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Closure Policy when Bank Inspection Can Be Manipulated ⋆

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Abstract. This paper analyzes inspection and closure policies of a bank, and the strategic reaction of its managers/shareholders when they can (costly) manipulate the information available to the regulator. We derive optimal intervention policy, and analyze its effect on managerial strategies. Regulatory intervention may induce shareholders to manipulate the information available to the regulator in order to avoid intervention and closure, and we find that these incentives to manipulate information may increase with tighter capital requirements. Finally we show that, in order to avoid manipulation by the banker, some degree of forbearance in closure may be ex ante optimal.

Key words: bank closure, bank inspection, forbearance, manipulation of information

JEL classification codes: G21, G28

1. Introduction

Closure is a major instrument of bank regulation, and often the only one. There are many examples, ranging from widespread financial crisis (such as the Savings and Loans crisis in the US in the 1980's, Japan in the present day, etc.) to individual institutional crisis (e.g., Banesto in Spain in the 90's), in which closure policy has played a major role. By regulatory closure we mean a wide variety of policies: from liquidation or reorganization of the bank, to merger with a "willing" partner, selling off part of bank's assets, etc. The existence of regulatory closure is often justified by the presence of important agency problems within a bank between its managers/shareholders (henceforth, the banker) and its depositors (for example due to informational advantage and limited liability of the former). Since depositors can hardly monitor and intervene in bank activity, regulatory closure is required.

The design of regulatory closure should include two related steps: (1) the determination of the efficient closure policy for each possible state of the bank (taking

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into account the riskiness of bank's assets, its solvency, the value of the charter of the bank, etc.); and (2) regulatory inspection of the bank, needed due to the existence of asymmetric information between the regulator and the banker. Regulators monitor banks constantly; however, in order to acquire an in-depth knowledge of the state of the bank (reasonably required to take such a drastic action as it is the closure of a bank) it is not sufficient the day to day monitoring such as monthly reporting; it requires an in-depth investigation of the solvency and profitability of the bank, a thorough and costly inspection of bank activity, including on-site examinations. Since such a strong inspection is costly, the regulator needs to design an inspection policy. These two regulatory decisions (inspection and closure policy) is what in the present work we define as 'regulatory intervention': when to inspect thoroughly a bank, and when to close it as a function of the information obtained.

The aim of the present paper is to study regulatory intervention in a framework where the banker can (costly) manipulate some of the information available to the regulator. We first derive ex post optimal inspection and closure policy, and analyze the strategic reaction concerning manipulation by the banker. We show that, intuitively, the optimal policy consists of inspecting the bank when it appears to be in a bad state according to the available information (e.g., in a number of countries supervisory authorities have traditionally required banks to continuously report their various liquidity measures).[1] Such an inspection policy is precisely what triggers manipulation by the banker of this information, with the purpose to try to avoid external intervention, and thus enjoy the benefits of following normally with bank activity.

We show that regulatory intervention can have two effects: first one is the efficient closure of the bank when there exists inspection and the state of the bank is truly bad; and second, the possible inducement of manipulation, which is socially and privately costly. As a consequence, we show that forbearance in closure policy may be ex ante optimal in some states. That is, it may be optimal ex ante to commit to leave the bank open even when it is ex post optimal to close it. This is so because closure induces strategic manipulation by the banker, which may be substantially costly compared to the benefits of ex post optimal closure. Finally, we also analyze the effect of a minimum capital requirement in such a framework (e.g., see Buser et al. (1981), Kim and Santomero (1988) and Rochet (1992) on bank capital regulation). We show that tightening minimum capital requirements may further increase the incentives of the banker to manipulate the information available to the regulator. A higher capital stake may increase the benefits to the banker of continuation, therefore raising its incentives to avoid intervention.

Until recently, literature on bank closure has mostly abstracted from informational asymmetries between banks and the regulator. However, in a context of perfect information, several studies have discussed the effects that closure policies may have on the strategies of banks. Davies and McManus (1991), Noe et al. (1996), Suarez (1998) and Mailath and Mester (1994) analyze (in different frame-

[1] See the special issue on "Commercial bank surveillance" of the Economic Review (1983).

works) the effect that closure policy may have on bank risk-taking behavior, showing that a change in closure policy (e.g., raising the level of net worth at which a bank is closed) could result in more or less asset risk for insured banks. Also, Acharya (1996) obtains that forbearance in closure policy may be optimal when taking into account bank charter values. Recent literature dealing with bank closure has introduced and stressed the importance of the informational asymmetries between banks and the regulator. Campbell et al. (1992) formalize the notion of substitutability between capital requirements and monitoring in controlling the behaviour of bank managers. Aghion el al. (1999) analyze the optimal design of bailouts of troubled banks. They do so in a context of asymmetric information between the banker and the regulator, however they do not consider inspection by the latter. Mazumdar (1997) and Mitchell (2000) introduce regulatory inspection. However, inspection policy consists of simply setting a monitoring probability, hence information (and beliefs) manipulation by bank managers in order to avoid regulatory intervention is not an issue.

The paper is organized as follows. Next section presents the model, shows socially optimal strategies, and the banker-depositors' moral hazard problem. Section 3 analyzes regulatory intervention (with and without commitment ability by the regulator) and the strategic reaction by the banker. Section 4 ends with some concluding remarks.

2. The Model

To develop the analysis, consider a three periods economy (a version of the one in Dewatripont and Tirole, 1994) with a bank and a regulator. The bank is owned and managed by the providers of capital K. Henceforth we speak indistinctly about owners and managers of the bank: we call them the banker and their common objective is the maximization of the profit of the bank. There are also depositors that supply D units of funds. (Figure 1 below presents the timeline of the model, which we now proceed to describe).

In period 0 the bank may invest its resources in (or may grant a loan to a firm with) a one unit project that matures in period 2, yielding $\tilde{v}$ gross returns.

In period 1 new information arrives and some actions must be taken. Thus, the return of the project in period 2 depends upon the state of the bank s (known only in period 1 after the investment has been done) and upon an action A taken either by the banker or the regulator at period 1 after the state s of the bank is known. The state of the bank s can be high (s_H) or low (s_L), that is, $s \in \{s_L, s_H\}$, representing a positive or negative shock in the industries the bank operates, the loss of an important employee, etc. Action A can be one of two types: continuation (*Cont*) of bank activities, leaving the bank open; or liquidating (*Liq*) or closing it, that is, $A \in \{Cont, Liq\}$. Continuation and leaving it open stands for not interfering, whereas closing it stands for reorganization of the bank, a partial asset sale, a reduction in the scope of the bank, layoffs and firings or even literal liquidation.

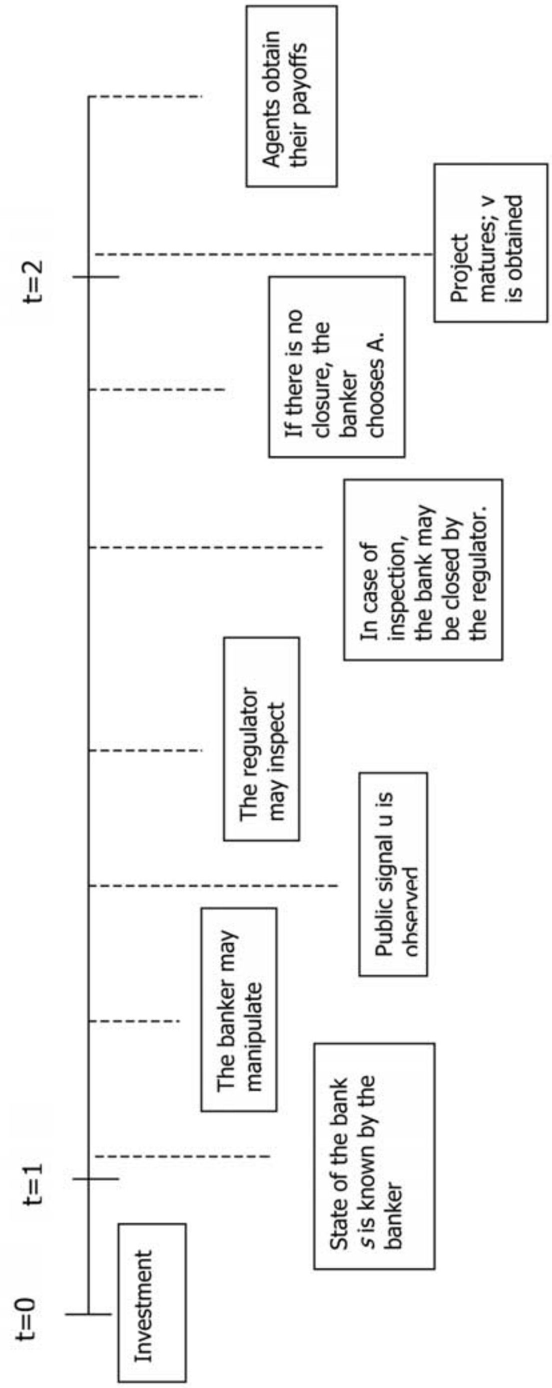

Figure 1. Time line of the model.

The state of the bank s is private information of the banker. Thus, because the banker enjoys such private information and limited liability, there exists a moral hazard problem concerning the choice of A. It is efficient to Liquidate or close the bank when its state is low; however, in this low state, the banker prefers to Continue normally with bank operations since with some small probability the project will be successfull. Thus, the banker is willing to gamble and never liquidate the project, and he will not do this unless forced to by means of external interference.

As we just said, the state of the bank s is private information of the banker; however, the regulator can find out the true state of the bank if and only if it (costly) inspects the bank. Also, in this same period 1, after s is known by the banker, but before action A is taken, an informative signal on the state of the bank is publicly observed by everybody. This signal u could be bank's stock valuation, reported profits, cash flow, some liquidity ratios or, generally speaking, any low cost (in our case zero) signal providing information to the regulator on the long term returns of the bank. u is drawn from a random variable $\tilde{u}$ which depends on the state of the bank s: a higher state of the bank implies a higher expected signal u.

Such a modelling of the informational assumptions tries to capture in a simplified way the real-life information transmission system between banks and the regulator. In the US for instance, bank supervisors rely both on on-site examinations and off-site surveillance to assess the conditions of banks (Gilbert et al., 2000). Although on-site examinations is the most effective tool for constraining bank risk, it is both costly to supervisors and to bankers. Moreover, bank conditions can deteriorate rapidly between on-site visits, and therefore supervisors have reasons to use off-site surveillance tools to help them allocate on-site resources efficiently by identifying those institutions that need immediate attention. For these reasons, it is required that banks submit quarterly Reports of Condition and Income, often referred to as the call reports. Surveillance analysts thus use the call report data to monitor the condition of banks between exams. Supervisors have developed various tools for using call report data, including econometric models. One of such models estimates a hypothetical CAMELS rating that is consistent with the financial data in the bank's most recent call report.[2] Every quarter, the latest call report data is fed into these models and forwarded to each of the twelve Reserve Banks. Surveillance analysts in the Reserve Banks will then investigate the institutions that the models point as exceptions.

A crucial element of the analysis is that the banker can influence and manipulate the value of the signal u (in a way to be specified below in the following subsection). In practice, asset purchases and sales or the management of commercial loans affect this signal of future returns. The banker may sell undervalued assets (that is, assets with a market price in excess of their accounting value) even when

[2] During a routine exam, the examiners of a bank assess six components of safety and soundness: capital protection (C), asset quality (A), management competence (M), earnings strength (E), liquidity risk (L) and market risk (S) – and assign a grade of 1 (best) through 5 (worst) to each component. Examiners then use these six scores to award a composite rating.

it would be profitable for the bank to keep those assets. Similarly the bank may want to demand the payment of a loan even if this hurts the borrower, rather than reschedule reimbursments. Conversely, the bank may keep overvalued assets, even if theses assets could be better managed outside the bank; it may also grant new loans to an illiquid borrower in order not to recognize losses, postponing loan loss provisions. Also, bank management may attempt to inflate collateral values to avoid loss recognition (in practice, this is most often accomplished by postponing recognition that the value of the collateral has declined). Finally, insider abuse and fraud have also been contributing factors in many bank failures, and can occur throughout a bank's operation. Fraud and abuse typically are concealed from routine scrutiny by different means, e.g., low quality assets sold to affiliated and unaffiliated banks, inflated real estate appraisals, etc. (See OCC (2001) for a more detailed and extensive discussion of such possible manipulatory practices by bank management). Akerloff and Romer (1994) provide evidence on the existence and importance of such manipulatory behavior: when analyzing the S&L crisis in the US in the 80s, they show that a big part of the crisis was due to the fact that the owners of a bank (inefficiently) invested in projects with higher short term returns at the expense of long term returns. The owners of the bank privately obtained benefits from such short term projects, and regulatory intervention was rare because in the short term the bank showed no signs of distress.

Finally notice that such activity to manipulate and influence the signal u, that is, the information available to the regulator, is costly. We assume there are two types of costs. On one hand, if the banker is caught having manipulated u it is imposed a penalty fee f or, more generally, incurs in a reputation cost (which implies, e.g., a reduction in future earnings). On the other hand, such manipulatory activity is also costly in terms of future long term returns of the bank: for instance, when the banker sells undervalued assets even when it would be profitable for the bank to keep those assets: this clearly implies a loss in the long term returns of the bank. Thus, our assumption is that manipulatory activity by the banker also entails long term social costs.

In our framework, we take the need for regulation as given, arising from the moral hazard problem concerning the choice of A, and assume there is full deposit insurance, which implies that depositors are passive agents all along.[3] The regulator maximizes expected social return.[4] As we explained above and show below, the existing moral hazard problem implies that the banker will not, on his own, maximize social expected return: in the low state (s_L) he will try to continue normally with

[3] Several rationales for the existence of regulation of financial intermediaries have been provided. One is based on the need to protect small depositors because they are too small, dispersed and uninformed to be able to inspect and intervene in bank activity. See Dewatripont and Tirole (1994, p. 29) for a discussion on 'why regulate banks?'.

[4] Alternatively, we could assume that the regulator minimizes the payment of the deposit insurance fund caused by bank failures. It will become clear below that our main results would also hold under this alternative assumption.

bank activities, whereas liquidation would entail higher social expected returns. Hence, regulation might increase welfare by imposing closure. We will concentrate the analysis on regulatory intervention, and make some assumptions concerning inspection and closure:

- In order to close the bank, the regulator needs to have very reliable information on the state of the bank, that is, it needs to know s with certainty, for which it must inspect bank activity thoroughly.[5]
- Both inspecting and closing (or reorganizing) the bank is costly to the regulator.

The first assumption means that closure policy decision has to be based on accurate information. The regulator cannot force the bank to reorganize simply on account of light information such as bank's stock market value or not too reliable profit prospects.[6] It needs to inspect the bank in order to be able to close it. Otherwise, the banker can continue normally without external interference. Regarding the second assumption, there exists important evidence concerning the importance of monitoring and closure costs. James (1991), Barth et al. (1991) and Bovenzie and Murton (1988) find that in bank failures the resolution cost to asset ratio is around 0.3. When inspecting the bank, the regulator incurs in a fixed cost m. Closure costs are included in bankruptcy costs c, which comprise the administrative costs of closing the bank and paying back depositors (which we discuss below) and the negative externalities associated with a bank failure (contagion to other banks, breakup of lending relationships, etc.). Thus, such bankruptcy costs c exist in case of liquidation of the bank, or in case of failure when there has been continuation.

Finally, we make two assumptions regarding minimum capital requirements. First, minimum capital requirements are always binding; and second, these minimum capital requirements are never so large that the moral hazard problem disappears in the low state of the bank.[7]

2.1. MODEL DETAILS

The details of the model are as follows. The resources of the bank (capital plus deposits) are normalized to 1, i.e., $K + D = 1$. At the beginning of period 0, the

[5] A possible interpretation of the regulatory framework presented so far is that the regulator has two levels of inspection: soft and thorough. Soft inspection is low cost and provides not so reliable and possibly manipulated information (u), whereas stronger-bigger inspection provides much better and precise information (s) at a much higher cost.

[6] It is very likely that closure decision ends up in court; thus the regulator has to be able to provide hard evidence in the court room to justify its decision. In the section Documentation of Supervisory Risks in Problem Banks in OCC (2001) we can read: "It is not unusual for examiner conclusions and enforcement actions relating to problem banks to be challenged by bank management and/or directors. For that reason, examiners must take extra care in fully documenting in writing their work and decision processes in problem banks."

[7] It is clear that tightening minimum capital requirements might soften the moral hazard problem in the continuation-liquidation decision of the banker. However, since this is not the objective of the paper, for simplicity, and in order to concentrate the analysis on what we are interested in, we assume it away.

bank invests in the one unit project. Afterwards, the state of the bank s is known; with probability p_H the state of the bank is s_H, and with probability $1 - p_H$ the state of the bank is s_L.

In period 2 the project matures and its gross return $\tilde{v}$ is:

$$\tilde{v}(s, A) = \begin{cases} \begin{cases} R & \text{with probability } p(s) \\ 0 & \text{with probability } 1 - p(s) \end{cases} & \text{if A=}Cont, \\ L \quad \text{with probability } 1 & \text{if } A = Liq. \end{cases} \tag{1}$$

We assume that a higher s implies that there is a higher probability of success of the project $p(s)$ in case of continuation and, furthermore, $p(s_L) \cdot R < L < p(s_H) \cdot R$. Also, there exists a bankruptcy cost c.

The efficient action (that which maximizes expected social return) is derived comparing expected return of continuation $p(s) \cdot R - (1 - p(s)) \cdot c$ with the return of liquidation $L - c$. It is thus efficient to close the bank in state s if and only if $p(s) < \frac{L}{R+c}$. On one hand, we assume it is always the case that $p(s_H) > \frac{L}{R+c}$, thus it will always be efficient to continue in the high state s_H. On the other hand, the efficient action in the low state s_L depends on the probability of success in case of continuation $p(s_L)$ $(< p(s_H))$ and on how large bankruptcy costs are. For a small $p(s_L)$ and small bankruptcy costs it is efficient to close the bank.

Let $\pi(s, A)$ be the profit of the bank in state s when action A is taken in period 1. Will the banker undertake the efficient action when there is no external intervention? To answer this, it is enough to see the profit function of the bank in period 1 after knowing the state s:

$$\pi(s, A) = \begin{cases} p(s) \cdot (R - D) & \text{if } A = Cont, \\ \max\{L - D, 0\} & \text{if } A = Liq. \end{cases} \tag{2}$$

We assume all along that $L < D$, that is, K is not too large (recall that $K + D = 1$). Therefore $\pi(s, Cont) > 0 = \pi(s, Liq)$, for any s. Hence, the banker will always take action $A = Cont$, that is, he will always want to continue normally with bank operations, and never liquidate, close or stop bank activities.[8]

In period 1 signal u is known. u is drawn from random variable $\tilde{u} \equiv s + \tilde{\varepsilon} + \alpha$, where s is the true state of the bank, and $\tilde{\varepsilon}$ is a white noise random variable normally distributed ($\tilde{\varepsilon} \sim N(0, \sigma_\varepsilon^2)$). This implies that $\tilde{u}$ is normally distributed, i.e., $\tilde{u} \sim N(s + \alpha, \sigma_\varepsilon^2)$. Through the choice of $\alpha \in \{0, \theta\}$, with $\theta > 0$, the banker can (possibly) influence/manipulate signal $\tilde{u} \equiv s + \tilde{\varepsilon} + \alpha$.

Manipulation of signal $\tilde{u}$ is costly: with manipulation and continuation, the return of the project in case of success is $\hat{R} < R$; and with liquidation it is $\hat{L} < L$.

[8] If K were large enough ($K > 1 - L$) then the banker's preferred action would depend on the probability of success in case of continuation in that state, $p(s)$. That is the banker would be willing to liquidate if and only if this probability were small enough: $p(s) < \dfrac{L + K - 1}{R + K - 1}$. But, as we said above, we assume that capital is not so large that the moral hazard problem disappears.

Analogous to above assumptions, we assume that $p(s_L) \cdot \hat{R} < \hat{L} < p(s_H) \cdot \hat{R}$. Hence, above moral hazard concerning the choice of A is still present in the same way when there has been manipulation by the banker. Furthermore, when the regulator finds out there has been manipulation, the banker incurs in a direct private cost f. f may represent a penalty fee imposed by the regulator, or a loss of reputation incurred by the banker.

3. Regulatory Intervention

The inspection and closure policies that the regulator can implement are determined by its ability to commit. We now analyze the scenario where neither the regulator nor the banker can commit to follow any strategy or policy. Hence, each agent follows subgame perfect strategies: at each point in time they do what is best at that point. This implies that solving the game requires solving for the perfect Bayesian equilibrium.[9] As defined in Fudenberg and Tirole (1991), "a perfect Bayesian equilibrium (PBE) is a set of strategies and beliefs such that, at any stage of the game, strategies are optimal given the beliefs, and the beliefs are obtained from equilibrium strategies and observed actions using Bayes' rule. Note the link between strategies and beliefs: the beliefs are consistent with the strategies, which are optimal given the beliefs."

To solve through backward induction, the regulator needs to make some conjecture on whether the banker has manipulated or not the signal u. It will become clear below that in the high state s_H the banker has no incentives to manipulate $\widetilde{u}$. Hence, let α^e be the conjecture of the regulator on whether the banker has manipulated or not in the low state, with $\alpha^e \in \{0, \theta\}$. Furthermore, let R^e and L^e denote the gross returns of the project depending on whether the regulator conjectures that the banker has manipulated or not, where $R^e \in \{\widehat{R}, R\}$, and $L^e \in \{\widehat{L}, L\}$.

Continuation – liquidation decision

If the bank has not been closed (whether because there has not been inspection, or because the regulator has decided not to close it), in the end of period 1 the banker takes action A that maximizes his profits $\pi(s, A)$. We have shown above that $\pi(s, Cont) > \pi(s, Liq) = 0$, for any s. Therefore, the banker will always continue with bank operations, regardless of the state of the bank s, and regardless of whether there has been manipulation or not. Hence, for any s, $A = Cont$.

Closure

If it has not inspected the bank the regulator must allow continuation. If it has inspected, the regulator must take action A: it has to decide whether to close it or to leave it open given the information on the state of the bank s. The expected social return of closing the bank is $L^e - c$, whereas the expected social return of allowing continuation is $p(s) \cdot R^e - (1 - p(s)) \cdot c$. Therefore, the regulator will close the

[9] See Tirole (1988, chapter 11) for an introduction to the perfect Bayesian equilibirum.

bank if and only if $L^e > p(s) \cdot (R^e + c)$. It is easy to see that for bankruptcy costs $c < \dfrac{L^e}{p(s_L)} - R^e$, it is efficient to close the bank in the low state s_L. On the other hand, for bankruptcy costs $c > \dfrac{L^e}{p(s_L)} - R^e$ the efficient closure policy consists of leaving the bank open in both the low and the high state. Hereafter, so as to focus in the interesting case in which the regulator has a role to play, we will assume that $c < \min\left[\dfrac{L - p(s_L) \cdot R}{p(s_L)}, \dfrac{\hat{L} - p(s_L) \cdot \hat{R}}{p(s_L)}\right]$. This assumption implies that it is always ex post efficient to close the bank in the low state.

Inspection

The regulator has a cost m of inspecting thoroughly. Then, the regulator inspects if and only if inspecting maximizes social expected return conditional on available information, and taking into account the closure policy that it will follow in case it inspects. Available information is realization of $\tilde{u}$, signal u. The regulator has a conjecture α^e on whether the banker has manipulated u. We first obtain the following lemma:

LEMMA 1 The probability of being in the low state decreases with the value of the signal, for a given conjecture. That is, the higher the signal u, the smaller the probability of being in the low state.

The proof is in Appendix A. For a given α^e, let E_1 be the gross (of inspection costs) expected social return when the regulator inspects the bank, conditional on a realization u of the signal and given the optimal closure policy stated above; and let E_0 be the expected social return when the regulator does not inspect the bank conditional on signal u. Both the returns of the project and the distribution of $\tilde{s}$ conditional on realization of $\tilde{u}$, depend upon the conjecture on α, α^e. Let $\Pr(s \mid u, \alpha^e)$ be the probability that the state of the bank is s given signal u and conjecture α^e. Thus, since for state s_L the regulator closes the bank and for s_H the regulator allows continuation, we obtain that

$$\begin{aligned} E_1 &= \Pr\left(s_H \mid u, \alpha^e\right) \cdot \left[p(s_H) \cdot R^e - (1 - p(s_H)) \cdot c\right] \\ &\quad + \Pr\left(s_L \mid u, \alpha^e\right) \cdot \left(L^e - c\right), \qquad (3) \\ E_0 &= \Pr\left(s_H \mid u, \alpha^e\right) \cdot \left[p(s_H) \cdot R^e - (1 - p(s_H)) \cdot c\right] \\ &\quad + \Pr\left(s_L \mid u, \alpha^e\right) \cdot \left[p(s_L) \cdot R^e - (1 - p(s_L)) \cdot c\right]. \qquad (4) \end{aligned}$$

Let $G(u, \alpha^e) \equiv E_1 - E_0$. Thus

$$G(u, \alpha^e) = \Pr\left(s_L \mid u, \alpha^e\right) \cdot \left[L^e - p(s_L) \cdot \left(R^e + c\right)\right]$$

is the regulator's gross expected benefit of inspecting the bank when signal is u. It is clear that it is optimal to inspect if and only if $G(u, \alpha^e) > m$.

From Lemma 1 it is immediate that $G(u, \alpha^e)$ is decreasing in u. Thus, there exists $\overline{u} \equiv \overline{u}(\alpha^e)$ such that $G(u, \alpha^e) > m$ if and only if $u < \overline{u}$. This defines optimal inspection policy $I^*(u, \alpha^e)$ as

$$I^*\left(u, \alpha^e\right) = \begin{cases} \text{inspect} & \text{if } u < \overline{u}, \\ \text{do not inspect} & \text{if } u \geq \overline{u}. \end{cases} \tag{5}$$

That is, subgame perfect optimal inspection policy consists of setting a cut off level value $\overline{u}$ for signal u such that for lower actual values of the signal ($u < \overline{u}$) the regulator inspects the bank, and for higher values ($u \geq \overline{u}$) the regulator does not inspect. This result comes from the fact that the regulator (optimally) uses u as a signal of the state of the bank s. Given any conjecture α^e on the strategy of the banker, a lower u is a signal of the bank being in the low state s_L with higher probability. On the other hand, the benefits of inspecting arise when the regulator discovers the bank to be in the low state and closes it. Therefore, the regulator optimally inspects bank activity when it is more likely that the bank is in the low state, more precisely when the bank is in a state in which the regulator is going to close the bank if there is inspection. And this happens when signal u is low.

The cutoff value $\overline{u}$ depends on whether the regulator believes that the banker has manipulated the signal or not, and on the level of bankruptcy costs. Then, assume that $\hat{L} - p(s_L) \cdot \left(\hat{R} + c\right)$ is not much smaller than $L - p(s_L) \cdot (R + c)$, which implies that the costs of manipulation are not such that the gains of closing the bank in the low state when there has been manipulation are very small. Then, since $\Pr(s_L \mid u, 0) < \Pr(s_L \mid u, \theta)$, we obtain that $\overline{u}(\theta) > \overline{u}(0)$ (recall that $\alpha = 0$ means that the banker has not manipulated, whereas $\alpha = \theta$ means that the banker has manipulated) . That is, inspection policy is stricter when the regulator believes there has been manipulation of the information. Finally, notice that smaller bankruptcy costs imply higher benefits of inspection and, therefore, a more strict inspection policy (higher $\overline{u}$).

Thus, proposition 1 summarizes the main results obtained so far.

PROPOSITION 1 (Ex post optimal intervention policy).

1. Ex post optimal closure policy depends on the probability of success in case of continuation $p(s)$ and on bankruptcy (and closure) costs c. It is optimal to close the bank in the low state if and only if $p(s_L)$ and c are small enough.
2. Ex post optimal inspection policy consists of inspecting the bank if and only if the information accrued from signal $\tilde{u}$ is bad enough, that is, for low enough values of the signal, (for $u < \overline{u}$).

We can further characterize the ex post optimal intervention policy:

- Tightening minimum capital requirements does not affect optimal intervention policy.
- When there is a recession in the economy or in the industries the bank operates (smaller p_H and $p(s_L)$), ex post optimal inspection and closure policy become more strict.

(Their proof is in Appendix A). On the one hand, the fact that a marginally more strict capital requirement does not affect intervention policy is because the regulator aims at maximizing social expected return. This implies that K is not important as long as it does not change the continuation-liquidation decision of the banker. On the other hand, when there is a recession (smaller probability of being in the high state, and smaller probability of success in the low state) closure policy optimally becomes more strict. Where before closure was not optimal due to bankruptcy costs, in a recession closure may turn optimal because the probability of success in the low state decreases. This alone increases the incentives of the regulator to inspect bank activity. Furthermore, the probability of being in a low state increases, and this raises the incentives of the regulator to inspect in order to close the bank.

Manipulation

The banker can manipulate signal $\tilde{u}$ after finding out the true state of the bank. It should be clear by now that the only purpose of manipulating signal $\tilde{u}$ is avoiding inspection by the regulator. Since manipulation is costly to the banker, and since in the high state s_H the bank will always continue to operate normally regardless of whether there is inspection or not, this implies that the banker never manipulates in the high state of the bank. Thus, let $\pi_m(\alpha)$ be the expected profit of the banker as a function of the manipulation action $\alpha \in \{0, \theta\}$, in state s_L, given the continuation – liquidation strategy of the banker, and given the conjectured inspection $(\overline{u}^e)$ and closure policy of the regulator.

As we said above when discussing closure in this same section, in what follows we focus in the interesting case in which parameter constellations are such that it is ex post efficient to close the bank in the low state. Hence, suppose now the state of the bank is s_L; this means that in case the regulator inspects the bank, it will close it. Thus, $\Pr\left(\tilde{u} \geq \overline{u}^e \mid s_L, \alpha\right)$ is the probability that the bank will not be inspected by the regulator in state s_L and given action $\alpha \in \{0, \theta\}$ has been taken. If the banker does not manipulate $\tilde{u}$, his expected profit in state s_L is

$$\pi_m(0) = \Pr\left(\tilde{u} \geq \overline{u}^e \mid s_L, 0\right) \cdot p(s_L) \cdot (R - D), \quad (6)$$

whereas if he manipulates $\tilde{u}$, he obtains

$$\pi_m(\theta) = \Pr\left(\tilde{u} \geq \overline{u}^e \mid s_L, \theta\right) \cdot \left(p(s_L) \cdot \left(\hat{R} - D\right) + f\right) - f, \quad (7)$$

where, recall that f is the penalty fee the banker must pay in case the bank is inspected when there has been manipulation. Clearly, the banker manipulates in state s_L if and only if $\pi_m(\theta) > \pi_m(0)$. Proposition 2 characterizes precisely the manipulation strategy of the banker.

PROPOSITION 2 (Banker's incentives to manipulate). Only in state s_L there exists an interval of cut-off values of u determining inspection policy $(\overline{u}_1, \overline{u}_2)$ such that it is optimal for the banker to manipulate signal $\tilde{u}$ if and only if the banker conjectures inspection cut-off value $\overline{u}^e \in (\overline{u}_1, \overline{u}_2)$. Furthermore, it happens that

1. Tightening minimum capital requirements increases banker's incentives to manipulate, that is, the interval $(\overline{u}_1, \overline{u}_2)$ becomes larger.
2. Increasing the penalty fee f that the banker must pay when caught having manipulated, reduces its incentives to manipulate ($(\overline{u}_1, \overline{u}_2)$ becomes smaller).
3. The incentives to manipulate increase (that is, the interval $(\overline{u}_1, \overline{u}_2)$ becomes larger) when the economy goes into a recession and the technology to manipulate is inefficient (small θ and large manipulation costs).

(The proof is in Appendix A). Manipulation only makes sense if the bank is going to be closed in case of inspection. Thus, manipulation will not take place when conditional on inspection the regulator will not close the bank, but can take place otherwise, for $s = s_L$. In such a case, the banker does manipulate whenever he expects cut-off value $\overline{u}$ to lie within an interval. If the banker expects $\overline{u}$ to be very large, that is, if he expects inspection policy to be very strict, then manipulation does not occur because with very high probability the bank will be inspected regardless of whether there is manipulation or not. On the other hand, for very small $\overline{u}$, that is, very soft inspection policy, then manipulation is not necessary since with high probability the bank will not be inspected.

Concerning point 1 intuition is clear. Tightening capital requirements marginally raises the incentives of the banker (that is, shareholders) to manipulate because their stake in the bank increases and therefore have larger incentives to avoid intervention. If the increase in capital requirement was large this could change. A larger increase might imply that shareholders' incentives regarding action A might change: with large K shareholders' might prefer to liquidate the bank in the low state, hence moral hazard might disappear. Point 2 states the intuitive point that higher penalty fees will reduce the incentive of the banker to undertake manipulation activities. Finally, point 3 shows that the efficiency of the manipulation technology determines in which way the incentives of the banker change depending on the economic prospects. When this technology is inefficient (or when it is very costly to manipulate a little), and the probablity of success of continuation diminishes, these incentives to manipulate increase. A reduction in the probability of success reduces the expected benefits of continuation, both with and without manipulation. However, the expected benefits of not manipulating decrease by a larger amount than the expected benefits of manipulation.

Equilibrium

In our model a perfect Bayesian equilibrium (PBE) is defined by the strategy of the banker (manipulate or not, and continue or liquidate the bank), the strategy of the regulator (inspection and closure policy), the beliefs of the banker $\overline{u}^e$ and beliefs of the regulator α^e. In equilibrium it must be that strategies are optimal given beliefs, and that beliefs are consistent with the strategies, which implies that in equilibrium it must be that $\alpha^e = \alpha$ and $\overline{u}^e = \overline{u}$. In the appendix we prove proposition 3.

PROPOSITION 3 (Equilibria with manipulation).

1. For some parameter constellations there exists one and only one perfect Bayesian equilibrium in which the banker does manipulate. That is, $\alpha^e = \theta$ and $\overline{u}^e = \overline{u} \in (\overline{u}_1, \overline{u}_2)$ is part of a unique PBE.
2. For some other parameter constellations there exist two equilibria: one in which manipulation does not take place, and another one in which manipulation does take place.

(The proof is in Appendix A). In order to avoid inspection and closure, the banker does (sometimes) in equilibrium costly manipulate the information available to the regulator. In some cases, this is the unique equilibrium. In other cases, it can be that an equilibrium with manipulation coexists with an equilibrium without manipulation.[10]

Summarizing so far, we have shown that regulatory intervention can have two effects: first, the efficient closure of the bank when there exists inspection and the state of the bank is low; and second, inducing manipulation by the banker in this same low state, which is socially costly. Intervention (and more specifically closure) policy will thus be optimal when the benefits of closure are larger than the costs of manipulation, and this raises the question of whether ex post optimal closure policy is always ex ante optimal. This is the issue of the following subsection.

3.1. EX ANTE OPTIMAL CLOSURE POLICY

The analysis so far has assumed that the regulator is not able to commit and, therefore, we have derived ex post optimal intervention policy. We now focus our analysis in the optimal closure policy when the regulator is able to commit to an intervention policy before the banker has decided whether to manipulate or not. Clearly, optimal closure policy depends on the inspection policy that the regulator follows, and viceversa.

When the regulator is able to commit, optimal intervention policy will, in general, differ from the ex post optimal one. Since it knows the strategy of the banker, the regulator can try to avoid manipulation and its corresponding social costs. In a situation where ex post optimal inspection and closure policy do not induce the banker to manipulate the information available to the regulator, such an intervention policy is also ex ante optimal: there is no way in which the regulator can increase ex ante social expected return, thus commitment has no value. However, for some parameter constellations ex post optimal intervention policy does induce the banker to manipulate $\tilde{u}$. In this scenario, it may be optimal for the regulator to change intervention policy in order to avoid manipulation by the banker.

[10] The coexistence of both types of equilibria is possible because the equilibrium depends on the conjectures of the regulator and of the banker. Thus, it can be that the regulator conjectures that there is no manipulation, therefore setting an inspection policy which does not induce manipulation by the banker; and it can also be within the same parameter constellation that the regulator conjectures there is manipulation, and sets an inspection policy that does indeed induce manipulation by the banker.

The regulator has several alternative intervention policies that induce the banker to not manipulate.[11] When the only equilibrium with ex post optimal policy includes manipulation by the banker, one way to avoid it is simply by not closing the bank in the low state; then the banker has no incentive to manipulate u. With such a closure policy, ex ante optimal inspection policy also differs from the ex post optimal one: since the regulator closes the bank neither in the low nor in the high state, there is no benefit from inspecting the bank, thus the regulator never inspects bank activity.[12] An alternative intervention policy consists of maintaining closure in the low state, and setting an inspection policy that induces the banker not to manipulate. It is straightforward to see that there are two possibly optimal inspection policies that allow this. Recall that when the cutoff value determining inspection policy lies within $(\overline{u}_1, \overline{u}_2)$, as defined in Proposition 2, the banker is induced to manipulate signal $\tilde{u}$. Thus, in order to avoid manipulation the regulator should set the threshold determining inspection values just outside this interval; thus ex ante optimal inspection policy is determined by cut-off value $\overline{u}_1$ or $\overline{u}_2$. In any case, manipulation by the banker is avoided; the optimal choice between $\overline{u}_1$ or $\overline{u}_2$ must trade-off the benefits of higher probability of closure in the low state altogether with higher inspection costs, versus lower probability of closure in the low state altogether with lower costs of inspection.

All this allows us to state the following proposition, which characterizes when forbearance in closure policy is ex ante optimal.

PROPOSITION 4 (Forbearance in closure policy). Forbearance in closure policy is ex ante optimal whenever ex post optimal intervention policy always induces manipulation by the banker, and the following conditions hold:

$$\begin{aligned} p_H \Pr(\tilde{\varepsilon} &< \overline{u}_N - s_H)m + (1 - p_H)p(s_L)(R - \hat{R}) \\ &> (1 - p_H)\Pr(\tilde{\varepsilon} < \overline{u}_N - s_H - \theta)(\hat{L} - p(s_L)(\hat{R} + c) - m); \\ p_H \Pr(\tilde{\varepsilon} &< \overline{u}_j - s_H)m > (1 - p_H)\Pr(\tilde{\varepsilon} < \overline{u}_1 - s_H - \theta)(L - p(s_L) \\ &\times (R + c) - m); \end{aligned}$$

[11] Clearly, when manipulation as an equilibrium with ex post optimal intervention policy coexists with an equilibrium without manipulation, the ex ante optimal intervention policy consists of setting the ex post optimal intervention policy in which there is no manipulation by the banker. In this case, intervention policy is both ex ante and ex post optimal.

[12] This extreme result is clearly a consequence of the two states nature of our model. In a more general model this would not be the case. Suppose, as in the working paper version of this paper (Calveras, 2001), that there are three states in the model: low, medium and high; suppose that, on one hand, it is always (ex ante and ex post) optimal to close the bank in the low state; on the other hand, it is ex post optimal to close the bank in the medium state. Then, whenever forbearance in the medium state were ex ante optimal, inspection policy would still exist. In this alternative modeling there is still a rationale for inspection: closing the bank in the low state; and inspection policy is optimally less strict than ex post optimal since the bank is not closed in the medium state, a result analogous to our extreme result of no inspection at all in a two states world.

$$p_H \Pr(\tilde{\varepsilon} < \overline{u}_j - s_H)m > (1 - p_H)\Pr(\tilde{\varepsilon} < \overline{u}_2 - s_H - \theta)(L - p(s_L) \times (R + c) - m).$$

(The proof is in Appendix A). Recall that we had defined public signal $\tilde{u} \equiv s + \tilde{\varepsilon} + \alpha$; thus $\tilde{\varepsilon}$ is a white noise random variable ($\tilde{\varepsilon} \sim N\left(0, \sigma_{\varepsilon}^2\right)$) which adds to the true state of the bank and to the manipulation decision by the banker. Then, first condition ensures that forbearance in closure policy is preferred to following the ex post optimal policy that induces manipulation (with ex post optimal inspection policy determined by cut-off value $\overline{u}_N$). We see that the benefit of forbearance lies in avoiding the costs of manipulation in the low state, and in avoiding the costs of inspection in the good state. Of course, the opportunity cost of forbearance is continuation in the low state when inspection would occur with the expost optimal inspection policy. Thus, a priori, larger inspection costs m, larger manipulation costs $\left(R - \hat{R}\right)$, and lower benefits of closure in the low state, would make forbearance relatively more attractive.

Second and third condition ensure that forbearance in closure is preferred to following the intervention policy consisting of closing in the low state, and inspecting the bank whenever $u < \overline{u}_j$, with $\overline{u}_j \in \{\overline{u}_1, \overline{u}_2\}$, in which cases manipulation is avoided. Here, we also see that the benefit of forbearance arise from the elimination of inspection costs due to non inspection, and the costs arise from not closing the bank in the low state whenever inspection would occur with the alternative intervention policy. Thus, higher inspection costs m, and smaller benefits of closure in the low state would tend to make forbearance relatively more attractive.

We should be cautious, however, concerning the prediction on when forbearance will be optimal, since in equilibrium a change in the parameters has multiple effects. For instance, an increase in manipulation costs tends to make forbearance relatively more atractive. However, higher manipulation costs also have the effect of reducing the incentives of the banker to manipulate. This may thus make that switching to a less or more strict inspection policy that does not induce manipulation is socially less costly.[13] By means of numerical simulations (shown in Appendix B) we obtain the following results. First, we show numerically that forbearance in closure is indeed the optimal policy for some parameter constellations, and second, we do some comparative statics on the optimality of forbearance in closure policy.

RESULT 1 For some parameter constellations, forbearance in closure policy is part of an equilibrium when the regulator is able to commit ex ante. Furthermore, forbearance is more likely the optimal policy when

1. both manipulation costs and ex post benefits of closure are small.

[13] Take another example. Higher inspection costs m also imply that ex post optimal inspection policy is less strict. As a consequence, manipulation may disappear, or it can happen that distorting just a bit the inspection policy is the ex ante optimal intervention policy.

2. manipulation costs are very small and the ex ante probability of being in the low state is very small; manipulation costs are not so small and the ex ante probability of being in the low state is not so small.
3. ex post benefit of closure in the low state is very small, and ex ante probability of being in the low state is rather large; ex post benefit of closure in the low state is not so small and the ex ante probability of being in the low state is rather small.
4. when neither manipulation costs nor inspection costs are too small.

4. Discussion and Concluding Remarks

The starting point of this paper was the existence of a moral hazard problem between the banker (managers and/or shareholders) and depositors, and the asymmetry of information between the regulator and the banker. This gives rise to the need of regulatory closure and inspection policies (which we defined as regulatory intervention). Hence, our aim was to derive and analyze both optimal intervention and the strategic reaction and behaviour of the bank with such optimal policies and other regulatory measures (such as minimum capital requirements).

After characterizing ex post optimal intervention policies the analysis has shown that, as a response to optimal policies, the banker may react strategically and manipulate the information that is available to the regulator in order to influence its inspection policy. This manipulation by the banker is undertaken to avoid intervention by the regulator and it generates welfare losses. As a result this strategic reaction reduces the efficiency effects of intervention. Furthermore, we also show that tightening the minimum capital requirements that the bank faces may further increase the incentives of the bank to strategically manipulate the information available to the regulator. This is so because a higher stake by the shareholders in bank's resources increases their incentives to avoid intervention.

The analysis has allowed us to provide some insights regarding ex ante optimal closure policy. Some degree of forbearance may be ex ante optimal. That is, there are social benefits from committing to leave the bank open when it would be ex post optimal to close it down. The intuition behind this result is straightforward: the benefits of ex post optimal closure must be traded off against the costs of the manipulation driven by closure policy. Since the benefits of the banker from manipulation decrease with forbearance in closure policy, an ex post optimal closure policy can be dominated by some degree of forbearance. Intuitively, for instance, the ex post benefits of closure increase when the bank investments suffer some shock; or the industries in which the bank operates turn into a recession. In such a scenario, tightening closure rules may be ex post optimal, but it is ex ante suboptimal when it induces a much higher probability of manipulation.

Appendix A

Proof of lemma 1. We compute

$$
\begin{aligned}
&\Pr\left(s_L \mid u, \alpha^e\right) \\
&= \frac{\Pr(u \mid s_L)\cdot \Pr(s = s_L)}{\Pr(u \mid s_L)\cdot \Pr(s = s_L) + \Pr(u \mid s_H)\cdot \Pr(s = s_H)} \\
&= \frac{\Pr(\varepsilon = u - s_L - \alpha)\cdot(1 - p_H)}{\Pr(\varepsilon = u - s_L - \alpha)\cdot(1 - p_H) + \Pr(\varepsilon = u - s_H - \alpha)\cdot p_H} \\
&= \frac{1}{1 + \dfrac{p_H}{(1-p_H)}\dfrac{\Pr(\varepsilon = u - s_H - \alpha)}{\Pr(\varepsilon = u - s_L - \alpha)}} \\
&= \frac{1}{1 + \dfrac{p_H}{(1-p_H)}\dfrac{\exp\left\{\dfrac{-1}{2\sigma_\varepsilon^2}\left(u - (s_H + \alpha^e)\right)^2\right\}}{\exp\left\{\dfrac{-1}{2\sigma_\varepsilon^2}\left(u - (s_L + \alpha^e)\right)^2\right\}}} \\
&= \frac{1}{1 + \dfrac{p_H}{(1-p_H)}\exp\left\{\dfrac{1}{2\sigma_\varepsilon^2}\left[(s_L + \alpha^e)^2 - (s_H + \alpha^e)^2 + 2u\,(s_H - s_L)\right]\right\}},
\end{aligned}
$$

Then it is easy to compute the following derivative:

$$
\frac{\partial \Pr(s_L \mid u, \alpha^e)}{\partial u} < 0. \qquad \blacksquare
$$

Characterization of the ex post optimal intervention policy

- *"Tightening minimum capital requirements does not affect optimal intervention policy."* We assumed when presenting the moral hazard problem of the bank that $L < D$, that is $L < 1 - K$. As long as with the increase in K the inequality continues to hold, it is immediate to see that closure and policy are not affected.
- *"When there is a recession in the economy or in the industries the bank operates (smaller p_H and $p(s_L)$), ex post optimal inspection and closure policy become more strict."* A recession means that p_H and $p(s_L)$ are smaller. Thus, since inspection policy is determined by $G(u, \alpha^e)$, it is easy to see that, for any given u, this increases with smaller p_H and $p(s_L)$. $\Pr(\overline{s} \mid u, \alpha^e)$ decreases with p_H, and $(L^e - p(s_L)\cdot(R^e + c))$ decreases with $p(s_L)$.

Proof of proposition 2. **Banker's incentives to manipulate**
Let $M\left(\overline{u}^e\right) \equiv \pi_m(\theta) - \pi_m(0)$. Then, manipulation occurs if and only if $M\left(\overline{u}^e\right) > 0$. Since $\tilde{u} \equiv \tilde{\varepsilon} + s_L + \alpha$, note that

$$
\Pr\left(\tilde{u} \geq \overline{u}^e \mid s_L, \alpha\right) = \Pr\left(\tilde{\varepsilon} \geq \overline{u}^e - s_L - \alpha\right).
$$

Therefore, manipulation occurs if and only if

$$\begin{aligned} & \Pr\left(\tilde{\varepsilon} \geq \overline{u}^e - s_L - \theta\right) \cdot \left(p\,(s) \cdot \left(\hat{R} - D\right) + f\right) - f \\ \geq\ & \Pr\left(\tilde{\varepsilon} \geq \overline{u}^e - s_L\right) \cdot p\,(s_L) \cdot (R - D)\,. \end{aligned}$$

It is important to notice that $\Pr\left(\tilde{\varepsilon} \geq \overline{u}^e - s_L - \theta\right)$ goes to 0 as $\overline{u}^e \to -\infty$, $\Pr\left(\tilde{\varepsilon} \geq \overline{u}^e - s_L\right)$ approaches 0 as $\overline{u}^e \to -\infty$, $\Pr\left(\tilde{\varepsilon} \geq \overline{u}^e - s_L - \theta\right)$ approaches 1 as $\overline{u}^e \to +\infty$ and $\Pr\left(\tilde{\varepsilon} \geq \overline{u}^e - s_L\right)$ approaches 1 as $\overline{u}^e \to +\infty$.

Thus for very small $\overline{u}^e$ it is never optimal to manipulate since $f > 0$. And neither for very large $\overline{u}^e$, since it is easy to show that

$$\left(p\,(s_L) \cdot \left(\hat{R} - D\right) + f\right) - f < p\,(s_L) \cdot (R - D)\,.$$

Therefore, it is left to show whether it is optimal to manipulate for $\overline{u}^e$ neither very small nor very large. Notice that

$$\begin{aligned} M\left(\overline{u}^e\right) \ =\ & \int_{\overline{u}^e - s - \theta}^{+\infty} f_\varepsilon\,(\varepsilon) \cdot d\varepsilon \cdot \left(p\,(s_L) \cdot \left(\hat{R} - D\right) + f\right) \\ & - f - \int_{\overline{u}^e - s}^{+\infty} f_\varepsilon\,(\varepsilon) \cdot d\varepsilon \cdot p\,(s_L) \cdot (R - D)\,. \end{aligned}$$

Derivating with respect to $\overline{u}^e$ we obtain

$$\begin{aligned} M'\left(\overline{u}^e\right) \ =\ & -f_\varepsilon\left(\overline{u}^e - s_L - \theta\right) \cdot \left(p\,(s_L) \cdot \left(\hat{R} - D\right) + f\right) \\ & + f_\varepsilon\left(\overline{u}^e - s_L\right) \cdot p\,(s_L) \cdot (R - D)\,. \end{aligned}$$

Doing some algebra we get that $M'\left(\overline{u}^e\right) > 0$ if and only if

$$\exp\left\{\frac{1}{2}\left(\frac{\theta\left(\theta - 2\left(\overline{u}^e - s_L\right)\right)}{\sigma_\varepsilon^2}\right)\right\} > \frac{p\,(s_L) \cdot \left(\hat{R} - D\right) + f}{p\,(s_L) \cdot (R - D)}.$$

By doing logarithms, we get that $M'\left(\overline{u}^e\right) > 0$ if and only if $\overline{u}^e < \hat{u}$, where

$$\hat{u} \equiv \frac{1}{2}\left(\theta - \frac{2\sigma_\varepsilon^2}{\theta} \ln \frac{p\,(s_L) \cdot \left(\hat{R} - D\right) + f}{p\,(s_L) \cdot (R - D)}\right) + s_L.$$

Next, set $f = 0$, and $\hat{R} = R$. Then it is easy to show that $M\left(\hat{u}\right) > 0$ always. It is intuitive: if manipulation has no cost, then the manager will always be willing to manipulate. Thus, $\hat{u}$ makes $M\left(\overline{u}^e\right)$ largest and positive. Then, by continuity, for some f close to 0, and for some $\hat{R}$ close to R, $M\left(\hat{u}\right)$ is still positive.

Thus, we have shown that there exists $\hat{u}$ such that $M'\left(\hat{u}\right) > 0$ if and only if $\overline{u}^e < \hat{u}$. We have also shown that for some f and some $\hat{R}$, $M\left(\hat{u}\right)$ is strictly positive . This implies that there exist an interval $(\overline{u}_1, \overline{u}_2)$ such that whenever $\overline{u}^e \in (\overline{u}_1, \overline{u}_2)$ the owners of the bank manipulate the signal $\tilde{u}$. Thus we obtain that the manipulation strategy of the managers α depends on the expected inspection policy, that is, $\alpha \equiv \alpha\left(\overline{u}^e\right)$.

1) Since $D \equiv 1 - K$, it is easy to compute

$$\frac{dM\left(\overline{u}^e\right)}{dK} = p\left(s_L\right) \cdot \left(\Pr\left(\tilde{\varepsilon} \geq \overline{u}^e - s_L - \theta\right) - \Pr\left(\tilde{\varepsilon} \geq \overline{u}^e - s_L\right)\right) > 0.$$

Thus, a marginal increase in the capital requirements increases the incentives of the shareholders to manipulate the information available to the regulator.

2) It is easy to compute $\dfrac{dM\left(\overline{u}^e\right)}{df} = \Pr\left(\tilde{\varepsilon} \geq \overline{u}^e - s_L - \theta\right) - 1 < 0.$

3) We can compute

$$\frac{dM\left(\overline{u}^e\right)}{dp\left(s_L\right)} = \Pr\left(\tilde{\varepsilon} \geq \overline{u}^e - s_L - \theta\right) \cdot \left(\hat{R} - D\right) - \Pr\left(\tilde{\varepsilon} \geq \overline{u}^e - s_L\right) \cdot (R - D)\,.$$

Thus, $\dfrac{dM\left(\overline{u}^e\right)}{dp\left(s_L\right)} < 0$ for 'small' θ and $\hat{R}$ sufficiently 'smaller' than R. ■

Proof of proposition 3. **Equilibria with manipulation**

Let's be more precise with the notation. Let cut-off value $\overline{u}^*$ determine the optimal inspection policy of the regulator under the conjecture that there has been manipulation by the banker; and let cut-off value $\overline{u}^{**}$ determine the optimal inspection policy of the regulator under the conjecture that there has *not* been manipulation by the banker.

Then, a PBE with manipulation by the owners of the bank exists whenever beliefs are consistent with the strategies, that is, $\alpha^e = \alpha\left(\overline{u}^e\right) = \theta$ for state s_L, and $\overline{u}^e = \overline{u}^*$; and whenever the strategies are optimal given the beliefs, that is, $\alpha\left(\overline{u}^e\right) = \theta$ is optimal for state s_L whenever $\overline{u}^e \in (\overline{u}_1, \overline{u}_2)$, and by construction $\overline{u}^* \in (\overline{u}_1, \overline{u}_2)$ is optimal given beliefs $\alpha^e = \theta$.

Hence, for such a PBE to exist, all we need is that, under the conjecture that the banker has manipulated, optimal inspection policy $\overline{u}^* \in (\overline{u}_1, \overline{u}_2)$. Then, it is optimal for the owners of the bank to manipulate, and beliefs by the regulator that the managers will manipulate are consistent with the strategies.

We showed above that interval $(\overline{u}_1, \overline{u}_2)$ exists for f not too large, and for $\hat{R}$ not much smaller than R. Interval $(\overline{u}_1, \overline{u}_2)$ is determined by equation $M\left(\overline{u}^e\right) = 0$.

Since closure policy consists of closing the bank only in the low state, cutoff value $\overline{u}^*$ is determined by equation $G(u, \alpha^e) = m$, which, after rearranging, becomes

$$\Pr\left(s_L \mid u, \alpha^e\right) = \frac{m}{\left(\hat{L} - p\left(s_L\right) \cdot \left(\hat{R} + c\right)\right)}.$$

Since $\Pr(s_L \mid u, \alpha^e)$ is strictly decreasing, with $\Pr(s_L \mid u, \alpha^e) = 0$ for $u \to +\infty$, and $\Pr(s_L \mid u, \alpha^e) = 1$ for $u \to -\infty$, for any interval $(\overline{u}_1, \overline{u}_2)$, we can find $m \in \left(0, \hat{L} - p(s_L) \cdot \left(\hat{R} + c\right)\right)$ such that $\overline{u}^* \in (\overline{u}_1, \overline{u}_2)$.

It is now left to show that for some parameter constellations, the equilibrium with manipulation is unique (point 1 of the proposition), whereas for some other parameter constellations, the equilibrium coexists with an equilibrium without manipulation (point 2 of the proposition). Cut-off value $\overline{u}^{**}$ is determined by condition

$$\Pr\left(s_L \mid u, \alpha^e\right) \cdot (L - p(s_L) \cdot (R + c)) = m.$$

Thus, it should be clear that there exists an equilibrium without manipulation if and only if $\overline{u}^{**} \notin (\overline{u}_1, \overline{u}_2)$. Thus, for those parameter constellations such that both $\overline{u}^* \in (\overline{u}_1, \overline{u}_2)$ and $\overline{u}^{**} \in (\overline{u}_1, \overline{u}_2)$, then the only equilibrium has manipulation by the banker (point 1 of the proposition). On the other hand, whenever $\overline{u}^* \in (\overline{u}_1, \overline{u}_2)$ but $\overline{u}^{**} \notin (\overline{u}_1, \overline{u}_2)$, then there are two equilibria that coexist: one with manipulation, and another one without manipulation (point 2 of the proposition). ■

Proof of proposition 4. **Forbearance in closure policy**

Let ex post optimal intervention policy consist of inspecting the bank whenever u lies below $\overline{u}_N$, and closing the bank in the low state. On one hand, whenever with ex post optimal intervention policy there is no manipulation by the banker, then the ex ante optimal policy is the same one. This happens whenever $\overline{u}_N = \overline{u}^{**} \notin (\overline{u}_1, \overline{u}_2)$, with $\overline{u}^{**}$ as defined in the proof of proposition 3. On the other hand, it can be that ex post optimal intervention policy induces the banker to manipulate. This happens whenever $\overline{u}_N = \overline{u}^* \in (\overline{u}_1, \overline{u}_2)$, with $\overline{u}^*$ as defined in the proof of proposition 3. If at the same time (with the same parameter constellations) it happens that $\overline{u}^{**} \notin (\overline{u}_1, \overline{u}_2)$, this implies that there are two equilibria: one with manipulation, and another one without manipulation. It is then clear that in such a case, the ex ante optimal intervention policy consists of closing the bank in the low state and inspecting the bank whenever $u < \overline{u}^{**} \notin (\overline{u}_1, \overline{u}_2)$. Then, there will be no manipulation by the banker, and intervention policy is also ex post optimal.

However, it can be that with ex post optimal intervention policy there is always manipulation by the banker. (When it is always the case that $\overline{u}^{**} \in (\overline{u}_1, \overline{u}_2)$). Then the regulator has four possible alternatives:

(1) Maintaining the ex post optimal intervention policy: closing the bank in the low state, and inspecting the bank whenever $u < \overline{u}_N = \overline{u}^* \in (\overline{u}_1, \overline{u}_2)$. With such a policy, the banker manipulates u.

(2) Closing the bank in the low state, and inspecting the bank whenever $u < \overline{u}_1$, with $\overline{u}_1$ as defined in proposition 2. With such a policy the banker does not manipulate u.

(3) Closing the bank in the low state, and inspecting the bank whenever $u < \overline{u}_2$, with $\overline{u}_2$ as defined in proposition 2. With such a policy the banker does not manipulate u.

(4) Leaving the bank open in both the high and the low state and, therefore, never inspecting bank activity. Clearly, with such a policy the banker does not manipulate u.

We can compute social welfare under each possible policy:

$$\begin{aligned}
W_1 &= p_H[p(s_H)R - (1-p(s_H))c - \Pr(\tilde{\varepsilon} < \overline{u}^* - s_H)\cdot m] \\
&\quad +(1-p_H)[p(s_L)(\hat{R}+c) - c + \Pr(\tilde{\varepsilon} < \overline{u}^* - s_L - \theta) \\
&\quad \times(\hat{L} - p(s_L)(\hat{R}+c) - m)], \\
W_2 &= p_H[p(s_H)R - (1-p(s_H))c - \Pr(\tilde{\varepsilon} < \overline{u}_1 - s_H)\cdot m] \\
&\quad +(1-p_H)[p(s_L)(R+c) - c + \Pr(\tilde{\varepsilon} < \overline{u}_1 - s_L) \\
&\quad \times(L - p(s_L)(R+c) - m)], \\
W_3 &= p_H[p(s_H)R - (1-p(s_H))c - \Pr(\tilde{\varepsilon} < \overline{u}_2 - s_H)\cdot m] \\
&\quad +(1-p_H)[p(s_L)(R+c) - c + \Pr(\tilde{\varepsilon} < \overline{u}_2 - s_L)(L - p(s_L) \\
&\quad \times(R+c) - m)], \\
W_4 &= p_H[p(s_H)R - (1-p(s_H))c] + (1-p_H)[p(s_L)R - (1-p(s_L))c].
\end{aligned}$$

Clearly, the ex ante optimal intervention policy is that which yields the highest welfare. Thus, whenever with ex post optimal policy there is always manipulation by the banker, the ex ante optimal policy is policy (j), where policy (j) is such that $W_j \in \arg\max\{W_1, W_2, W_3, W_4\}$.

It is obtained straight from the previous analysis that the first condition in the proposition is a simplification of inequality $W_4 > W_1$, the second condition is a simplification of $W_4 > W_2$, and the third condition is a simplification of $W_4 > W_3$.

■

Appendix B: Numerical Simulations

In this appendix we show the numerical simulations concerning result 1. To facilitate the analysis, we have made several simplifying assumptions.

Assumption 1. $\hat{R} \equiv (1-g)\,R$; $\hat{L} \equiv (1-h)\,L$.

Assumption 2. $L - p\,(s_L)\,R \equiv \hat{L} - p\,(s_L)\,\hat{R}$.

Let $\Phi \equiv L - p\,(s_L)\,(R+c) - m$. Then in the simulations we are going to set Φ, that is, the benefit to the regulator of closure in the low state. So as to keep Φ constant, we are going to accomodate c by setting $c = \frac{L - p(s_L)R - m - \Phi}{p(s_L)}$.

It is clear to see that assumption 1 and 2 imply that $h = g\frac{p(s_L)R}{L}$, and since $p\,(s_L)\,R < L$ this means that $h < g$. Thus, concerning manipulation costs, determining g is sufficient to determine manipulation costs: the larger g, the larger the manipulation costs are. Furthermore, assumption 2 also implies that Φ, the benefit for the regulator of closure in the low state, is the same irrespective of whether there has been manipulation by the banker or not.

Table I. Tables of the simulations

		ϕ			
		0.01	**0.05**	**0.1**	**0.15**
g	**0.05**	**F**	**F**	NF	NF
	0.1	**F**	**F**	**F**	NF
	0.15	NF	NF	**F**	**F**
	0.2	NF	NF	NF	**UNO**

		p_L				
		0.05	**0.1**	**0.15**	**0.2**	**0.25**
ϕ	**0.01**	NF	NF	NF	NF	NF
	0.05	NF	NF	NF	NF	F
	0.1	NF		F	F	F
	0.15	NF	F	F	F	NF

		p_L				
		0.05	**0.1**	**0.15**	**0.2**	**0.25**
g	**0.01**	**F**	**F**	**F**	NF	NF
	0.05	**F**	**F**	**F**	**F**	NF
	0.1	NF	NF	**F**	**F**	**F**
	0.15	NF	NF	NF	NF	NF

		m			
		0.05	**0.15**	**0.25**	**0.35**
ϕ	**0.01**	NF	NF	NF	NF
	0.05	F	NF	NF	NF
	0.1	NF	F	F	NF
	0.15	NF	NF	F	F

		m			
		0.05	**0.15**	**0.25**	**0.35**
g	**0.05**	NF	NF	F	F
	0.1	NF	F	F	F
	0.15	NF	F	F	NF
	0.2	NF	NF	NF	NF

		m			
		0.05	**0.15**	**0.25**	**0.35**
p_L	**0.05**	F	NF	NF	NF
	0.1	F	NF	NF	NF
	0.15	NF	F	NF	NF
	0.2	NF	F	F	NF
	0.25	NF	F	F	F

F means that forbearance in closure policy is ex ante optimal.
NF means that forbearance in closure policy is not ex ante optimal.

We are going to restrict comparative statics to some of the parameters. Thus fix $R = 1.5$; $L = 0.8$; $D = 0.8$; $p(s_H) = 1$; $p(s_L) = 0.2$; $\theta = 1.5$; $\sigma_\varepsilon^2 = 2$, $f = 0.001$; $s_H = 1$; $s_L = -1$. Then, we are going to do comparative statics with the remaining parameters $g,\ \Phi,\ m,\ p_L$. Unless otherwise stated in the tables, the values for theses parameters are $g = 0.1,\ \Phi = 0.1,\ m = 0.15,\ p_L = 0.8$.

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