-(1-\theta)(1-m)h]^2}. \tag{A.50}$$

This last quantity is clearly positive, so that $\frac{-d^2 g_E}{dh d\theta}$ is negative.

We now turn to $g_G(\theta) + (1+\lambda)g_E(\theta)$. Using (33), we have:

$$\frac{d[g_G(\theta) + (1+\lambda)g_E(\theta)]}{dh} = -\eta[(1-m)I - mR_0]\frac{(1-\theta)}{[1-(1-\theta)(1-m)][1-(1-\theta)(1-m)h]^2}. \tag{A.51}$$

The fraction is clearly decreasing in θ, so that $\frac{d^2[g_G(\theta)+(1+\lambda)g_E(\theta)]}{dh d\theta} \geq 0$.

Combining the two results, $d\dot{T}(\theta)/dh$ decreases in α. For α sufficiently close to zero we have $d\dot{T}(\theta)/dh \geq 0$, a positive signaling effect, and for α large enough we have $d\dot{T}(\theta)/dh \leq 0$, a negative signaling effect. In the former case, the combination of the surplus effect and the signaling effect is such that the delay increases in h, whereas in the latter case the combined effect is ambiguous.

A.14 Proof of Corollary 9

To prove that $P^E(t)$ increases in t it suffices to show that the value of the bank to shareholders, $[1-e^{-\beta\Delta(\theta)}]E_0(\theta)+e^{-\beta\Delta(\theta)}E(\theta,\theta)$, increases in θ. This is equivalent to:

$$\begin{aligned}
&[1-e^{-\beta\Delta(\theta)}]\dot{E}_0(\theta)+e^{-\beta\Delta(\theta)}[E_1(\theta,\theta)+E_2(\theta,\theta)]-\beta\dot{\Delta}(\theta)[E(\theta,\theta)-E_0(\theta)]\geq 0\\
\Leftrightarrow&[1-e^{-\beta\Delta(\theta)}][\dot{E}_0(\theta)-E_1(\theta,\theta)]+e^{-\beta\Delta(\theta)}E_2(\theta,\theta),
\end{aligned}\tag{A.52}$$

where we use (11) to replace $\dot{\Delta}(\theta)$. As $E_2\geq 0$, it suffices to show that $\dot{E}_0(\theta)\geq \dot{E}_1(\theta,\theta)$, which writes as:

$$X-R_0-h(1-(1-\theta)(1-m))\frac{(1-m)I-mR_0}{[1-(1-\theta)(1-m)h]^2}\geq 0.\tag{A.53}$$

It is sufficient to show that this condition is satisfied when $h=1$ and $\theta=0$, in which case it reduces to $mX\geq(1-m)I$. As the model assumes $mX\geq I$, we obtain that $P^E(t)$ increases in t. This implies also that $\bar{P}^E(t)\leq P^E(t)$.

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

A.15 Proof of Corollary 10

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

For the shareholders, it is sufficient to prove that for any θ the quantity $[1-e^{-\beta\Delta(\theta)}]E_0(\theta)+e^{-\beta\Delta(\theta)}E(\theta,\theta)$ decreases in h. As $E_0(\theta)$ does not depend in h, this requires to show that:

$$-\beta\frac{d\Delta(\theta)}{dh}e^{-\beta\Delta(\theta)}[E(\theta,\theta)-E_0(\theta)]+e^{-\beta\Delta(\theta)}\frac{dE(\theta,\theta)}{dh}\geq 0.\tag{A.54}$$

It is easily shown that $E(\theta,\theta)$ decreases in h, as $R(\theta)$ increases in h. Moreover, Corollary 3 shows that Δ increases in h, so that condition (A.54) is satisfied. This shows that $P^E(t)$ decreases in h.

A.16 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 $\alpha = 0.1$.

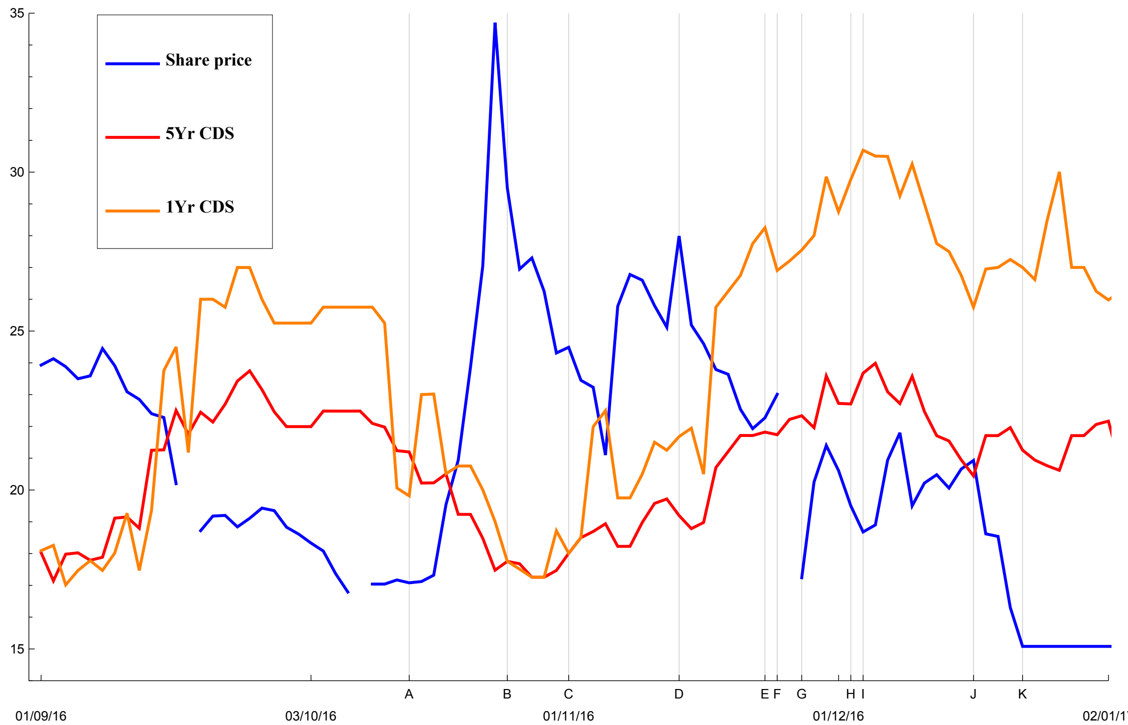

Figure 1: **Monte dei Paschi di Siena.** This graph plots the share price, 1-year and 5-year CDS premia for Monte dei Paschi di Siena between September 2016 and January 2017. CDS premia are multiplied by 1/20 for better readability.

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.

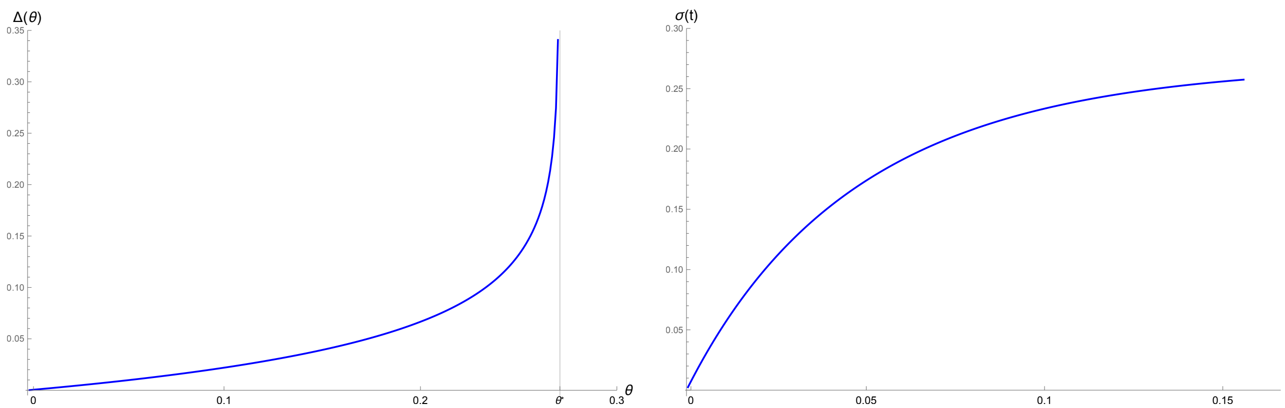

Figure 2: **Equilibrium delay $\Delta(\theta)$, and equilibrium belief $\sigma(t)$.**

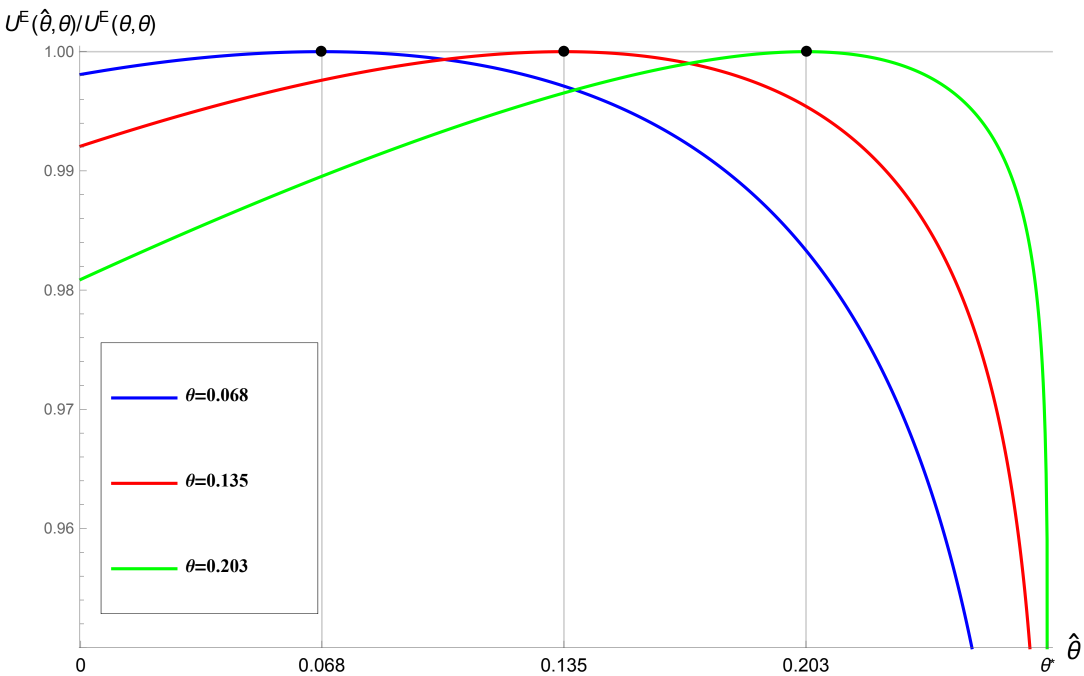

Figure 3: **Manager's incentives to report truthfully.** This graph plots the ratio $U^E(\hat{\theta},\theta)/U^E(\theta,\theta)$ as a function of $\hat{\theta}$, for different values of θ. $U^E(\hat{\theta},\theta)$ is always maximized in $\hat{\theta} = \theta$.

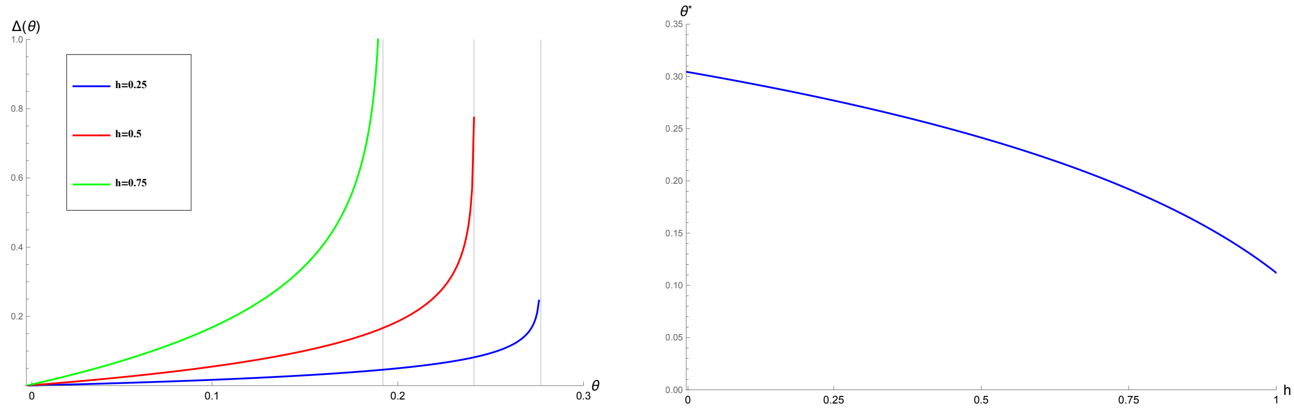

Figure 4: **Equilibrium delay and haircuts.** The left panel plots the equilibrium delay $\Delta(\theta)$ as a function of θ for different values of the haircut h. The right panel plots the maximum type making an offer, θ^*, as function of h.

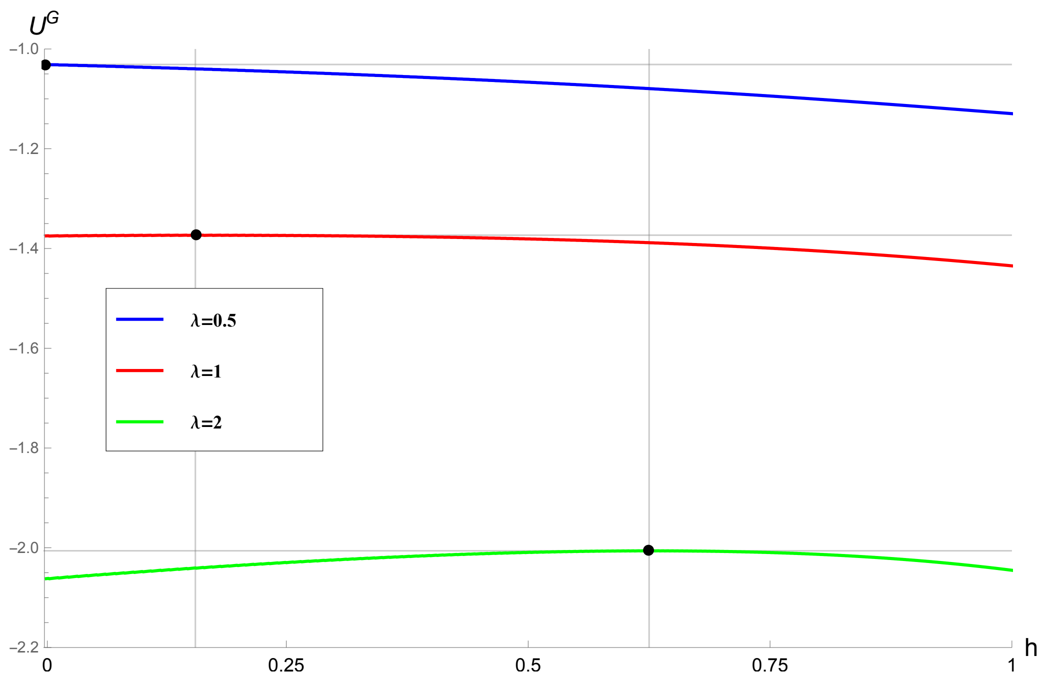

Figure 5: **Expected government payoff and haircuts.** This graph plots the expected government payoff U^G as a function of the haircut h, for different values of the cost of public funds λ.

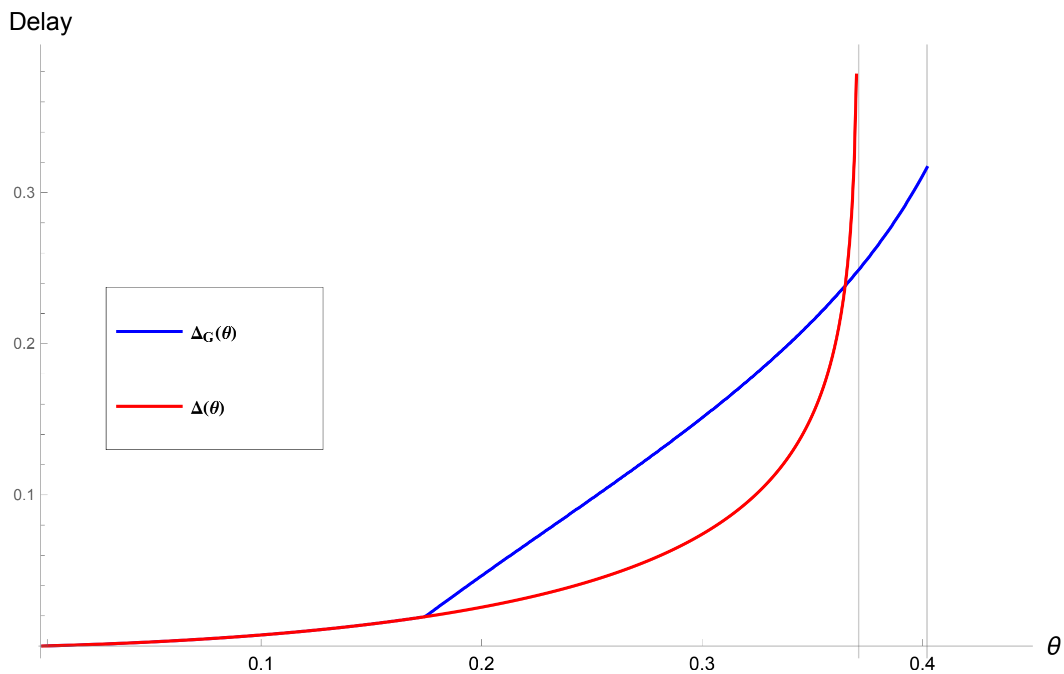

Figure 6: **Government involvement and equilibrium delay.** This graph plots the equilibrium delay with government involvement $\Delta_G(\theta)$ and the delay without government involvement $\Delta(\theta)$.

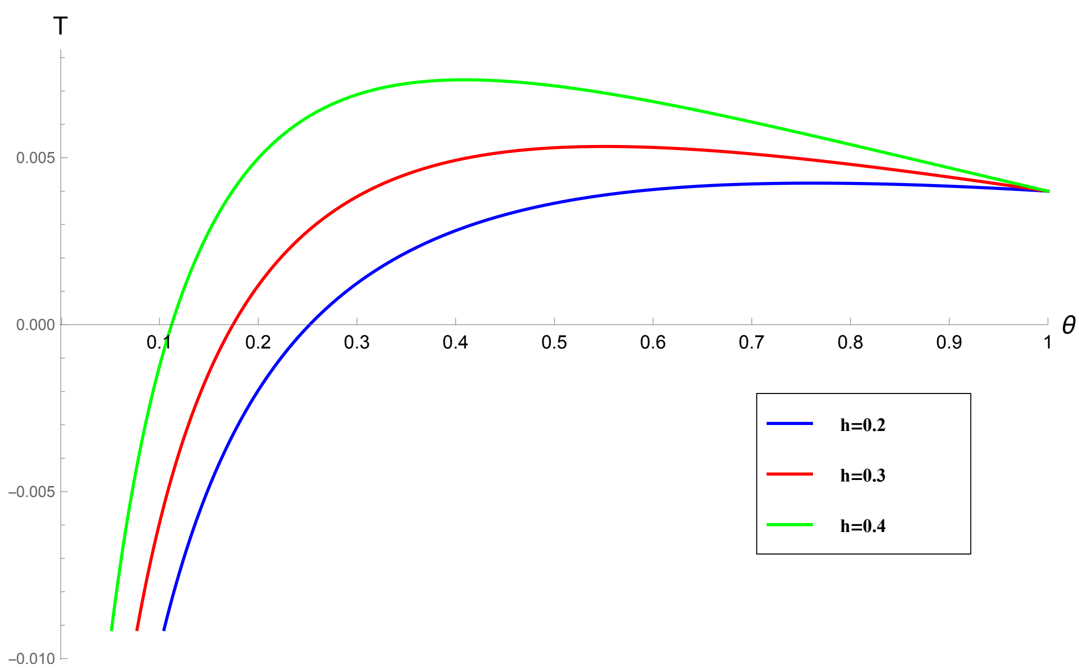

Figure 7: **Impact of haircuts on government transfers.** This graph plots $T(\theta)$ as a function of θ for different levels of the haircut h.

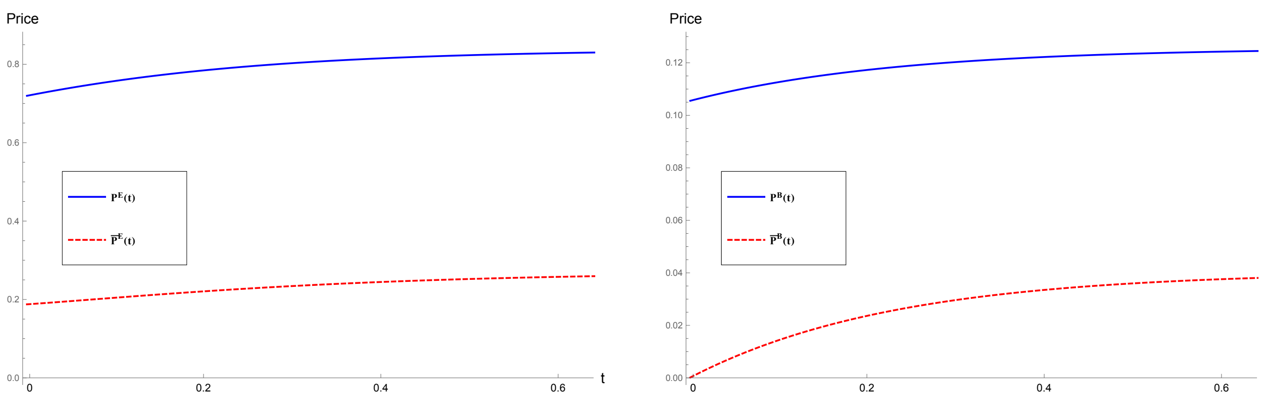

Figure 8: **Market value of equity and debt.** This graph plots the market values of equity and debt $P^E(t)$ and $P^C(t)$ over time, as well as $\bar{P}^E(t)$ and $\bar{P}^C(t)$. If restructuring occurs at time t, the equity value drops from $P^E(t)$ to $\bar{P}^E(t)$, and the debt value from $P^C(t)$ to $\bar{P}^C(t)$.