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Bail-in vs. *Bailout: a False Dilemma?*

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Abstract
This paper analyzes the effects of bail-in policies on banks' funding cost, incentives for loan monitoring, and financing capacity. In a model with moral hazard and two investment stages, a full bail-in turns out to be, *ex post*, the first-best policy to deal with failing banks. As a consequence, however, investors expect bail-ins rather than bailouts. *Ex ante*, this raises banks' cost of debt and depresses bankers' incentives to monitor. When moral hazard is severe, this time inconsistency leads to a credit market collapse unless the government pre-commits to an alternative resolution policy. The optimal policy is either a combination of bail-in and bailout or liquidation, depending on the severity of moral hazard and the shadow cost of the partial bailout.

JEL Classification: D82, E58, G21, G28

Keywords: bail-in; bailout; moral hazard, resolution policies; bank regulation.

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1 Introduction

In early 2010 the CEO of Credit Suisse, Paul Calello, and its former chief risk officer, Wilson Ervin, in a well-known article in *The Economist*, proposed a new resolution mechanism for banks in distress: the *bail-in*. This consists essentially in a debt-equity swap imposed by the regulator which allows to recapitalize the bank from within by converting part of its debt into equity.[1] Since then, many economists and policy-makers around the world have stressed the importance of this new policy tool. Unlike bailouts, bail-ins would enable the government to rescue systemically important financial institutions using their internal resources in lieu of taxpayers' money, thus mitigating the "too-big-to-fail" problem while at the same time avoiding inefficient liquidations. Yet considerably less attention has been paid to the possible costs associated with bail-ins, above all the rise in the cost of debt that is likely to stem from their expected adoption, owing to the losses imposed on banks' creditors in the conversion.

The aim of this paper is to shed light on the effects of bail-ins on bank behavior – highlighting also the potential inefficiencies that they can generate – and to compare bail-ins with the alternative policy tools for dealing with failing banks. More specifically, in a model *à la* Holmstrom and Tirole (1997) with two investment stages, I explore how adding the bail-in to the bank resolution toolkit available to regulators affects banks' funding costs and incentives to monitor loans. In the model, a full bail-in turns out to be the first-best policy to deal – *ex post* – with large banks in distress. By assigning bank shares to debt-holders, the regulator can indeed efficiently recapitalize a troubled bank, allowing it to operate profitably in the future, and thus avoiding both the shadow cost of bailouts (distortionary taxation) and inefficient liquidation of the bank. However, this *ex post* optimality itself makes bail-in the sole resolution tool the regulator can be expected to deploy, in equilibrium. Therefore, *ex ante*, bail-in expectations raise the cost of debt for banks – owing to the

[1] Hence, a bail-in is a statutory power that enables the regulator to restore the solvency of a financial institution in distress, reducing its leverage. It differs substantially from contingent convertibles, *i.e.* CoCos, which are fixed-income instruments whose conversion into equity when a specified trigger event occurs is already envisaged in the debt contract, together with the conversion rate.

removal of implicit bailout guarantees – which in turn can affect bank incentives in the presence of moral hazard: the decline in expected profits decreases the bankers' incentive to monitor loans. In other words, the bail-in creates a problem of dynamic inconsistency that can exacerbate instead of mitigating moral hazard. In some cases, there is no gross return that the banker can promise to investors such that the former has an incentive to monitor and the latter break even. In such cases, the credit market collapses and banks are unable to raise funds and finance entrepreneurs, damaging the entire economy.

Although significant, this result does not imply, *per se*, that the introduction of bail-ins generates a loss for society: the credit market may collapse in situations where bailouts would have led to an even less efficient equilibrium. Thus, the bail-in equilibrium must be measured against the equilibrium that would arise in a regime in which the bailout is the only resolution policy available to the regulator for recapitalizing troubled banks. In such a "pre-bail-in" world, the main social cost would derive from the implicit guarantee provided by the government, which induces investors to fund banks even when they have no incentive to monitor their loans, thus heightening insolvency risk. The model shows that when moral hazard is severe this cost may be lower than that associated with bail-ins. The intuition is the following: when investors anticipate that the regulator will invariably bail a failing bank out, the required return on debt is lower than it would be given bail-in; lowering the cost of the debt increases bank profits and induces the banker to exert monitoring effort, thus producing an efficient equilibrium. So, there are cases in which bailouts are more efficient than bail-ins: they avoid credit market collapse and induce better monitoring incentives. In these cases, introducing bail-ins diminishes social welfare.

When the expected implementation of bail-in leads to credit market collapse, the government cannot restore efficiency unless it credibly pre-commits to an alternative resolution policy. In particular, it must decide whether to pre-commit to recapitalize – and if so, by what means – or to liquidate the bank. I show that the optimal recapitalization policy is a combination of bail-in and bailout. In the recapitalization, the government converts part of the bank's debt into equity

– leaving the banker the lowest possible share of future profits that satisfies *ex post* incentive compatibility – and uses the partial bailout just to reduce bank's funding cost enough to satisfy *ex ante* incentive compatibility. This mixed bail-in, bailout policy is always the most efficient way to recapitalize banks, and is preferable to liquidation as long as moral hazard and the cost of transferring resources from the public to the private sector are low enough. If this is not the case, bank rescues are too costly, and the government must pre-commit to liquidate failing banks, so as to make sure the banker has the incentive to monitor loans and can accordingly raise funds and provide financing at least in the first investment stage. The main results from the model – the dynamic inconsistency created by the introduction of bail-in and the optimal policy design when bail-ins are inefficient – hold regardless of the degree of banking competition and banks' capital structure.

These results offer new insights into the effects of bail-in policies and contribute to the lively debate on optimal resolution policies for large financial institutions in distress. While bail-ins prove to be *ex post* efficient, these findings indicate that that they are no *panacea* for the "too-big-to-fail" problem, given the danger of an *ex ante* adverse reaction in the credit market. Because of this trade-off between *ex ante* and *ex post* optimality, bail-ins can generate a time-inconsistency problem, just like bailouts, although for a totally different reason. Whereas the main problem of the bailout is the implicit guarantees of public intervention, which leads investors to fund banks regardless of their behavior, the side effect of bail-ins is an increase in the cost of debt, which can distort incentives and lower banks' financing capacity: with full bailout, too many *bad* investments are made; with full bail-in, too few *good* investments are financed. To avert a credit crunch, the regulator should pre-commit to use bail-ins together with bailouts, not simply switch from the latter to the former. By using the two tools together, the burden of bank failure on taxpayers can be eased and at the same time the adverse effects of bail-in expectations on funding cost and monitoring incentives mitigated. In light of this result, the dispute between bail-ins and bailouts would appear to be a false dilemma. Both policies, if used alone, have undesirable side effects that can be moderated by applying them in combination.

The rest of the paper is organized as follow. Section 2 summarizes the regulatory context and the relevant literature. Section 3 presents the framework and the equilibrium of the model with no pre-commitment. A comparison with a bailout regime is then presented in Section 4, and Section 5 describes the optimal recapitalization policy and the pre-commitment equilibrium. Section 6 extends the analysis to comprise banking competition for fundings and equity issuance. Section 7 concludes.

2 The regulatory context and the relevant literature

Since they were first proposed, bail-in policies have now been introduced in several countries. In the US, the bail-in process was embedded in Title II of the Dodd-Frank Act, which establishes the Orderly Liquidation Authority. Under the Title II "Single Point of Entry" (SPoE) approach, the Federal Deposit Insurance Company (FDIC) is the appointed receiver of the defaulting financial company, whose losses are to be borne by shareholders and unsecured creditors. This strategy is intended to impose market accountability and preserve financial stability, imposing losses on both shareholders and debt-holders.[2] In this case, the bail-in serves to reduce the charge to taxpayers and the social cost of the resolution, the bank being treated as a gone concern. That is, the US approach consists of a *closed bank* bail-in, designed to minimize systemic disruption in a liquidation rather than to rescue a troubled financial institution.

In 2014, the European Union reached political agreement on its own Bank Resolution and Recovery Directive (BRRD) – Directive 2014/59/EU – which establishes the legislative basis for bail-in within the EU. Unlike the US one, the European approach also considers the possibility of using the bail-in as an *open bank* resolution process to efficiently recapitalize the bank and preserve it as a going concern. In this case, according to the BRRD, bail-ins can entail either the cancellation or the dilution of existing shares and the entitlement of bailed-in debt-holders to shares in the bank.

[2] A detailed description of this SPoE strategy is given in a joint paper by the FDIC and the Bank of England in 2012.

Hence bail-ins can take different forms, and their optimal design remains the subject of ongoing discussion for policy-makers. Meanwhile, some countries have already experienced bail-in events. An exhaustive summary of such cases is presented by Schäfer et al. (2016) in an analysis of the effects of bail-ins on creditors' expectations. One of the first European countries to experience a bail-in event was Denmark. On 6 February 2011, the Danish authorities decided to bail-in senior debt-holders and unsecured depositors of the Amagerbanken, imposing a haircut of 41%. Similarly, the Dutch bank SNS Reaal was bailed-in at the beginning of 2013: the bank was nationalized and junior bondholders lost their entire investment. The best-known case of bail-in in the eurozone to date is Cyprus where on 28 April 2013, the Bank of Cyprus converted 47.5% of its uninsured deposits above 100,000 euros into equity. In August 2014, the Portuguese Banco Espírito Santo was bailed-in, with junior debt-holders bearing some of the losses. Examining the behavior of bank CDS spreads and stock prices before and after these bail-ins, as well as around the date of the implementation of the BRRD in Europe, Schäfer et al. (2016) find empirical evidence of a negative impact of bail-ins on subsequent bank returns – especially for systemically important banks and for banks in peripheral eurozone countries – owing to the increase in funding costs due to the decreased chance of future bailouts. In a related study, Giuliana (2017) also finds evidence of an increase in the yield spread between bail-inable and non-bail-inable debt around these events. Evidence on the real effects of bail-in is provided by Beck et al. (2017), who investigate the reaction of Portuguese banks more and less exposed to the bail-in of Banco Espírito Santo as credit suppliers, and find those more exposed cut back more on credit granted to Portuguese firms. Taken together, these various studies suggest that one direct consequence of bail-ins is an increase in the cost of debt for banks, due to the shift in the burden of bank failures from taxpayers to debt-holders.

From the theoretical standpoint, the issues arising from the adoption of statutory bail-in are still under-researched. Additionally, most of the literature sees the bail-in as the optimal resolution mechanism. In an IMF position note, for instance, Landier and Ueda (2009) show that as long as debt renegotiation is feasible a debt-equity swap can lower a bank's probability of default without government intervention. Similarly, Zhou et al. (2012) argue that "[...] bail-in could mitigate the systemic risks associated with disorderly liquidations, reduce deleveraging pressures, and preserve asset values that might otherwise be lost in a liquidation." (p.3). The Association for Financial Markets in Europe (AFME) published a paper in 2010 on the need to give national regulators the authority to quickly recapitalize banks through debt-equity swaps so as to avoid their inefficient liquidation and avert fire-sales and bank runs. A resolution procedure that requires a minimum haircut on uninsured creditors is essential to promote financial stability also according to Calomiris (2011), while Huertas (2013) argues that bail-ins are better than bailouts since they soften the negative impact of banks' insolvency on the economy at no cost to taxpayers. Using an agent-based model framework with no moral hazard, Klimek et al. (2015) argue that bail-ins are always more efficient than bailouts. More recently, Chari and Kehoe (2016) show that empowering the government to impose losses on unsecured debt-holders reduces the inefficiency of bailout subsidies.[3] Philippon and Salord (2017) also advocate bail-ins as a way of promoting financial stability.

Only a few authors have drawn attention to the potential disadvantages of bail-ins. Avgouleas and Goodhart (2014), for instance, contend that bail-ins might not be sufficient to reduce the threat of a systemic bank crisis, when bailouts might be preferred. Similarly, Dewatripont (2014) discusses the potential pitfalls of bail-ins, concluding that bailouts should not be excluded but should complement bail-ins, especially in times of crisis. Anderson (2011) also argues that an effective bail-in process requires careful design, especially as regards the allocation of ownership and control rights among the investors involved in the recapitalization.[4]

While the literature on bail-ins is limited and mostly in favor of this instrument, that on bailouts is more extensive but divided. Some studies observe that bailouts can encourage bankers to take on risk (Repullo, 2005) and discourage uninsured debt-holders from monitoring the conduct of the bank (Kaufman, 1991) thus leading to excessive risk-taking. Bailouts are also seen as a source

[3] Actually, the authors show that such resolution procedures are more efficient than bailouts, but do not reduce the incentives for firms to be inefficiently large. Because of this, the regulator should tax size and put a limit on banks' debt-to-value ratio.

[4] Other recent works on bail-ins are Bernard et al. (2017), on the interactions between bail-ins and interbank networks, and Mendicino et al. (2017), on bail-ins and banks' total loss-absorbing capacity in the presence of moral hazard.

of systemic risk, in that they give banks an incentive to pick correlated risks so as to maximize bailout gains in case of systemic collapse (Farhi and Tirole, 2012). However, others view bailouts as a way to avert contagion risk by reducing the likelihood of fire sales (Acharya and Yorulmazer, 2008) and to attenuate moral hazard, for instance by increasing the charter value of banks and so inducing bankers to choose a safer portfolio (Cordella and Yeyati, 2003).[5] Keister (2016) argues that preventing bailouts can have unintended effects on financial stability, increasing the fragility of relatively stable economies. Also according to Leonello (2018) government guarantees to financial institutions can prevent panic-driven banking crises, thus improving the stability of the banking industry while at the same time lowering the probability of sovereign insolvency in countries with solid economic prospects. Finally, in order to minimize the losses entailed in the liquidation of large financial institutions while mitigating the moral hazard problem implicit in bailouts, a mixed strategy in which banks are bailed out not certainly but with some positive probability might prove optimal. This concept, introduced by Freixas (2000), is known as "constructive ambiguity".

In short, a substantial but ambivalent literature has been produced on bailouts while the theoretical literature on bail-ins is comparatively scanty. Furthermore, very few studies compare the two resolution mechanisms from a social perspective or consider the possibility of combining them to restore bank solvency efficiently. These are precisely the two main contributions of this paper.

3 The model

3.1 The Setup

I consider a three-date economy with no discounting populated by risk-neutral agents: i) a representative bank run by an owner-manager – the banker; ii) entrepreneurs endowed with risky

[5] Diamond and Rajan (2005) and Dell'Ariccia and Ratnovski (2013) also show that government interventions can reduce systemic risk.

projects, competing for bank loans; iii) competitive investors; and iv) a benevolent government whose objective is to maximize the sum of the payoffs of the agents in the economy.

At time 0, the banker can extend a unit-sized loan to an entrepreneur for a project that yields either x, in case of success, or nothing. The probability of success depends on whether the banker exerts effort in monitoring the entrepreneur. Conditional on exerting effort, the probability of success is p_H, otherwise it is $p_L < p_H$, and the banker gets a private benefit equal to B, which can be interpreted as the monitoring cost he saves. The bank has no capital at t_0 and, in order to invest in the project, the banker must borrow one unit of money from competitive outside investors through standard debt contracts, promising a repayment equal to R_1 at time 1.

At t_1, the outcome of the project is publicly observable. If it succeeds, the bank gains the revenue produced – namely x – net of the repayment promised to debt-holders and operates a second investment stage. If instead the project fails, the bank gets zero and cannot repay the investors. The government observes the outcome of the project before the end of the first period, and in case of failure it can decide whether to liquidate the bank in t_1 (in which case debt-holders receive an exogenous liquidation value, L) or to rescue it, thus allowing the bank to operate a second investment project, lending to another entrepreneur. The tools available to the government to rescue the bank *via* recapitalization are bail-in and bailout. By bail-in, the government converts part of the bank's debt into equity. Debt-holders are not fully repaid for their initial loan but are entitled to a share of the bank's future profits. By bailout, the government directly transfers an amount of money M in exchange for bank shares, and the banker uses this cash infusion to repay the debt-holders. In principle, the government can recapitalize the bank either *via* one of the two policies alone – *i.e.*, full bail-in or full bailout – or *via* a combination of the two. In the latter case, it converts a fraction of the bank's debt into equity while simultaneously effecting a partial bailout, with $M < R_1$. In any case, if the government intervenes to rescue the bank, the banker is entitled only to a fraction α of future profits, the rest, $1 - \alpha$, going to government and bailed-in debt-holders. More specifically, bailed-in debt-holders are entitled to a share of future profits $(1-\alpha)\beta$, while the remaining fraction $(1-\alpha)(1-\beta)$ of the bank's equity is acquired by the government. The banker keeps running the bank, regardless of α – *i.e.* of the portion of the shares still in his hands after the recapitalization. The parameters α and β are chosen by the government when it makes its policy option. Finally, bailout money is costly: for each unit injected into the bank, the government must raise $1+\lambda$ units from taxpayers, where λ represents the shadow cost of the bailout and can be interpreted as the deadweight cost of tax revenue. This cost will typically be greater in weaker economies as well as in crises, when it is more costly for the government to levy a tax large enough to rescue a systemically important bank.

Before continuing with the description of the setup, it is worth discussing the modeling of bailout and bail-ins. First, postulating that the banker is not completely wiped out but keeps running the bank after the recapitalization might appear to be at odds with reality. In fact, the top executives are usually replaced during a bail-in or a bailout. Yet the bank's business plan, long-term investments and policy typically do not change overnight. Moreover, assuming that the banker remains in charge simply implies that he acts in the interest of the former shareholders rather than either the government or the bailed-in debt-holders. The latter, in particular, are likely to be too unsophisticated and dispersed to exercise any control over the bank immediately upon recapitalization.[6] Finally, the assumption that the banker gets a fraction α of the shares – his holding is diluted but not completely eliminated – finds support in the actual design of bail-ins by the BRRD, which prescribes that existing shares are not to be entirely cancelled or transferred but to be diluted through the conversion of debt into equity when this helps to safeguard the value of the bank.

So, if the first project succeeds or if the government saves the bank, the banker can lend to a second entrepreneur at t_1, whose project again yields x in case of success and zero otherwise. This second investment stage also features moral hazard: the probability of success can be either

[6] This is the typical distinction between *insiders* and *outsiders*. The former can be considered as controlling shareholders with superior monitoring skills, whose interests are aligned with those of the bank's executives. The latter might be seen, for instance, as institutional investors with no monitoring capacity.

p_H or p_L depending on whether the bank manager monitors the entrepreneur or not; if not, he gets a private benefit B. As in the first stage, the banker must borrow one unit of money from competitive outside investors, promising the return R_2 to be paid in one period.

At t_2, the outcome of the second project is realized. In the case of failure, the bank goes bankrupt and its liquidation value is zero.[7] If the project succeeds, the bank repays R_2 to the debt-holders that lent at t_1 and remains active. In this case, it has a charter value equal to V. In the case in which the bank was rescued in the previous period, $\alpha\,(x + V - R_2)$ goes to the banker and $(1 - \alpha)\,(x + V - R_2)$ to the government and/or to the bailed-in debt-holders. If instead the first investment too was successful, the entire profit goes to the banker, who therefore gets $x + V - R_2$.

The two-stage structure of the game, which resembles Mailath and Mester (1994), allows to model the trade-off for regulators between *ex post* and *ex ante* optimality of the resolution mechanism, and so to compare the equilibrium outcomes with and without pre-commitment. A graphical representation of the setup is given in Figure 1, where p_i can be either p_H or p_L depending on whether or not the manager monitors.

As to the parameters of the model, I make the following assumptions:

Assumption 1. *The investment that the banker can make at t_0 and t_1 has positive net present value if the manager exerts effort to monitor the entrepreneur, and negative net present value otherwise. Furthermore, the net present value of the project, given effort, is greater than the liquidation value of the bank, L, but less than of the pledged repayment required by debt-holders, 1. Also, the sum of the charter value of the bank at t_2, V, and the net present value of the project is less than 1, conditional on monitoring, and less than zero, with no monitoring. Formally:*

$$1 > p_H(x + V) - 1 > \underbrace{p_H x - 1}_{NPV^H} > L > 0 > p_L(x + V) - 1 > \underbrace{p_L x - 1}_{NPV^L}, \tag{1}$$

Assuming that NPV^H is less than 1 ensures that in case of failure at time 1, debt-holders have

[7] Assuming a positive liquidation value at t_2 also does not alter the main results of the model.

no incentive to lend an additional unit of money to the bank in the second stage. This is the typical debt overhang problem: debt-holders anticipate that, out of the $p_H(x+V)$, $\frac{1}{p_H}$ must go to repay past debt-holders. So, in expected value, debt-holders would not be fully repaid (as $p_H(x+V)-1<1$), even if in the good state of nature they get the bank's entire surplus, $x+V-\frac{1}{p_H}$. Furthermore, assuming that the net present value of the project is positive only when the banker monitors and negative otherwise implies that, from a social perspective, rescuing the bank is efficient only when the banker is expected to exert effort in the second investment stage.

Assumption 2. *The degree of moral hazard is such that the banker would have no incentive to monitor in a one-shot version of the model, with a single investment stage and no charter value. The positive charter value for surviving banks mitigates moral hazard and incentivizes he banker to exert monitoring effort:*

$$\frac{B}{\Delta p} \in \left(x - \frac{1}{p_H}; x + V - \frac{1}{p_H}\right) \tag{2}$$

Assumption 3. *The parameters of the model are such that:*

$$V < -\frac{p_L x - 1}{p_H(1-p_L)}. \tag{3}$$

This assumption ensures that debt-holders have no incentive to lend to the bank at t_0 if the banker is not going to monitor the first project. If this assumption does not hold, the profits from the second investment stage would be so high that debt-holders expecting a full bail-in might be willing to lend even when the banker is not expected to monitor the first-stage investment, because even in case of failure of the latter they would still earn enough profits in the second stage after the recapitalization.

Assumption 4. *Finally:*

$$V < \frac{p_H x - 1}{1-p_H}. \tag{4}$$

This condition ensures that, absent any government intervention – that is, the bank is never rescued after failure of the first project – the manager has the incentive to exert monitoring effort in the first investment stage.

3.2 The equilibrium

This subsection characterizes the Subgame Perfect Nash Equilibrium of the model. It will consist in a strategy profile that represents a Nash equilibrium of every subgame. To illustrate this equilibrium, proceed by backward induction starting from the second investment stage.

3.2.1 The second investment stage

The second investment stage occurs only if the bank was successful in the first investment stage or else was rescued by the government after failure of the first project. In these cases, the banker has the opportunity to invest in a project – that is, to lend one unit of money to another entrepreneur – yielding either x or zero at t_2. To invest in this project the banker borrows money from outside competitive investors, promising them a gross return equal to R_2.[8]

Outside investors are willing to lend only if their participation constraint is satisfied, *i.e.* if

$$p_i \min\{x, R_2\} \geqslant 1, \quad \text{with } i = \{H, L\}. \tag{5}$$

Since $p_L x < 1$, by Assumption 1, investors will lend only if the banker is going to exert monitoring effort.

Hence, in the second investment stage, the banker's incentive constraint too must be satisfied. Unlike the participation constraint of investors, this constraint is conditional on the outcome of the

[8]For simplicity, I assume that the banker borrows the needed money from outside investors regardless of the outcome of the first project. Removing this assumption and letting the banker invest some of the profits from a successful first-stage investment does not alter the results. Indeed, after a success, the manager has enough incentives to monitor and does not need to invest his own money to attract outside investors. Furthermore, the expected profits from the second investment stage would not change, thus leaving unchanged the banker's incentive to monitor in the first period.

first investment and the choice made by the government when recapitalizing the bank. If the first project succeeds, the manager remains the sole owner of the bank, entitled to all future profits. Therefore, his incentive constraint is:

$$p_H(x + V - R_2) \geqslant p_L(x + V - R_2) + B, \tag{6}$$

which can be rewritten as

$$R_2 \leqslant x + V - \frac{B}{\Delta p} \equiv \hat{R}_2^S, \tag{7}$$

where $\Delta p = p_H - p_L$.

If instead the first project fails and the bank is rescued at t_1, the banker is entitled only to a fraction α of the future profits, the remainder $1 - \alpha$ going to bailed-in debt-holders and/or the government, depending on the recapitalization policy chosen. Hence, the bankers' incentive constraint is:

$$\alpha p_H(x + V - R_2) \geqslant \alpha p_L(x + V - R_2) + B, \tag{8}$$

which can be rewritten as

$$R_2 \leqslant x + V - \frac{B}{\alpha \Delta p} \equiv \hat{R}_2^F. \tag{9}$$

From (7) and (9), it is immediate that $\hat{R}_2^F \leqslant \hat{R}_2^S$, since the maximum repayment that can be promised to debt-holders without violating the banker's incentive constraint is lower if the bank is recapitalized than if the first project succeeds. This is because the recapitalization process reduces the banker's share of future profits, thus weakening his incentive to monitor.

Competition among investors implies that the equilibrium gross return has to satisfy their participation constraint with equality, so that $R_2 = \frac{1}{p_H}$. Using the equilibrium return in (7) gives the condition for the existence of an equilibrium with investment in t_1, following success in the first investment stage, which is:

$$R_2 = \frac{1}{p_H} \leqslant x + V - \frac{B}{\Delta p} \equiv \hat{R}_2^S, \tag{10}$$

and is always satisfied, given Assumption 2. So, after first-stage success manager of the bank can always raise funds in the second investment stage and finance the entrepreneur.

Similarly, an equilibrium with investment recapitalization exists only if

$$R_2 = \frac{1}{p_H} \leqslant x + V - \frac{B}{\alpha \Delta p} \equiv \hat{R}_2^F. \tag{11}$$

Since $\hat{R}_2^S = \hat{R}_2^F$ when $\alpha = 1$, then (11) too is always satisfied for $\alpha = 1$. Given that $\hat{R}_2^F$ is monotonically increasing in α, it is possible to identify a minimum level of α, strictly less than 1, that the banker must earn in order not to violate his incentive constraint. This minimum level of α – denoted by $\underline{\alpha}$ – is the one that satisfies (11) as equality. Hence:

$$\frac{1}{p_H} = x + V - \frac{B}{\underline{\alpha} \Delta p} \Longrightarrow \underline{\alpha} = \frac{1}{(x + V - 1/p_H)} \frac{B}{\Delta p} \tag{12}$$

By Assumption 2, $\underline{\alpha}$ is strictly positive and less than 1.

The following lemma thus summarizes the second-stage equilibrium.

Lemma 1. *The banker can always raise funds at the competitive interest rate and operate the second investment stage if the first investment is successful or if the government recapitalizes the bank, entitling the banker to a fraction of bank shares no lower than* $\underline{\alpha}$.

Figure 2 provides a graphical representation of the second-stage equilibrium in the space $[\alpha, R_2]$. Note that the competitive interest rate, equal to $\frac{1}{p_H}$, is always lower than $\hat{R}_2^S$, while $\hat{R}_2^F$ is an increasing and concave function of α and is higher than the competitive interest rate only for α greater than $\underline{\alpha}$. Intuitively, the smaller the banker's stake α after recapitalization, the lower the maximum incentive-compatible gross return that can be promised to debt-holders.

3.2.2 Policy choice

Immediately before t_1, the government observes the outcome of the first project, and in the case of failure must decide whether to liquidate the bank or rescue it, and how. In making this policy choice, the government anticipates that if it elects bank rescue, the banker will monitor in the next period only when he is entitled to a fraction of bank shares no lower than $\underline{\alpha}$. Therefore, a recapitalization leaving less than $\underline{\alpha}$ to the banker is never optimal, since the bank would be unable to raise funds in the second investment stage and will have to close down anyway.

The government, being benevolent, chooses the policy that maximizes the aggregate expected payoffs of the agents in the economy. If the bank is liquidated, only outside investors that lent in the first stage obtain a positive payoff, which is equal to the liquidation value of the bank, L. In the case of recapitalization instead: (i) the banker is entitled to a share α of the expected profits in the second investment stage, which are equal to the net present value of the project conditional on monitoring plus the present value of the bank's charter value, V; (ii) debt-holders are entitled to a share of future profits equal to $(1-\alpha)\beta$ and receive M from the government; (iii) the government incurs a cost equal to $(1+\lambda)M$ because of distortionary taxation, and is entitled to a share of future profits equal to $(1-\alpha)(1-\beta)$. Table 1 summarizes the agents' payoffs depending on the government's choice.[9]

Table 1: Payoffs from government's choice

	Recapitalization	Liquidation
D	$(1-\alpha)\,\beta(NPV^H + p_H V) + M$	L
E	$\alpha(NPV^H + p_H V)$	0
G	$(1-\alpha)\,(1-\beta)\,(NPV^H + p_H V) - (1+\lambda)\,M$	0
Aggregate	$NPV^H + p_H V - \lambda M$	L

When the government rescues the bank social welfare – that is, the sum of the expected payoffs of agents in the economy – is equal to $NPV^H + p_H V - \lambda M$. It is straightforward that, conditional

[9] G is the government, E is the manager – that is, the sole initial equity-holder of the bank – and D the initial debt-holders, who become shareholders in case of partial or full bail-in. It is worth recalling that α has to be in the interval $[\underline{\alpha}, 1]$. Finally, $NPV^H = p_H x - 1$.

on $\alpha \geqslant \underline{\alpha}$, aggregate welfare does not depend on α, or on β. Moreover, since transferring money from the public to the private sector is costly, the government optimally sets $M = 0$, opting for a full bail-in; therefore $1 - \beta = 0$. Hence, the first-best policy never involves a bailout. Finally, a full bail-in with $M = 0$, $\beta = 1$, and $\alpha \geqslant \underline{\alpha}$ is always preferred to liquidation since, by Assumption 1, $NPV^H + p_H V > L$. The equilibrium policy is so described by the lemma below.

Lemma 2. *In the case of bank failure, the optimal ex post policy is full bail-in through which the government converts all of the bank's debt into a fraction $1 - \alpha$ of bank shares, with $\alpha \in [\underline{\alpha}, 1]$, and does not allocate public funds for the recapitalization.*

Hence, once envisaged, the bail-in becomes the first-best policy, *ex post*, for dealing with a failing bank. In fact, it allows to rescue a distressed bank – thus allowing it to operate profitably in the future – with no use of public funds. In the conversion, however, the banker needs to be left with a large enough stake in the bank in order to be incentivized to monitor future loans.

3.2.3 The first investment stage

Having defined the equilibrium strategies following the failure of the first project, we can solve for the equilibrium in the first investment stage. At t_0, potential investors anticipate that if the project fails the government will effect a bail-in and that they will get a fraction $1 - \alpha$ of the profits in the second investment stage, *i.e.* $NPV^H + p_H V$.[10] This gives the following participation constraint:

$$p_i \min\{x, R_1\} + (1 - p_i)(1 - \alpha)(NPV^H + p_H V) \geqslant 1, \quad \text{with } i = \{H, L\}. \tag{13}$$

Remark 1. *Assumption 3 guarantees that this constraint can be satisfied only for $p_i = p_H$. Therefore, if debt-holders expect the banker not to monitor the first investment, they do not fund the bank. Proof.* See Appendix A.1.

[10] On the equilibrium path, beliefs have to be correct, and therefore both investors and the banker correctly anticipates the equilibrium α.

Hence, a first-stage equilibrium in which the bank is able to raise funds and to invest in the project, given that the banker has the incentive to monitor, will feature a gross return R_1 that satisfies both the participation constraint of outside investors for $p_i = p_H$ and the incentive constraint of the banker, which is:

$$p_H(x - R_1 + p_H(x + V - R_2)) + \alpha\,(1 - p_H)\,p_H(x + V - R_2) \geqslant \\ p_L(x - R_1 + p_H(x + V - R_2)) + \alpha\,(1 - p_L)\,p_H(x + V - R_2) + B. \quad (14)$$

Replacing the gross return to be promised to second-stage investors, R_2, with the competitive return, $\frac{1}{p_H}$, condition (14) can be written as:

$$R_1 \leqslant x + (1 - \alpha)(NPV^H + p_H V) - \frac{B}{\Delta p} \equiv \hat{R}_1^{BI}. \quad (15)$$

Competition in the credit market implies that the equilibrium gross return required by investors must satisfy their participation constraint as equality, also in t_0. Therefore:

$$R_1^{BI} = \frac{1}{p_H} - (1 - p_H)\,(1 - \alpha)\left(x + V - \frac{1}{p_H}\right). \quad (16)$$

Hence, the condition that ensures that the bank can raise funds in the first stage is:

$$R_1^{BI} = \frac{1}{p_H} - (1 - p_H)\,(1 - \alpha)\left(x + V - \frac{1}{p_H}\right) \leqslant x + (1 - \alpha)(NPV^H + p_H V) - \frac{B}{\Delta p} \equiv \hat{R}_1^{BI} \quad (17)$$

which can again be expressed as a condition regarding α, *i.e.* the share of the bank's equity left to the banker in the eventual bail-in. In fact, rearranging condition (17) yields:

$$\alpha \leqslant \frac{2(x - \frac{1}{p_H}) + V - \frac{B}{\Delta p}}{x + V - \frac{1}{p_H}} \equiv \bar{\alpha}. \quad (18)$$

Intuitively, $\bar{\alpha}$ is the maximum fraction of shares that the banker can expect in a full bail-in without depressing his incentive to monitor in the first investment stage. When α is higher than

$\bar{\alpha}$, the banker has no incentive to monitor in the first period because he anticipates that even if the project fails he will still be able to invest again in the second period and will be entitled to a relatively high portion of future profits. In this case, however, investors will not fund the bank in the first period. The resulting first-stage equilibrium is outlined in the following lemma.

Lemma 3. *In the first investment period, on the equilibrium path, the banker is able to obtain funding at the competitive interest rate and will monitor the investment only if he is expected to get a share α of bank equity (weakly) lower than $\bar{\alpha}$ in the bail-in.*

3.2.4 The Subgame Perfect Equilibrium

When the first investment fails, the government's optimal choice is a full bail-in leaving at least a share $\underline{\alpha}$ of bank equity to the banker. In the first investment stage, competitive investors anticipate this and lend to the bank only if they are promised a return equal to R_1^{BI} in case of success and the banker is expected to monitor the first investment, which requires him receiving a share of bank equity no higher than $\bar{\alpha}$ in the bail-in. Intuitively, if the banker's equity – that is, the equity of the initial shareholders – is excessively diluted in the conversion, he will not have the incentive to behave properly in the future but at the same time if his equity is not diluted enough, he has no incentive to monitor in the first investment stage.

Thus, in order to have a Subgame Perfect Nash Equilibrium in which investors fund the bank in both stages and the manager monitors both projects, the set $[\underline{\alpha}, \bar{\alpha}]$ has to be non-empty. When this is not the case, outside investors anticipate that the banker will not monitor either in the first or in the second stage and do not fund the bank. Hence, the relevant condition for the existence of such an equilibrium is $\underline{\alpha} \leqslant \bar{\alpha}$, which requires:

$$\frac{B}{\Delta p} \leqslant x + \frac{V}{2} - \frac{1}{p_H} \equiv \Psi_{BI}. \tag{19}$$

In equilibrium two different cases may emerge:

- If (19) holds, the bank gets funding in both stages, the banker monitors both projects, and in the case of failure of the first project, the government recapitalizes the bank with a full bail-in and chooses any α in $[\underline{\alpha}, \bar{\alpha}]$, which is perfectly anticipated in t_0.
- If (19) does not hold, the bank cannot raise funds in the first stage, so the game ends in t_0 with no project financed. This is because investors in t_0 anticipate that the government will opt for a full bail-in in case of failure and will give the banker a fraction $\alpha \geqslant \bar{\alpha}$ of future profits, to make sure he monitors the second project, but then he has no incentives to monitor the first one.

Given these results, the following proposition describes the equilibrium of the model.

Proposition 1. *In the Subgame Perfect Nash Equilibrium, the banker is able to raise funds and exerts monitoring effort in both stages only if moral hazard is not too severe, i.e., when $\frac{B}{\Delta p} \leqslant \Psi_{BI}$. If instead $\frac{B}{\Delta p} > \Psi_{BI}$, the credit market collapses at the start of the first period.*

This is one the key insights from this model. It indicates that, while optimal *ex post*, bail-ins can have severe *ex ante* side effects on the credit market. When moral hazard is severe, there is no gross return that the banker can promise to debt-holders who expect a full bail-in such that these break even and the banker will exert monitoring effort. As a result, the bank is unable to raise funds and cannot lend to entrepreneurs, thus forgoing profitable investment opportunities.

4 A comparison with the pre-bail-in world

So far, it has been shown that bail-ins can lead to credit market collapse. However, the crucial question for policy-makers is: was the world better before the introduction of the bail-in? To respond, we can derive the equilibrium of the model with no bail-ins and compare the outcome in this *pre-bail-in* world with that produced once bail-ins are introduced.

Absent bail-in, the government's choice when facing banks in distress is between bail-out and liquidation. In this case, as long as λ is not too high, the government strictly prefers bailout when the first investment fails.[11] In the bailout, the government acquires a share $1-\alpha$ of the bank's equity and transfers $M=R_1$ to the banker, who uses these funds to repay the initial debt-holders. Anticipating this, investors require a repayment $R_1=1$ in the first stage, given the government's implicit guarantee. The banker too anticipates bailout if the project fails, and in this case he will get a fraction α of the profits generated by the second investment project. As shown in Section 3.2.1, the banker has to be entitled to a fraction of the bank's shares no smaller than $\underline{\alpha}$ to make sure he behaves properly in the second period. Therefore, his incentive constraint in the first period requires :

$$\begin{aligned} p_H(x-1+p_H(x+V-R_2)) + (1-p_H)\,\alpha p_H(x+V-R_2) \geqslant \\ p_L(x-1+p_H(x+V-R_2)) + (1-p_L)\,\alpha p_H(x+V-R_2) + B, \quad (20) \end{aligned}$$

which, given $R_2=\frac{1}{p_H}$, can be re-written as:

$$\alpha \leqslant \frac{x+p_H(x+V)-2-\frac{B}{\Delta p}}{p_H(x+V)-1} \equiv \bar{\alpha}^{BO}. \quad (21)$$

However, in this *pre-bail-in* world, investors fund the bank even if the banker's incentive constraint is violated, since they expect the government to intervene and reimburse them in case of failure. Hence, the equilibrium with no bail-in is given by the following proposition.

Proposition 2. *In the pre-bail-in Subgame Perfect Equilibrium:*

- *investors always fund the banker at an equilibrium gross return equal to* 1*;*
- *if the first-period loan is not repaid, the government rescues the bank with a full bailout in which it acquires a fraction* $1-\alpha$ *of the bank's equity, with* $\alpha \leqslant \underline{\alpha}$*;*
- *the banker monitors in the first investment period only if* $\alpha \geqslant \bar{\alpha}^{BO}$.

[11] Specifically, bailout is preferred to liquidation, *ex post*, if $\lambda \leq NPV^H + p_H V - L$. I assume this is the case throughout this section so as to rule out the relatively obvious case in which bailouts are never optimal, *ex post*, and the government always liquidates a distressed bank.

This equilibrium is efficient only if the space $[\underline{\alpha}, \bar{\alpha}^{BO}]$ is not empty, the relevant condition being:

$$\frac{B}{\Delta p} \leqslant x + \frac{p_H V - 2}{1 + p_H} \equiv \Psi_{BO}. \tag{22}$$

Hence, the efficiency of the equilibrium with no bail-in depends on the degree of moral hazard and on the profitability of the project. When moral hazard is sufficiently low and the project is profitable enough (x large), a bailout is the first-best policy. Otherwise, the expectation of a bailout leads to an equilibrium in which the bank can fund its lending but has no incentive to monitor loans. In this case, bailout expectations produce a welfare loss: negative-NPV projects are financed in the first period, and only liquidation would be efficient.[12]

Therefore, while bail-ins may cause a credit market collapse, bailouts can result in a welfare loss owing to the lack of monitoring incentives because of the implicit public guarantee. In order to compare these two resolution mechanisms, one should compare the threshold levels of $\frac{B}{\Delta p}$ in the equilibrium with and without bail-in. By doing so, the following result emerges.

Lemma 4. *The threshold Ψ_{BO} is strictly higher than Ψ_{BI}. Hence, in the intermediate moral hazard region where $\frac{B}{\Delta p}$ is in the interval $[\Psi_{BI}, \Psi_{BO}]$, the introduction of bail-ins generates a welfare loss that would not occur with only bailouts. Proof.* See Appendix A.2.

Thus, there are cases in which bail-ins cause credit market collapse because of moral hazard, while bailouts would provide the incentive to monitor and allow the banker to finance the investment. This is one of the key results of the model: in an intermediate region of moral hazard, full bailout can actually be more efficient than full bail-in. The intuitive explanation is that when investors expect a full bail-in they require a higher return on their debt, and if this return is too high, the banker has no incentives to monitor loans and the credit market collapses. Bailouts may mitigate moral hazard in such cases by reducing bank funding enough to induce the banker to monitor first-period loans.

[12] As is shown in Section 5, the threat of liquidation induces the manager to monitor in the first period, resulting in a more efficient equilibrium.

Figure 3 illustrates, within the space $[p_H, B]$, the regions in which the bail-in and the pre-bail-in equilibria are efficient (assuming $\lambda \leqslant NPV^H + p_H V - L$). In the figure, the lower and the upper bound for p_H, namely $\underline{p_H}$ and $\overline{p_H}$, define the region where $p_H x - 1 > 0$ and $p_H(x + V) - 1 < 1$, while the dashed black lines delimit the region satisfying Assumption 2, namely $\frac{B}{\Delta p} \in \left(x - \frac{1}{p_H}; x + V - \frac{1}{p_H}\right)$. There exist three different regions depending on the severity of moral hazard and on the probability of success of the project. When B is relatively low – and moral hazard is not severe – the government can optimally effect a bail-in. For intermediate values of B, the bail-in equilibrium is not efficient, while the full-bailout equilibrium gives the banker the incentive to monitor and allows him to obtain funding and to seize profitable investment opportunities. In this region, introducing the bail-in causes a significant welfare loss. Finally, when moral hazard is severe, neither full bail-in nor full bailout is efficient.

5 The pre-commitment equilibrium and the optimal recapitalization policy

In Section 3.2 we saw that in the Subgame Perfect Equilibrium the government always opts for full bail-in when dealing with a failing bank, provided this does not undercut the banker's incentive to monitor in the second investment stage. However, anticipating this policy choice can generate an adverse reaction, possibly leading to collapse, in the credit market. In this case, the only way the government can increase welfare is by credibly pre-committing to an alternative resolution strategy that induces the banker to monitor at the beginning of the game.

Remark 2. *Avoiding credit market collapse by pre-committing to a rescue policy that does not induce the manager to monitor in the first stage - such as a full bailout if* $\frac{B}{\Delta p} > \Psi_{BO}$ *- is never optimal, since the resulting equilibrium is always dominated by an equilibrium with pre-commitment to liquidation.* *Proof.* See Appendix A.3

Consequently, in what follows I focus on the case where $\frac{B}{\Delta p} > \Psi_{BI}$ – that is, where a full bail-in does produce credit market collapse – and assume that the government can credibly pre-commit at t_0 to an alternative policy, *i.e.* an incentive-compatible recapitalization – involving both bail-in and bailout – or else liquidation.

With a pre-committing to liquidation, the investors' participation constraint at t_0 is

$$p_H \min\{R_1, x\} + (1 - p_H)L \geqslant 1 \tag{23}$$

and competition among investors implies:

$$R_1^L = \frac{1}{p_H} - \frac{1 - p_H}{p_H} L. \tag{24}$$

The banker's incentive constraint, given that the bank will not be rescued, is

$$R_1^L \leqslant x + NPV^H + p_H V - \frac{B}{\Delta p} \equiv \hat{R}_1^L. \tag{25}$$

Hence, first-stage incentive compatibility in this case requires

$$\frac{B}{\Delta p} \leqslant \left(x - \frac{1}{p_H}\right)(1 + p_H) + p_H V - \frac{1 - p_H}{p_H} L, \tag{26}$$

and is always satisfied, given Assumption 4. It follows that:

Lemma 5. *In the pre-commitment equilibrium, the government can give the banker the incentive to monitor in the first stage, thus allowing him to get funding from investors, by pre-committing to liquidate failing banks. In the case of bank distress, pre-commitment to liquidation yields an ex post aggregate payoff equal to the bank's liquidation value, L. Proof.* See Appendix A.4.

If instead the government wants to rescue the bank, given that full bail-in is not incentive-compatible, it must announce a policy that combines bail-in with partial bailout. That is, the government converts part of the bank's debt into equity, entitling the initial debt-holders to a share $(1 - \alpha)\beta$ of future profits, and transfers M to the banker, who then uses these funds to repay the debt-holders. In exchange for M, the government acquires a share $(1-\alpha)(1-\beta)$ of the bank's equity and raises $(1+\lambda)M$ from taxpayers.

When the government pre-commits to rescue the bank, investors' participation constraint at t_0 is:

$$p_H R_1 + (1-p_H)\left[M + (1-\alpha)\beta(NPV^H + p_H V)\right] \geqslant 1 \tag{27}$$

and the competitive interest rate is:

$$R_1^* = \frac{1}{p_H} - \frac{1-p_H}{p_H}M - (1-p_H)(1-\alpha)\beta\left(x + V - \frac{1}{p_H}\right). \tag{28}$$

Then, the banker's incentive constraint, given the strategy announced by the government, is:

$$R_1 \leqslant x + (1-\alpha)\, p_H \left(x + V - \frac{1}{p_H}\right) - \frac{B}{\Delta p} \equiv \hat{R}_1^*. \tag{29}$$

Conditional on bank distress, as long as incentive compatibility is satisfied, this policy yields an *ex post* aggregate payoff equal to the net present value of the second investment less the cost of transferring M from the public to the private sector. Hence, the government faces the following maximization problem:

$$\max_{\alpha,\beta,M} \left(NPV^H + p_H V\right) - \lambda M \tag{30}$$

$$\text{subject to} \quad : \quad R_1^*(\alpha,\beta,M) \leqslant \hat{R}_1^*(\alpha). \tag{31}$$

Since both the government's objective function and the equilibrium interest rate are decreasing in M, it is optimal to choose the lowest level of M that satisfies the incentive compatibility constraint. And, since R_1^* is increasing in α, and $\hat{R}_1^*$ is decreasing in the share of future profits left to the banker in the recapitalization, the government can relax the constraint by setting $\alpha = \underline{\alpha}$. Similarly, it sets $\beta = 1$. Intuitively, the government's objective is to minimize the amount of the bailout required to restore bank's solvency, which means leaving the largest possible share of equity to initial debt-holders and acquiring no equity stake.

Therefore, the optimal rescue policy is a combination of a bail-in and bailout in which: i) the banker gets to the lowest possible share of future profits in the conversion, *i.e.* $\alpha = \underline{\alpha}$; ii) the government acquires no bank equity and transfers to the banker (and thus to bailed-in debt-holders) an amount M that satisfies the incentive compatibility constraint with equality. It follows that the optimal level of M solves:

$$\frac{1}{p_H} - \frac{1-p_H}{p_H}M - (1-p_H)(1-\underline{\alpha})\left(x + V - \frac{1}{p_H}\right) = x + (1-\underline{\alpha})\,p_H\left(x + V - \frac{1}{p_H}\right) - \frac{B}{\Delta p}, \quad (32)$$

and is therefore equal to:

$$M^* = \frac{2p_H}{1-p_H}\left[\frac{B}{\Delta p} - \Psi_{BI}\right]. \quad (33)$$

In case of bank distress, under this policy the aggregate payoffs are equal to $NPV^H + p_H V - \lambda M^*$. Future bank profits are divided between bailed-in debt-holders – who also get M – and the banker, while the government incurs a cost equal to $(1+\lambda)M^*$.[13] The lemma below summarizes the main features of the optimal recapitalization policy with pre-commitment.

Lemma 6. *In the pre-commitment equilibrium, the government can give the banker the right incentive to monitor in the first stage, thus enabling him to get funds from investors, by pre-committing to an optimal rescue policy that combines a partial bailout with a bail-in entitling debt-holders to the largest possible share of future profits. In case of bank distress, this optimal policy yields a total payoff equal to the expected profits from the second stage less the shadow cost of the partial bailout, deriving from distortionary taxation.*

So, pre-commitment to bank rescue yields $NPV^H + p_H V - \lambda M^*$, while pre-committing to liquidation yields L. Therefore, pre-committing to recapitalization is preferable to liquidation as long as $NPV^H + p_H V - \lambda M^* \geqslant L$.[14] It follows that, in equilibrium, the government optimally

[13] In principle, if $M^* > 1$, the government might prefer to pre-commit to a full bailout, thus decreasing the amount that has to be transferred to the bank. However, $M^* > 1$ either implies $\frac{B}{\Delta p} > \Psi_{BO}$ or violates Assumption 1 (see the corresponding proof in Appendix A.5). Hence, pre-commitment to full bailout is always inefficient.

[14] Both policies induce the banker to monitor in the first investment stage and therefore imply $p_i = p_H$ in t_0. Also, under both policies, the expected payoffs in t_1, after a success in the first period, are the same and equal $NPV^H + p_H V$. Therefore, when making its choice, the government simply considers and compares

pre-commits to rescue the bank if

$$\lambda \leqslant \frac{x + V - \frac{1}{p_H} - \frac{L}{p_H}}{\frac{B}{\Delta p} - \Psi_{BI}} \cdot \frac{1 - p_H}{2} \equiv \hat{\lambda}. \tag{34}$$

Hence, the proposition below follows.

Proposition 3. *In the SPNE with credible pre-commitment, the optimal policy depends on the deadweight cost of tax revenue,* λ*:*

- *when* λ *is relatively high, the government optimally pre-commits lo liquidation;*
- *when* λ *is relatively low, the government optimally announces and pre-commits to recapitalization by a combination of bail-in and bailout.*

Figure 4 summarizes the results of the model, characterizing the optimal policy in the space $[B, \lambda]$. There exist three regions. When moral hazard is relatively low, the government does not need to pre-commit to alternative resolution mechanisms, and full bail-in is efficient. When instead moral hazard is in an intermediate region and the deadweight cost of tax revenue is not too high, the government efficiently pre-commits to the optimal recapitalization policy. Finally, when moral hazard and/or the deadweight cost of tax revenue are very high, the efficient pre-commitment equilibrium policy is liquidation.

The characterization of the optimal recapitalization yields some important policy implications for the regulator. According to the model, the optimal government policy depends on two variables: the severity of moral hazard – *i.e.*, the cost of monitoring to bankers – and the cost of transferring resources from the public to the private sector. In countries where such transfer is particularly costly, for instance because public debt is already high, the regulator should opt for bail-in unless the banking system is characterized by excessive moral hazard, in which case pre-committing to liquidation is the only way to induce bankers to invest safely. Conversely, solid economies can avoid

the different aggregate expected payoffs that the two policies yield in case of failure of the first investment.

the pitfalls of bail-ins by simply supplementing them with partial bailouts, not needing the threat of liquidation to discipline banks.

6 The effect of competition and bank equity issues

One of the main results of the model is that bail-in policies can lead to credit market collapse. Here I introduce competition among banks and the possibility of equity issues by banks and show that this result is not affected, nor is that on the optimal pre-commitment policy needed to restore efficiency.

6.1 The equilibrium with bank competition for funds

This first extension considers an economy populated by a number of banks competing for funding, and shows that Proposition 1 holds also under perfect competition among banks.

If banks compete for funds, so that investors appropriate the entire expected surplus of the projects, the equilibrium gross returns on debt are not those that satisfy investors' participation constraint as equality but those that satisfy the banker's incentive constraint with equality. As in the baseline model, an equilibrium in which the banker can raise funds and finance entrepreneurs after a bail-in requires that the banker is left with a large enough equity stake during the recapitalization. Specifically, it requires $\alpha \geqslant \underline{\alpha}$, where $\underline{\alpha}$ is the same of Equation (12).

Thus, also under bank competition, the first-best *ex post* policy is full bail-in with any $\alpha \in [\underline{\alpha}, 1]$. In the first investment stage, investors anticipate the bail-in and fund the banker only if he is expected to receive a relatively low share of bank equity in the conversion, that is, if:

$$\alpha \leqslant \frac{B}{2B - (x - 1/p_H)\Delta p} \equiv \bar{\alpha}^C.^{15}. \tag{35}$$

As in the baseline model, there are two bounds on α, the fraction of shares that is left to the manager in the bail-in. Therefore, an SPNE in which the bank gets funding in both investment stages and the government opts for full bail-in when the first project fails requires the set $[\underline{\alpha}, \bar{\alpha}^C]$ to be non-empty, that is, $\underline{\alpha}$ has to be lower than $\bar{\alpha}^C$, which is the case as long as:

$$\frac{B}{\Delta p} \leqslant x + \frac{V}{2} - \frac{1}{p_H}. \tag{36}$$

This condition on the severity of moral hazard is precisely the same as in Proposition 1, which therefore holds even in the presence of bank competition for funding.

Intuitively, the degree of competition among banks changes the equilibrium gross returns promised to outside investors in both periods but does not affect the threshold value of $B/\Delta p$ above which bail-in leads to the credit market collapse. In this case, as in the baseline model, the only way to improve welfare is to pre-commit to the optimal mix of bail-in and bailout described in Section 5.

6.2 The equilibrium with equity issuance

Another assumption of the baseline model is that the bank can finance projects only *via* standard debt contracts; that is it does not issue equity. Here I relax this assumption, allowing the bank to issue equity as well as debt at the beginning of the game.

In particular, assume that at t_0 the banker can sell a fraction ϕ of bank shares in the market,

[15] The equilibrium returns on debt in both investment stages and details on the derivation of the upper bound on α under bank competition, $\bar{\alpha}^C$, are provided in Appendix A.6

in exchange for an amount of money γ, used to finance the first project together with an amount $1-\gamma$ of debt. Given bail-in after failure of the first project, the bank issues no additional equity in the second investment stage.[16] Finally, for simplicity, I consider again the case of competitive investors.

In the second investment stage, on the equilibrium path, the banker is able to get funding and monitors the project only if the fraction of equity left to him in the bail-in is large enough, that is, if:

$$\alpha \geqslant \frac{B}{(1-\phi)\,(x+V-1/p_H)\,\Delta p} \equiv \underline{\alpha}^E, \tag{37}$$

as is shown in Appendix A.7. First, notice is that this threshold value for α is lower than one only if

$$\phi \leqslant 1 - \frac{B}{(x+V-1/p_H)\,\Delta p} \equiv \bar{\phi}. \tag{38}$$

In other words, there is no equilibrium with funding in the second investment stage if the amount of equity issued by the bank in the first period is too large, because the banker would be entitled to too small a share of profits after the bail-in, and would have no incentive to monitor the future loan.

Therefore, a second-stage equilibrium in which the banker gets funding and invests in the project requires that, given bail-in, the share of equity left to "old" shareholders – that is, the banker and the investors that bought equity at t_0 – has to be at least $\underline{\alpha}^E$. And this requires that the share of equity sold by the banker to finance the first project is lower than $\bar{\phi}$.

Comparing this threshold value for α with that defined in the baseline model (Equation 12), it is immediately apparent that equity issuance at t_0 aggravates moral hazard in the second period, by reducing the share of profits that goes to the banker and thus his incentive to monitor. In particular, the more equity is issued, the higher is the minimum α that must go to shareholders to ensure that the investment in the second period has positive net present value.

[16] In reality, after a bail-in, equity issues are likely to be extremely costly.

At t_1, as in the baseline version, the social-maximizing choice for the government in case of failure of the bank is full bail-in with any $\alpha \in \left[\underline{\alpha}^E, 1\right]$, as long as this set is non-empty, that is if $\phi \leqslant \bar{\phi}$. Therefore, the manager has no incentive to sell more than $\bar{\phi}$ shares at t_0 because, if he does, the government will liquidate the bank for sure in case of failure of the first project. So the banker always sells a fraction of bank shares ϕ less than or equal to $\bar{\phi}$.[17]

Hence, in the first investment stage, the bank can finance the project by issuing both debt and equity. In particular, the manager borrows $1 - \gamma$ from outside investors and receives γ from investors who purchase equity, in exchange for a share ϕ of the bank's equity. In order to make sure that the bank is able to raise funds, the participation constraint for both debt-holders and equity-holders must be satisfied. Assuming competition among lenders and in the equity market yields the equilibrium values of γ and R_1 to be substituted into the banker's incentive constraint.[18] This gives another condition concerning α, namely:

$$\alpha \leqslant \frac{1}{1-\phi}\left[\frac{2(x-1/p_H)+V-B/\Delta p}{x+V-1/p_H}\right] \equiv \bar{\alpha}^E. \tag{39}$$

As in the baseline version of the model, an equilibrium in which the banker gets funding in both investment stages and the government opts for full bail-in after failure requires the set $[\underline{\alpha}^E, \bar{\alpha}^E]$ to be non-empty. This is the case when $\underline{\alpha}^E \leqslant \bar{\alpha}^E$. Again, this condition can be rewritten as a condition on $\frac{B}{\Delta p}$, the severity of moral hazard, which is:

$$\frac{B}{\Delta p} \leqslant x + \frac{V}{2} - \frac{1}{p_H}. \tag{40}$$

Again in this case, Proposition 1 holds. Even though equity issuance changes the equilibrium gross returns to be promised to outside investors in both stages, it does not affect the threshold value of $B/\Delta p$ above which full bail-in policies produces credit market collapse, nor the optimal

[17] This is an interesting result on its own account: it shows that when the government cannot pre-commit not to liquidate banks, *ex ante* these have an incentive to remain undercapitalized, in the sense of not issuing too much outside equity.

[18] See Appendix A.8 for details on the equilibrium of the first investment stage with equity issuance.

rescue policy to which the government can pre-commit to restore efficiency, which is again a bail-in supplemented by a partial bailout of size M^*.

7 Conclusions

When a systemically important financial institution is in distress, governments and central banks face a complicated trade-off: on the one hand, a bailout can reduce the social cost of a major bank failure, averting fire sales and contagion; on the other hand, however, salvage is costly, both in public resources and in terms of moral hazard. A possible solution to this trade-off is a statutory bail-in, a resolution mechanism that is now increasingly popular. A debt-equity conversion imposed by the regulator would allow governments to recapitalize banks without spending taxpayers' money and thus, according to most of the literature, mitigate the moral hazard problem implicit in bailouts.

This paper analyzes the linkages between bail-in policies, the cost of debt and bank managers' behavior in a dynamic setting that takes account of the trade-off between *ex post* and *ex ante* optimality. The model shows that bail-in is, *ex post*, the first-best policy for recapitalizing failing banks but that, *ex ante*, it can generate a time inconsistency problem, just like bailout. While the main problem with bailouts is the weakening of market discipline induced by implicit public guarantees, the problem with bail-ins is the implied increase in banks' funding cost, which can undercut bankers' incentives to monitor their loans. This makes investors less willing to lend to the bank and – when moral hazard is particularly severe – prevents banks from raising funds and lending to entrepreneurs. Hence, despite being the first-best *ex post* policy to deal with failing banks, bail-in can have traumatic *ex ante* effects.

To avoid credit crunch, governments and policy-makers should be cautious with bail-ins; in some cases, they are better off pre-committing to use bail-ins *together* with alternative resolution mechanisms, including bailouts. Intuitively, bail-ins can minimize the cost of the rescue operation by entitling debt-holders to some of the bank's equity, while bailouts offer a partial insurance to debt-holders, thus mitigating the adverse effects of bail-in on banks' funding costs and incentives to monitor. Hence, a combination of bail-in with bailout dominates full bailouts and also avoids the pitfalls of full bail-ins. Of course, such a policy mix still draws on taxpayers' money and is accordingly practicable only if the cost of transferring resources from the public to the private sector is not too high. In countries where this cost is very high – due for instance to highly distortionary taxation or tight public budget constraints – the only way to restore efficiency is pre-commitment to liquidation.

To conclude, the bail-in is an attractive and valuable instrument for policy makers, but it needs to be handled with care. When announcing a policy of mandatory bail-in to be implemented in case of bank failures, governments should not ignore the potential consequences for banks' funding and the functioning of the credit market. In other words, bail-ins should not be thought of as the *panacea* for the too-big-to-fail problem and should be used together with and not just in place of the other available resolution mechanisms, including bailouts.

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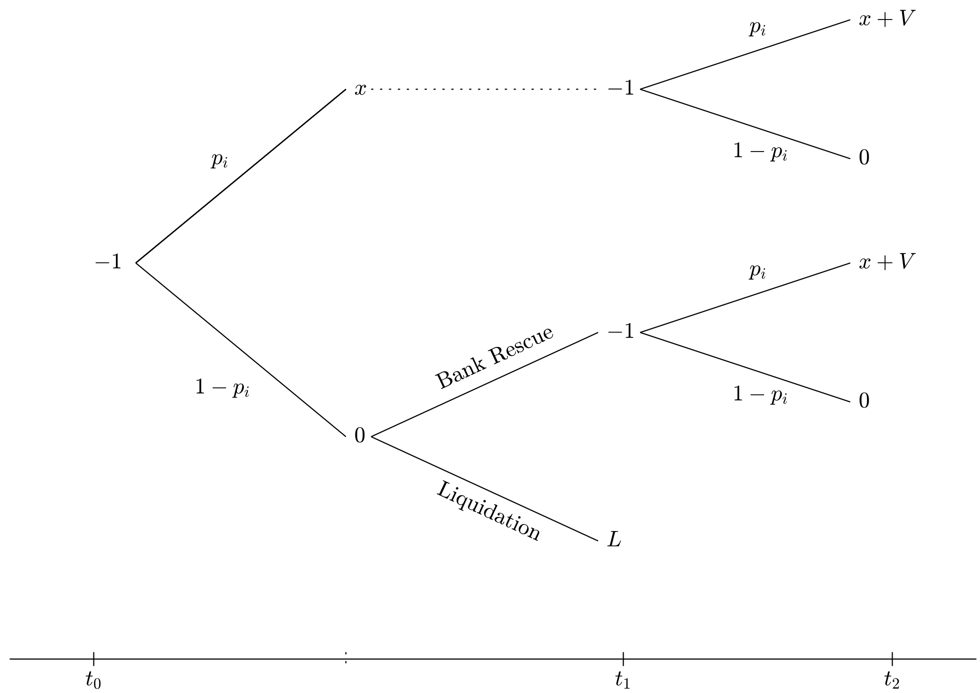
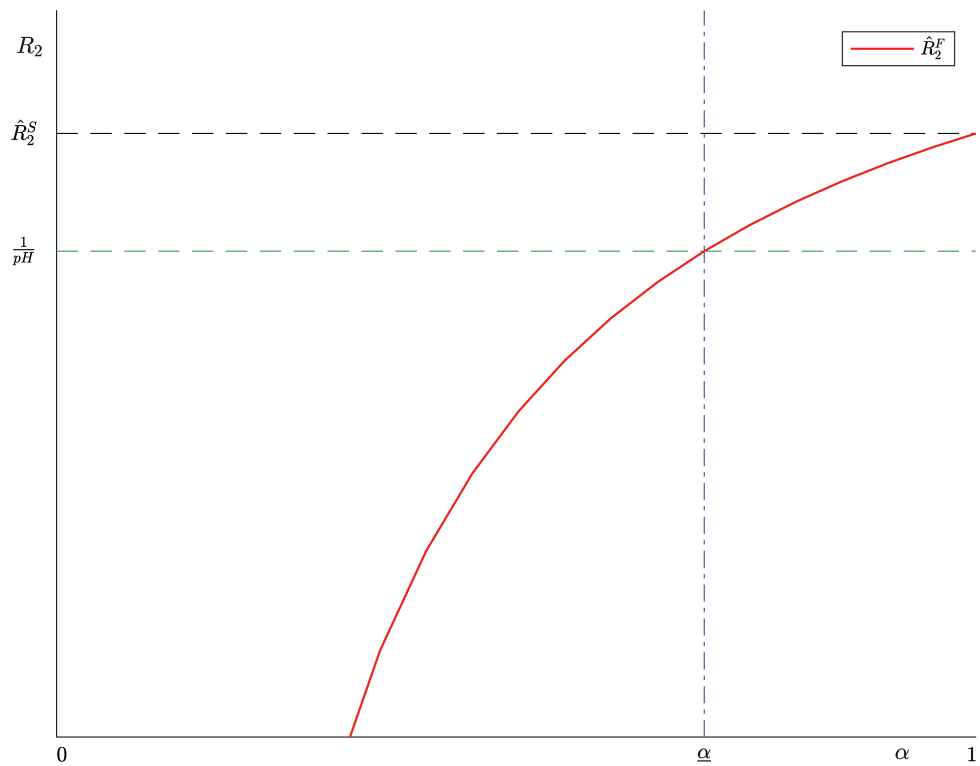
Figure 1: Timeline of the model



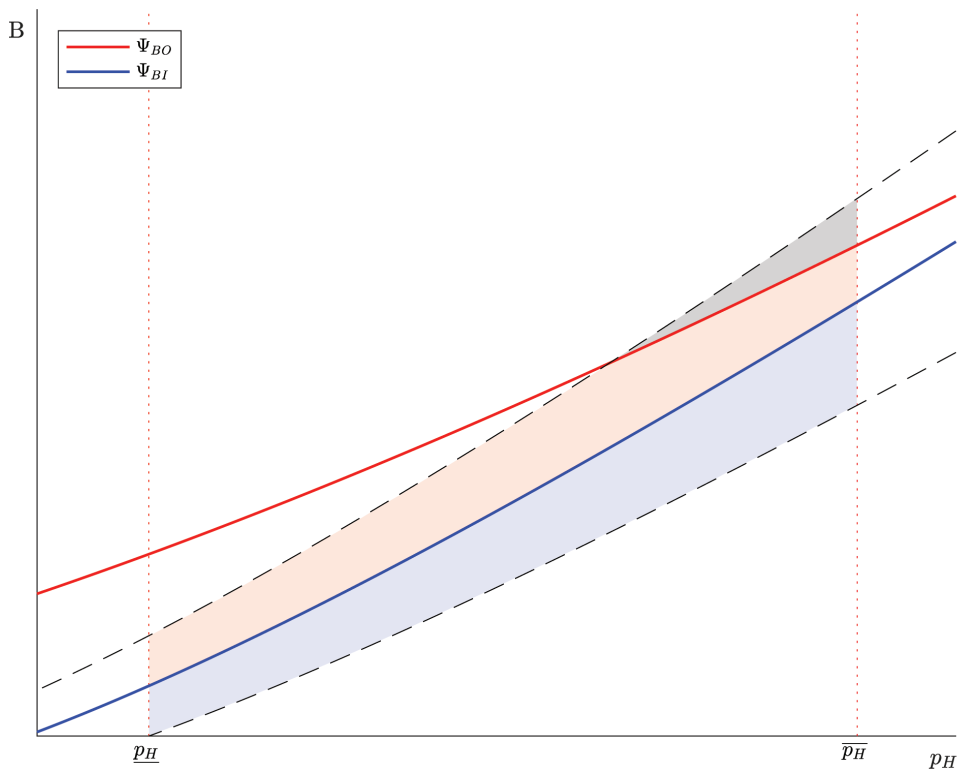
Note: This figure plots the timeline of the game. In t_0 the banker invests in the first project, if he is able to raise funds. Before the end of period 1, the government observes the outcome of the project and, in case of failure, decides whether or not to rescue the bank. Either if the first investment is successful or if the bank is rescued by the government, a second investment stage occurs in t_1. The outcome of the second project is observed in t_2. Both stages are characterized by moral hazard, so that p_i can be either p_H or p_L in each investment stage depending on whether the banker monitors the entrepreneur.

Figure 2: The equilibrium in the second investment stage



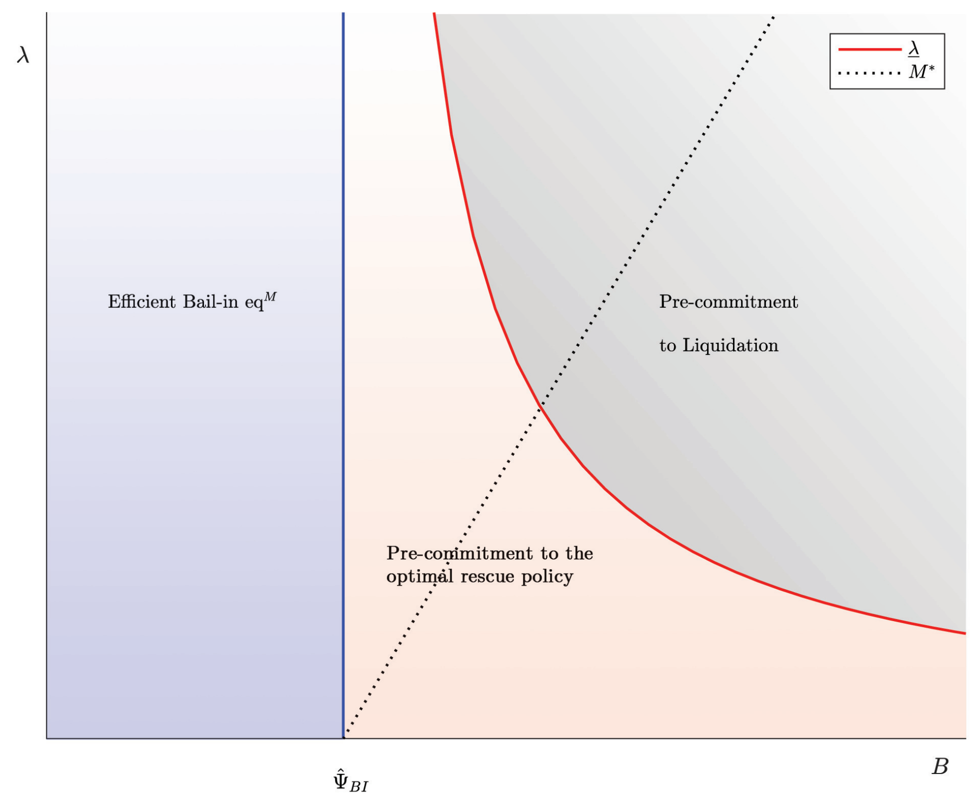
Note: This figure represents the equilibrium in the second investment stage, in the space $[\alpha, R_2]$. The competitive gross return is equal to $\frac{1}{p_H}$ and is always less than $\hat{R}_2^S$, the maximum incentive-compatible repayment that can be pledged to debt-holders after a success in the first investment stage. $\hat{R}_2^F$ is instead the maximum return that can be pledged after full bail-in without violating the incentive constraint of the banker. While the former is independent of α, the latter is an increasing and concave function of the share of equity left to the banker in the conversion.

Figure 3: Efficiency of bail-in and *pre-bail-in* equilibria



Note: This figure illustrates the regions in which the bail-in and the pre-bail-in equilibria are efficient, in the case $\lambda \leqslant NPV^H + p_H V - L$. The dashed lines delimit the space $[p_H, B]$ satisfying Assumption 2, while $\underline{p_H}$ and $\overline{p_H}$, are the ones that satisfy $p_H x - 1 > 0$ and $p_H(x+V) - 1 < 1$ as equality. The blue and the red lines in the figure represent the combinations of B and p_H satisfying as equality $\frac{B}{\Delta p} \leqslant \Psi_{BI}$ and $\frac{B}{\Delta p} \leqslant \Psi_{BO}$ respectively. When B is below Ψ_{BI} bail-ins are efficient. When B lies in the region included between the two curves, the *pre-bail-in* equilibrium is more efficient than that emerging once bail-ins are introduced. Finally, when B is above both Ψ_{BI} and Ψ_{BO}, the bailout equilibrium is also inefficient, and liquidation would dominate both a full bail-in and a full bailout.

Figure 4: The pre-commitment equilibrium



Note: This figure provides a graphical representation, in the space $[B, \lambda]$ of the equilibrium strategies of the government in the equilibrium with pre-commitment. $\hat{\Psi}_{BI}$ is the threshold value for B above which bail-ins lead to the collapse of the credit market and equals $\Psi_{BI} \times \Delta p$ where Ψ_{BI} is defined as in Equation (19). In the region to the right of this threshold, the government can optimally pre-commit to the optimal recapitalization policy if the deadweight cost of tax revenues is low enough, that is, if $\lambda \leqslant \hat{\lambda}$ – the latter being the red line in the figure; otherwise it has to pre-commit to liquidation. The dotted line represents the size of the partial bailout implied by the optimal rescue policy, namely M^*, which is increasing in B.

A Appendix

This Appendix contains the proofs of those statements that do not immediately follow from the arguments provided in the main text.

A.1 Proof of Remark 1

If investors expect the manager not to monitor, their participation constraint is

$$p_L \min\{x, R_1\} + (1 - p_L)(1 - \alpha)(NPV^H + p_H V) \geqslant 1. \tag{41}$$

The left-hand-side of this inequality is increasing in $\min\{x, R_1\}$ and decreasing in α, so it is maximized when $\min\{x, R_1\} = x$ and $\alpha = \underline{\alpha}$; that is, when the banker pledges to debt-holders the entire profit coming from a successful initial investment and the government is expected to effect a bail-in in case of failure, leaving to the banker the lowest possible share of equity satisfying incentive compatibility in t_1. In this case, the participation constraint reduces to

$$p_L x + (1 - p_L)\left(NPV^H + p_H V - p_H \frac{B}{\Delta p}\right) \geqslant 1 \tag{42}$$

which, rearranging, can be written as:

$$\frac{B}{\Delta p} \leqslant x + V - \frac{1}{p_H} + \frac{p_L x - 1}{p_H(1 - p_L)} \equiv \Psi_1. \tag{43}$$

Therefore, to have an equilibrium in which investors fund the bank even when they expect it not to monitor in the first investment stage, $\frac{B}{\Delta p}$ has to be less than Ψ_1. Since $\frac{B}{\Delta p} > x - \frac{1}{p_H}$ (by Assumption

2), this is possible only if $\Psi_1 > x - \frac{1}{p_H}$, that is, if:

$$\begin{aligned} x + V - \frac{1}{p_H} + \frac{p_L x - 1}{p_H(1-p_L)} &\geqslant x - \frac{1}{p_H} \\ V + \frac{p_L x - 1}{p_H(1-p_L)} &\geqslant 0 \\ V &\geqslant -\frac{p_L x - 1}{p_H(1-p_L)}, \end{aligned}$$

which clearly violates Assumption 3. Hence, investors never fund the bank in the first period if the banker is expected not to monitor.

A.2 Proof of Lemma 4

Ψ_{BO} is larger than Ψ_{BI} as long as

$$x + \frac{p_H V - 2}{1 + p_H} \geqslant x + \frac{V}{2} - \frac{1}{p_H}, \tag{44}$$

which reduces to

$$V \leqslant \frac{2}{p_H}. \tag{45}$$

This latter condition is implied by Assumption 1, according to which $p_H(x + V) < 2$. Hence, Ψ_{BO} is strictly greater than Ψ_{BI}.

A.3 Proof of Remark 2

With pre-commitment to a rescue policy that violates incentive compatibility in the first but not in the second stage, the expected aggregate expected payoffs over the two periods are:

$$\begin{aligned} p_L\left(x + NPV^H + p_H V\right) - 1 + (1-p_L)\left(NPV^H + p_H V - \lambda M\right) = \\ = NPV^L + NPV^H + p_H V - (1-p_L)\,\lambda M, \end{aligned} \tag{46}$$

since in this case the banker would finance the negative-NPV project in the first stage and the positive-NPV project in the second. If instead the government pre-commits to liquidation - provided this always induces the banker to monitor in the first period as shown in Appendix A.4 - aggregate payoffs equal:

$$\begin{aligned} & p_H \left(x + NPV^H + p_H V \right) - 1 + (1 - p_H)\, L = \\ & = NPV^H + p_H \left(NPV^H + p_H V \right) + (1 - p_H)\, L. \end{aligned} \tag{47}$$

Therefore, pre-committing to liquidation always dominates an incentive-incompatible rescue policy, since (46) is greater than (47), even for $M = 0$, given that:

$$NPV^H + p_H \left(NPV^H + p_H V \right) + (1 - p_H)\, L \quad > \quad NPV^L + NPV^H + p_H V \tag{48}$$

$$p_H NPV^H - NPV^L + (1 - p_H)\, L \quad > \quad (1 - p_H)\, p_H V \tag{49}$$

$$\frac{p_H NPV^H}{1 - p_H} - \frac{NPV^L}{1 - p_H} + L \quad > \quad p_H V \tag{50}$$

$$\frac{NPV^H}{1 - p_H} - \frac{NPV^L}{p_H (1 - p_H)} + \frac{L}{p_H} \quad > \quad V, \tag{51}$$

which is implied by both Assumption 3 and Assumption 4.

A.4 Proof of Lemma 5

Pre-commitment to liquidation is incentive-compatible when

$$\frac{B}{\Delta p} \leqslant x + NPV^H + p_H V - \frac{1 - (1 - p_H) L}{p_H} \equiv \Psi_L. \tag{52}$$

By Assumption 2, we know that

$$\frac{B}{\Delta p} \leqslant x + V - \frac{1}{p_H}. \tag{53}$$

It follows that, if Ψ_L is strictly larger than $x + V - \frac{1}{p_H}$, condition (52) always holds. Since Ψ_L is strictly increasing in L, we can consider the lowest possible L, that is $L = 0$, and check whether $\Psi_L > x + V - \frac{1}{p_H}$. If this is the case, then it must be true for any $L > 0$. So:

$$\begin{aligned} x + NPV^H + p_H V - \frac{1}{p_H} &\geqslant x + V - \frac{1}{p_H} \\ NPV^H + p_H V &\geqslant V \\ \frac{NPV^H}{1 - p_H} &\geqslant V \\ \frac{p_H x - 1}{1 - p_H} &\geqslant V, \end{aligned}$$

which is implied by Assumption 4. Hence, liquidation is always incentive-compatible.

A.5 Proof that pre-committing to full bailout is always inefficient

As is shown in Section 5, the optimal amount of the bailout in the pre-commitment equilibrium is given by $M^* = \frac{2p_H}{1-p_H}\left[\frac{B}{\Delta p} - \Psi_{BI}\right]$. Hence, M^* is greater than 1 if

$$\frac{B}{\Delta p} > x + \frac{V}{2} - \frac{1}{p_H} + \frac{1 - p_H}{2p_H} \equiv \Psi_{(M>1)}. \tag{54}$$

Hence, if $\frac{B}{\Delta p}$ is within the interval $\left[\Psi_{(M>1)}, \Psi_{BO}\right]$ pre-committing to a full bailout would be efficient and would increase welfare, by reducing the public transfer to the failing bank. The set $\left[\Psi_{(M>1)}, \Psi_{BO}\right]$ is non-empty as long as:

$$\begin{aligned} x + \frac{V}{2} - \frac{1}{p_H} + \frac{1 - p_H}{2p_H} &\leqslant x + \frac{p_H V - 2}{1 + p_H} &(55) \\ \frac{p_H V - 2}{2p_H} + \frac{1 - p_H}{2p_H} &\leqslant \frac{p_H V - 2}{1 + p_H} &(56) \\ (2 - p_H V)\frac{1 - p_H}{1 + p_H} &\geqslant 1 - p_H &(57) \\ V &\leqslant \frac{1}{p_H} - 1. &(58) \end{aligned}$$

But if this is the case, then $\Psi_{(M>1)}$ is greater than $x + V - \frac{1}{p_H}$. Hence, any level of $\frac{B}{\Delta p} \in \left[\Psi_{(M>1)}, \Psi_{BO}\right]$ would violate Assumption 2, by which $\frac{B}{\Delta p} < x + V - \frac{1}{p_H}$. It follows that pre-committing to full bailout can never be efficient.

A.6 Equilibrium returns with banking competition

Under bank competition, in the second investment stage the equilibrium return after a bail-in is

$$R_2^C = x + V - \frac{B}{\alpha \Delta p}. \tag{59}$$

This return is compatible with outside investors' participation constraint only if the banker is entitled to a share of bank equity less than

$$\underline{\alpha} = \frac{1}{(x + V - 1/p_H)} \frac{B}{\Delta p}, \tag{60}$$

which is the same as in Equation (12) in Section 3.2.

Anticipating that the government opts for full bail-in of distressed bank, the banker's incentive constraint in the first investment stage – since $\alpha = E[\alpha]$, on the equilibrium path – is:

$$\begin{aligned} p_H(x - R_1^C + p_H(X + V - R_2^C)) + \alpha\,(1 - p_H)\,p_H(x + V - R_2^C) \geqslant \\ p_L(x - R_1^C + p_H(X + V - R_2^C)) + \alpha\,(1 - p_L)\,p_H(x + V - R_2^C) + B. \end{aligned} \tag{61}$$

Using the equilibrium R_2^C from Equation (59) in this constraint and solving it as equality yields the equilibrium gross return in the first stage:

$$R_1^C = x - \frac{B}{\Delta p}\left(1 - \frac{1 - \alpha}{\alpha} p_H\right). \tag{62}$$

This return also satisfies the participation constraint of outside investors, namely:

$$p_H R_1^C + (1-p_H)\,(1-\alpha)\,p_H(x+V-R_2^C) \geqslant 1. \tag{63}$$

Replacing R_1^C and R_2^C with their equilibrium values, this condition can be written as:

$$\alpha \leqslant \frac{B}{2B-(x-1/p_H)\Delta p} \equiv \bar{\alpha}^C. \tag{64}$$

A.7 Second-stage equilibrium returns with equity issuance

In the equilibrium with equity issuance, the gross repayment to be promised to debt-holders in the second investment stage is that which satisfies their participation constraint as equality, namely:

$$R_2 = \frac{1}{p_H}. \tag{65}$$

So, while equity issuance does not change the equilibrium return in the second investment stage compared to the baseline model, it does affect the banker's incentive constraint after a full bail-in. Indeed, in a bail-in equity-holders are entitled to a share α of bank equity, while the remainder $1-\alpha$, goes to the bailed-in debt-holders. Given that the banker sold a fraction ϕ of bank shares at the beginning of the game, he is now entitled to a fraction $\alpha(1-\phi)$ of the future profits, while a fraction $\alpha\phi$ goes to the investors that bought equity in the first period.[19] So the banker's incentive constraint becomes:

$$\alpha(1-\phi)p_H(x+V-R_2) \geqslant \alpha(1-\phi)p_L(x+V-R_2)+B, \tag{66}$$

which can be written as

$$R_2 \leqslant x+V-\frac{B}{\alpha(1-\phi)\Delta p} \equiv \hat{R}_2^E. \tag{67}$$

[19] As for bailed-in debt-holders, I assume outside investors purchasing equity to act as *outsiders*, whose interests are not perfectly aligned with those of bank managers or controlling shareholders, *i.e.*, the *insiders*.

Hence, the banker can raise funds in the second stage only if $R_2 \leqslant \hat{R}_2^E$, that is when the competitive return on debt does not violate his incentive constraint. This is the case only when the share left to the banker after a full bail-in is such that:

$$\alpha \geqslant \frac{B}{(1-\phi)\,(x+V-1/p_H)\,\Delta p} \equiv \underline{\alpha}^E, \tag{68}$$

as discussed in Section 6.2.

A.8 First-stage equilibrium returns with equity issuance

In the first investment stage of the model with equity issuance, the participation constraint of debt-holders is

$$p_H R_1 + (1-p_H)\,(1-\alpha)\,(NPV^H + p_H V) \geqslant 1-\gamma, \tag{69}$$

and that for equity-holders is

$$p_H\phi(x - R_1 + NPV^H + p_H V) + (1-p_H)\phi\alpha(NPV^H + p_H V) \geqslant \gamma. \tag{70}$$

Thus the banker's first-period incentive constraint in the equilibrium with equity issuance is:

$$\begin{aligned} &p_H(1-\phi)(x - R_1 + NPV^H + p_H V) + (1-p_H)\,\alpha(1-\phi)(NPV^H + p_H V) \geqslant \\ &\qquad p_L(1-\phi)(x - R_1 + NPV^H + p_H V) + (1-p_L)\,\alpha(1-\phi)(NPV^H + p_H V) + B. \end{aligned} \tag{71}$$

Competition among lenders implies that their participation constraint, in equilibrium, is satisfied with equality, so that the equilibrium gross repayment on debt is equal to

$$R_1^E = \frac{1-\gamma}{p_H} - (1-p_H)\,(1-\alpha)\left(x + V - \frac{1}{p_H}\right). \tag{72}$$

Substituting this equilibrium return into the participation constraint of equity-holders, and solving it with equality, yields

$$\gamma = \left(2NPV^H + p_H V\right) \frac{\phi}{1-\phi}. \tag{73}$$

Finally, substituting the equilibrium values of γ and R_1^E into the banker's incentive compatibility constraint (Equation 71) yields the condition on α described by Equation (39) in Section 6.2.