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SAFE Working Paper Series No. 9

Center of Excellence SAFE Sustainable Architecture for Finance in Europe
A cooperation of the Center for Financial Studies and Goethe University Frankfurt

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Basel III and CEO compensation in banks: Pay structures as a regulatory signal☆

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March 6, 2013

Abstract

This paper proposes a new regulatory approach that implements capital requirements contingent on managerial compensation. We argue that excessive risk taking in the financial sector originates from the shareholder moral hazard created by government guarantees rather than from corporate governance failures within banks. The idea of the proposed regulation is to utilize the compensation scheme to drive a wedge between the interests of top management and shareholders to counteract shareholder risk-shifting incentives. The decisive advantage of this approach compared to existing regulation is that the regulator does not need to be able to properly measure the bank investment risk, which has been shown to be a difficult task during the 2008-2009 financial crisis.

Keywords: Basel III, capital regulation, compensation, leverage, risk
JEL: G21, G28, G30, G32, G38

☆The authors appreciate helpful comments from Tim Eisert, Guido Friebel, Axel Haus, Florian Hett, Steffen Juranek, Michael Kosfeld, Jan Pieter Krahnen, Ernst Maug, Bjoern Richter, Uwe Walz, Jochen Werth, David Yermack, seminar participants at Goethe University Frankfurt, as well as conference participants at the 5th International Risk Management Conference, the Financial Stability Conference in Luxembourg, the 14th INFER Annual Conference, the Annual Meeting of the Verein für Socialpolitik 2012, the Frontiers of Finance 2012 Conference, and the 61th Congress of the French Economic Association

*Christian Eufinger thanks the Ph.D. Program in Law and Economics of Money and Finance and the Stiftung Geld- und Waehrung for funding.

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1. Introduction

In response to the 2008-2009 financial crisis that exposed the excessive risk-taking of banks, legislators seek to curb risk-taking incentives in the financial sector. Since the compensation schemes of bank managers can often be directly linked to the risky investment behavior of many financial institutions (e.g., Bear Stearns, Lehman, UBS, Citigroup, Merrill Lynch, and AIG)[1], it has been argued that corporate governance failures within banks were a primary cause of the financial crisis. Following this line of argument, aligning executive pay arrangements with the interests of banks' shareholders may limit excessive risk-taking.

However, shareholders of financial institutions may have strong risk-shifting incentives due to the presence of explicit and implicit government guarantees. Hence, shareholder empowerment aggravates the excessive risk problem, since shareholders will just pass on their risk-shifting incentives to bank managers. The regulatory solution to this problem has so far been the implementation of risk-weighted capital requirements. In this paper, we propose a new regulatory approach that involves capital requirements that are contingent on managerial compensation. This approach utilizes the compensation scheme to drive a wedge between the interests of top management and shareholders, counteracting shareholder risk-shifting incentives.

Risk-shifting incentives have been intensively studied since the seminal work of Jensen and Meckling (1976). The classical risk-shifting problem between debtholders and shareholders arises when debtholders are unable to obtain adequate adjustments of risk premiums in case the investment risk increases. This problem is particularly relevant for banks due to their high leverage and the fact that they can relatively easy change the degree of risk of their business activities. This risk-shifting problem can be mitigated to some extent by including loan covenants in the debt contract (e.g., Berlin and Mester (1992) and Chava and Roberts (2008)) or using short-term debt (Chava and Roberts (2008)).

However, for financial institutions an even more severe risk-shifting problem arises when governments implicitly or explicitly guarantee part of the banks' deposits or borrowed funds. These guarantees limit the downside risk of debt and in turn increase the expected repayment to debtholders. Therefore, insured debtholders have no incentive to adjust capital costs appropriately for risk. Thus, banks are incentivized to increase the amount of insured debt as much as possible, since it is comparatively inexpensive. The resulting high leverage in turn incentivizes banks to invest in risky assets, since the capital costs of insured debt are not risk adjusted. Ultimately, this risky behavior leads to a correspondingly high default probability. While equityholders do not bear the expected costs of

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

a bank failure in the form of a higher cost of debt funding ex ante, taxpayers have to bear all the costs of bank failures ex post. Wealth is thereby transferred from society to equityholders.

This issue justifies regulatory intervention, which so far has been the implementation of risk-weighted capital requirements. However, the 2008-2009 financial crisis revealed that measuring bank risk is a difficult task, since risk modeling per se has strong limits (e.g., Danielsson (2002) and Danielsson (2008)). Furthermore, after the implementation of regulatory measures, shareholders still have an incentive to circumvent the regulations by putting compensation schemes in place that reinforce the attractiveness of regulatory arbitrage. For this reason Bebchuk and Spamann (2010) advocate that monitoring compensation structures should play an important role in determining the appropriate capital requirements specific to each financial institution. The authors argue that this approach improves the overall effectiveness of banking regulation, since information about pay structures can be used to produce a better fit between capital requirements and the investment risks posed by individual banks.

Inspired by this idea, we present a model that theoretically justifies this approach. In particular, we show how the excessive risk-taking problem, given explicit or implicit guarantees, can be solved by a regulatory approach that makes the capital requirements of banks contingent on the compensation schemes of management. This regulatory measure works as follows: The more the compensation structure decouples bank managers' interests from those of shareholders by curbing risk-taking incentives, the higher the amount of insured debt a bank is permitted to take on. In this case, the risk-taking incentives arising from insured debt and the risk-mitigating incentives created by the compensation structure offset each other, such that the manager chooses the socially optimal risk level.

This approach has several advantages over existing regulation. First, the regulator does not need to be able to properly measure the bank investment risk, as in the case of risk-weighted capital requirements such as the Basel Accords. Relying on banks reporting their own risks is also not an effective solution, since banks anticipate that reporting high investment risks leads to higher levels of required equity capital, which gives them an incentive to understate their risk levels. Instead of relying on banks' risk reporting, the proposed regulatory approach uses the observable compensation scheme to draw conclusions about bank risks. Furthermore, compared to corporate governance measures that regulate bank managers remuneration, the proposed approach does not involve direct regulation of the compensation schemes and hence does not restrict contractual freedom between shareholders and managers. Instead, it only takes the compensation schemes into account when determining a bank's individual capital requirements.

The remainder of the paper is organized as follows. Section 2 provides an overview of the related literature. Section 3 presents the model setup. In Section 4 we first determine the capital structure and investment decisions of banks when they are not regulated. Section 5 then analyzes the effects of regulatory approaches that do not incorporate the compensation scheme of the management. In Section 6 we propose the new regulatory approach that makes capital regulation contingent on the compensation structure. Section 7 discusses policy implications and Section 8 concludes the paper.

2. Related Literature

The question of how bank CEO contracts can be designed to establish optimal investment risk decisions has gained increasing attention during and in the aftermath of the 2008-09 financial crisis. Early work by John and John (1993), conceptually the most related paper to ours, determines optimal compensation rules given a specific exogenously given leverage. Our approach proposes a regulatory mechanism that works vice versa, that is, the allowed leverage depends on the compensation scheme. This mechanism has several implementation-related advantages, discussed in Section 6.

The theoretical analysis provided by John, Saunders, and Senbet (2000) proposes a regulatory approach in which the deposit insurance premium scheme incorporates incentive features of top management compensation. A problem with this approach is that insurance premiums do not cover implicit insured debt and thus risk-shifting incentives are still prevalent. Edmans and Liu (2011) show that a compensation scheme that is also based on debt components can improve effort as well as deter risk-shifting. However, as described before, public guarantees distort the value of debt. Therefore, using this approach, bank managers may still have an incentive to increase bank systemic risk to maximize the value of implicit government guarantees.

A very recent paper by Bolton, Mehran, and Shapiro (2010) proposes the inclusion of CDS spreads in the compensation scheme to mitigate the risk-shifting problem. However, CDS spreads do also not reflect the actual investment risks of banks, since the spreads also incorporate the government guarantees and thus tend to be too low. Thanassoulis (2012) and Hakenes and Schnabel (2012) develop theoretical arguments for caps on bankers' bonuses.

Various papers empirically investigate the relation between shareholder power, CEO compensation, insured debt, and banks' risk-taking decisions. Chesney, Stromberg, and Wagner (2010) find evidence suggesting that higher risk-taking incentives for managers of U.S. financial institutions were significantly positively associated with write-downs during the crisis. Cheng, Hong, and Scheinkman (2010) also show that there is a correlation between compensation structures and risk-taking. Furthermore, Fahlenbrach and Stulz (2011) find evidence that banks with CEOs whose incentives were better aligned with shareholder interests performed worse during the crisis, on average. Laeven and Levine (2009) show that great shareholder power within a bank's corporate governance structure translates into the bank's higher risk taking. Furthermore, the authors show that an increase in shareholder power is associated with a rise in risk in response to tougher regulation and more access to deposit insurance. Westman (2010) confirms these results. The empirical study by Gropp and Koehler (2010) finds that shareholder-controlled banks behave in a riskier fashion and obtain more government assistance than manager-controlled banks. Taken together, empirical evidence also suggests that deposit insurance schemes induce excessive risk-taking by banks and that alignment of the interests of shareholders and managers is thus not socially optimal.

3. Model setup

To study the risk-shifting incentives of bank shareholders and bank managers, we follow the model of John and John (1993). To apply the model to the financial sector, we have to extend it by endogenizing capital structure choice. Therefore, we use the model of Inderst and Mueller (2008), since it coincides with empirical findings and enables us to also incorporate the risk-shifting problem.[2]

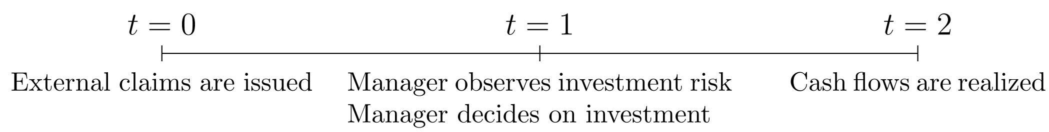

Figure 1: Timing of the model

We consider an economy that consists of three dates, $t = 0, 1, 2$, and four parties: a bank, its shareholders and creditors, and the bank manager. All parties are risk neutral and the shareholders have all the bargaining power. The bank has access to two investment possibilities, a risky investment opportunity and a safe one. Both investments require a fixed capital outlay of k. The bank manager decides on the bank's investments as well as its capital structure and acts on his own behalf, given the incentive contracts in place. For the incentive contract we consider the common compensation scheme consisting of a fixed wage and a performance-based component, that depends on the return on equity achieved.

[2]Several empirical studies find that banks often hold equity in excess of the minimum 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 the optimal leverage of banks is simply too low for the minimum capital requirements to be binding. The theories of Diamond and Rajan (2000), Inderst and Mueller (2008), and Allen, Carletti, and Marquez (2011) are consistent with non-binding minimum capital requirements and stable leverage over time. However, only the model of Inderst and Mueller (2008) enables incorporation of the risk-shifting problem.

This type of contract is closely related to remuneration schemes observed in practice. The timing of our model is depicted in Figure 1.

At $t = 0$ the external claims are issued and investors demand an appropriate risk premium. We assume that bank liabilities are at least partially protected by public guarantees, which include deposit insurance and the expectations of bailouts for systemically important institutions. However, our model acknowledges that public guarantees do not extend fully to all of the bank's debt. Therefore, we assume that the bank can raise insured debt only up to a certain limit $\overline{d}_i < k$, which prevents the bank from financing its investments solely with insured debt. This upper limit of insured debt $\overline{d}_i$ is increasing in the amount of insured deposits (insured through a deposit guarantee scheme) the bank has access to, as well as in the level of systemic risk that emanates from the bank. The latter increases the amount of insured debt, because systemic risk enhances the implicit debt guarantee given by a possible government bailout. Hence, the sources of capital that are explicitly studied are equity (e) provided by the shareholders and debt in the form of explicit and implicit insured debt (d_i) as well as non-insured debt (d_n), yielding total funds of $K := e + d_i + d_n$. Since all of the bank's investment opportunities require a capital outlay k, we specify that $K = k$.

We assume that all investors have the opportunity cost of capital r. Since insured creditors are not demanding a risk premium, the interest rate of insured debt is equal to the opportunity cost of capital r. However, the cost for equity and non-insured debt fully reflects the ex-ante riskiness of the funds. Therefore, neither form of financing is intrinsically cheaper. All debt claims mature at $t = 2$ and the bank promises non-insured debtholders to repay the principal d_n and the interest $d_n r_D$ whenever possible.

The bank's investments possibilities materialize at $t = 1$. The success probability of the risky investment opportunity depends on the investment's quality, which is given by $s \in S = [0, 1]$. With probability s, the risky investment generates a positive return of R_H and with probability $(1 - s)$ the risky investment fails. In the latter case the bank defaults on its debt, if $d_i + d_n(1 + r_D) > 0$. However, in the course of bankruptcy proceedings, the risky investment opportunity yields a liquidation value of δ (with $\delta + \overline{d}_i < k$), which can be seized by the non-insured creditors. Therefore, δ is a measure of the downside risk of the risky investment opportunity.

Instead of investing in the risky investment, the bank can choose a safe investment opportunity that always yields the risk-free return R_L, with $R_H > R_L > k(1 + r)$. Before deciding between the two investment possibilities, the manager learns the quality of the risky investment opportunity, s, through a screening procedure. The manager then decides between the risky and riskless investments based on the manager's private observation of s at $t = 1$. Since the quality of the investment is the manager's private information, it is not possible to write a contract contingent on the investment quality s. However, all the relevant parties know that s is distributed uniformly over the interval $[0, 1]$.

At $t = 2$ the cash flows from the investment made at $t = 1$ are realized. The possible and verifiable cash flow realizations are (i) $y = R_L$ if the bank invested in the safe investment, (ii) $y = R_H$ if the bank chose the risky investment and was a success, and (iii) $y = \delta$ if the risky investment was chosen, went bad, and was liquidated during bankruptcy proceedings.

First, we start by determining the first-best investment decision from a social welfare perspective. This first-best decision is then the reference point for the following analyses. Therefore, we have to determine the range of investment quality s for which the risky investment has a higher expected return than the safe investment and should thus be selected over the safe investment opportunity. Thus, it is first-best efficient to invest in the risky investment opportunity whenever $s \geq s_{FB}$ and to reject it if $s < s_{FB}$, where s_{FB} is the investment quality at which the two investments have the same expected return:

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

As John and John (1993), we define an investment policy of investing in the risky investment opportunity for all $s \geq \widetilde{s}$ as investment policy $\widetilde{s}$. As expected, the critical threshold s_{FB} depends positively on the return of the safe asset R_L and negatively on the upside potential of the risky investment opportunity R_H and its downside risk δ.

4. Capital structure and investment decisions without regulation

In this section, the capital structure and bank managers's investment choice are characterized for the case where the government does not introduce any regulation. In this case the shareholders align the manager's incentives with their own by paying the manager only a performance-based wage that depends on the return on equity achieved. Hence, we can treat the manager as an owner manager (e.g., the manager owns the bank).

As described, concerning the capital structure decision at $t = 0$, the owner manager (or bank hereafter, for simplicity) can choose between three different forms of funding: equity e, insured debt $d_i \leq \overline{d}_i$, and non-insured debt d_n. Regarding the investment decision at $t = 1$, the bank can choose between a safe investment and a risky one. If the bank invests in the safe asset, the corresponding payoff to the shareholders equals $R_L - d_i - d_n\,(1 + r_D)$, where we assume that the return of the safe investment is always high enough to enable the bank to settle its liabilities. If the bank invests in the risky investment and it turns out to be a failure, the payoff is zero, since the bank defaults and outside creditors seize the liquidation value of the investment. Lastly, in case the bank decides to invest in the risky investment and it is a success, the payoff to the shareholders is $R_H - d_i - d_n(1+r_D)$. We solve the bank's optimization problem by backward induction. Thus, we first determine the privately optimal investment policy at $t=1$ and then solve for the optimal capital structure at $t=0$. Regarding the investment decision at $t=1$, the bank optimally invests in the risky investment opportunity whenever $s \geq \overline{s}^*$, where $0 < \overline{s}^* < 1$ solves

$$\begin{aligned} \overline{s}^* \left[R_H - d_i - d_n(1+r_D)\right] &= R_L - d_i - d_n(1+r_D) \\ \Rightarrow \overline{s}^* &= \frac{R_L - d_i - d_n(1+r_D)}{R_H - d_i - d_n(1+r_D)} \end{aligned} \tag{2}$$

From (2), we can infer that the investment policy $\overline{s}^*$ decreases as the amount of debt increases, since the derivative of $\overline{s}^*$ with respect to the face value of debt is negative:

$$\frac{\partial \overline{s}^*}{\partial(d_i + d_n(1+r_D))} = -\frac{R_H - R_L}{\left(R_H - d_i - d_n(1+r_D)\right)^2} < 0$$

Hence, if the face value of debt increases, the investment policy becomes riskier since it is likelier that the bank will choose the risky investment opportunity. On account of this fact, the investment decision at $t=1$ is influenced by the capital structure decision at $t=0$.

Therefore, at $t=0$ the bank chooses the capital mix that maximizes the expected return on equity, taking into account the impact on the investment policy at $t=1$. Since the quality s of the risky investment opportunity is distributed uniformly over the interval $[0,1]$, the expected value of equity at $t=0$ is given by

$$\begin{aligned} V_E &:= (1-\overline{s}^*)\left(\frac{1}{2} + \frac{1}{2}\overline{s}^*\right)\left[R_H - d_i - d_n(1+r_D)\right] \\ &+ \overline{s}^*\left[R_L - d_i - d_n(1+r_D)\right] \end{aligned} \tag{3}$$

where the first term represents the cash flow to the shareholders in case the risky investment was chosen and was successful and the second term represents the cash flow for the case where the bank invested in the safe asset. To attract non-insured debt from creditors, r_D must satisfy their participation constraint, which is the case if their expected repayment, V_D, satisfies

$$\begin{aligned} V_D &:= (1-\overline{s}^*)\left(\frac{1}{2} + \frac{1}{2}\overline{s}^*\right) d_n(1+r_D) + (1-\overline{s}^*)\left(\frac{1}{2} - \frac{1}{2}\overline{s}^*\right)\delta \\ &+ \overline{s}^* d_n(1+r_D) \geq d_n(1+r) \end{aligned} \tag{4}$$

where again the first two terms give the value of the non-insured debt claim in case the risky investment was chosen, successfully or not, and the third term states the claims of the uninsured creditors in the case of investment in the safe asset. By optimality, this constraint binds, since the bank has the bargaining power and it could otherwise extract more profits by lowering r_D. By substituting the binding constraint (4) into (3), we obtain the following for the expected return on equity at $t = 0$:

$$\begin{aligned} V_E - e(1+r) &= (1-\overline{s}^*)\left(\frac{1}{2}+\frac{1}{2}\overline{s}^*\right)[R_H - d_i] + (1-\overline{s}^*)\left(\frac{1}{2}-\frac{1}{2}\overline{s}^*\right)\delta \\ &+ \overline{s}^*[R_L - d_i] + [d_i - k](1+r) \end{aligned} \tag{5}$$

where we used also that $e + d_i + d_n = k$. The objective of the bank at $t = 0$ is now to maximize (5) by choosing an optimal capital structure. From (5) it can directly be inferred that the bank takes on as much insured debt as possible, since the derivative of (5) with respect to d_i is positive:

$$\frac{\partial V_E - e(1+r)}{\partial d_i} = \frac{1}{2}(1-\overline{s}^*)^2 + r > 0$$

Therefore, the bank always chooses $d_i^* = \overline{d}_i$, since insured debt is cheaper than the other two funding sources. Since equity and non-insured debt fully reflect the ex-ante riskiness of the funds, the financing costs are the same and, in regard to the cost of capital, the bank would be indifferent between the two funding sources. This indifference can also be seen from (5), since the expected return on equity does not depend on the amount of non-insured debt. However, as described before, substituting non-insured debt for equity alters the investment policy at $t = 1$, which in turn changes the expected value of equity. Therefore, the bank can use the capital structure decision at $t = 0$ to maximize the expected return on equity by committing to, through the capital structure choice at $t = 0$, the privately optimal investment policy at $t = 1$. Therefore, we first derive the ex-ante privately optimal investment policy and then determine the capital structure required to commit to this policy. For the ex-ante optimal investment policy $\underline{s}^*$, optimizing the expected return on equity from (5) with respect to the investment policy at $t = 1$ yields:

$$\frac{\partial V_E - e(1+r)}{\partial \overline{s}^*} \overset{!}{=} 0 \Rightarrow \underline{s}^* = \frac{R_L - \delta - \overline{d}_i}{R_H - \delta - \overline{d}_i} < s_{FB} \tag{6}$$

where we already inserted the optimal amount of insured debt $d_i^* = \overline{d}_i$. Since we made sure that $R_L > \delta + d$ holds for the return of the safe asset, $\underline{s}^*$ will be an interior solution. The threshold $\underline{s}^*$ in equation (6) is decreasing in the amount of insured debt, since the derivative of $\underline{s}^*$ with respect to $\overline{d}_i$ is negative:

$$\frac{\partial \underline{s}^*}{\partial \overline{d}_i} = -\frac{R_H - R_L}{(R_H - \delta - \overline{d}_i)^2} < 0$$

Therefore, the desired investment policy becomes riskier if the amount of insured debt increases. A comparison of expressions (1) and (6) directly shows that the bank wants to commit itself to a riskier investment policy than the first-best one. This behavior then leads to the classical risk-shifting problem. The shareholders do not have to bear the expected costs of bank failure in the form of higher costs of debt funding ex-ante due to public guarantees. Therefore, they are incentivized to take on as much insured debt as possible and to make riskier investments than are socially optimal. Since the taxpayers have to bear all the costs of a bank failure ex-post, wealth is transferred from society to the shareholders.

To commit to the privately optimal investment policy desired, the bank chooses a face value of non-insured debt such that $\overline{s}^*$ from (2) and $\underline{s}^*$ from (6) coincide. For the optimal face value of non-insured debt, setting (6) equal to (2) and rearranging yields:

$$d_n^* \left(1 + r_D^*\right) = \delta$$

Therefore, the amount of non-insured debt that is required to commit to the privately optimal investment policy coincides with the downside risk δ of the risky investment. Hence, the total amount of debt chosen by the bank is

$$d_i^* + d_n^* \left(1 + r_D^*\right) = \overline{d}_i + \delta$$

These results yield the following proposition.

Proposition 4.1. *If the government does not introduce any regulation, the bank chooses a capital structure at $t = 0$ such that it commits to the investment policy*

$$\underline{s}^* = \frac{R_L - \delta - \overline{d}_i}{R_H - \delta - \overline{d}_i} < s_{FB}$$

which leads to a risk-shifting problem, since the chosen investment policy is riskier than the first-best investment policy and wealth is transferred from society to the shareholders.

5. Regulation without considering the compensation scheme

In this section we determine and analyze possible regulatory responses to the risk-shifting problem described in the previous section. However, in this section we first only consider regulatory approaches that do not regulate the compensation schemes or take them into account in any way. The objective of the regulator is to implement the first-best investment policy given in (1) to prevent a wealth transfer from taxpayers to shareholders. To do so, the regulator can introduce a regulatory scheme at $t = 0$ before the external claims are issued, which is common knowledge in the market. In particular, we analyze the regulatory approaches of banning insured debt, introducing a deposit insurance premium, and implementing capital requirements.

5.1. Banning insured debt

From the optimal desired investment policy $\underline{s}^*$, given by (6), it follows that banning insured deposits, as well as committing to a no-bailout policy and thereby eliminating implicit guarantees, would induce the bank to commit to $\overline{s}^* = s_{FB}$ at $t = 0$ by choosing $d_n^*(1 + r_D^*) = \delta$. However, it is not reasonable to generally ban insured debt due to the possibility of classical bank runs and/or interbank market disruptions (e.g., Diamond and Dybvig (1983); Blanchard (2009)).

5.2. Deposit insurance premium

Another way the regulator can implement the first-best investment incentives at $t = 0$ is to introduce a deposit insurance premium that the bank has to pay when it takes on insured debt. This premium has to be increasing in the riskiness of the bank's investment policy, as well as in the amount of the bank's insured debt, such that it offsets the risk-shifting incentives that arise through taking on insured debt. Hence, the appropriate deposit insurance premium that has to be imposed on the bank at $t = 0$ is given by

$$\phi = \left[\frac{1}{2}(\overline{s}^*)^2 - \overline{s}^*\right]\overline{d}_i \tag{7}$$

This result can be verified by subtracting the fee ϕ from the expected return on equity given in (5), which yields

$$\begin{aligned} V_E - e(1+r) \quad = \quad & (1 - \overline{s}^*)\left(\frac{1}{2} + \frac{1}{2}\overline{s}^*\right)[R_H - d_i] + (1 - \overline{s}^*)\left(\frac{1}{2} - \frac{1}{2}\overline{s}^*\right)\delta \\ + \quad & \overline{s}^*[R_L - d_i] + [d_i - k](1+r) - \left[\frac{1}{2}(\overline{s}^*)^2 - \overline{s}^*\right]\overline{d}_i \end{aligned} \tag{8}$$

Optimizing (8) with respect to the investment policy at $t = 1$, $\overline{s}^*$, yields the new desired investment policy at $t = 0$ in the case the bank has to pay an additional deposit insurance premium ϕ:

$$\frac{\partial V_E - e(1+r)}{\partial \overline{s}^*} \stackrel{!}{=} 0 \Rightarrow \underline{s}^* = \frac{R_L - \delta}{R_H - \delta} \tag{9}$$

which, in fact, coincides with the first-best investment policy s_{FB}. However, since the appropriate deposit insurance premium ϕ depends on $\overline{s}^*$ as well as the amount of insured debt, the regulator must be able to observe and measure additional investment- and bank-specific properties. The most critical properties are obviously the upside potential of the risky investment, R_H, as well as the maximal available amount of insured debt $\overline{d}_i$. To quantify these parameters, the regulator must be able to evaluate the risks of the bank's investments, as well as measure the systemic risks that emanate from the bank and in turn the bailout probabilities associated therewith. However, the 2008-2009 financial crisis revealed that risk modeling in the financial sector has strong limits (e.g., Danielsson (2002); Danielsson (2008)). Hence, such a regulatory approach is hardly able to achieve the objectives of the regulator efficiently.

5.3. Capital requirements

Furthermore, a regulator could also force the bank to choose the first-best investment policy without banning insured debt or introducing a deposit insurance premium. Therefore, the regulator has to introduce capital requirements that set the total level of debt (i.e., insured and uninsured) such that the bank establishes the first-best investment policy at $t = 1$ ($\overline{s}^* \equiv s_{FB}$). This regulation prevents the bank from committing to the desired investment policy $\underline{s}^*$, which is riskier than the first-best investment policy, through the capital structure choice. Setting the investment policy $\overline{s}^*$ from (2) equal to the first-best given in (1) and solving for the face value of debt yields:

$$d_i + d_n(1 + r_D) = \delta \tag{10}$$

Therefore, the maximal permitted leverage level depends on the downside risk of the investment, as in the Basel Accords. If the regulator prohibits the bank to take on more debt than δ, the bank manager will choose the first-best investment policy at $t = 1$. This regulation translates into the following minimum equity capital requirements:

$$e = k - [d_i + d_n(1 + r_D)] = k - \delta \tag{11}$$

As can be seen from (11), when using the classical capital regulation approach, such as the Basel Accords, the regulator needs to be able to observe the downside risk of the investments to establish the first-best investment policy. Therefore, this regulation is also hardly able to work effectively due to the above-mentioned limits of risk modeling in the financial sector.

Hence, we can conclude that all regulatory approaches that do not take into account management's compensation scheme have major drawbacks. Banning insured debt risks triggering bank runs and/or interbank market disruptions. To effectively introduce deposit insurance fees and/or capital regulation, the regulator must be able to observe and measure investment and bank specific properties, which is difficult.

6. Capital regulation contingent on the compensation structure

In this section, we show that a regulatory approach that makes capital requirements contingent on management's compensation scheme is able to avert the risk-shifting problem and to implement the first-best investment policy without requiring the regulator to measure the bank investment risk. We again consider but now also formalize the standard compensation structure, consisting of a fixed wage S, which is paid in all states in which the bank is solvent, and a performance-based component. The latter is the fraction α of the expected return on equity. Hence, the expected compensation for the manager becomes

$$V_M := E[S] + \alpha[V_E - e(1+r)] \geq 0 \tag{12}$$

The manager can still choose between the three different forms of funding and two different investment opportunities. We solve the manager's optimization problem by backward induction. Therefore, the manager decides to invest in the risky investment opportunity at $t = 1$ whenever the success probability s is greater or equal to $\overline{s}_M^*$, where $\overline{s}_M^*$ solves

$$\begin{aligned} &\overline{s}_M^* \left[S + \alpha \left[R_H - d_i - d_n \left(1 + r_D\right) - S\right]\right] = S + \alpha \left[R_L - d_i - d_n \left(1 + r_D\right) - S\right] \\ &\Rightarrow \overline{s}_M^* = \frac{(1-\alpha)S + \alpha \left[R_L - d_i - d_n \left(1 + r_D\right)\right]}{(1-\alpha)S + \alpha \left[R_H - d_i - d_n \left(1 + r_D\right)\right]} \end{aligned} \tag{13}$$

The left-hand side of the equation represents the expected wage payment in case the manager chooses the risky investment and the right-hand side is the remuneration in case the safe investment is chosen. In the event of the risky investment's failure, it is assumed that the fixed wage is subordinated (i.e., junior) to debtholder claims in the bankruptcy procedure, as in Dewatripont and Tirole (1994) and Hart and Moore (1995). As shown in (13), the investment decision at $t = 1$ is still influenced by the capital structure decision at $t = 0$ and, in addition, this decision is now affected by the compensation structure.

Next, we consider the manager's capital structure decision at $t = 0$. Since the manager chooses the capital mix that maximizes his expected compensation in (12), we first have to determine the expected return on equity again. Hence, after incorporating the manager's fixed wage payment, the expected value of equity becomes

$$\begin{aligned} V_E \;\; := \;\; & \left(1 - \overline{s}_M^*\right) \left(\frac{1}{2} + \frac{1}{2}\overline{s}_M^*\right) \left[R_H - d_i - d_n \left(1 + r_D\right) - S\right] \\ + \;\; & \overline{s}_M^* \left[R_L - d_i - d_n \left(1 + r_D\right) - S\right] \end{aligned} \tag{14}$$

The participation constraint of the non-insured creditor is the same as in (4) when accounting for the new critical investment threshold $\overline{s}_M^*$:

$$\begin{aligned} V_D \;\; := \;\; & \left(1 - \overline{s}_M^*\right) \left(\frac{1}{2} + \frac{1}{2}\overline{s}_M^*\right) d_n \left(1 + r_D\right) + \left(1 - \overline{s}_M^*\right) \left(\frac{1}{2} - \frac{1}{2}\overline{s}_M^*\right) \delta \\ + \;\; & \overline{s}_M^* d_n \left(1 + r_D\right) \geq d_n(1 + r) \end{aligned} \tag{15}$$

Again we need to plug the binding constraint (15) into (14), which now yields for the expected return on equity, after rearranging,

$$V_E - e(1+r) \;\; = \;\; \left(1 - \overline{s}_M^*\right) \left(\frac{1}{2} + \frac{1}{2}\overline{s}_M^*\right) \left[R_H - d_i - S\right]$$

$$
\begin{aligned}
&+ \quad (1-\overline{s}_M^*)\left(\frac{1}{2}-\frac{1}{2}\overline{s}_M^*\right)\delta \\
&+ \quad \overline{s}_M^*\left[R_L-d_i-S\right]+\left[d_i-k\right](1+r) \qquad (16)
\end{aligned}
$$

Plugging the expected return on equity from (16) into (12) yields for the expected payment to the manager at $t=0$:

$$
\begin{aligned}
V_M \quad = \quad & (1-\overline{s}_M^*)\left(\frac{1}{2}+\frac{1}{2}\overline{s}_M^*\right)\left[(1-\alpha)S+\alpha R_H-\alpha d_i\right] \\
+ \quad & (1-\overline{s}_M^*)\left(\frac{1}{2}-\frac{1}{2}\overline{s}_M^*\right)\alpha\delta \\
+ \quad & \overline{s}_M^*\left[(1-\alpha)S+\alpha R_L-\alpha d_i\right]+\alpha\left[d_i-k\right](1+r) \qquad (17)
\end{aligned}
$$

The manager's objective at $t=0$ is now to maximize (17) by choosing a privately optimal capital structure. From (17) one can again directly infer that the manager takes on as much insured debt as possible, since the derivative of (17) with respect to d_i is again positive:

$$\frac{\partial V_M}{\partial d_i}=\frac{1}{2}\alpha(1-\overline{s}_M^*)+\alpha r>0$$

Furthermore, as can be seen from (17), substituting non-insured debt for equity still does not alter the expected payment directly. However, it still influences the investment policy at $t=1$ given in (13), which in turn changes the manager's expected payment. Thus, we first determine the investment policy the manager would like to commit to at $t=0$ and then the amount of non-insured debt required to commit to this privately optimal investment policy. The first-order condition of (17) with respect to $\overline{s}_M^*$ yields

$$\frac{\partial V_M}{\partial \overline{s}_M^*}\overset{!}{=}0\Rightarrow \underline{s}_M^*=\frac{(1-\alpha)S+\alpha\left(R_L-d_i-\delta\right)}{(1-\alpha)S+\alpha\left(R_H-d_i-\delta\right)} \qquad (18)$$

To commit to the privately optimal investment policy desired, the manager now chooses a face value of non-insured debt such that $\overline{s}_M^*$ from (13) and $\underline{s}_M^*$ from (18) coincide.

Hence, the regulator is able to implement the first-best investment policy if he ensures that the desired investment policy given in (18) equals the first-best investment policy from (1). In this case, the manager will choose the face value of non-insured debt, committing himself to the first-best investment policy. The idea of the new regulatory approach proposed in this paper is that the manager's compensation scheme can be used by the regulator to implement the first-best investment policy by making capital requirements contingent on the remuneration structure. Equation (18) shows that an increase in the performance-based wage component α leads to a decrease in $\underline{s}_M^*$:

$$\frac{\partial \underline{s}_M^*}{\partial \alpha}=-S\frac{R_H-R_L}{\left((1-\alpha)S+\alpha\left(R_H-d_i-\delta\right)\right)^2}<0$$

Hence, higher performance-based remuneration incentivizes the manager to choose a riskier investment policy. On the other hand, raising the fixed wage S increases $\underline{s}_M^*$ and thus reduces the manager's risk-shifting incentives so that the manager chooses a less risky investment policy:

$$\frac{\partial \underline{s}_M^*}{\partial S} = \alpha(1-\alpha)\frac{R_H - R_L}{((1-\alpha)S + \alpha\left(R_H - d_i - \delta\right))^2} > 0$$

Therefore, the regulator has to make sure that the risk-shifting incentives created by the availability of insured debt are offset by an appropriate ratio between fixed and performance-based remuneration components. This optimal relation can be determined by setting $\underline{s}_M^* = s_{FB}$ and solving for the face value of insured debt, which yields the following regulatory requirement:

$$d_i^r = \frac{(1-\alpha)}{\alpha} S \tag{19}$$

where the compulsory level of insured debt d_i^r increases in the fixed wage S and decreases in the performance-based component α. After plugging in the regulatory requirement from (19), the objective function of the manager at $t = 0$ reduces to

$$\begin{aligned} V_M \quad := \quad & (1 - \overline{s}_M^*)\left(\frac{1}{2} + \frac{1}{2}\overline{s}_M^*\right)[\alpha R_H] + (1 - \overline{s}_M^*)\left(\frac{1}{2} - \frac{1}{2}\overline{s}_M^*\right)\alpha\delta \\ + \quad & \overline{s}_M^*\,[\alpha R_L] + \alpha[\frac{(1-\alpha)}{\alpha}S - k](1+r) \end{aligned} \tag{20}$$

Deriving the new first-order condition of (20) with respect to $\overline{s}_M^*$ verifies that the newly proposed regulatory approach is in fact able to implement the first-best investment incentives:

$$\frac{\partial V_M}{\partial \overline{s}_M^*} \stackrel{!}{=} 0 \Rightarrow \underline{s}_M^* = \frac{(R_L - \delta)}{(R_H - \delta)} = s_{FB} \tag{21}$$

Hence, the regulator has to ensure via mandatory capital requirements that the level of insured debt does not exceed the level determined in equation (19). A special feature of this regulatory approach is the fact that the regulator no longer needs to be able to measure the bank investment risk to implement the first-best investment policy. Therefore, the need to monitor the adequacy of risk assessments for the assets of financial institutions is greatly reduced. Instead, the regulator only needs to gather information about the manager's compensation structure, which is much easier to do. This information can then be used to draw conclusions about bank risk.

Given this kind of capital regulation, the manager maximizes the amount of insured debt until the capital requirements bind and thus chooses $d_i^* = d_i^r =$

$\frac{(1-\alpha)}{\alpha}S$. The manager then tries to commit to the first-best investment policy at $t = 0$ by choosing the appropriate amount of non-insured debt. Now, we have to check whether the manager can do so, because this commitment is only possible if the investment policy at $t = 1$ is still influenced by the capital structure decision at $t = 0$, given the new regulatory requirements. Plugging (19) into (13) yields the investment policy of the manager at $t = 1$, given the regulation policy from (19):

$$\overline{s}_M^* = \frac{R_L - d_n(1 + r_D)}{R_H - d_n(1 + r_D)} \tag{22}$$

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 of (22). Setting $\overline{s}_M^*$ from (22) equal to s_{FB} from (1) and solving for $d_n(1 + r_D)$ yields the amount of non-insured debt that the manager chooses at $t = 0$ under this regulatory regime:

$$d_n^*(1 + r_D^*) = \delta$$

Thus for the total amount of debt we obtain

$$d_i^* + d_n^*(1 + r_D^*) = \frac{(1-\alpha)}{\alpha}S + \delta$$

These results yield the following proposition.

Proposition 6.1. *The implementation of capital requirements contingent on the fixed and performance-based compensation components induces the manager to choose the first-best investment policy. Furthermore, using this kind of regulation, the regulator does not need to be able to measure the bank investment risk.*

With the regulatory scheme from (19) in place, shareholders can alter the permitted level of insured debt by setting the compensation components accordingly. Hence, this regulatory approach allows all kinds of business models. Shareholders can adjust the wage components in such a way that the bank is allowed to take on its maximum available amount of insured debt $\overline{d}_i$. Furthermore, this regulatory approach does not regulate the remuneration directly, since banks can still freely choose how they pay their executives. However, with the new regulation in place, this decision now alters the bank's capital requirements.

The economic intuition is as follows. Banks that pay their manager very conservatively (with a relatively high S and low α) can choose a higher amount of explicit and/or implicit insured debt. On the other hand, banks that implement very steep incentives (with relatively low S and high α) can only choose a rather low level of explicit and implicit insured debt. This result is quite intuitive. Implementing a conservative compensation structure (low risk on the managerial side) enables a (potentially) riskier debt structure, since the risk-shifting incentives induced by high leverage are offset by a remuneration structure that mitigates risk taking incentives. On the other hand, in case the bank implements a compensation structure that provides incentives for risky investment behavior, the bank is forced to choose a low risk capital structure.

In the following, we extend our model by adding the negative external costs of a bank default on society (denoted by B_s) and analyze the consequences for our regulatory approach as a robustness check. The negative external costs of a bank default can be understood as the costs that arise due to distortions in the interbank market and the consequences for the real economy associated therewith. Without regulation, the negative externalities of a bank default widen the gap between the first-best investment policy from a social welfare perspective and the bank's desired risky investment policy. Incorporating these welfare costs of a bank default, the new first-best optimal investment policy becomes

$$\begin{aligned} & s_{FB}(R_H + (1 - s_{FB})\,\delta - (1 - s_{FB})\,B_s = R_L \\ & \Rightarrow s_{FB} = \frac{R_L - \delta + B_s}{R_H - \delta + B_s} \end{aligned} \tag{23}$$

In case the risky investment is chosen and fails, the resulting bank default implies additional welfare costs B_s. These costs can never arise if the bank invests in the safe investment at $t = 1$. Since the social costs of a bank default do not affect the bank or, in turn, management compensation, the manager does not incorporate them into the decision. Therefore, the investment policy at $t = 1$ from (13) and the desired investment policy at $t = 0$ from (18) are still the same as before.

Therefore, to incentivize the manager to commit to the first-best investment policy at $t = 0$, the regulator has to ensure that the cut-off level $\underline{s}_M^*$ from (18) equals the first-best investment policy from (23). Setting $\underline{s}_M^* = s_{FB}$ and solving for the face value of insured debt yields

$$d_i^r = \frac{(1-\alpha)}{\alpha} S - B_s \tag{24}$$

where the permitted amount of d_i^r increases in the fixed wage S and decreases in the performance-based component α, as before. In addition, it also decreases in social bankruptcy costs B_s. This result is very intuitive. 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 bank's default probability. This regulation scheme is not as easy to implement as before, since the regulator would also need to know the social costs of a bank default.

7. Discussion and policy implications

Compared to the related approaches of John, Saunders, and Senbet (2000) and John and John (1993), the regulatory proposal presented in this paper has decisive implementation-related advantages. The approach of John and John (1993) proposes a mandatory compensation structure that depends, among other factors, on the firm's capital structure. The proposal of John, Saunders, and Senbet (2000) suggests a compensation structure-based rule for setting deposit insurance premiums. However, in both models the debt levels are exogenously given. Therefore, it is somewhat unclear how incorporating the endogeneity of capital structure decision would affect these approaches. To implement the approach of John and John (1993) effectively, the mandatory compensation structure must be changed as soon as the bank's capital structure is altered. This issue is especially problematic for financial institutions, since their capital structure can be easily altered by the manager on a daily basis. Furthermore, the banks' capital structure also changes constantly without an actively intervention by managers, due to price fluctuations in the banks' assets. This problem is also inherent in the proposal of John, Saunders, and Senbet (2000), although to a lesser extent. In case the capital or compensation structure changes, the insurance premiums must be adjusted. Due to the continual variation of the banks' capital structure, the insurance premiums would have to be adjusted very frequently, which can also cause implementation problems. Furthermore, this approach has the drawback that deposit insurance premiums do not cover debt that is implicitly insured through government bailout guarantees. Hence, the risk-shifting problem may still be prevalent with such a regulation in place.

Capital requirements that are contingent on the compensation structure significantly mitigate these implementation problems, since the requirements would only have to be altered whenever the compensation structure changes. This regulation is much easier to implement since, in comparison to the continual variations in banks' capital structure, the compensation structures are altered less frequently and changes are readily identified. Furthermore, institutional requirements such as the so-called "say on pay" rules prohibit frequent changes of the remuneration scheme. These rules require a shareholder vote to approve the remuneration packages of executives. Since bank general meetings are often held only annually, the compensation structure can not be altered that frequently with such requirements in place.

Moreover, considering the comprehensive implementation of our regulatory approach, we must also address the concern of excessive leverage levels. With the new regulatory approach in place, banks' tendencies to incur excessive risks are countered, since this regulation is able to effectively eliminate the risk-shifting problem created by the availability of insured debt. However, banks could be run with a large balance sheet and very high leverage in case an extremely low performance-based compensation component is chosen. Then, in case the risk management of a bank fails, a default of the bank becomes very likely, since there are no sufficiently high equity cushions to absorb such risk management errors. Therefore, in addition to the compensation structure-based capital requirements, a safeguard is needed to preclude excessive leverage levels. One possible regulatory response to this problem is the imposition of a fixed leverage limit, usually referred to as a leverage ratio, as a complement to the newly proposed approach. Therefore, banks would have to meet two independent measures of capital adequacy: the capital requirement contingent on the compensation structure to mitigate the risk-shifting problem and the fixed leverage ratio to prohibit the bank from becoming too highly leveraged. Empirical evidence shows that using a combination of investment risk-sensitive requirements and a leverage ratio is very effective (e.g., Estrella, Park, and Peristiani (2000)).

Another implementation issue that needs to be addressed is the scope of the regulation with respect to the affected financial institutions and the management levels of a bank considered. Since the cause of the risk-shifting problem is access to public guaranteed debt, the proposed regulatory approach needs only be applied to the subset of deposit-taking banks, as well as financial institutions that are considered systemically important. The other institutions do not need to be subject to regulation. Regarding the management levels, whose executive compensation schemes should be included in the regulation, linking the compensation scheme of the bank's top management to the requirements seems to be sufficient. Since the board of directors, especially the CEO, is responsible for setting the compensation structure and incentives of all other bank employees, as well as monitoring them, one can assume that top management will pass on its incentives to its subordinates by either implementing the right compensation schemes and/or closely monitoring the employees. The effectiveness of focusing on top management's remuneration structure is also supported by empirical evidence. Ang, Lauterbach, and Schreiber (2002) show that top executives in banks have very similar compensation structures and pay-performance elasticities, except for the CEO. They argue that this pattern is due to the fact that immediate subordinates are closely monitored by the CEO.

Imposing any kind of regulation on the banking industry always incentivizes banks to engage in regulatory avoidance behaviors. When the regulator implements the compensation structure-based capital requirements, banks may respond to the new regulatory approach by remunerating management with implicit forms of compensation, such as benefit packages and other perks, instead of paying their top management with explicit forms of executive compensation. Hence, the regulator has to make sure that these forms are also covered by regulation. Furthermore, banks have an incentive to disguise performance-based compensation as some kind of fixed wage to reimplement risk-shifting incentives for the manager. A possible solution to this problem is to call for high transparency with respect to the compensation scheme, for instance, through regulatory filing requirements, to sufficiently evaluate the structure. Another way to solve this problem is to restrict the compensation to several clearly differentiable types of remuneration that can be reliably classified as fixed or performance-based wage payments. Furthermore, banks may respond to the introduction of the proposed regulatory approach by moving their business operations into the shadow banking system. However, this problem is inherent in all regulatory measures and must always be tackled by extending the scope of the regulation accordingly.

Furthermore, the proposed regulatory approach mitigates the problem of manager self-selection that otherwise aggravates the excessive risk-taking problem. Dohmen and Falk (2011) show that workers with a low level of risk aversion are attracted by firms that operate a risky business model and that pay their employees mainly based on performance instead of remunerating them with fixed payments. With the proposed regulation in place, high-risk banks have to remunerate their managers mainly with fixed payments, which leaves risk-loving managers indifferent between the different types of banks. Critics can also raise the concern that incorporating pay into the capital regulations will drive away talent from the financial sector. However, this regulation is aimed at the compensation structure and not at levels of expected pay. Therefore, even if the compensation schemes were less attractive to certain managers, banks would be able to compensate those executives with higher levels of expected pay.

8. Conclusion

Without any regulatory measures, shareholders design the compensation contracts of top management such that it is incentivized to take on excessive risks. These risk-shifting incentives emerge if public guarantees are granted to bank depositors and creditors. This issue calls for regulatory intervention. However, determining the riskiness of bank assets and the corresponding appropriate level of capital requires intimate knowledge of the banks' asset portfolios, as well as an extremely sophisticated understanding of risk modeling. This risk assessment has been shown to be a rather difficult task during the 2008-2009 financial crisis. We argue that observable incentive features of the managerial compensation scheme provide valuable information about shareholder objectives, which can help the regulator reduce the information disadvantages vis--vis bank managers. Implementing capital requirements conditional on compensation structures can thus curtail bank incentives for risk shifting and in turn lead to welfare improvements. This approach has the decisive advantage that the regulator does not need to be able to properly measure investment risk. Instead, the regulator only needs to be able to observe the compensation structure of top management to implement first-best outcomes.

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