Basel III and CEO compensation in banks: A new regulatory attempt after the crisis[☆]

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Abstract

The paper analyzes the mutual influence of the capital structure and the investment decision of a bank, as well as the incentive effects of the bank executives compensation schemes on these decisions. In case the government implicitly or explicitly insures deposits and/or the banks debt, banks are incentivized to invest in risky assets and to have a high leverage. Capital regulation could potentially solve this excessive risk taking problem. However, this is only possible if the regulator can observe and properly measure the investment risks of the bank, which was called into question during the 2008-09 financial crisis. Hence, we propose a regulatory approach that is also able to implement the first best risk taking levels by the bank, but does not require the regulator to know the investment risk of the bank. The regulatory approach involves the implementation of capital requirements, which are made contingent on the management compensation.

Keywords: Basel III, capital regulation, compensation, leverage, risk
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1. Introduction

The 2008-09 financial crisis has prompted many questions about the suitability of incentive schemes in the financial sector. Compensation failures seemed to be endemic to many firms and often the compensation of bank managers could directly be linked to the excessive risk taking in many financial institutions (e.g. Bear Stearns, Lehman, UBS, Citigroup, Merrill Lynch, and AIG).[1] Therefore, policy makers are trying to establish rules that prohibit excessive risk taking by managers of financial institutions. A well known phenomenon in this context is the risk shifting problem (also known as asset substitution), as Jensen and Meckling (1976) have pointed out. Once debt is in place, the value of a firm's equity is like a call option due to the limited liability of the equityholders. Since the value of a call option increases as volatility increases, the shareholders are able to transfer value from other stakeholders (e.g. debtholders and society) to themselves by increasing the riskiness of the investments. This issue is particularly relevant for banks, due to their high leverage. CEOs, in case their incentives are aligned with those of the shareholders, 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. Hence, corporate governance measures that are exclusively aimed at aligning the incentives of managers and shareholders are not able to mitigate the excessive risk taking problem.

The risk shifting problem arises due to the fact that once debt contracts are concluded, debtholders might not be able to ask for adequate risk premiums in case the riskiness of the banks portfolio is increased. To avoid this agency problem, the debtholders need to have bargaining power after the investment decision has taken place and not just ex ante. Therefore, one possible solution for mitigating the risk-shifting problem is the use of "debt covenants" (see e.g. Berlin and Mester (1992) and Chava and Roberts (2008)). Via debt covenants, debtholders demand an adequate risk premium and thereby prevent incentives for too risky investment decisions by the shareholders. Another possible solution to the moral hazard problem is the use of short term debt, since in this case the debt terms can frequently be renegotiated and thereby short-term debt can act as a disciplining device (see e.g. Calomiris and Kahn (1991)).

However, a more severe agency problem arises for financial institutions, since governments often implicitly or explicitly guarantee at least part of the deposits or borrowed funds of these institutions. These guarantees increase the expected repayment to debtholders and thereby lower the required risk premium. Therefore, even the above-mentioned measures are not able to prevent the risk shifting problem, since insured debtholders do not have an incentive to adjust capital

[1] for details see Kashyap, Rajan, and Stein (2008), Acharya and Richardson (2009), and Bebchuk, Cohen, and Spamann (2010)

costs appropriately for risk, which leads ceteris paribus to a riskier behavior by the bank and in turn to a value transfer from the society to the equityholders, due to negative external effects. This justifies an intervention by the regulator. Given this pattern, one may argue that government guarantees of deposits should be repealed. However, there are many well known justifications for such a regulatory intervention (e.g. Diamond and Dybvig (1983)).

A regulatory response to this problem are minimum capital requirements like the Basel Accords. However, there are at least two major difficulties with this approach. First, as shown in section 3, regulators need to know exactly the underlying risks of the banks assets. As risk modeling per se has strong limits (see e.g. Danielsson (2002) and Danielsson (2008)), such a regulatory approach is hardly able to work. Secondly, since capital regulations run counter to the interests of the shareholders, they have an incentive to undercut capital regulation through regulatory arbitrage. Hence, the shareholders will put compensation schemes in place that reinforce the attractiveness of regulatory arbitrage, and ensure that managers will take full advantage of regulatory loopholes. For this reason Bebchuk and Spamann (2010) argue that in addition to directly regulating the banks behavior, regulators could incorporate compensation structures into the regulation, such that executive incentives work for, rather than against, the goals of financial regulation. In this paper, we are taking up the idea and present 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. This approach does not require the regulator to observe the investment risk of the bank and at the same time does not involve a direct regulation of the managers compensation schemes and hence does not restrict contractual freedom. However, it takes the compensation schemes into account when determining the bank individual minimum capital requirements.

The question how contracts of bank CEOs can be designed in order to establish optimal investment risk decisions has gained increasing attention during and in the aftermath of the 2008-09 financial crisis among academics. Early work by John and John (1993), conceptually the most related paper to ours, show that the shareholders of a bank can use the management compensation schemes to commit to a certain investment-policy and thereby are able to implement the first-best risk level. However, in their framework debt is exogenously given. Therefore, the authors determine optimal compensation rules given a specific leverage. In order for their approach to work effectively, the compensation structure would have to be changed as soon as the capital structure of the bank is altered. This is especially a problem for financial institutions, as they typically change their capital structure on a daily basis. Our approach proposes a regulatory mechanism that works vice versa. This is much easier to implement, since compensation structures are altered less frequently due to e.g. institutional requirements.[2] John, Saunders, and Senbet (2000) propose a regulatory approach, in which the deposit insurance premium scheme incorporates incentive features of top-management compensation. This mitigates the problem of frequent necessary adjustments of the compensation structure every time the leverage of the banks changes, since this can be addressed by an adjustment of the insurance premiums. However, insurance premiums do not cover implicit debt insurance.

Edmans and Liu (2011) show that a compensation scheme, which is based on equity and debt components can improve effort as well as deter risk shifting. In an extension of our model, we include their framework in our setup and show that first-best decision rules can theoretically be implemented using debt value dependent payments, but regulators would hardly be able to do so, because they would also have to know the investment risk of the bank. A very recent paper published by Bolton, Mehran, and Shapiro (2010) proposes to include CDS spreads in the compensation scheme in order to mitigate risk shifting. A crucial assumption for this approach to work is that CDSs are traded by informed subjects, while bondholders can not observe actual risks. Thanassoulis (2011) develops a theoretical argument for caps on bankers bonuses.

There are various paper that empirically investigate the relationship between CEO compensation and risk-taking decisions of banks. Chesney, Stromberg, and Wagner (2010) find evidence suggesting that higher risk-taking incentives for managers of U.S. financial institutions are significantly positively associated with write-downs during the crisis. Also Cheng, Hong, and Scheinkman (2010) show that there is a correlation between the compensation structures and risk-taking. Furthermore, Fahlenbrach and Stulz (2011) find evidence that banks with CEOs whose incentives were aligned better with the interests of shareholders performed worse during the crisis on average. Laeven and Levine (2009) show that in case shareholders have a high comparative power within the corporate governance structure of the bank, this translates into higher risk taking by the bank.

All of the theoretical models on CEO compensation in banks we are aware of consider an exogenously given capital structure and determine mechanisms that are able to implement first-best risk taking decision given a certain leverage level. However, among others, Adrian and Shin (2010) and Adrian and Shin (2008) show that there is a mutual influence of the investment risk and the capital structure decision. Hence, especially for banks, both decisions have to be considered as endogenous decision variables. Therefore, we endogenize the investment risk as well as the capital structure decision. To endogenize the capital structure we make use of the model in Inderst and Mueller (2008), since it coincides with empirical findings and enables to consider a risk-shifting problem.[3]

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[2]For example the so called say on pay rules, which require a vote of the general meeting to approve director pay packages.

[3]Several empirical studies found that banks often hold equity in excess of the minimum

The remaining paper is organized as follows. Section two presents the model setup. Section three discusses the effects of a capital regulation that does not incorporate the manager compensation. In section three we propose the new regulatory approach, that makes the capital regulation contingent on the compensation structure. In section four we consider two extensions of the model and section five concludes.

2. Model setup

The model consists of a single lender (the bank represented by its shareholders), the 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 manager has the possibility to give a risky loan to the borrower or he can invest in a safe investment opportunity. Both investments require a fixed capital outlay of $k > 0$, which is normalized to one. All parties are risk neutral and the bank has all the bargaining power. The manager acts on his own behalf given the incentive contracts in place. This management compensation contract is designed by the corporate board of directors who are acting on behalf of the shareholders. When structuring the management compensation contracts, the shareholders anticipate the 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. The timing of our model is as follows:

$t = 0$	$t = 1$	$t = 2$
Compensation is established External claims are issued Contract between bank and borrower is concluded	Project of borrower materializes Manager observes project quality Manager decides on investment	Cash flows from investments are realized

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 $K := E + D^I + D^N$.

regulatory requirement (e.g. Flannery and Rangan (2008)) and that changes in banks' capital structure are not related to changes in regulatory requirements (e.g. Gropp and Heider (2010)). Hence, it seems that that the optimal leverage of banks is simply too low for the minimum capital requirements to be binding. The theories of Diamond and Rajan (2000), Allen, Carletti, and Marquez (2011), and Inderst and Mueller (2008) are consistent with non-binding minimum capital requirements and stable leverage over time. However, only the last one enables to incorporate a risk-shifting problem.

Since all investment opportunities of the bank require a capital outlay $k = 1$, we specify that $K = 1$.

We assume that the bank is able to raise insured debt only up to a certain limit d. This upper limit $d < 1$ 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 of capital r, which is 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.[4] 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 is provided by a single investor.

The last step in $t = 0$ is the conclusion of a debt contract between the bank and the borrower, that stipulates a repayment of R_B in case the bank decides to give out the loan and the project turns out to be a success. The contract thereby is written before the investment decision takes place. This assumption is in line with Inderst and Mueller (2006) which argues that predefined contracts are at least for small business loans well known. 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 a success, the project generates a positive gross return of $R_H > 0$ with probability s. With probability $(1 - s)$ the project fails, in which case the project has a liquidation value of δ, 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 yields the risk-free interest R_L, with $R_H > R_L > 1$. Before deciding upon the investment, the manager gets to know 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 contingent on the value of the parameter s. However, all the relevant parties know that s is distributed uniformly over the interval $[0, 1]$. 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 from the investments made at $t = 1$ are realized.

[4]Normally, banks need to pay an deposit insurance premium. However, as long as this premium does not cover all the riskiness of the investments by the bank, the results do not change.

Given $K = 1$, the bank's possible, verifiable cash flow realizations are (i) $y = R_L$ if no loan was made, (ii) $y = R_B$ if a successful loan was made, and (iii) $y = \delta$ if the loan went bad. First, we have to determine the values of the project quality, for which the project has a positive NPV and hence should be financed. This will then be our reference point for the following analyses. With this setup it is first-best efficient to invest in the risky project, whenever $s \geq s_{FB}$ 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:

$$s_{FB}R_H + (1 - s_{FB})\,\delta = R_L \Leftrightarrow s_{FB} = \frac{R_L - \delta}{R_H - \delta} \tag{1}$$

As in John and John (1993), we define an investment policy of investing in the risky project for all $s \geq \widetilde{s}$ as investment policy $\widetilde{s}$. As expected, the critical threshold from which on investing in the risky project is rational and hence the first-best investment policy s_{FB} depends positively on the interest rate of the safe asset and negatively on the projects expected return and its liquidation value.

3. Capital regulation without considering compensation

In this section, the investment choice of the bank manager is characterized for the case that the government decides not to regulate the compensation schemes nor take them into account for the capital requirements. Therefore, it is assumed that the shareholders totally align the incentives of the manager with their own. In this case, we can treat the manager as an owner-manager (e.g. the manager owns the bank). Concerning the capital structure decision, the owner-manager can choose between three different forms of funding: equity E, insured $D^I \leq d$ and non-insured debt D^N. In analogy to the first-best investment policy, the privately investment decision follows again a cutoff rule. If the bank invests in the safe asset, the respective payoff to equity equals $R_L - D^I - D^N\left(1 + r_D^N\right)$.[5] 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 $R_B - D^I - D^N\left(1 + r_D^N\right)$. Hence, the owner-manager optimally approves a loan at $t = 1$, if $s \geq s^*$, where $0 < s^* < 1$ solves

$$s^*\left[R_B - D^I - D^N\left(1 + r_D^N\right)\right] = R_L - D^I - D^N\left(1 + r_D^N\right)$$
$$\Rightarrow s^* = \frac{R_L - D^I - D^N\left(1 + r_D^N\right)}{R_B - D^I - D^N\left(1 + r_D^N\right)} \tag{2}$$

It is convenient to specify that the manager approves the loan also in case of indifference, which is a zero-probability event. It is easy to see that s^* diminishes

[5] It is assumed that the return of the safe investment is always high enough to enable the bank to settle its liabilities.

as the amount of debt increases. Thus, as 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 equal, 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. Furthermore, the higher the loan rate R_B, the higher the likelihood that the loan is approved, i.e., the lower the cutoff s^* in (2). As the borrower receives the residual payoff $R_H - R_B$ in case a financed project was successful, the borrower's participation constraint at $t = 0$ becomes

$$(1 - s^*)\left(\frac{1}{2} + \frac{1}{2}s^*\right)[R_H - R_B] \geq \bar{V}_B > 0 \tag{3}$$

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

$$R_B = R_H - \frac{2\bar{V}_B}{\left(1 - (s^*)^2\right)} < R_H \tag{4}$$

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

$$\begin{aligned} V_E \;&:=\; (1 - s^*)\left(\frac{1}{2} + \frac{1}{2}s^*\right)\left[R_B - D^I - D^N\left(1 + r_D^N\right)\right] \\ &+\; s^*\left[R_L - D^I - D^N\left(1 + r_D^N\right)\right] \end{aligned} \tag{5}$$

where the first term represents the cashflow to equityholders in case the risky project was chosen and has been successful and the second represents the cashflow for the case 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

$$\begin{aligned} V_D^N \;&:=\; (1 - s^*)\left(\frac{1}{2} + \frac{1}{2}s^*\right)D^N\left(1 + r_D^N\right) + (1 - s^*)\left(\frac{1}{2} - \frac{1}{2}s^*\right)\delta \\ &+\; s^* D^N\left(1 + r_D^N\right) \geq D^N \end{aligned} \tag{6}$$

where again the first two terms state the value of the debt claim in case the project has been undertaken, either successfully or not, and the third term states the debt claims in the case of an 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 are raised through debt, D^N and D^I. Since insured debt is cheaper then the other two funding sources, the bank always chooses $D^I = d$. The bank's constraints are the participation constraint of non-insured creditors (6) and the participation constraint of the borrower (3). By optimality, the two constraints bind, since otherwise the bank could extract more profits out of the project. Substituting the binding constraints (6) and (4) into (5), we obtain

$$\begin{aligned} V_E - E &= (1-s^*)\left(\frac{1}{2}+\frac{1}{2}s^*\right)\left[R_H - D^I\right] + (1-s^*)\left(\frac{1}{2}-\frac{1}{2}s^*\right)\delta \\ &+ s^*\left[R_L - D^I\right] - 1 + D^I - \bar{V}_B \end{aligned} \tag{7}$$

where we also used that $E + D^I + D^N = 1$. 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 $t = 1$:

$$\frac{\partial V_E - E}{\partial s^*} \stackrel{!}{=} 0 \Rightarrow s^* = \frac{R_L - \delta - D^I}{R_H - \delta - D^I} \tag{8}$$

In order to get a solution for s^*, which lies in the interval $[0, 1]$, we restrict the liquidation δ such that $R_L > \delta + d$. The threshold s^* in equation (8) is decreasing in D^I. Therefore, the investment policy s^* becomes riskier if the amount of insured debt D^I increases. Since the owner-manager chooses $D^I = d > 0$, it can be seen from the comparison of expressions (1) and (8), that it would be optimal for the manager to choose a capital structure at $t = 0$ such that he commits himself to a riskier investment policy than the first-best investment decision. This yields the following proposition.

Proposition 3.1. *In case $\bar{V}_B$ is not too high, the manager is able to and will choose a uniquely optimal level of debt $D^N\left(1 + r_D^N\right) > 0$ so that his privately optimal investment policy coincides with $s^* = \frac{R_L-\delta-d}{R_H-\delta-d} < s_{FB}$.*

Proof See the appendix.

Inserting s^* from (8), $D^I = d$, and R_B from (4) into (2) and solving for the face value of non-insured debt yields

$$D^N\left(1 + r_D^N\right) = \delta + \frac{2\bar{V}_B(R_H - \delta - d)^2(R_L - \delta - d)}{(R_H - R_L)^2(R_H + R_L - 2\delta - 2d)}$$

Therefore, the total amount of debt that is chosen by the manager is given by

$$D^I + D^N\left(1 + r_D^N\right) = \delta + d + \frac{2\bar{V}_B(R_H - \delta - d)^2(R_L - \delta - d)}{(R_H - R_L)^2(R_H + R_L - 2\delta - 2d)}$$

Equation (8) shows that 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^*. By credibly 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 risky project (the bank manager acts as he 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 $t = 0$. However, it is not reasonable to ban insured debt in general due to the possibility of classical bank runs and/or an interbank market disruption.

The only way the regulator can enforce the bank to choose the first-best investment decision rule without banning insured debt is the following. The regulator can introduce a capital requirement which sets the combined levels of debt (insured and uninsured) in such a way that the bank manager establishes first-best ex-post at $t = 1$ ($s^* \equiv s_{FB}$). By inserting (4) into (2), setting the result equal to the first-best in (1) and solving for the face value of debt, we get:

$$\begin{aligned} &D^I + D^N(1 + r_D^N) = \\ &\delta + \bar{V}_B \left[\frac{3(R_L - \delta)}{2(R_H - R_L)} + \frac{(R_L - \delta)^2}{(R_H - R_L)^2} + \frac{R_L - \delta}{2(R_H + R_L - 2\delta)} \right] \end{aligned} \tag{9}$$

If the regulator prohibits the bank to take on more debt than the amount specified in (9), the bank manager will choose the first-best investment policy at $t = 1$. This regulation translates into the following minimum equity capital requirements:

$$\begin{aligned} &E = 1 - \left[D^I + D^N(1 + r_D^N) \right] = \\ &1 - \delta - \bar{V}_B \left[\frac{3(R_L - \delta)}{2(R_H - R_L)} + \frac{(R_L - \delta)^2}{(R_H - R_L)^2} + \frac{R_L - \delta}{2(R_H + R_L - 2\delta)} \right] \end{aligned} \tag{10}$$

As it can be seen from (10), when using the classical capital regulation approach such as the Basel Accords, the regulator needs to be able to observe all project specific parameters such as R_H, R_L, and δ, in order to be able to establish the first-best investment policy. As risk modeling per se has strong limits (see e.g. Danielsson (2002) and Danielsson (2008)) such an regulatory approach is not feasible. This yields the following proposition.

Proposition 3.2. *The only way for the regulator to implement the first-best investment policy for the bank at $t = 0$, without taking the manager compensation into account, is to ban insured debt. In order to be able to implement capital* *requirements which can establish the first-best policy at t = 1, the regulator needs to know all investment specific parameters.*

Proof Omitted.

In this section we showed that if the government implements regulatory measures without considering the compensation structures, the shareholders will align the incentives of the bank manager fully with their own. Thus, the only way to enforce the manager to choose ex ante at $t = 0$ the first-best investment cut-off rule is to set the level of insured debt equal to zero by eliminating deposit insurance guarantees and committing to a no-bailout policy. However, this is clearly and rightly not the intense of policy makers. Secondly, we proofed that a regulator may have the opportunity to establish the first-best investment behavior by the bank ex post at $t = 1$. However, as can be seen from (10), the regulator would need to know all project specific parameters such as the returns in both states. Therefore, this approach is also not feasible. In the next section, we show that making capital requirements contingent on the management compensation schemes is able to implement the first best risk choices by the bank manager without requiring the regulator to know the investment risk of the bank.

4. Capital regulation contingent on the compensation structure

In this section we describe how managers who are not fully aligned with the shareholders (i.e. their compensation consists of the common fixed and performance based pay components) can be "used" by the regulator to establish first-best investment behavior by factoring in the compensation structure of the manager into the capital regulation. Hence, the compensation scheme has the following form:

$$V_M = S + \alpha V_E \geq \bar{V}_M > 0 \tag{11}$$

where the expected management compensation V_M consists of a fixed wage S and a equity component αV_E. Furthermore, the expected compensation of the manager has to be larger than his outside option $\bar{V}_M$. 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_M^*, where s_M^* solves:

$$\begin{aligned} & s_M^* \left[S + \alpha \left[R_B - D^I - D^N \left(1 + r_D^N \right) - S \right] \right] \\ & = S + \alpha \left[R_L - D^I - D^N \left(1 + r_D^N \right) - S \right] \\ & \Rightarrow s_M^* = \frac{(1-\alpha)S + \alpha \left[R_L - D^I - D^N \left(1 + r_D^N \right) \right]}{(1-\alpha)S + \alpha \left[R_B - D^I - D^N \left(1 + r_D^N \right) \right]} \end{aligned} \tag{12}$$

where the left hand side of the equation represents the expected wage payment in case the manager chooses the risky project and the right hand side the wage in case the safe investment is chosen. In case the risky project fails, it is assumed that the fixed wage is subordinated (i.e. junior) to debtholders claims in the bankruptcy procedure, as in Dewatripont and Tirole (1994) and Hart and Moore (1995). Hence, incorporating the payment to the manager, the expected value function of equity becomes:

$$\begin{aligned} V_E &:= (1-s_M^*)\left(\frac{1}{2}+\frac{1}{2}s_M^*\right)\left[(1-\alpha)\left[R_B - D^I - D^N\left(1+r_D^N\right)\right] - S\right] \\ &+ s_M^*\left[(1-\alpha)\left[R_L - D^I - D^N\left(1+r_D^N\right)\right] - S\right] \end{aligned} \tag{13}$$

Therefore, the expected payment to the manager at $t = 0$ becomes:

$$\begin{aligned} V_M &:= (1-s_M^*)\left(\frac{1}{2}+\frac{1}{2}s_M^*\right)\left[(1-\alpha)S + \alpha\left[R_B - D^I - D^N\left(1+r_D^N\right)\right]\right] \\ &+ s_M^*\left[(1-\alpha)S + \alpha\left[R_L - D^I - D^N\left(1+r_D^N\right)\right]\right] \end{aligned} \tag{14}$$

The participation constraint of the non-insured creditor is the same as in (6) and the participation constraint of the borrower is the same as in (3), when accounting for the new critical investment threshold s_M^*. Again we need to plug in the binding constraint (6) and (4) into (14), which yields:

$$\begin{aligned} V_M &:= (1-s_M^*)\left(\frac{1}{2}+\frac{1}{2}s_M^*\right)\left[(1-\alpha)S + \alpha R_H - \alpha D^I\right] \\ &+ (1-s_M^*)\left(\frac{1}{2}-\frac{1}{2}s_M^*\right)\alpha\delta \\ &+ s_M^*\left[(1-\alpha)S + \alpha R_L - \alpha D^I\right] - \alpha D^N - \alpha \bar{V}_B \end{aligned} \tag{15}$$

Again, we first determine the cut-off investment level the manager would like to commit to at $t = 0$. The first order condition of (15) with respect to s_M^* yields

$$\frac{\partial V_M}{\partial s_M^*} \stackrel{!}{=} 0 \Rightarrow s_M^* = \frac{(1-\alpha)S + \alpha R_L - \alpha D^I - \alpha\delta}{(1-\alpha)S + \alpha R_H - \alpha D^I - \alpha\delta} \tag{16}$$

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 (16) equals the first-best cut-off level from (1). Setting $s_M^* = s_{FB}$ and solving for the face value of insured debt yields the following regulatory requirement:

$$D^I = \frac{(1-\alpha)}{\alpha} S \tag{17}$$

where the compulsory level of insured debt D^I is increasing in the fixed wage S and decreasing in the performance based component α. Hence, the regulator has to ensure that the level of insured debt does not exceed the level determined in equation (17). The special feature of this regulatory approach is the fact that the regulator does not need to know investment specific details. Instead, he only needs to gather information about the compensation structure of the manager, which is much easier to do. This translates into the following simple minimum equity capital requirement:

$$E = 1 - \left[D^I + D^N(1 + r_D^N)\right] = 1 - \frac{(1-\alpha)}{\alpha}S - D^N(1 + r_D^N) \tag{18}$$

Given this kind of capital regulation, the manager chooses $D^I = \frac{(1-\alpha)}{\alpha}S$ and thus 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 (17) into (12) yields the ex-post investment decision rule of the manager at $t = 1$ given the regulation policy from (18):

$$s_M^* = \frac{R_L - D^N\left(1 + r_D^N\right)}{R_B - D^N\left(1 + r_D^N\right)} \tag{19}$$

Now it is crucial to observe that the investment decision at $t = 1$ can still be influenced by the capital structure decision at $t = 0$, due to the presence of the face value of debt on the right hand side in (19). Hence, the compensation scheme in (11) 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 (18). This yields the following proposition.

Proposition 4.1. *The implementation of minimum equity capital requirements, which are made contingent on the fixed and performance based compensation components of the manager, induces the manager to choose the first-best investment policy. Furthermore, the regulator does not need to observe investment specific parameters.*

Proof Omitted.

Setting s_M^* from (19) equal to s_{FB}, plugging in R_B from (4) and solving for $D^N\left(1 + r_D^N\right)$ yields the amount of uninsured debt that the manager chooses at $t = 0$ under this regulatory regime:

$$D^N\left(1 + r_D^N\right) = \delta + \bar{V}_B\left[\frac{3(R_L - \delta)}{2(R_H - R_L)} + \frac{(R_L - \delta)^2}{(R_H - R_L)^2} + \frac{R_L - \delta}{2(R_H + R_L - 2\delta)}\right]$$

thus for the total amount of debt we get:

$$D^I + D^N\left(1 + r_D^N\right) =$$
$$\frac{(1-\alpha)}{\alpha}S + \delta + \bar{V}_B\left[\frac{3(R_L - \delta)}{2(R_H - R_L)} + \frac{(R_L - \delta)^2}{(R_H - R_L)^2} + \frac{R_L - \delta}{2(R_H + R_L - 2\delta)}\right]$$

With this regulatory scheme in place, the shareholders can alter the allowed level of insured debt by setting the compensation components accordingly. Hence, they will adjust the components in such a way, that they are allowed to take on the bank specific maximal available amount of insured debt d and that the participation constraint (11) of the bank manager binds.

In this section we showed that the regulator does not need to implement any direct regulation or fixed rule regarding the structure or amount of the manager compensation in order to enforce the first-best investment decisions by the bank (manager). Therefore, banks can freely choose how they pay their executives. However, this decisions alters the minimum capital requirements of the bank. The economic intuition is as follows. Banks that pay their manager very conservative (relative high S and low α) are allowed to choose a higher amount of explicit and/or implicit insured debt. On the other hand, banks which implement very steep incentives (relative low S and high α) 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. This regulatory approach thus enables all kinds of business models. It only encourages the shareholders of a bank to adjust their manager compensation structure accordingly.

5. Extensions

In the following we discuss two extension of our model. First, we include the social costs of a bank default and private bankruptcy costs in form of the possible loss of future returns and second, we discuss the effects of a compensation structure that also includes a debt component as in Edmans and Liu (2011).

5.1. Social costs of bank default and private bankruptcy costs

In the following we add negative external costs of a bank default on society (denoted by B_s) and private bankruptcy costs to the model and analyze the consequences for our regulatory approach. The negative external costs of a bank default can be understood as the costs that arise due to distortions in the inter-bank market and the in turn occurring consequences for the real economy. We model the private bankruptcy costs (denoted as V_E^F) as the possibility to loose the future franchise value of the bank. Hence, in case a bank defaults, it looses expected revenues, which would otherwise be realized in the future. Therefore, the "new" socially optimal investment policy is the following:

$$s_{FB}(R_H + V_E^F) + (1 - s_{FB})\,\delta - (1 - s_{FB})\,B_s = R_L + V_E^F$$
$$\Rightarrow s_{FB} = \frac{R_L - \delta + V_E^F + B_s}{R_H - \delta + V_E^F + B_s} \tag{20}$$

In case the manager chooses the risky investment and the bank defaults, the social costs B_s arise and the future franchise value V_E^F is lost. Both can never happen if the safe investment is chosen. Thus, the manager, who is still paid with a fixed wage S and an equity component αV_E, decides to invest in the risky loan at $t = 1$, whenever the project quality s is greater or equal to s_M^*, where s_M^* solves:

$$\begin{aligned} & s_M^* \left[S + \alpha \left[R_B + V_E^F - D^I - D^N \left(1 + r_D^N\right) - S \right] \right] \\ & = S + \alpha \left[R_L + V_E^F - D^I - D^N \left(1 + r_D^N\right) - S \right] \\ & \Rightarrow s_M^* = \frac{(1-\alpha)S + \alpha \left[R_L + V_E^F - D^I - D^N \left(1 + r_D^N\right)\right]}{(1-\alpha)S + \alpha \left[R_B + V_E^F - D^I - D^N \left(1 + r_D^N\right)\right]} \end{aligned} \tag{21}$$

Since the social costs of a bank default do not affect the bank, the manager does not incorporate them into his decision. However, he factors in the possible loss of the franchise value. Hence, the expected value function of equity, the expected franchise value $t = 0$, becomes:

$$\begin{aligned} V_E \ &:= \ (1 - s_M^*) \left(\frac{1}{2} + \frac{1}{2} s_M^* \right) \left[(1-\alpha) \left[R_B + V_E^F - D^I - D^N \left(1 + r_D^N\right)\right] - S \right] \\ &+ \ s_M^* \left[(1-\alpha) \left[R_L + V_E^F - D^I - D^N \left(1 + r_D^N\right)\right] - S \right] \end{aligned} \tag{22}$$

where the only change in comparison to (13) is the incorporation of the future franchise value. This changes the expected compensation scheme for the manager at $t = 0$ to:

$$\begin{aligned} V_M \ &:= \ (1 - s_M^*) \left(\frac{1}{2} + \frac{1}{2} s_M^* \right) \left[(1-\alpha)S + \alpha \left[R_B + V_E^F - D^I - D^N \left(1 + r_D^N\right)\right] \right] \\ &+ \ s_M^* \left[(1-\alpha)S + \alpha \left[R_L + V_E^F - D^I - D^N \left(1 + r_D^N\right)\right] \right] \end{aligned} \tag{23}$$

Inserting the binding participation constraint of the borrower (4) where s^* is replaced by s_M^* yields

$$\begin{aligned} V_M \ &:= \ (1 - s_M^*) \left(\frac{1}{2} + \frac{1}{2} s_M^* \right) \left[(1-\alpha)S + \alpha \left(R_H + V_E^F \right) - \alpha D^I \right] \\ &+ \ (1 - s_M^*) \left(\frac{1}{2} - \frac{1}{2} s_M^* \right) \alpha\delta \\ &+ \ s_M^* \left[(1-\alpha)S + \alpha \left(R_L + V_E^F \right) - \alpha D^I \right] - \alpha D^N - \alpha \bar{V}_B \end{aligned} \tag{24}$$

Again, we first determine the cut-off investment level the manager would like to commit to at $t = 0$. The first order condition of (24) with respect to s_M^* yields

$$\frac{\partial V_M}{\partial s_M^*} \stackrel{!}{=} 0 \Rightarrow s_M^* = \frac{(1-\alpha)S + \alpha \left(R_L + V_E^F \right) - \alpha D^I - \alpha\delta}{(1-\alpha)S + \alpha \left(R_H + V_E^F \right) - \alpha D^I - \alpha\delta} \tag{25}$$

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 (25) equals the first-best investment policy from (20). Setting $s_M^* = s_{FB}$ and solving for the face value of insured debt yields:

$$D^I = \frac{(1-\alpha)S}{\alpha} - B_s \tag{26}$$

where D^I is increasing in the fixed wage S and decreasing in the performance based component α as before. In addition, it is also decreasing in the social bankruptcy costs B_s. This result is very intuitively. In case the social costs of a bank default are high, the amount of insured debt should be relatively small, since a high amount of insured debt incentivizes the manager to choose a very risky investment policy, which in turn increases the default probability of the bank. However, the regulator does not need to take into account the possible loss of the franchise value, since it is in the banks/managers own interest to adjust the investment policy in this regard. To insure that the bank acts as desired by the regulator the following minimum capital requirement needs to be fulfilled:

$$E = 1 - \left[D^I + D^N(1 + r_D^N)\right] = 1 - \frac{(1-\alpha)S}{\alpha} + B_s - D^N(1 + r_D^N) \tag{27}$$

This regulation scheme truly is not easy to be implemented as the regulator would need to know the social costs of a bank default. Newly proposed measures of systemic risk can help to mitigate this problem. As before the manager tries to commit to the first-best investment policy at $t = 0$. 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 (26) into (21) yields the ex-post investment decision rule of the manager at $t = 1$ given the regulation policy from (27):

$$s_M^* = \frac{R_L + V_E^F + B_s - D^N\left(1 + r_D^N\right)}{R_B + V_E^F + B_s - D^N\left(1 + r_D^N\right)} \tag{28}$$

This proofs that even after including social and private bankruptcy costs proposition (4.1) still holds.

5.2. 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 risk-shifting 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 again demands an minimum expected payment of $\bar{V}_M > 0$, due to his outside options. Hence, the contract takes the following form:

$$V_M = S + \alpha V_E + \beta V_D \geq \bar{V}_M > 0 \tag{29}$$

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_M^*, where s_M^* solves the following equation:

$$\begin{aligned}
& s_M^* \left[S + \alpha \left[R_B - D^I - D^N \left(1 + r_D^N\right) - S\right] + \beta \left[D^I + D^N \left(1 + r_D^N\right)\right]\right] \\
& + (1 - s_M^*) \beta\delta \\
& = S + \alpha \left[R_L - D^I - D^N \left(1 + r_D^N\right) - S\right] + \beta \left[D^I + D^N \left(1 + r_D^N\right)\right] \\
& \Rightarrow s_M^* = \frac{(1-\alpha)S + \alpha R_L + (\beta - \alpha) \left[D^I + D^N \left(1 + r_D^N\right)\right] - \beta\delta}{(1-\alpha)S + \alpha R_B + (\beta - \alpha) \left[D^I + D^N \left(1 + r_D^N\right)\right] - \beta\delta}
\end{aligned} \tag{30}$$

The value function of equity accounting for the compensation payment to the manager takes now the following form:

$$\begin{aligned}
V_E \quad := \quad & (1 - s_M^*) \left(\frac{1}{2} + \frac{1}{2} s_M^*\right) \left[\begin{array}{l} (1-\alpha) \left[R_B - D^I - D^N \left(1 + r_D^N\right)\right] \\ -\beta \left[D^I + D^N \left(1 + r_D^N\right)\right] - S \end{array}\right] \\
+ \quad & s_M^* \left[\begin{array}{l} (1-\alpha) \left[R_L - D^I - D^N \left(1 + r_D^N\right)\right] \\ -\beta \left[D^I + D^N \left(1 + r_D^N\right)\right] - S \end{array}\right]
\end{aligned} \tag{31}$$

where the only difference to (5) are the compensation components for the manager. Hence, the expected compensation for the manager becomes

$$\begin{aligned}
V_M \quad := \quad & (1 - s_M^*) \left(\frac{1}{2} + \frac{1}{2} s_M^*\right) \left[\begin{array}{l} (1-\alpha)S + \alpha \left[R_B - D^I - D^N \left(1 + r_D^N\right)\right] \\ +\beta \left[D^I + D^N \left(1 + r_D^N\right)\right] \end{array}\right] \\
+ \quad & (1 - s_M^*) \left(\frac{1}{2} - \frac{1}{2} s_M^*\right) \beta\delta \\
+ \quad & s_M^* \left[\begin{array}{l} (1-\alpha)S + \alpha \left(R_L - D^I - D^N \left(1 + r_D^N\right)\right) \\ +\beta \left(D^I + D^N \left(1 + r_D^N\right)\right) \end{array}\right]
\end{aligned} \tag{32}$$

with a proportional fraction α of the equity value, a proportional fraction β 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:

$$\begin{aligned}
V_D^N \quad := \quad & (1 - s_M^*) \left(\frac{1}{2} + \frac{1}{2} s_M^*\right) D^N \left(1 + r_D^N\right) + (1 - s_M^*) \left(\frac{1}{2} - \frac{1}{2} s_M^*\right) (1 - \beta) \delta \\
+ \quad & s_M^* D^N \left(1 + r_D^N\right) \geq D^N
\end{aligned} \tag{33}$$

Inserting R_B and the expected value of uninsured debt from (33) into (32) yields for the expected compensation of the manager

$$\begin{aligned} V_M \quad := \quad & (1-s_M^*)\left(\frac{1}{2}+\frac{1}{2}s_M^*\right)\left[(1-\alpha)S+\alpha R_H+(\beta-\alpha)\,D^I\right] \\ + \quad & (1-s_M^*)\left(\frac{1}{2}-\frac{1}{2}s_M^*\right)\left(\beta^2+\alpha-\alpha\beta\right)\delta \\ + \quad & s_M^*\left[(1-\alpha)S+\alpha R_L+(\beta-\alpha)\,D^I\right]+(\beta-\alpha)\,D^N-\alpha\bar{V}_B \end{aligned} \quad (34)$$

The first order condition of (34) with respect to s_M^* 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:

$$\frac{\partial V_M}{\partial s_M^*}\overset{!}{=}0\Rightarrow s_M^*=\frac{(1-\alpha)S+\alpha R_L+(\beta-\alpha)\,D^I-(\beta^2+\alpha-\alpha\beta)\,\delta}{(1-\alpha)S+\alpha R_H+(\beta-\alpha)\,D^I-(\beta^2+\alpha-\alpha\beta)\,\delta} \quad (35)$$

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 (35) to the first-best cutoff s^{FB} in (1). Setting $s_M^*=s_{FB}$ and solving for α yields the following regulatory scheme:

$$\alpha=\frac{S+\beta(D^I-\delta\beta)}{S+D^I-\delta\beta} \quad (36)$$

Therefore, in case the regulator forces the bank to pay its manager according to (36), 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 α and therefor the total payment to the manager, the shareholders will set $S=0$ and consequently $\alpha=\beta$. 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 (35), the investment decision at $t=1$, yields:

$$s_M^*=\frac{R_L-\delta}{R_B-\delta} \quad (37)$$

It is clear to see that the manager never chooses $s_M^*=s_{FB}^*$. Instead, he would like to commit to a less risky investment policy than the first best one. Furthermore, since the capital structure decision at $t=0$ does not have an influence on the investment policy at $t=1$ anymore, it can not be used to commit to a certain investment policy. One possibility to regulate ex-ante such that the manager chooses first-best ex-post is the rule above $\alpha = \frac{S+\beta(D^I-\delta\beta)}{S+D^I-\delta\beta}$ 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 feasible.

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 (35) equal to the first-best decision rule ($s_M^* = s_{FB}$) from (1) yields for the compensation regulation:

$$\alpha = \frac{(R_H - R_L)\left(S + \beta\left[D^I + D^N\left(1 + r_D^N\right)\right]\right) - \beta\delta}{(R_H - R_L)\left[D^I + D^N\left(1 + r_D^N\right)\right] + \bar{V}_B\left(\delta - R_H\right) - \delta} \tag{38}$$

Now there are two possibilities how a regulator can act:

1. the regulator can set S, α and β in line with his 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 $(R_H - R_L)\left[D^I + D^N\left(1 + r_D^N\right)\right] > \delta$, the regulator can choose α to establish first-best in the following way.

$$\alpha = \frac{(R_H - R_L)}{(R_H - R_L)\left[D^I + D^N\left(1 + r_D^N\right)\right] + \bar{V}_B\left(\delta - R_H\right) - \delta} \tag{39}$$

All of these solutions bear two problems. First, the regulator (government) needs to observe the investment risk of the bank and second, the regulator has to be able to force the institutions to stick to certain levels of the compensation components.

6. Conclusion

We present a model which endogenously combines the decisions made upon the capital structure and investment choice of a bank. We can show that, in case the government explicitly and/or implicitly insures the debt owned by banks, the banks decide to take on excessive risks. We demonstrate that a regulator is not able to implement the first-best investment policy by putting a capital regulation in place that does not incorporate the compensation scheme of the bank manager, due to the lack of information about the exact investment risk of the bank. In a next step we analyze whether the proposed capital regulation contingent on the compensation is able to solve the excessive risk taking problem. We find that the regulator can *use* the manager to implement first-best investment decisions by making the capital regulation contingent in the compensation structure of the manager.

Appendix

Proof of Proposition 3.1

Inserting s^* (8) and $D^I = d$ into (2) and solving for the face value of non-insured debt yields $D^N\left(1+r_D^N\right) = \delta + (R_L - \delta - d)\left(1 - \frac{R_B - R_L}{R_H - R_L}\right)$. Since we restricted δ such that $R_L > \delta + d$, it is easy to see that both terms on the right hand side are greater than zero. Therefore, the chosen $D^N\left(1+r_D^N\right)$ is also greater than zero. Inserting R_B from (4) into the result for $D^N\left(1+r_D^N\right)$ and simplifying yields

$$D^N\left(1+r_D^N\right) = \delta + \frac{2\bar{V}_B(R_H-\delta-d)^2(R_L-\delta-d)}{(R_H-R_L)^2(R_H+R_L-2\delta-2d)}$$

In order to be able to commit to the investment policy derived in (8), the therefor necessary level of $D^N\left(1+r_D^N\right)$ has to be smaller than one. This is the case if

$$\bar{V}_B < \frac{(R_H-R_L)^2(1-\delta)(R_H+R_L-2\delta-2d)}{2(R_H-\delta-d)^2(R_L-\delta-d)}$$

Hence, if $R_L > \delta + d$ and $\bar{V}_B$ is smaller than the derived threshold, the owner-manager optimally chooses a strictly positive debt-level at $t = 0$ to commit himself on his privately optimal investment decision at $t = 1$. QED.

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