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# Basel III and CEO compensation

## A new regulation attempt after the crisis <sup>☆</sup>

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### Abstract

The paper analyzes the interaction between an endogenous capital structure and investment decision, and the incentive scheme of bank executives. We show that the implementation of capital requirements, which are contingent on compensation schemes, drive a wedge between the interests of the shareholder and the CEO. This non-alignment can mitigate excessive risk taking. In particular, linking the amount of insured debt to the ratio of fixed and performance based salary encourages first-best outcomes. We derive empirical predictions and policy implications.

*Keywords:* compensation, leverage, risk

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## 1. Introduction

Due to the financial crisis, policy makers are trying to establish rules that prohibit excessive risk taking by CEOs of financial institutions. A well known phenomenon in this context is the risk shifting problem (also known as asset substitution). Risk shifting enables a value transfer from other stakeholders (e.g. debtholders and society) to equityholders (Jensen and Meckling (1976)). CEOs, aligned with shareholder interests, thereby have an incentive to invest in risky negative NPV (net present value) projects and thus increase the value of equity but in turn destroy overall firm value. The solution for the agency problem between the shareholder of the bank and their debtholder is rather simple. Debtholder need to have bargaining power after the investment decision has taken place and not just ex ante. An automatic way of such a bargaining process is inherent in "debt covenants". Hence, including covenants in the debt contracts can solve the risk shifting problem between shareholder and debtholders of the bank (see e.g. Berlin and Mester (1992) and Chava and Roberts (2008)). Via debt covenants, debtholder demand an adequate risk premium and thereby destroy incentives for too risky investment decisions by the shareholders.

The more severe problem arises in case the state implicitly or explicitly guarantees at least part of the deposits or borrowed funds of the bank. These guarantees increase the expected repayment to debtholders and thereby lower the required risk premium. Therefore, capital costs are not appropriately adjusted for risk and this leads ceteris paribus to a riskier behavior by the bank and in turn to a value transfer from the state to the equityholders, due to negative external effects. This justifies an intervention by the regulator. Given this pattern, one may argue that guarantees of deposits should be repealed. However, there are many well known justification for such a regulative intervention. E.g. Diamond and Dybvig (1983) show that government of deposit insurance can produce superior outcomes.

One way to solve this problem of antidromic effects is equity regulation (Basel Principles). This regulation scheme seeks to mitigate the risk shifting problem by implementing minimum capital requirements. However, there are at least three major difficulties with this approach. First, regulators need to know exactly the underlying risks of the assets. As risk modeling per se has strong limits (see e.g. Danielsson (2002) and Danielsson (2008)) such an regulation approach is hardly able to work. Secondly, as capital decisions of banks change rapidly in a very short time horizon, regulation attempts should reflect this issue and thereby need to be either dynamic or focus on other dimensions to prohibit excessive risk taking by banks. Furthermore, since capital regulations are going against the interests of the shareholders, they

create incentives to get around them through regulatory arbitrage. Hence, the shareholders have an incentive to put compensation schemes in place that reinforce the attractiveness of regulatory arbitrage, and ensure that managers and traders will take full advantage of any loopholes they can find. Hence, Bebchuk and Spamann (2010) argue that instead regulator could place constraints on the compensation structures of bank CEOs. Such pay regulation should focus on the structure of compensation with the aim to avoid excessive risk taking. We tackle this issue by presenting a model that shows how the excessive risk taking problem, given ex- or implicit guarantees, can be solved by a regulatory approach that makes the capital requirement of banks contingent on the compensation schemes of its management.

Therefrom it follows the major research question of our paper: how should executives of financial institutions be paid. We know from a large literature that the higher the equity based salary is, the steeper are the incentives for the manager — thereby *ceteris paribus* the riskier is his project choice. This directly underlines the effect of CEO compensation on the riskiness of the investment strategy. Furthermore, Acharya and Richardson document in their book about financial stability (Acharya and Richardson (2009)) that there is also a strong link between compensation and the capital structure choice. They show, for example, that the compensation of managers of UBS were directly linked to the massive balance sheet increase by leveraging up and buying AAA-rated, super-senior tranches of CDOs. Therefore, both the capital structure and the investment strategy of financial institutions are influenced by the compensation schemes in place.

Compensation failures, such as in the UBS case, seemed to be endemic to many firms (e.g. Citigroup, Merrill Lynch, and AIG) (see Kashyap, Rajan, and Stein (2008)). Therefore, taking CEO compensation into account when designing bank regulation could help to prevent the next financial crisis, since this would induce bank executives to work for, not against, the goals of banking regulation (see Bebchuk and Weisbach (2009)).

Former literature often suggests that the more aligned executives and stockholders are the less agency conflicts arise. Fahlenbrach and Stulz (2011) instead find evidence that banks with CEOs whose incentives were better aligned with the interests of shareholders performed worse during the crisis on average. From the regulators point of view our paper explains how non-alignment (e.g. paying the executives not only in stock) is able to overcome excessive risk taking by banks. We can demonstrate how problems which arise due to a bailout possibility or insured deposits can be solved via compensation schemes and thereby develop direct policy implications to establish a first-best outcome. Moreover, we can show that newly discussed compensation

rules which link managerial compensation not only to the value of equity but also to the value of debt (see e.g. Edmans and Liu (2011)) are not able to solve agency problems in a financial institution framework.

Our paper tackles two wide fields of existing literature. The first field is on the design of compensation contracts of bank CEOs to establish optimal risk behavior while the second builds on capital decisions by the bank.

Various papers have focused on how one should embellish compensation schemes. Edmans and Liu (2011) show that a compensation based on equity and debt components can be a more effective solution to creditor expropriation than salaries, bonuses, reputation and private benefits. We include their framework in our model and can show that first-best decision rules can theoretically be implemented using indebted payments, but regulators would hardly be able to do so. John and John (1993), conceptually the most related paper to ours, include exogenously given debt in their compensation framework. They then determine optimal compensation rules given a specific level of debt. In order for the approach to work effectively, compensation schemes have to be changed as soon as the capital structure of the bank is altered. This is especially valid as banks typically change their capital structure on a daily basis. Another very recent paper is the one by Bolton, Mehran, and Shapiro (2010). They include CDS spreads in their compensation scheme framework in order to mitigate risk shifting. A crucial and in our view not very reasonable assumption is that CDSs are traded by informed subjects, while bondholders can not observe actual risks. Sundaram and Yermack (2007) show that CEO compensation exhibits a balance between debt and equity incentives — with a dramatically increase in the debt fraction as CEO grow older. They define inside debt as the outstanding pension entitlements a CEO has. They can show that CEOs with high inside debt incentives manage their company more conservative.

All of the models we are aware of only consider compensation regulation to determine optimal risk profiles and thereby take the capital decision by the manager e.g. the capital structure as given. However, Adrian and Shin (2010) and Adrian and Shin (2008) show that there is a negative correlation between risk and leverage. Hence, the decision about capital structure interacts with the chosen risk profile and it is therefore not effective to regulate the risk profile of a financial institution without considering the capital structure decision. Therefore, we endogenize the investment and the capital structure decision and develop a model that shows how to link capital structure requirements and compensation scheme components to mitigate agency problems and thereby excessive risk taking.

Another string of the literature focuses on the capital decision of banks.

Diamond and Rajan (2000) argue that the optimal capital structure of a bank trades off the ability to create liquidity and credit against stability, whereas Allen, Carletti, and Marquez (2011) show that borrowers may demand banks to commit some of their equity when extending credit. Since borrowers do not fully internalize the cost of raising equity, the equity level demanded by market participants may be above the regulatory minimum. Therefore, the stable capital structures arise in both theories due to the fact that banks chose an optimal capital structure given a customer-determined structure of their assets. Most related to ours is the paper by Inderst and Mueller (2008) who show why banks have a higher (optimal) leverage than non-financial corporations. We amend this literature by providing further insides how compensation contracts affected by regulative interventions interact with capital decisions.

The remaining paper is organized as follows. Section two presents the model. Section three discusses possible empirical implications as well as political implications. Section four concludes.

## 2. Model

Consider a single lender (the bank), creditors of the bank, the manager of the bank, and a penniless firm (the borrower). The borrower has access to a risky project, but needs a loan from the bank in order to be able to conduct the project. The bank has the possibility to give a risky loan to the borrower or it can invest in a safe investment opportunity. Both investments require a fixed capital outlay of  $k > 0$ . All parties are risk neutral. The manager acts on his own behalf given the incentive contracts in place. Without any regulation in place, this management compensation contract is optimally designed by the corporate board of directors who are acting on behalf of the shareholders. In structuring the management compensation contracts, the shareholders anticipate the ex post managerial investment and capital structure choices and their effects on their wealth. It will be convenient for expositional purposes to lay out the model as a three-date, two-period model. At  $t = 0$  the managerial compensation structure is established. This is common knowledge in the market. Then, the external claims are issued and investors pay the appropriate price for these claims. The only external claims that are explicitly studied are equity ( $E$ ) and debt in the form of explicit and implicit insured ( $D^I$ ) and non-insured debt ( $D^N$ ), yielding total funds of  $K := E + D^I + D^N$ . Since all investment opportunities of the bank require a capital outlay  $k$ , we specify that  $K = k$ .

We assume that the bank is able to raise insured debt only up to a certain limit  $d$ . This upper limit  $d < k$  is increasing in the amount of insured

deposits (insured through a deposit-guarantee scheme) the bank has access to and the systemic risk that emanates from the bank, because systemic risk enhances the implicit debt guarantee, given by a possible bailout from the government. We assume that all investors have the opportunity cost  $r$ , which are normalized to zero. Hence, the interest rate for insured debt is  $r_D^I = r = 0$ , since insured creditors are not asking for a risk premium. With no loss of generality we assume that this interest rate does not cover all the riskiness of the undertaken loans by the bank. Clearly the banks needs to pay an insurance premium (may it be that the bank partially finance an institution guaranteeing small investors deposits or other forms of costs), but as this premium does not reflect the true riskiness the following results do not change. However, the cost for equity and non-insured debt fully reflect the ex-ante riskiness of the funds. Therefore, neither form of financing is intrinsically cheaper. The bank promises non-insured debtholders to repay the principal  $D^N$  and the interest  $D^N r_D^N$ , whenever this is feasible. For simplicity, we stipulate that equity finance is provided by a single investor.

The last step in  $t = 0$  is the conclusion of a contract between the bank and the borrower, that stipulates repayment of the principal plus interest  $r_B$  in case the bank decides to give the loan and the project turns out to be a success. The contract thereby is written before the decision to invest or not to invest takes place. This assumption is in line with Inderst and Mueller who argue that predefined contracts are at least for small business loans well known (Inderst and Mueller (2006)). The bank's offer must also be sufficiently attractive to the borrower. More precisely, we require that the borrower's expected profits from approaching the bank must not fall short of a strictly positive reservation value  $\bar{V}_B > 0$ .

The project of the borrower materializes at  $t = 1$ . The success probability depends on the quality of the project, which is given by  $s \in S = [0, 1]$ . In case of success, the project generates a positive excess return of  $r_H > 0$  with probability ( $s$ ). With probability  $(1 - s)$  the project goes bad, in which case the project has a liquidation value of  $\delta k$ , where  $\delta < 1$ . This liquidation value can be pledged as collateral to non-insured creditors. Instead of investing in the borrower's project, the bank can choose a safe investment opportunity, which bears the interest  $r_L$ , with  $r_H > r_L > 0$ . An interest rate of the safe project  $r_L > 0$  can be interpreted as the value of the bank's ability to transfer terms.

Before deciding upon the investment, the manager learns the quality of the project  $s$  through a credit screening. A key point is that only the manager and the borrower can observe the quality of the project, which precludes any contracting (either managerial contracts or debt covenants) contingent on

the value of the parameter  $s$ . However, all the relevant parties know that  $s$  is distributed uniformly over the interval  $[0, 1]$ . In the exposition that follows, it will be clear that the manager makes the investment risk choice privately. That is, the manager decides between the risky project and the riskless project based on his private observation of  $s$  at  $t = 1$ .

At  $t = 2$  the cash flows are realized from the investments made at  $t = 1$ . Given  $K = k$ , the bank's possible, verifiable cash flow realizations are (i)  $y = k(1 + r_L)$  if no loan was made, (ii)  $y = k(1 + r_B)$  if a successful loan was made, and (iii)  $y = \delta k$  if the loan went bad.

First we study the case where there are no forms of asymmetric information. This will be our reference point. With this setup it is first-best efficient to invest in the risky project, whenever  $s > s_{FB}$  and to reject it if  $s < s_{FB}$ , where  $s_{FB}$  is the project quality at which the NPV of the project is just zero:

$$s_{FB}k(1 + r_H) + (1 - s_{FB})\delta k = k(1 + r_L) \Leftrightarrow s_{FB} = \frac{1 + r_L - \delta}{1 + r_H - \delta} \quad (1)$$

As expected, the critical threshold from which on investing in the risky project is rational, depends positively on the interest rate of the safe asset and negatively on the projects expected return.

### 3. Owner-manager — all equity financed bank

In this section, the investment choice is characterized for the case that the government decides not to regulate the compensation schemes or take them into account for the capital requirements. In this case, it is assumed that the shareholders totally align the incentives of the manager with their own. Therefore, we can treat the manager as a owner-manager (e.g. the manager owns the bank). First, we derive the investment policy of the owner-manager, when the bank is financed solely by equity. In analogy to the first-best decision rule, the privately investment decision follows again a cutoff rule. In case this cutoff is interior with  $0 < s_E^* < 1$ , with  $s_E^*$  being the "Equity-Threshold". This threshold is defined by the requirement that at  $s_E^*$  the manager is just indifferent between making the loan or investing in the safe asset:

$$s_E^*k(1 + r_B) + (1 - s_E^*)\delta k = k(1 + r_L) \Leftrightarrow s_E^* = \frac{1 + r_L - \delta}{1 + r_B - \delta} \quad (2)$$

It is convenient to specify that the manager approves the loan also in case of indifference, which is a zero-probability event. The higher the loan rate  $r_B$ , the higher the likelihood that the loan is approved, i.e., the lower the cutoff



$s_E^*$  in (2). As the borrower (again the penniless company which is able to undertake the project) receives the residual payoff  $k(1+r_H) - k(1+r_B)$  in case a financed project was successful, the borrower's participation constraint at  $t = 0$  becomes

$$(1 - s_E^*) \left( \frac{1}{2} + \frac{1}{2}s_E^* \right) k [(1+r_H) - (1+r_B)] \geq \bar{V}_B > 0 \quad (3)$$

The bank's (manager's) program is now conceivably simple: Choose  $r_B$  as high as possible until the borrower's participation constraint (3) becomes binding, which implies that

$$r_B = r_H - \frac{2\bar{V}_B}{k(1 - (s_E^*)^2)} \quad (4)$$

Hence,  $r_B < r_H$  and from (2) it follows that  $s_E^* > s_{FB}$ . As  $\bar{V}_B > 0$ , the bank can not extract all profits from the investment, implying that the bank then chooses a strictly higher cutoff  $s_E^* > s_{FB}$ . Furthermore, the wedge between  $s_E^*$  and  $s_{FB}$  increases the higher is the borrower's reservation value  $\bar{V}_B$ .

**Proposition 3.1.** *The privately optimal credit decision of an all-equity financed bank is too conservative:  $s_E^* > s_{FB}$ , meaning that an all-equity financed bank approves too little loans. Moreover, an increase in the borrower's reservation value  $\bar{V}_B$  raises the cutoff value  $s_E^*$ . This result is in line with Inderst and Mueller (2008).*

**Proof.** The result follows immediately from (2) and (4).

#### 4. Owner-manager — debt and equity financed bank

Now, the investment and capital structure choices of the owner-manager is characterized for the case the bank can take on debt. The bank now can choose between three different forms of funding: equity  $E$ , insured  $D^I \leq d$  and non-insured debt  $D^N$ .

If a levered bank invests in the safe asset, the respective payoff to equity equals  $k(1+r_L) - D^I - D^N(1+r_D^N)$ . If a loan was made but the project was not successful, the payoff is zero, since outside creditors are seizing the liquidation value of the project, which has been pledged as collateral. Finally, after financing a successful project the payoff is  $k(1+r_B) - D^I - D^N(1+r_D^N)$ . The bank then optimally approves a loan at  $t = 1$ , if  $s \geq s^*$ , where  $0 < s^* < 1$  solves

$$\begin{aligned}
s^* \left[ k(1+r_B) - D^I - D^N(1+r_D^N) \right] &= k(1+r_L) - D^I - D^N(1+r_D^N) \\
\Rightarrow s^* &= \frac{k(1+r_L) - D^I - D^N(1+r_D^N)}{k(1+r_B) - D^I - D^N(1+r_D^N)} \tag{5}
\end{aligned}$$

It is easy to see that  $s^*$  diminishes as the amount of debt scales up. So the higher the face value of debt is, the riskier is the investment policy and the more projects will get financed as the critical threshold declines. What is crucial to note is that the investment decision at  $t = 1$  can be influenced by the capital structure decision at  $t = 0$ . Since the costs of equity as well as non-insured debt are the same, the capital structure decision at  $t = 0$  can be used to commit to a certain investment decision threshold at  $t = 1$ . Therefore, substituting non-insured debt for equity does not alter the expected equity value directly, however, it alters the value indirectly by changing the critical investment threshold. The fact that the bank is now allowed to take on debt, changes the critical investment threshold from  $s_E^*$  to  $s^*$ . Therefore, the participation constraint of the borrower is altered and  $r_B$  changes to:

$$r_B = r_H - \frac{2\bar{V}_B}{k(1-(s^*)^2)} \tag{6}$$

Taking into account the interest rates  $r_B$  and  $r_D^N$ , the expected value of equity at  $t = 0$  is given by

$$\begin{aligned}
V_E &:= (1-s^*) \left( \frac{1}{2} + \frac{1}{2}s^* \right) \left[ k(1+r_B) - D^I - D^N(1+r_D^N) \right] \\
&\quad + s^* \left[ k(1+r_L) - D^I - D^N(1+r_D^N) \right] \tag{7}
\end{aligned}$$

where the first term states the equity claim if the project has been successful and the second that the bank invested in the safe asset. To attract non-insured debt from creditors,  $r_D^N$  must satisfy their break-even constraint, which is the case if their expected repayment,  $V_D^N$ , satisfies

$$\begin{aligned}
V_D^N &:= (1-s^*) \left( \frac{1}{2} + \frac{1}{2}s^* \right) D^N(1+r_D^N) + (1-s^*) \left( \frac{1}{2} - \frac{1}{2}s^* \right) \delta k \\
&\quad + s^* D^N(1+r_D^N) \geq D^N \tag{8}
\end{aligned}$$

where again the first two terms state the value of claims in case the project has been undertaken, either successfully or not, and the third term states the debt claims in the case of investment in the safe asset.

Recall next that the bank has now three choice variables: (i) the loan rate,  $r_B$ , (ii) the interest rate,  $r_D^N$ , and (iii) what fraction of the total funds  $k$  are raised through debt,  $D^N$  and  $D^I$ . Since insured debt is cheaper than the other two funding sources, the bank always chooses  $D^I = d$ . The bank's constraints are the participation constraint of non-insured creditors (8) and the participation constraint of the borrower. By optimality, the two constraints bind, since otherwise the bank could extract more profits out of the project. Substituting the binding constraints (8) and (6) into (7), we obtain

$$\begin{aligned} V_E - E &= (1 - s^*) \left( \frac{1}{2} + \frac{1}{2} s^* \right) [k(1 + r_H) - D^I] + (1 - s^*) \left( \frac{1}{2} - \frac{1}{2} s^* \right) \delta k \\ &+ s^* [k(1 + r_L) - D^I] - k + D^I - \bar{V}_B \end{aligned} \quad (9)$$

where we also used that  $E + D^I + D^N = k$ . From an ex ante perspective at  $t = 0$ , the owner-manager wishes to maximize  $V_E - E$  by committing to the following investment policy at  $t = 1$ :

$$\frac{\partial V_E - E}{\partial s^*} \stackrel{!}{=} 0 \Rightarrow s^* = \frac{k(1 + r_L) - \delta k - D^I}{k(1 + r_H) - \delta k - D^I} \quad (10)$$

Since the owner-manager chooses  $D^I = d > 0$ , it can be seen from expression (10), that it would be optimal for the manager to choose the capital structure at  $t = 0$  such that he commits himself to a riskier investment policy than the first-best credit decision.

**Proposition 4.1.** *The manager chooses a uniquely optimal level of debt  $D^N > 0$  so that his privately optimal investment decision coincides with  $s^* = \frac{k(1+r_L)-\delta k-D^I}{k(1+r_H)-\delta k-D^I} < s_{FB}$ .*

**Proof.** Inserting (10) into (5) and solving for the face value of non-insured debt yields  $D^N \left( 1 + r_D^N \right) = k(1 + r_L) - D^I + \frac{(r_B - r_L)(D^I - k(1 + r_L) + \delta k)}{r_H - r_L}$ . Thereby it is shown that the owner-manager optimally chooses a strictly positive debt-level at  $t = 0$  to commit himself on his privately optimal investment decision at  $t = 1$ .

In line with Inderst and Mueller (2008) this result may help to understand why financial intermediaries such as banks have higher leverage ratios than non-financial institutions. If the regulator would decide to ban insured deposits and commit to a no-bailout policy and thereby eliminating implicit guarantees, the owner-manager would choose  $s^* = s_{FB}$  because of the following. First, it is crucial to understand why debt enables the bank to lower its critical cutoff level. This is due to the fact that via debt the bank can commit

itself to choose a lower critical  $s^*$ . Through credible lowering its critical  $s^*$  (financing *ceteris paribus* more projects) the demanded rate the borrower expects goes down and thereby the bank can extract c.p. more profits. The second feature to observe is that the bank exactly chooses the first-best cutoff. Up to this point the bank is able to extract additional profits from the borrower (the bank acts as she would own the project). As soon as  $D^I > 0$ , the owner-manager chooses a riskier strategy than the first-best one.

Comparing this result to the first-best it is easy to see that setting  $D^I = 0$  is the only way for the regulator to implement the first-best incentives for the bank at  $t = 0$ . Since it is not reasonable to ban insured debt in general (due to the possibility of classical bank runs, the possibility of an interbank market disruption, etc.), capital regulation per se does not help to implement the first-best investment decision policy at  $t = 0$ . Clearly capital regulation is what often happens in reality (Basel II). The only way the regulator can enforce the bank to choose its first-best decision rule is the following. The regulator can set the combined levels of debt (insured and uninsured) the way that the bank (manager) establishes first-best *ex-post* at  $t = 1$  ( $s^* \equiv s_{FB}$ ). By inserting (4) into (5), setting the result equal to the first-best in (1) and solving for the facevalue of debt, we get:

$$D^I + D^N(1 + r_D^N) = \delta k + \bar{V}_B \left[ \frac{3(1 + r_L - \delta)}{2(r_H - r_L)} + \frac{(1 + r_L - \delta)^2}{(r_H - r_L)^2} + \frac{1 + r_L - \delta}{2(r_H + r_L + 2 - 2\delta)} \right] \quad (11)$$

As it can be seen in (11), when using the classical capital regulation approach such as Basel II, the regulator needs to observe all project parameters such as  $r_H$ ,  $r_L$ , and  $\delta$ , in order to be able to establish first-best. As risk modeling per se has strong limits (see e.g. Danielsson (2002) and Danielsson (2008)) such an regulation approach is impossible to implement and can be ruled out.

The findings of the last section may explain why intermediaries, even if capital regulated, have much higher leverage ratios than other still capital-unregulated corporations. The only way the bank chooses *ex ante* the first-best cut-off rule is to set the level of insured debt equal to zero by voiding deposit insurance guarantees and committing to a no-bailout policy. As this is clearly and rightly not the intense of policy makers, setting the level of insured debt equal to zero is not a feasible approach. Secondly we see that a regulator may have the opportunity to establish *ex post* first best behavior by the bank. As it can be seen in (11) the regulator would need to know project specific parameters such as returns in either of the states. Therefore

this approach can also be ruled out.

## 5. External manager

In the previous section we discussed the case where the incentives of the manager is fully aligned with these of the shareholder and documented that given any positive level of insured debt the bank always chooses a too high level of overall (insured and non-insured) debt and therefore acts too risky. Any regulation that can lead to an first decision rule would need to control for project specific parameters which is clearly unrealistic. In the following sections we describe how managers who are not fully aligned with the shareholders (fixed and performance based pay) can be "used" by the regulator to establish first-best behavior by factoring in the compensation structure of the manager into the capital regulation. The first part of the chapter analyses whether a regulator can use the newly discussed pay forms which combine debt and equity parts to solve the problems while the second part looks at a classical combination of fixed and performance (equity) based pay and documents how a regulator can enable first-best behavior.

### 5.1. Compensation with debt component

In the following we discuss the compensation schemes proposed in Edmans and Liu (2011) and analyze whether this approach enables us to mitigate the under- or over-investment problem proposed in the last sections. The manager's contract now consists of three different components: a fixed wage, an equity as well as a debt component. Suppose that the manager, due to competitive forces on the managerial labor market, requires an minimum expected payment of  $\bar{V}_M > 0$ . Therefore only such contracts that fulfill the requirement above will be considered. Hence, the contract takes the following form:

$$V_M = S + \alpha V_E + \beta V_D \geq \bar{V}_M > 0 \quad (12)$$

where  $V_D$  and  $V_E$  are the respective debt and equity values at maturity and  $\bar{V}_M$  is the reservation value of the manager. Hence, the manager decides to invest in the risky loan at  $t = 1$ , whenever the project quality  $s$  is greater or equal to  $s_C^*$ , where  $s_C^*$  solves the following equation:

$$\begin{aligned} & s_C^* \left[ S + \alpha \left[ k(1 + r_B) - D^I - D^N (1 + r_D^N) \right] + \beta \left[ D^I + D^N (1 + r_D^N) \right] \right] \\ & + (1 - s_C^*) \beta \delta k \\ & = S + \alpha \left[ k(1 + r_L) - D^I - D^N (1 + r_D^N) \right] + \beta \left[ D^I + D^N (1 + r_D^N) \right] \end{aligned} \quad (13)$$

Solving (13) for  $s_C^*$  yields

$$s_C^* = \frac{S + \alpha k(1 + r_L) + (\beta - \alpha) [D^I + D^N (1 + r_D^N)] - \beta \delta k}{S + \alpha k(1 + r_B) + (\beta - \alpha) [D^I + D^N (1 + r_D^N)] - \beta \delta k} \quad (14)$$

The participation constraint of the borrower now changes to:

$$r_B = r_H - \frac{2\bar{V}_B}{k(1 - s_C^{*2})} \quad (15)$$

The value function of equity inclusive the compensation schemes for the manager takes now the following form:

$$\begin{aligned} V_E := & (1 - s_C^*) \left( \frac{1}{2} + \frac{1}{2} s_C^* \right) \left[ \begin{array}{l} (1 - \alpha) [k(1 + r_B) - D^I - D^N (1 + r_D^N)] \\ -\beta [D^I + D^N (1 + r_D^N)] - S \end{array} \right] \\ & + s_C^* \left[ \begin{array}{l} (1 - \alpha) [k(1 + r_L) - D^I - D^N (1 + r_D^N)] \\ -\beta [D^I + D^N (1 + r_D^N)] - S \end{array} \right] \end{aligned} \quad (16)$$

where the only difference to (7) are the compensation components for the manager. Hence, the expected compensation for the manager becomes

$$\begin{aligned} V_M := & (1 - s_C^*) \left( \frac{1}{2} + \frac{1}{2} s_C^* \right) \left[ \begin{array}{l} S + \alpha [k(1 + r_B) - D^I - D^N (1 + r_D^N)] \\ +\beta [D^I + D^N (1 + r_D^N)] \end{array} \right] \\ & + (1 - s_C^*) \left( \frac{1}{2} - \frac{1}{2} s_C^* \right) \beta \delta k \\ & + s_C^* \left[ \begin{array}{l} S + \alpha (k(1 + r_L) - D^I - D^N (1 + r_D^N)) \\ +\beta (D^I + D^N (1 + r_D^N)) \end{array} \right] \end{aligned} \quad (17)$$

with a proportional fraction  $\alpha$  of the equity value, a proportional fraction  $\beta$  of the debt value as well as fixed wage  $S$ . Since the non-insured creditor now has to share the liquidation value of the project with the manager, the expected value of non-insured debt slightly changes to:

$$\begin{aligned} V_D^N := & (1 - s_C^*) \left( \frac{1}{2} + \frac{1}{2} s_C^* \right) D^N (1 + r_D^N) + (1 - s_C^*) \left( \frac{1}{2} - \frac{1}{2} s_C^* \right) (1 - \beta) \delta k \\ & + s_C^* D^N (1 + r_D^N) \geq D^N \end{aligned} \quad (18)$$

Inserting  $r_B$  and (18) into (17) yields for the expected compensation of the manager

$$\begin{aligned} V_M &:= (1 - s_C^*) \left( \frac{1}{2} + \frac{1}{2} s_C^* \right) \left[ S + \alpha k (1 + r_H) + (\beta - \alpha) D^I \right] \\ &+ (1 - s_C^*) \left( \frac{1}{2} - \frac{1}{2} s_C^* \right) (\beta^2 + \alpha - \alpha\beta) \delta k \\ &+ s_C^* \left[ S + \alpha k (1 + r_L) + (\beta - \alpha) D^I \right] + (\beta - \alpha) D^N - \alpha \bar{V}_B \end{aligned} \quad (19)$$

The first order condition of (19) with respect to  $s_C^*$  yields the investment policy the manager would like to commit to from an ex ante perspective at  $t = 0$ . Hence, the manager wishes to maximize  $V_M$  by committing to the following investment policy:

$$s_C^* = \frac{S + \alpha k (1 + r_L) + (\beta - \alpha) D^I - (\beta^2 + \alpha - \alpha\beta) \delta k}{S + \alpha k (1 + r_H) + (\beta - \alpha) D^I - (\beta^2 + \alpha - \alpha\beta) \delta k} \quad (20)$$

Since we are interested in the policy that the regulator can deploy in order to implement the first-best investment policy, we compare the result in (20) to the first-best cutoff  $s^{FB}$  in (1). Setting  $s_C^* = s^{FB}$  and solving for  $\alpha$  yields the following regulatory scheme:

$$\alpha = \beta + \frac{S}{D^I - \beta \delta k} \quad (21)$$

Therefore, in case the regulator forces the bank to pay its manager according to (21), the manager would like to commit himself at  $t = 0$  to chose the first-best investment policy at  $t = 1$ . As the fixed wage component  $S$  has no incentive relevant function and is just increasing the required level of  $\alpha$ , we assume with no loss of generality that the shareholders will set  $S = 0$  and therefore  $\alpha = \beta$ . Since the participation constraint of the manager requires the expected compensation of the manager to be higher than or equal to the reservation value  $\bar{V}_M > 0$ , it follows that  $\alpha = \beta > 0$ . This result is in line with Edmans and Liu (2011). The interesting difference occurs when we study the ex-post managerial decision given the ex-ante optimal contract  $S = 0$  and  $\alpha = \beta$ . Inserting  $S = 0$  and  $\alpha = \beta$  into (14), the investment decision at  $t = 1$ , yields:

$$s_C^* k (1 + r_B) + (1 - s_C^*) \delta k = k (1 + r_L) \Rightarrow s_C^* = \frac{k (1 + r_L) - \delta k}{k (1 + r_B) - \delta k} \quad (22)$$

It is clear to see that the manager never chooses  $s_C^* = s_{FB}^*$ . Instead he always chooses  $s_C^* = s_E^*$ , independent of the capital structure in place. Since the capital structure decision at  $t = 0$  does not have an influence on the investment policy at  $t = 1$ , it can not be used anymore to commit to a certain investment policy. Thereby, we can show that a compensation scheme following Edmans and Liu (2011) does not solve the incentive problems in a framework with insured debt. Instead, it leads to an underinvestment problem. One possibility to regulate ex-ante such that the manager chooses first-best ex-post is the rule above  $\alpha = \beta + \frac{S}{D^I - \beta \delta k}$  combined with the obligation to set  $S > 0$ . Again the problem is that the regulator needs to observe the project specific parameters, which is not possible.

The next question is whether a regulator can directly set the compensation ingredients such that the manager chooses first-best ex-post investment levels at  $t = 1$ , without considering the incentives at  $t = 0$ . Setting (14) equal to the first-best decision rule ( $s_C^* = s_{FB}$ ) from (1) yields for the compensation regulation:

$$\alpha = \frac{(r_H - r_L) \left( S + \beta \left[ D^I + D^N (1 + r_D^N) \right] \right) - \beta \delta k}{(r_H - r_L) \left[ D^I + D^N (1 + r_D^N) \right] + \bar{V}_B (\delta - 1 - r_H) - \delta k} \quad (23)$$

Now there are many possibilities a regulator can act.

1. Set  $S, \alpha$  and  $\beta$  due to its own preferences (legal requirements, e.g.  $S, \alpha, \beta \geq 0$  or political predilections).
2. As the bank (if not otherwise forced to) will set  $S = 0$  and  $\beta = 0$  as long as  $(r_H - r_L) \left[ D^I + D^N (1 + r_D^N) \right] > \delta k$ , the regulator can choose  $\alpha$  to establish first-best in the following way.

$$\alpha = \frac{(r_H - r_L)}{(r_H - r_L) \left[ D^I + D^N (1 + r_D^N) \right] + \bar{V}_B (\delta - 1 - r_H) - \delta k} \quad (24)$$

All of these solutions bear a lot of problems. Inherent to this solution is that the regulator (government) needs to observe every parameter of the compensation scheme as well as be able to force the institutions to stick to the defined ones.

## 5.2. Minimum capital requirements in combination with compensation

In the following we show that the most efficient and easiest way for the regulator to implement the first-best investment decision at  $t = 1$  is to make the capital requirements contingent on a relative simple compensation scheme and its components. In this case the contract takes the following form:



$$V_M = S + \alpha V_E \geq \bar{V}_M > 0 \quad (25)$$

where the expected managerial value  $V_M$  only consists of a fixed wage  $S$  and an equity component  $\alpha V_E$ . In this case, the manager decides to invest in the risky loan at  $t = 1$ , whenever the project quality  $s$  is greater or equal to  $s_C^*$ , where  $s_C^*$  solves:

$$\begin{aligned} & s_C^* \left[ S + \alpha \left[ k(1 + r_B) - D^I - D^N (1 + r_D^N) \right] \right] \\ &= S + \alpha \left[ k(1 + r_L) - D^I - D^N (1 + r_D^N) \right] \\ \Rightarrow s_C^* &= \frac{S + \alpha \left[ k(1 + r_L) - D^I - D^N (1 + r_D^N) \right]}{S + \alpha \left[ k(1 + r_B) - D^I - D^N (1 + r_D^N) \right]} \end{aligned} \quad (26)$$

Hence, the expected value function of equity becomes:

$$\begin{aligned} V_E &:= (1 - s_C^*) \left( \frac{1}{2} + \frac{1}{2} s_C^* \right) \left[ (1 - \alpha) \left[ k(1 + r_B) - D^I - D^N (1 + r_D^N) \right] - S \right] \\ &+ s_C^* \left[ (1 - \alpha) \left[ k - D^I - D^N (1 + r_D^N) \right] - S \right] \end{aligned} \quad (27)$$

Therefore, the expected compensation scheme for the manager without being paid in a fraction of the debt-value changes to:

$$\begin{aligned} V_M &:= (1 - s_C^*) \left( \frac{1}{2} + \frac{1}{2} s_C^* \right) \left[ S + \alpha \left[ k(1 + r_B) - D^I - D^N (1 + r_D^N) \right] \right] \\ &+ s_C^* \left[ S + \alpha \left[ k(1 + r_L) - D^I - D^N (1 + r_D^N) \right] \right] \end{aligned} \quad (28)$$

The participation constraint of the non-insured creditor is the same as in (8) and the participation constraint of the borrower is the same as in (??), when accounting for the new critical investment threshold  $s^*$ . Again we need to plug in the binding constraint (8) and (??) into (28), which yields:

$$\begin{aligned} V_M &:= (1 - s_C^*) \left( \frac{1}{2} + \frac{1}{2} s_C^* \right) \left[ S + \alpha k(1 + r_H) - \alpha D^I \right] \\ &+ (1 - s_C^*) \left( \frac{1}{2} - \frac{1}{2} s_C^* \right) \alpha \delta k \\ &+ s_C^* \left[ S + \alpha k(1 + r_L) - \alpha D^I \right] - \alpha D^N - \alpha \bar{V}_B \end{aligned} \quad (29)$$

Again, we first determine the cut-off investment level the manager would like to commit to at  $t = 0$ . The first order condition of (29) with respect to  $s_C^*$  yields

$$s_C^* = \frac{S + \alpha k (1 + r_L) - \alpha D^I - \alpha \delta k}{S + \alpha k (1 + r_H) - \alpha D^I - \alpha \delta k} \quad (30)$$

In order to implement the incentives to commit to the first-best investment policy at  $t = 0$ , the regulator has to ensure that the cut-off level in (30) equals the first-best cut-off level from (1). Setting  $s_C^* = s_{FB}$  and solving for the face value of insured debt yields:

$$D^I \leq \frac{S}{\alpha} \quad (31)$$

Given this kind of capital regulation, the manager tries to commit to the first-best investment policy at  $t = 0$ . Now, we have to check whether he is able to do so, because this commitment is only possible, if the investment policy at  $t = 1$  is influenced by the capital structure decision at  $t = 0$ . Plugging (31) into (26) yields the ex-post investment decision rule of the manager at  $t = 1$  given the regulation policy from (31):

$$s_C^* = \frac{k(1 + r_L) - D^N(1 + r_D^N)}{k(1 + r_B) - D^N(1 + r_D^N)} \quad (32)$$

Now it is crucial to observe that the investment decision at  $t = 1$  is still be influenced by the capital structure decision at  $t = 0$ , due to the face value of debt on the right hand side in (32). Hence, the compensations scheme in (25) gives the regulator the possibility to implement a capital regulation rule that enables the manager to stick ex-post to its ex-ante chosen investment levels, which are first-best given the regulatory scheme in (25). The manager does so by choosing  $D^N(1 + r_D^N) = \delta k + \frac{\bar{V}_B(1+r_H-\delta)}{r_H-r_L}$  at  $t = 0$ .

Thereby, it is clear to see that the regulator is not implementing direct and fixed rules on the height of either the fixed or the performance based compensation components. Banks can freely choose the amount of either of the two components. They just have to match the ratio of the two with the amount of implicit and explicit insured debt, which also can freely be chosen by the bank. The economic intuition is as follows. Banks that pay their manager very conservative (high  $\frac{S}{\alpha}$ ) are enabled to choose a higher amount of explicit or implicit insured debt. On the other hand, banks which implement very steep incentives (relatively large share of performance based components) are only allowed to choose a low level of explicit and implicit insured debt. This result is quite intuitive. Implementing risky behavior on the managerial side correspond to a low risk (in the view of the regulator) debt structure whereas conservative pay (low risk on the managerial side) goes in line with higher (potential) risks on the debt structure.

## 6. Empirical and Policy Implications

We can draw several interesting empirical and testable implications out of the model. First of all it would be quite interesting how "far away" the insured debt levels of banks are from our proposed ratio of fixed and performance based pay. The second one clearly is to look how costly such a regulation would be for the banks. Last but not least one should look deeper into how banks that behave more aligned with our theory act in the financial crisis and document whether there are institutional differences (retail vs. investment banks). This would help to further understand the role regulation played in the financial industry either in preventing or providing excessive risk taking.

Besides the empirical implications, our paper makes direct policy implications how to prohibit excessive risk taking in the financial sector. While actual regulation schemes mostly focus on capital requirements which hardly can be achieved as we and many other papers show — partly because of lack of observability of project specific parameters, partly because of the limits of risk models — we focus on an approach that combines CEO compensation and capital regulation. The major advantage is how straightforward this regulation can be implemented, without needing to know the portfolio of the banks.

## 7. Conclusion

We present for the first time a model which endogenously combines the decisions made upon capital structure and investment choice. We can show that an all-equity financed bank acts too conservative, thereby reject positive net present value projects. The bank can overcome this underinvestment problem by choosing a level of debt to self-commit to a riskier strategy than in the all-equity case. By introducing explicit and implicit insured debt the incentives by the bank dump in the opposite direction. The bank now chooses, unless the level of insured deposits is set equal to zero, a too risky investment strategy. We demonstrate that a regulator is not able to implement first-best decision rules due to the information lack on investment specific parameters. In a next step we analyze whether newly proposed compensations schemes such as the Inside Debt approach are able to overcome the problem. Again this is not possible. However, we can show that our approach (capital regulation contingent on the compensation schemes in place) is able to solve the problem. The regulator can *use* the manager to implement first-best investment decisions. He does so by setting the value of explicit and implicit insured debt equal to the fraction of fixed to equity based pay. This result clearly gives us strong policy implications.

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