Bank Capital Requirements and Managerial Self-Interest*

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Abstract

We analyze the effect of capital adequacy requirements on bank risk policy when managers and shareholders have different information about the quality of the loan portfolio. In a two-period model in which shareholders implement the optimal contract with managers, we show that the level of managerial effort (and therefore the quality of the loan portfolio) is higher when shareholders cannot observe the manager's action. When information regarding the bank loan portfolio is symmetric, capital requirements help to reduce the excess risk-taking problem that deposit insurance creates. Taking as given optimal regulation on capital requirements and deposit insurance, we show that the moral hazard problem in banks leads to a reduction in the banks' loan portfolio through an increase in the managerial effort in loan supervision. Only high-quality loans are accepted by the bank, but some profitable investments are bypassed because managers are more interested in maximizing their compensation (diluting the stock value) than in maximizing the shareholders wealth. Thus we conclude that the riskiness of banks may be suboptimal under moral hazard. We show how bank debt can help alleviate this problem. Our results are related to the theoretical and empirical literature that deals with the effects of the Basle Accords on the banks' credit policy.

Keywords: capital requirements, bank regulation, moral hazard.

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The role of regulation of banks and nancial institutions has been widely discussed in the nance literature. In a seminal paper, Diamond and Dybvig (1983) offer an explanation of deposit insurance that considered the real economic damages caused by the nancial distress of a depository institution. However, if deposit insurance helps preventing bank runs on one side, it does encourage risk-taking by bank managers on the other side. Thus some suggested that a regulatory scheme constraining the feasible set of investment choices and fund sources may partially solve such a problem. In fact, it is said, a regulation comprising deposit insurance and capital requirements (and possibly forbearance systems) is able to enforce the socially optimal level of risk (see Miles (1995), Chan et al. (1992), Dewatripont and Tirole (1994), Bensaid et al. (1993), Dermine (1983) and Rochet (1991) for the joint effect of deposit insurance plus capital requirements[1], and Nagarajan and Sealey (1995) for an analysis of forbearance systems).

If the only objective of the regulator was to ensure stability and continuity, it is certain that she was successful. However, stability comes at cost and it is not clear that the trade-off between stability and efficiency has been resolved completely. Competitive forces should drive poorly managed rms out of the market in any economy, yet bank failures have happened only sporadically until recently, and it has been argued that the bank system is too stable.

In this paper, we try to address this phenomenon and, more generally, we shed some light on the effect of capital requirements scheme on the risk and volume of the bank loan portfolio when managers actions are not observable. Although the con ict of interests between managers and shareholders is very much considered in corporate nance and the empirical results by Hughes and Mester (1994) explicitly inform us that bank s managers are *not* maximizing shareholders value, implying the existence of a relevant internal agency problem, the banking literature has been more interested in the potential con icts between the regulator and bank as a whole (often represented by the manager as the decision-maker). Giammarino et al. (1992) assume that bank managers know more about the riskiness of their loan portfolio than do regulators. Nagarajan and Sealey (1995) also introduce a moral hazard problem between managers and regulator and nd the optimal regulatory mechanism. Bensaid et al. (1993) analyze several models of banking and their optimal regulation. In their approach, bankers have some information on their investments quality and have to monitor the implementation of those projects. The regulator, however, has only access to accounting information. Sometimes, bank regulator may even pursue self interest rather than social welfare (Boot and Thakor (1993)). The general conclusion of all these models is that with information asymmetry between managers and regulator, the effort level proffered by the manager drives away from the rst best level and it is inefficient (see also Gorton and Winton (1995)).[2]

However, to which extent is the assumption of perfectly aligned managers-shareholders harmless? Is there an interaction between capital requirements (or more generally, between regulation) and agency problems? It should be clear by now that this is not just an empirically relevant matter. Recall in fact that much public policy draws from the empirical predictions of the literature and we know how much bank regulation is important.

To address this question, we consider a bank that is publicly owned in a multi-period setting. Bank managers choose the structure of the balance sheet, affecting the risk of insolvency by the choice of the debt-equity ratio, and determine the quality of the loan book by exerting effort. Two orders of countervailing incentives are considered into this paper. Firstly, the regulator-shareholders problem, centered around the assumption that there are some costs associated with financial distress that are borne by the society and not by shareholders. Secondly, and more importantly, the shareholders-manager internal agency problem arising in a framework where managers have to perform costly actions. When we analyze the case in which the only conflict of interest is between outsiders (bank regulator) and *the bank as a whole* (i.e. the interests of shareholders and bank managers are perfectly aligned), we show, in line with most part of the previous literature, that capital requirements help reduce the excess risk-taking problem created by deposit insurance. Additionally, we are able to fully characterize the optimal capital adequacy scheme in a closed form solution and the optimal level of effort exerted by the manager. Then, we introduce the other level of conflict *within the firm*. We assume that effort is not observable and therefore not contractible: shareholders now can only induce the management to choose the right action through the compensation package. To directly test if the assumption of perfectly aligned managers-shareholders is indeed irrelevant and not driving the results, we take as given the *optimal regulation on capital requirements derived before* , and we solve once again the model. What we find is that the separation of ownership and control in the banking industry induces levels of risk that are suboptimal when compared to those that would be chosen in an ideal framework (with no conflict of interest between managers and shareholders) and therefore the internal agency problem must be acknowledged and cannot be passed by. The inefficiency arises because, with self-interested managers, the bank will only take on safe loans, and the risk level in the economy is too low with respect to what would be socially desirable. In other words, while it is possible to design a regulatory system with deposit insurance and capital requirements that provides the right incentives to achieve the optimal level of risk in an economy with asymmetric information between the bank as a whole and the regulator, the same scheme becomes suboptimal when it is applied to banks with internal agency problems: managers will exert an inefficiently high level of effort, some good loans will be passed by, and the bank will became too safe. We believe that this is the main contribution of the paper: to show that the assumption on the absence of internal agency problem is not harmless. Whenever internal agency problem are present, they are to be addressed otherwise models outcomes and policy implications may result seriously biased.

Through the introduction of a conflict of interests between managers and shareholders, our model sheds light to some stylized facts.

Firstly, it can motivate the observed divergence between the theoretical predictions (Miles (1995)) and the actual capital requirements. One of the counterintiutive features of Miles (1995) is that a relatively high level of capital requirements are needed to restore social efficiency, even when banks have a small chance to became insolvent. The values of capital requirements that he finds simulating his models are admittedly too high and difficult to compare with the actual levels. How can we reconcile the theoretical predictions with the standards set by the Basle Accord? Our model, at least in our view, can address this issue. In fact, this paper states that the effect of capital requirements on the reduction of the risk-taking activity by bank manager will be amplified and therefore, only a lower level of mandatory reserve will be enough to make banks safe and the financial system stable. We also find that bank debt is a potential device to circumvent the inefficiencies induced by capital requirements. Debt disciplines managers because it makes capital requirements more difficult to comply with, and then the regulator threat of taking over the bank when equity capital is insufficient becomes more likely.

Secondly, it addresses the relationship between regulatory activity and loan base size (the so-called credit crunch). One of the implications of the model is that the higher the mandatory reserve requirements imposed by the regulator, the higher will be the screening effort perfused by the management in equilibrium. This, in the logic of the model, translates immediately in a lower loan size and a corresponding reduction in the size of the bank. Peek et al. (1995) study empirically the issue of the extent to which bank shrinkage is directly tied to the enforcement action of federal regulators. Their sample includes all large insured institutions in New England between 1989 and 1992 (this is the region where many of the formal regulatory actions have been issued under the new capital guidelines). They find that the capital crunch reported in previous work has an explicit regulatory link (See also Hancock et al. (1992), Berger and Udell (1994)). Such a link was still unanswered from the theoretical point of view.

Finally, this model helps clarify the relationship between loan portfolio and managerial compensation. In line with the main body of literature in corporate finance, the model predicts that higher managerial ownership should be associated with reduced agency problems. This particular feature of the model is exactly in line with the empirical findings by Agrawal and Mandelker (1987). They find a positive relationship between security holdings of managers and changes in firm variance and leverage. These results are consistent with the hypothesis that executive security holdings have a role in alleviating agency problems. In the same line of research, Cornett and Tehranian (1994) analyze stock reactions to voluntary and involuntary (capital requirements induced) equity issues by commercial banks in the period 1983-1989. They show a significant relationship between managerial ownership (an inverse measure of the managers-shareholders conflict) and abnormal returns for involuntary issues. Ours is a theoretical explanation of this finding

The model presented here is closely related to John, Saunders and Senbet (1995). In their study, managerial compensation and deposit insurance premium are designed so as to avoid the risk shifting that is induced by the different incentives of managers and bank owners. They show that, under moral hazard, the investment policy that is selected by bank managers is less risky than when manager s interest are fully aligned with equity interests. By selecting the appropriate compensation package (consisting of a xed cash salary plus a bonus which is increasing in the capitalization of the bank) bank owners may restore the Pareto-optimal investment policy.

The model is introduced in the next section. Section 3 analyzes the case of moral hazard between managers and shareholders, and some features of the capital adequacy scheme in the Basle Accords are analyzed. We conclude with some nal remarks.

1 A model with deposit insurance and capital requirements

1.1 The basic setup

We consider a bank which is publicly owned and lives for one period, with disperse and risk neutral shareholders.

At $t = 1$, the bank manager chooses the structure of the balance sheet. The bank s assets consist of loans of xed size L, and riskless reserves R. Those investments are nanced with deposits D or raising equity from the market K_1. To lend L, the bank must spend cL as cost of credit, which can be interpreted as inspection, advertising and transaction costs which are entirely paid by the bank.

Loans contractual repayment at $t = 2$ is $(1+r)L$ where r denotes the lending rate. We do not consider downward sloping demand for credit since it is assumed that the credit market is competitive. However, loans are risky and only a random proportion θ is paid back. For simplicity, it is assumed that reserves and deposits pay no interest rate. We consider r as exogenous where $r > 0$. Finally, to ensure that loans are pro table, we will further assume that $r > c$.

Assumption 1. $r > c$

Deposits are insured in the sense that depositors will receive the amount D at $t = 2$ even if the bank cannot meet its obligations: when so happens the regulator (either Central Bank or Deposit Insurance Corporation) takes over the bank, collects outstanding debtors and repays deposits through an injection of additional liquidity. However, there is a social cost of providing liquidity in nancial distress, and for any dollar contributed by the regulatory institution, the cost to society is $1 + \delta$, where $\delta > r$.

Capital requirements dictate that, for any amount L that is lent to the market at $t = 1$, $B(L)$ must be, at least, raised as equity:

$$K_1 \geq B(L) \tag{1}$$

with $B'(L) > 0$, $B''(L) \geq 0$[3]

Therefore capital requirements guarantee that the bank cannot assume any additional loan without communicating it to the market through a demand of extra funds.

Thus, at $t = 1$, the budget constraint for the bank is as follows:

$$D + K_1 = R + (1 + c)L \tag{2}$$

Bank managers can affect the bank performance by exerting a level of effort $e \in [0, \infty)$. The nal level of effort affects the distribution of θ since e denotes the quality of the managerial screening in the credit market. Intuitively, when more resources are spent in investigating potential borrowers, the quality of the loans, in terms of probability of repayment, increases. In particular, it is assumed that θ can take two possible values:

$$\theta = \begin{cases} 1 \text{ with prob. } \frac{e}{1+e} \\ 0 \text{ with prob. } \frac{1}{1+e} \end{cases}$$

Note that the characterization is such that loans are risky even when the maximum level of effort is exerted[4]. The proportion of loans that are paid back is thus a concave function of effort, and the probability of default is then known if managerial effort is observed.

At $t = 1$ shareholders, who are risk neutral, calculate the expected value of their stake in the bank given its credit policy (which is common knowledge), the deposit insurance scheme and the probability of repayment:

$$E[K_2] = E[\max\{(1 + r)\,\theta L + R - D, 0\}]$$

In order to ensure that the bank is in nancial distress whenever loans are not paid back, we have to assume that repayment to depositors cannot be nanced via reserves.

Assumption 2. $D > R$

De ning θ_0 as the level of repayment that guarantees a positive value for the equity, we can write the last expression as:

$$E[K_2 \mid \theta \geq \theta_0] = E[(1 + r)\,\theta L + R - D\,|\theta \geq \theta_0] \qquad for \quad \theta \geq \theta_0 \tag{3}$$

Substituting R in (3) from (2) results in:

$$E[K_2 \mid \theta \geq \theta_0] = E[[(1 + r)\,\theta - (1 + c)]\,L + K_1\,|\theta \geq \theta_0] \qquad for \quad \theta \geq \theta_0 \tag{4}$$

with $\theta_0 = \frac{1+c-\frac{K_1}{L}}{1+r}$

Finally, using Assumption 2, the expected value of equity becomes:

$$E\left[K_2\right] = \left[(r - c)\, L + K_1\right] \frac{e}{1 + e} \tag{5}$$

Managerial effort is costly and $W(e)$ denotes this cost. At this stage, we will simply assume that $W'(e) > 0$ and $\lim\limits_{e \to \infty} W(e) = \infty$. Any level of effort is chosen when its cost does not exceed the manager s compensation. The compensation scheme for the manager, who is risk neutral, consists of a proportion α of the rm value that is paid at $t = 2$ and contracted upon at $t = 1$. The salary α can be interpreted as a bonus that is determined based upon some measure of performance. The optimal contract is designed so as to achieve the desired level of effort. The percentage α is paid by shareholders and dilutes their holdings in the rm.

Managers are able to raise money from the market as long as investors discounted expectations about the rm value equal their investment:

$$K_1 = (1 - \alpha) E\left[K_2\right] \tag{6}$$

where we assume for simplicity that the required return to equity equals zero[5].

The nancial constraint together with the expression for the rm value in (5) de nes K_1 as a function of α and e solely[6] as:

$$E\left[K_2\right] = \frac{e}{1 + \alpha e}(r - c)L \tag{7}$$

We will assume linearity in both $W(e)$ and $B(L)$. The linearity of the cost function is allowed since e is not bounded to the right, and thus it is never possible to achieve the maximum level of effort even with $W'(e)$ very low. On the other hand, it is legitimate to assume that $B'(L) = b$ because L is given and the bank s managers cannot affect the shape of the capital requirements through their choice of L. With these arguments, de ne $W(e) = we$ and $B(L) = bL$, with $b > 0$, $w > 0$. The parameter w can be thought of as the reservation wage for the manager, and b as the mandatory percentage of loans that must be raised as equity[7].

Assumption 3. $W(e) = we$, $w > 0$

Assumption 4. $B(L) = bL$, $b > 0$

Rochet (1991) characterizes $B(L)$ as a non decreasing function (a portion of hyperbola). It is linear when the risk weights are proportional to the systematic risk or to the mean excess returns.

1.2 The benchmark: optimal bank regulation

At $t = 1$, managers and shareholders know the level of effort that will be exerted and they can contract upon it to determine the managerial compensation α. In this situation, shareholders will want to choose the credit risk level and the compensation scheme that maximize their expected rm value, constrained by the capital requirements. Formally, the problem is:

$$\max_{\alpha,e} \ (1-\alpha) E[K_2] \tag{8}$$

$$\begin{aligned} s.t. \qquad K_1 &\geq bL \\ \alpha E[K_2] &\geq we \\ e \geq 0, \ 0 \leq \alpha &\leq 1 \end{aligned} \tag{9}$$

Let us call this problem $[F2]$.

Shareholders choose the values for α and e that optimize the diluted value of equity[8]. The rst constraint says that equity at time $t = 1$ has to be raised so as to comply with the capital requirements. The second is a participation constraint for the manager, and says that the manager will accept the contract as long as the compensation scheme that is given by the shareholders exceeds the cost of exerting a level of effort e. Finally, e will be chosen so as to avoid bankruptcy.

However, and since the initial loan risk is not observed by bank regulators, optimal regulation must be designed so as to make bank managers choose the social optimum level of risk. We assume that the regulatory institution (FDIC for example) sets a capital requirements scheme $b(e)$ that assigns a level of required reserves to every choice of risk. Furthermore, we assume that the objective of FDIC is to maximize the expected value of the bank, less the deadweight loss incurred by deposit insurance. Hence, bank regulators choose $b(e)$ so as to solve:

$$\max_{b(e)} \ E[K_2] \qquad - \frac{(1+\delta)dL}{1+e} \tag{[F1]}$$

$$s.t. \ e \in \arg\max_{e} \ [F2]$$

where $[F2]$ becomes now:

$$\max_{\alpha,e} \ (1-\alpha) E[K_2] \tag{[F2]}$$

$$\begin{aligned} s.t. \qquad K_1 &\geq b(e)L \\ \alpha E[K_2] &\geq we \\ e \geq 0, \ 0 \leq \alpha &\leq 1 \end{aligned}$$

The regulator s objective function consists of the expected value of the bank s equity (observe that since deposits are insured the FDIC is not concerned about their expected value) minus the social cost of FDIC involvement in the banking activity. With probability $\frac{1}{1+e}$ loans repay zero and the bank is in nancial distress[9]. In such a situation FDIC must repay deposits $D = dL$, where $d = \frac{D}{L}$ represents the deposit rate, the social cost being $1 + \delta$.

The solution to $[F1]$ together with $[F2]$ is stated in the following Proposition:

Proposition 1 *When managerial effort is observed, then:*
-Capital requirements are binding,
-The bank is nanced with equity $K_1 = b^* L$
-Optimal Capital Requirements are:

$$b^* = (r - c)e^* - \frac{1 + e^*}{L} we^* \tag{10}$$

Additionally:

$$\alpha^* = \frac{w}{L(r - c) - we^*}$$

where e^* satis es:

$$(r - c)L = 2we^* - \frac{(1 + \delta)dL}{(1 + e^*)^2} \tag{11}$$

Shareholders are willing to obtain from the managers the maximum level of effort given by the managerial incentives. On the other hand, pro tability increases with the amount of loans, but the dilution factor disturbs the capital requirement. In this sense shareholders are also willing to reduce α as much as possible until capital requirements bind, and the reduction depends on the size of L. Note also that, as intuition suggests, α is increasing in effort. Additionally, it is always the case that $b^* > 0$, a direct implication of the fact that $0 \leq \alpha^* \leq 1$.

The next result shows the shape of the capital requirements scheme:

Corollary 2 *If $(r - c)L > 4w$ then b^* is increasing in the riskiness of the loan portfolio*

As expected, when more capital is required as a proportion of loans, the excess risk taking problem faced by shareholders is alleviated. Capital requirements ensure a positive expected rm value and increase the quality of the loans. Miles (1995) uses a similar model in which the regulator s decision is endogeneized. Then the problem becomes the choice of the percentage b that achieves the rst best effort. His framework is also one of asymmetric information between managers and depositors. However, in our paper we do obtain a closed form solution for the function $B(L)$

The next corollary illustrates another comparative statics result:

Corollary 3 *Under the assumptions in Corollary 2, the riskiness of the loan portfolio decreases with its size*

As the bank size increases, managers are able to select only those projects with higher probability of repayment, thus ensuring a higher pro t. Interpreted in another sense, the previous result says that smaller banks will undertake higher risks to make pro ts, and the managerial incentives to work hard are strongly related to the bank s size (remember here that L represents in our model both the loan portfolio size and the amount of deposits).

2 Capital requirements and managerial discretion

2.1 Introducing moral hazard between shareholders and managers

When effort is not observable by shareholders, they must design the contract that ensures the implementation of their desired effort level e^*. However, effort and thus loan quality is a managerial choice, and in this sense we formalize the idea of separation and control in the banking industry. Shareholders cannot affect the bank s performance, but just give the managers the right incentives to maximize share value. Managerial effort is never observed, so shareholders will force managers to adopt the optimal action through the compensation package $\alpha(e)$.

Despite this fact, regulators are not aware of the con ict of interests between bank managers and owners. The optimal regulation takes from granted that the interests of both parties are perfectly aligned and, from (10), still bank owners are enforced to maintain a level of equity nancing equal to b^*. We want to illustrate the resulting effect on managerial performance and compensation, as well as on the bank s risk policy.

The bene ts for the manager, again, come from the stake she receives in the rm at $t = 2$. De ning $\pi(e, \widehat{e})$ as the manager s pro ts when the effort e is undertaken and managerial compensation is $\alpha(\widehat{e})$, clearly, from (7):

$$\pi(e, \widehat{e}) = \frac{\alpha(\widehat{e})e}{1 + \alpha(\widehat{e})e}(r - c)L - W(e) \tag{12}$$

And the shareholders problem in this case becomes:

$$\begin{aligned} &\max_{\alpha(e)} \ (1 - \alpha(e)) E[K_2] && ([P1]) \\ &\quad s.t. \qquad \pi(e, e) \geq \pi(e, \widehat{e}) \qquad \forall \widehat{e} \\ &\qquad\qquad\qquad e \in \arg\max_{\widehat{e}} \{\alpha(\widehat{e}) E[K_2(\widehat{e})] - W(e)\} \\ &\qquad\qquad\qquad e \geq 0, \ 0 \leq \alpha \leq 1 \end{aligned}$$

The solution to [P1] characterizes the conditions that any function $\alpha(e)$ should satisfy under moral hazard. Call $\alpha^*(e) = \arg\max_{\alpha(e)} [P1]$. Now the bank managers optimal strategy solves:

$$\max_{e} \ \alpha(e)E[K_2] - W(e) \qquad ([P2'])$$
$$s.t. \qquad K_1(e) \ \geq \ b^*L$$

where $b^* = (r-c)e^* - \frac{1+e^*}{L}we^*$ comes from (10) and e^* is given by (11). The problem [P2] formalizes the managerial participation constraint. Additionally, the condition with respect to (12) turns out to be:

$$e = \arg\max_{\widehat{e}} \ \pi(e, \widehat{e}) \qquad \text{[P2]}$$

In the next proposition, we describe the solution to [P1], [P2] and [P2].

Proposition 4 *When managerial effort is not observed, then:*
-Capital requirements are binding,
-The bank is nanced with equity $K_1 = b^*L$
Additionally, e^*_{MH} is the minimum positive value that satis es:

$$we^*_{MH}(1 + e^*_{MH})^2 = (b^* + r - c)\left[\frac{b^*}{r-c} + e^*_{MH}\right]L \qquad (13)$$

and $\alpha^*(e^*_{MH})$ is given by:

$$\alpha^*(e^*_{MH}) = \frac{r - c - \frac{b^*}{e^*_{MH}}}{r - c + b^*} \qquad (14)$$

Intuitively, at a rst sight the owners of the bank are willing to reduce the agency problem by guaranteeing the managers a higher stake in the rm than they would get if effort were observable. However, an increase in the dilution factor reduces the equityholding value and thus may violate the capital requirements if these are binding. To avoid it, effort should increase to make the credit business more pro table. This trade-off between effort and compensation is provoked by the legal requirements on equity capital. In a world without regulation on reserves, managers would exert less effort and compensation would increase. When managers are forced to work so as to achieve some bounds in terms of risk, the situation changes. In the problem considered here, it is the manager who chooses the level of effort to maximize her net incentives. The compensation scheme gives her a maximum participation in the rm for a given level of effort, e^*_{MH}.Thus, there is a trade off for the manager in which an increase in effort (and then an increase in the expected value of equity but a proportionally higher increase in terms of costs) produces a reduction in her compensation since α^* decreases. In this situation, e^*_{MH} is optimal and shareholders implement their most preferred level of screening.

From the shareholders point of view, it is clear that the nal result in terms of wealth depends on the choice of e^*_{MH}. Even when dilution increases due to moral hazard, it is still possible that, because of capital requirements, $e^*_{MH} > e^*$.Our model indicates that, in some situations, this does happen.

Proposition 5 *There exists w^c, $0 < w^c < (r-c)L$, such that, for $w > w^c$, the loan portfolio risk is lower under moral hazard, $e^*_{MH} > e^*$*

The result says that when the bank is easily able to satisfy any demand for credit , bankers will only satisfy that demand which ensures repayment (high effort). In fact this credit policy may be suboptimal, and the suboptimo depends on the ability of shareholders to correctly observe (monitor) their management. In economic environments in which risk reduction is costly enough, managers will surprisingly tend to engage in safer projects (loans). The reason is that managerial compensation increases with w, therefore compensating bank managers for any additional increase in the probability of loans repayment. Note as well that, for $w > w^c$, the ex-ante probability of bank failure, $P[\theta < \theta_0] = \frac{1}{1+e}$ is lower in the moral hazard case, as a result of Proposition 5.

Extant literature (Chan et al. (1992), Dewatripont and Tirole (1994), Bensaid et al (1993), Rochet (1991), Nagarajan and Sealey (1995)) assumes that managers maximize shareholders value and uses this argument to formalize the problem of a regulator that chooses the optimal $B(L)$ function. The previous proposition seems to indicate that the optimal $B(L)$ under those assumptions induces a level of risk-taking that is suboptimal. In fact, banks will be smaller (the credit base will decrease) and will bypass some pro table loans.

It is clear from the previous result that the importance of the moral hazard problems depends crucially on the threshold value w^c. Banks with efficient managers will not suffer from suboptimal risk reduction, where efficiency means here the managerial ability to screen the loan portfolio. Additionally, as we prove below, w^c is increasing in the deposit rate d, increasing in the social cost of -nancial distress δ, and increasing in the bank pro tability, $r-c$. The rst result illustrates the role of leverage in disciplining bank managers. Intuitively, bank debt reduces the gains from reducing effort, while increases its costs (nancial distress and therefore loss of compensation). Hence the set of parameters for which the loan portfolio risk is too low shrinks. The relationship between w^c and the cost of nancial distress results from the additional increase in managerial effort induced by a less severe bank regulation, that happens when bankruptcy is socially very costly. Finally, when the bank s prospects are good, the probability of bankruptcy reduces and managerial compensation need not be so high to make managers provide efficient screening.

Corollary 6 *The threshold value w^c is:*
-Increasing in the deposit rate d
-Increasing in the social cost of nancial distress δ
-Increasing in the bank pro t margin $r-c$
-Increasing in the bank s debt to equity ratio

Wagster (1996) addresses the Basle Accords effect on the competitiveness of international banks. The paper examines the effect of a series of events leading up to the Basle Accords of 1988 (when capital requirements were established) on returns to stockholders of international banks from Canada, Germany, Japan, the Netherlands, Switzerland, UK and USA. The empirical results suggest that the Basle Accords failed to eliminate the pricing advantage of Japanese banks that allowed them to capture more than one third of international lending. Additionally, his results show that shareholders of banks from Canada, Switzerland, the United Kingdom, and the United States (countries in which the average capital ratios were well above the new requirement) did experience non negative wealth effects, while shareholders of banks from Germany, the Netherlands, and Japan (with signi cantly undercapitalized banks) did not experience the hypothesized wealth losses. The fourth statement in the last corollary shows that undercapitalized banks tend to suffer less from the agency con ict between bank managers and shareholders, in line with the evidence in Waster s paper.

Figure 1 shows the effect of deposit regulation on the extent of the moral hazard effect. It is straightforward to prove that e^* and e^*_{MH} are respectively increasing and decreasing in the deposit rate d. It is then possible to set a value for $d = d^*$ such that the credit risk level is restored to the rst best case, even when bank managers have different incentives. John, Saunders and Senbet (1995) demonstrate how managerial compensation can be used to cancel such a negative effect. In a framework with capital requirements, we have shown that regulation on both deposits and equity capital can be designed so as to reach socially optimal level of managerial effort.

[Insert Figure 1 here]

Giammarino et al. (1992) show that when the regulator is unable to monitor the extent to which bank resources are directed away from normal operations towards activities that lower asset quality, then the higher the quality of the bank s portfolio, the fewer reserves it is required to hold. Our results indicate that when the moral hazard problem exists between managers and shareholders, then regulation affects the quality of the bank s portfolio in an opposite way, as in the case of perfect information. Formally, e^*_{MH} is increasing in b and so an increase in capital requirements will lead to an adjustment in the managerial reward and also in its effort.

Corollary 7 *e^*_{MH} is increasing in b^**

As before, capital requirements are effective in reducing the excess risk-taking problem created by deposit insurance. However, the last result indicates that there is no way of reconciling the positive effect of capital adequacy measures with the wrong incentives to self interested managers that arise when a lower bound in equity is imposed.

Intuitively, when the bank s managers undertake excessive risk, it will be more difficult for present owners to convince outside shareholders to nance the bank than to invest their own wealth into it. With the right information disclosures the regulatory institution may reveal to the market the loans true quality, affecting then the amount of money the bank is able to raise. In this sense this scheme is a good means to avoid excessive risk. It is also possible that, being now more difficult to satisfy the capital requirements the higher the dilution to the managers, shareholders are willing to increase the loans quality e (therefore reducing risk) to increase the expected value of equity and thus the amount of money they can raise from shareholders. However, it will not be possible to increase effort when capital requirements are binding because this will violate the managerial participation constraint unless α increases as well. On the other hand, shareholders are willing to reduce dilution by driving managerial compensation down. This of course reduces the managerial incentives and thus the level of effort, therefore increasing risk. The nal outcome of this trade-off is a higher effort, smaller loan portfolio and less risk.

2.2 Capital requirements and managerial ownership

We have just shown that the separation of ownership and control in the banking industry induces levels of risk that are lower when compared to those that would be chosen in an ideal framework (perfect information, no con ict of interest between managers and shareholders). In other words, while it is possible to design a regulatory system with deposit insurance and capital requirements that provides the right incentives to achieve the optimal level of risk, the same scheme becomes suboptimal when it is applied to banks with non perfect monitoring and some good loans are bypassed.

The assumption that managerial interests and those of the shareholders are perfectly aligned is perfectly defendable from a theoretical point of view. Although some attempts have been made to model the behavior of sel sh managers (Novaes and Zingales (1995)) and some recent empirical evidence seems to indicate that this is the case (Tufano (1996), Hughes and Mester (1994)), most of the theoretical literature about capital requirements assume that the managerial objective function is exactly that of the shareholders. Novaes and Zingales (1995) simply assume that both the manager s and the shareholder s objective functions diverge, because the latter pursues share value maximization, while the former is trying to maximize the probability of staying in the job (probability of not being taken over, probability of non-bankruptcy states). Under their assumption, the capital structure of the rm is severely affected. In our case, managerial compensation consists of a proportion of equity that is paid by shareholders. Hence managers are interested in maximizing share value, but at the same time their actions may affect their stake in the company, which is endogenous. Under this characterization, we have proven the multiplicative effect of capital adequacy schemes[10].

Another alternative is to consider the managerial objective as a linear combination of both share value and own utility (which may include ring costs, bankruptcy penalties or private bene ts of control). By making the manager decision problem exogenous only illustrative results can be achieved. It would be interesting to study how the con ict of interests between managers and shareholders affects bank s loan portfolio and risk.

3 Conclusions

Our model helps clarify some unexplored aspects of capital adequacy regulations related to managerial incentives and con icts with the bank s owners. The banking literature has primarily analyzed the effects and problems of capital regulation from the point of view of the regulatory institution. Solvency ratios induce a suboptimal level of managerial effort (from the social point of view) even when moral hazard is introduced (in the sense that the regulator cannot observe the bank s actions). They also correct the disincentive to hold capital, the incentives to pursue risky activities and reduce cross-subsidization between safe and risky banks.

We go one step further and assume that the shareholders cannot observe the managerial actions. The main result is that the level of effort which is then chosen by managers is higher than in the symmetric information case. This is consistent with the evidence indicating that the Basle Accords may have contributed to the development of a global credit crunch, and proves the contributory role of a relaxation (of the ratio requirements and/or the way of their implementation) of such a regulation.

Some useful extensions are possible in our framework. We assumed for simplicity that all the agents in our model are risk neutral and thus the distribution of loan repayment depends on effort in the sense of rst order stochastic dominance. The introduction of risk-averse managers could avoid the undesirable linearities in our model and contribute to the study of the optimal risk weights in solvency ratios (as in Rochet (1991)). On the other hand, it allows for more complicated distributions and would show how the effect of managerial effort on loans risk is directly related to regulation. An analysis with that perspective should complete ours.

A Appendix

A.1 Proof of Proposition 1

First use (5) together with (6). Solving for $E[K_2]$ results:

$$E[K_2] = \frac{e}{1+\alpha e}(r-c)L \tag{15}$$

F2 is equivalent to:

$$\begin{aligned} \max_{e,\alpha} \; & \frac{(1-\alpha)e}{1+\alpha e}(r-c)L \\ s.t. \; & \frac{(1-\alpha)e}{1+\alpha e}(r-c) \geq b(e) \\ & \frac{\alpha e}{1+\alpha e}(r-c)L \geq we \end{aligned} \tag{16}$$

given that $e \geq 0$, $0 \leq \alpha \leq 1$ is satis ed

The Lagrangian is:

$$L(e,\alpha) = \frac{(1-\alpha)e}{1+\alpha e}(r-c)L + \lambda_1\left[\frac{(1-\alpha)e}{1+\alpha e}(r-c) - b(e)\right] + \lambda_2\left[\frac{\alpha e}{1+\alpha e}(r-c)L - we\right] \tag{Lagrangian}$$

Conditions for optimality are:

i) $\frac{\partial L}{\partial e} = \frac{1-\alpha}{(1+\alpha e)^2}(r-c)L + \lambda_1\left[\frac{1-\alpha}{(1+\alpha e)^2}(r-c) - b'(e)\right] + \lambda_2\left[\frac{\alpha}{(1+\alpha e)^2}(r-c)L - w\right] = 0$

ii) $\frac{\partial L}{\partial \alpha} = -(1+e)L - \lambda_1(1+e) + \lambda_2 L = 0$

iii) $\lambda_1\left[\frac{(1-\alpha)e}{1+\alpha e}(r-c) - b(e)\right] = 0$

iv) $\lambda_2\left[\frac{\alpha e}{1+\alpha e}(r-c)L - we\right] = 0$

Let s consider the possible solutions:

1. $\lambda_1 = \lambda_2 = 0$,which implies $\frac{(r-c)L}{(1+\alpha e)^2} = 0$ and $(1+e)L = 0$,or $e = -1$ impossible.

2. $\lambda_1 = 0, \lambda_2 < 0$,which implies $\frac{\alpha e}{1+\alpha e}(r-c)L = we$,and $\lambda_2 = 1+e > 0$,contradiction.

3. $\lambda_1 < 0, \lambda_2 = 0$. In this case, $-(1+)eL - \lambda_1(1+e) = 0 \Longrightarrow \lambda_1 = -L < 0$. Additionally, $b(e) = \frac{(1-\alpha)e}{1+\alpha e}(r-c)$, so $b'(e) = \frac{1-\alpha}{(1+\alpha e)^2}(r-c)$. Since $\lambda_1 < 0$, from iii):

$$\begin{aligned} & (1-\alpha)\frac{(r-c)L}{(1+\alpha e)^2} - L\left[\frac{1-\alpha}{(1+\alpha e)^2}(r-c) - b'(e)\right] \\ & = b'(e)L = \frac{(1-\alpha)e}{1+\alpha e}(r-c)L = 0 \end{aligned}$$

which implies $\alpha = 1$, minimum.

4. $\lambda_1 < 0, \lambda_2 < 0$.Hence:

$$\frac{(1-\alpha)e}{1+\alpha e}(r-c) = b(e)$$

$$\frac{\alpha e}{1+\alpha e}(r-c)L = we \tag{17}$$

which is equivalent to:

$$\alpha^* = \frac{w}{(r-c)L - we^*}$$

$$b^* = (r-c)e^* - \frac{1+e^*}{L}we^* \tag{18}$$

Therefore, solving i) and ii), yields:

$$\lambda_2 = \frac{L\left[\frac{1-\alpha}{(1+\alpha e)^2}(r-c) - b\right] - \frac{1-e}{(1+\alpha e)^2}(r-c)L}{\frac{L}{1+e}\left[\frac{1-\alpha}{(1+\alpha e)^2}(r-c) - b\right] + \frac{\alpha}{(1+\alpha e)^2}(r-c)L - w}$$

$$\lambda_1 = L\frac{\lambda_2 - 1 - e}{1+e}$$

and it turns out that $\lim\limits_{\alpha\to\alpha^*}\lambda_1 = \lim\limits_{\alpha\to\alpha^*}\lambda_2 = -\infty$. Finally, let s check that iii) and iv) are satis ed

$$\lim_{\alpha\to\alpha^*}\left(\lambda_2\left[\frac{\alpha e}{1+\alpha e}(r-c)L - we\right]\right) =$$

$$\lim_{\alpha\to\alpha^*}\frac{\lambda_2}{\frac{1}{\frac{\alpha e}{1+\alpha e}(r-c)L-we}}$$

$$= \lim_{\alpha\to\alpha^*}\frac{\frac{\partial\lambda_2}{\partial\alpha}}{\frac{\partial}{\partial\alpha}\frac{1}{\frac{\alpha e}{1+\alpha e}(r-c)L-we}} =$$

$$= \lim_{\alpha\to\alpha^*}\left[\frac{\frac{\partial\lambda_2}{\partial\alpha}}{-e^{-1}(r-c)\frac{L}{(\alpha Lr-\alpha Lc-w-w\alpha e)^2}}\right] = 0$$

Additionally:

$$\lim_{\alpha\to\alpha^*}\left(\lambda_1\left[\frac{(1-\alpha)e}{1+\alpha e}(r-c) - b(e)\right]\right) =$$

$$= \lim_{\alpha\to\alpha^*}\frac{\frac{\partial\lambda_2}{\partial\alpha}}{\frac{\partial}{\partial\alpha}\left[\frac{1}{\frac{(1-\alpha)e}{1+\alpha e}(r-c)-b(e)}\right]} =$$

$$= \lim_{\alpha\to\alpha^*}\frac{\frac{\partial\lambda_2}{\partial\alpha}}{e\frac{r-c+er-ec}{\left(-er+ec+e\alpha r-e\alpha c+\left[(r-c)e+\frac{-1-e}{L}we\right]+\left[(r-c)e+\frac{-1-e}{L}we\right]\alpha e\right)^2}} = 0$$

We solve now F1 using the solution to F2 obtained above.

F1 is equivalent to:

$$\max_{b} \quad \frac{e}{1+\frac{w}{(r-c)L-we}e}(r-c)L \quad -\frac{(1+\delta)dL}{1+e} \qquad (19)$$
$$s.t.\ b(e) = (r-c)e - \frac{1+e}{L}we$$

Or:

$$\max_{b} \quad e(r-c)L \quad -2we - \frac{(1+\delta)dL}{1+e} \qquad (20)$$
$$s.t.\ b(e) = (r-c)e - \frac{1+e}{L}we$$

whose solution is:

$$(r-c)L = 2we^{*} - \frac{(1+\delta)dL}{(1+e^{*})^{2}} \qquad (21)$$

Finally, from (17), $we^{*} < (r-c)L$, hence $\alpha^{*} > 0$. Besides, for $\alpha^{*} \leq 1$ it has to be $w \leq \frac{L(r-c)}{1+e^{*}}$, and from (18):

$$\frac{L(r-c)}{1+e^{*}} = w + \frac{b^{*}L}{e^{*}(1+e^{*})} > w$$

And $e^{*} > 0$ since, the right hand side in (21) is negative for $e^{*} = 0$ and increasing in e^{*}. ■

A.2 Proof of Corollary 2

First notice that $Var(\theta) = \frac{1}{(1+e)^{2}}$, decreasing in e.

Second, from (**??**),

$$\frac{\partial b^{*}}{\partial e} = \frac{(r-c)L - w - 2we}{L}$$

which is positive (negative) if $e^{*} < (>) \frac{(r-c)L-w}{2w}$

From (18), e^{*} satis es:

$$\begin{aligned} & 2we^{*3} + e^{*2}\left[4w - (r-c)L\right] + 2e^{*}\left[w - (r-c)L\right] - \left[(1+\delta)d + r - c\right]L = \\ = \ & P(e^{*}) = 0 \qquad (22) \end{aligned}$$

Note that $P(0) < 0$, $P'(0) < 0$, and under the assumption that $(r-c)L > 4w$, $P(e)$ only reaches a minimum at some $e > 0$. Therefore, to prove the statement it suffices to show that $P\left(\frac{(r-c)L-w}{2w}\right)$ is negative.

Plugging $\frac{(r-c)L-w}{2w}$ into $P(\cdot)$ and after some algebra, yields:

$$\begin{aligned} & P\left(\frac{(r-c)L-w}{2w}\right) = \\ = & \left[\frac{(r-c)L-2}{2w}\right]^2 \left[\frac{3w-(r-c)L}{2}\right] - \left[(1+\delta)d + r - c\right] L < 0 \end{aligned}$$

because $(r-c)L > 3w$.
Thus, $e^* > \frac{(r-c)L-w}{2w} \Rightarrow \frac{\partial b^*}{\partial e} < 0$ ■

A.3 Proof of Corollary 3.

From (22):

$$\frac{\partial e^*}{\partial L} = \frac{(r-c)(1+e^*)^2}{6we^{*2} + 2e(4w-(r-c)L) + 2(w-(r-c)L)} > 0$$

because the denominator is positive since $P(0) < 0$ and $P'(0) < 0$, $P(\cdot)$ is continuous. ■

A.4 Proof of Proposition 4

Let us rst solve for [P2]. From 12:

$$\left.\frac{\partial \pi(e, \widehat{e})}{\partial \widehat{e}}\right|_{\widehat{e}=e} = \frac{\alpha'(e)}{\left[1+\alpha(e)e\right]^2}(r-c)L = 0 \tag{23}$$

Hence, $\alpha'(e) = 0$
Additionally, constructing the Lagrangian for [P2], results:

$$\mathcal{L} = \alpha(e)E\left[K_2\right] - W(e) + \lambda\left[bL - (1-\alpha(e))E\left[K_2\right]\right]$$

with partial derivative:

$$\frac{\partial \mathcal{L}}{\partial e} = \alpha'(e)E\left[K_2\right] + \alpha\frac{\partial E\left[K_2\right]}{\partial e} - w + \lambda\left[\alpha'(e)E\left[K_2\right] - (1-\alpha(e))\frac{\partial E\left[K_2\right]}{\partial e}\right]$$

Both problems lead to two possible solutions, which are analyzed independently:
i) $\lambda = 0$, $\alpha'(e) = 0$, which implies $\alpha\frac{\partial E[K_2]}{\partial e} = w$.
ii) $\lambda \neq 0$, $\alpha'(e) = 0$. Solving for λ we obtain:

$$\lambda = \frac{\alpha(e)\frac{\partial E[K_2]}{\partial e} - w}{(1-\alpha(e))\frac{\partial E[K_2]}{\partial e}} \tag{24}$$

Then the solution to [P1] is equivalent to

$$\begin{array}{rcl} & & \max_{\alpha(e)} \left(1-\alpha(e)\right) E\left[K_2\right] \\ s.t. \qquad \alpha E[K_2] & \geq & we \end{array}$$

plus the conditions stated in either one of the two solutions to the manager s problem.

The only consistent solution (the one that solves both problems) compatible is the following:

$$\begin{array}{rcl} & & \max_{\alpha(e)} \left(1-\alpha(e)\right) E\left[K_2\right] \\ \left(1-\alpha(e)\right) E\left[K_2\right] & = & bL \\ \alpha \dfrac{\partial E\left[K_2\right]}{\partial e} & \leq & w \end{array}$$

It is easy to verify that the optimum is achieved when the last inequality is binding, which de nes $\alpha^*_{MH}$and e^*_{MH} as stated in the Proposition. Second order conditions are veri ed because of the convexity of the maximand.

From the de nition of e^*_{MH}, we can write

$$we^{*3}_{MH}+2we^{*2}_{MH}-e^*_{MH}\left[(b+r-c)L-w\right]-bL\frac{b+r-c}{r-c}=MH(e^*_{MH})=0 \quad (25)$$

And, since $MH(0)<0$ from Proposition 1, $MH(\cdot)$ is continuous and $\lim_{x\to+\infty} MH(x)=+\infty$,there exists $e^*_{MH}>0$ such that $MH(e^*_{MH})=0$.

Finally, from (14), it is immediate that $\alpha^*<1$. Besides, since $(1-\alpha^*(e^*_{MH}))\frac{e^*_{MH}}{1+\alpha^*(e^*_{MH})e^*_{MH}}(r-c)=b^*$, $\alpha^*(e^*_{MH})<0\Rightarrow e^*_{MH}<0$,which is absurd. Hence, $\alpha^*(e^*_{MH})\geq 0$.

And $e^*>0$ since, the right hand side in (21) is negative for $e^*=0$ and increasing in e^*. ■

A.5 Proof of Proposition 5

From the de nition of e^*_{MH}, we can write

$$we^{*3}_{MH}+2we^{*2}_{MH}-e^*_{MH}\left[(b+r-c)L-w\right]-bL\frac{b+r-c}{r-c}=MH(e^*_{MH})=0 \quad (26)$$

From the de nition of e^*:

$$(r-c)e^*-\frac{1+e^*}{L}we^*-b^*=0$$

which is equivalent to:

$$we^{*2}+e^*\left[w-(r-c)L\right]+b^*L=N(e^*)=0$$

Hence:

$$MH(e)-N(e)=we^3+we^2-b^*Le-b^*L\frac{b^*+2(r-c)}{r-c} \tag{27}$$

First notice that $MH(0)<0$ and $N(0)>0$, $MH''(\cdot)>0$, $N''(\cdot)>0$ .Also note that $N(\cdot)$ and $MH(\cdot)$ are continuous functions.

De ne w^c as the value of w such that $MH\left[e(w^c)\right]=N\left[e(w^c)\right]=0$.

From the de nition of e^*, and de ning $Z=(r-c)L-w^c$, clearly w^c satis es

$$e^*(w^c)=\frac{Z+\sqrt{Z^2-4bLw^c}}{2w^c}$$

From the participation constraint in (16), $\frac{\alpha e}{1+\alpha e}(r-c)L\geq we\Longrightarrow(r-c)L>w\ \forall w$. Hence $Z>0$.

Plugging e^* into (27) results:

$$\begin{aligned}MH(e^*)-N(e^*) &= \\ &= \frac{1}{4w^2}\left[2Z^3-8wb^*LZ+2Z^2w-4w^2b^*L\right] \\ &\quad+\frac{1}{4w^2}\left[2Z^2-4wb^*L+2Zw\right]\sqrt{Z^2-4b^*Lw} \\ &\quad-b^*L\frac{b^*+2(r-c)}{r-c}\end{aligned} \tag{28}$$

$$\begin{aligned}MH\left[e^*(w^c)\right]-N\left[e^*(w^c)\right] &= \\ &= \frac{1}{4\left(w^c\right)^2}\left[2Z^3-8w^cb^*LZ+2Z^2w^c-4\left(w^c\right)^2b^*L\right] \\ &\quad+\frac{1}{4\left(w^c\right)^2}\left[2Z^2-4w^cb^*L+2Zw^c\right]\sqrt{Z^2-4b^*Lw^c} \\ &\quad-b^*L\frac{b^*+2(r-c)}{r-c}=0\end{aligned} \tag{29}$$

It is clear that $MH(e^*)-N(e^*)$ is decreasing in w since both terms in brackets are decreasing in w. Therefore, $MH(e^*)-N(e^*)>0$ for $w<w^c$, $MH(e^*)-N(e^*)<0$ for $w>w^c$. Additionally, $MH\left[e^*(w)\right]-N\left[e^*(w)\right]$ is continuous for $w>0$ and $MH\left[e^*(w)\right]-N\left[e^*(w)\right]<0$ for $w=(r-c)L$, so $w^c<(r-c)L$

■

A.6 Proof of Corollary 6

First notice that w^c is implicitly de ne from $MH\left[e^*(w^c)\right] - N\left[e^*(w^c)\right] = 0$, which is decreasing in w^c. Clearly it is also decreasing in b^*. Therefore $\frac{\partial w^c}{\partial b^*} < 0$ and:

$$\frac{\partial w^c}{\partial d} = \frac{\partial w^c}{\partial b^*}\frac{\partial b^*}{\partial d}$$

Using (10):

$$\begin{aligned} \frac{\partial b^*}{\partial d} &= \frac{\partial b^*}{\partial e^*}\frac{\partial e^*}{\partial d} \\ &= \left[r - c - (1+2e)\frac{w}{L}\right]\frac{\partial e^*}{\partial d} \end{aligned}$$

The rst term in brackets is negative from (11). Deriving (11) as an implicit function of e^* and d, yields $\frac{\partial e^*}{\partial d} > 0$. Therefore $\frac{\partial b^*}{\partial d} < 0$, which proves the rst statement.

In the same way:

$$\begin{aligned} \frac{\partial w^c}{\partial \delta} &= \frac{\partial w^c}{\partial b^*}\frac{\partial b^*}{\partial \delta} \\ &= \frac{\partial w^c}{\partial b^*}\frac{\partial b^*}{\partial e^*}\frac{\partial e^*}{\partial \delta} \end{aligned}$$

And $\frac{\partial e^*}{\partial \delta} > 0$ from (11), which proves the second statement.

From (11) and (10):

$$\frac{\partial b^*}{\partial (r-c)} = \frac{\partial b^*}{\partial e^*}\frac{\partial e^*}{\partial (r-c)} < 0$$

And nally, the debt to equity ratio equals:

$$\frac{D}{K_1} = \frac{dL}{b^* L} = \frac{d}{b^*}$$

Clearly, since w^c increases with d and decreases with b^*, the fourth statement holds. ■

A.7 Proof of Corollary 7

From Proposition 5, $MH(e)$ is increasing at $e = e^*_{MH}$ and MH is decreasing in b^*. Therefore:

$$\frac{\partial e^*_{MH}}{\partial b} > 0$$

which is positive as long as e^*_{MH} satis es the non-bankruptcy condition. ■

B Notes

1. Although capital requirements have been extensively used as major instrument in the prudential regulation of banks, numerous authors came up with a number of results that force us to think back to their effectiveness. A positive relation between capital requirements and risk has been formalized in the theoretical work by Kim and Santomero (1980) and Gennotte and Pyle (1991). In Rochet (1991), the adoption of capital requirements may paradoxically entail an increase of the banks risk of default, unless the weights used in the computation of the capital ratio are proportional to the systematic risk of the assets.

2. Another class of incentives problem between managers and claimholders has been also analyzed. Dewatripont and Tirole (1995) focus on the incentive problem between bank managers and all the creditors of the bank (depositors and stockholders). This problem motivates capital requirements in a competitive environment. However, the effect of such a regulation on risk policy is not analyzed. In Daltung (1994), the moral hazard problem between managers and claimholders arises because the latter cannot observe the bank s portfolio choice. Thus the uninsured bank takes too much risk (undertakes projects with negative NPV). To mitigate this problem, a fairly priced deposit insurance scheme would induce the bank to take less risk. Miles (1995) considers information asymmetry between managers and depositors, which generates unregulated outcomes where equity capital is underutilized and lending is suboptimally low.

3. The eight-percent requirement in the Basle Accords may indicate a linear scheme. However, note that this percentage is calculated over the weighted risk. Therefore, $B''(L) \geq 0$, since our model does not allow for an increase in the riskiness of the rm as L grows.

4. Technically, this assumption allows us to linearize the cost of effort function, since the cost of effort will tend to in nity in any case. It presents the disadvantage that the effort is then unbounded to the right, which makes interpretation of results not so clear.

5. We could assume any positive required return $\rho > 0$ without any change in our results.

6. Consider the case in which the size of loan L is an endogenous choice. Then, from (5) and (6) it is clear that K_1 is an increasing function of L. The solution to the problem of maximizing the expected value of equity dictates $K_1 = L = \infty$ even when capital requirements are imposed! Thus, by making L exogenous we allow for interesting comparative statics without a great loss of generality.

7. The condition $b > 0$ ensures that the bank goes bankrupt when capital requirements are binding and no loans are paid back. Thus we will recon-

sider the expression for K_2 if a proportion of equity is issued above the minimum required.

8. Suppose we assume that $\rho \geq 0$ is a positive return to equity required by shareholders in equation (6) (see also footnote 4). Then the above problem becomes exactly equivalent to the following:

$$\begin{array}{rcl} & & \max_{\alpha,e} \ (1-\alpha)\left[E\left[K_2\right]-K_1\right] \\ s.t. \qquad K_1 & \geq & bL \\ \alpha\left[E\left[K_2\right]-K_1\right] & \geq & we \\ e & \geq & 0, \ 0 \leq \alpha \leq 1 \end{array}$$

i.e. the managerial compensation consists of a proportion of the **incremental** value of equity, where the expected value of equity at $t = 2$ becomes:

$$E\left[K_2\right] = (r-c)\frac{e(1+\rho)}{(1+e)(\alpha+\rho)}L$$

And the optimal solution involves $\rho = 0$, which leads to the original [F2].

9. Giammarino et al. (1993) consider a very similar net payoff function to the government. They state that, although several different formulations are possible for the bankruptcy costs, they do not affect the qualitative conclusions drawn.

10. The EC Own Funds Directive , a direct consequence of the Basle Accords, explicitly distinguishes between original own funds and additional own funds to de ne the capital base that is used to calculate the minimum capital requirement. Original own funds comprise:

-Paid-up share capital plus share premium accounts

-Eligible disclosed reserves plus published interim retained pro ts (net of foreseeable charges and dividends) which have been veri ed by (external) auditors.

-Funds for general banking risks.

Additional funds include, among others, holdings of own shares at book value, intangible assets and current year losses). The total amount of additional own funds may not exceed 100% of the total of original own funds .

It is clear from these de nitions that EC regulators were trying to exclude from capital sources that part of equity (own shares) devoted to remunerate managers.

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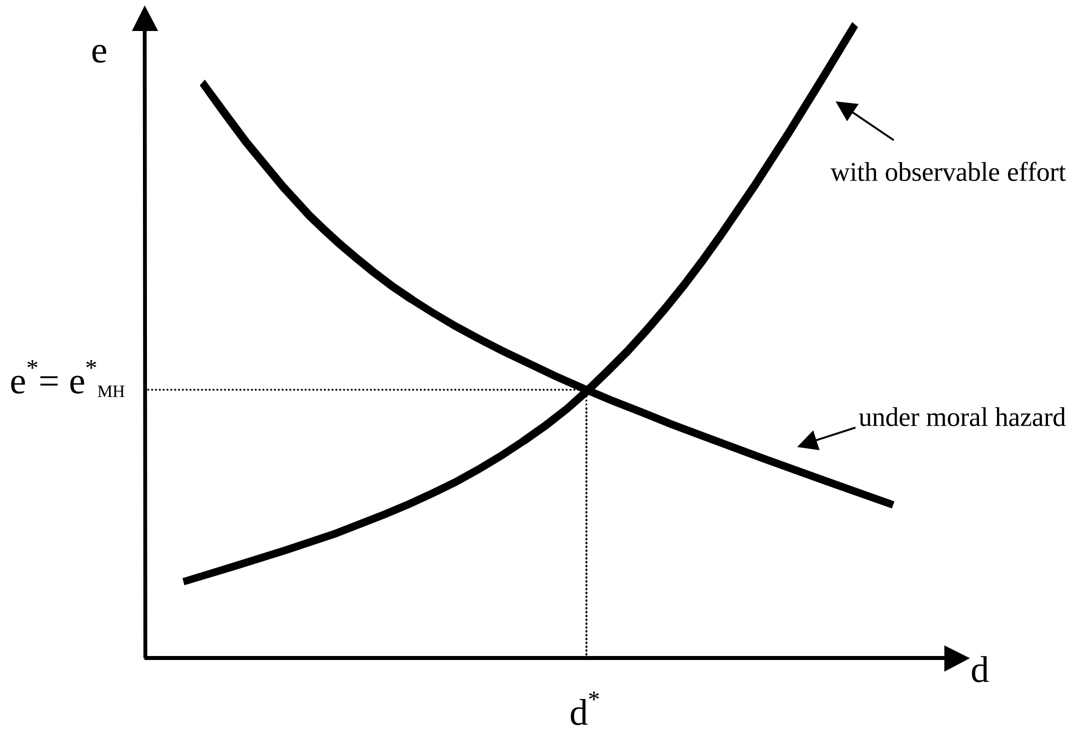

Figure 1. Effect of deposit rate on optimal portfolio risk both under perfect information and moral hazard. At d*, the optimal credit risk levels in both cases equal, eliminating the pervasive effect of the agency conflict between managers and shareholders