Bank Regulation, CEO Compensation, and Boards*

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Abstract

We analyze the limits of regulating bank CEO compensation to reduce risk shifting in the presence of an active board that retains the right to approve new investment strategies. Compensation regulation prevents overinvestment in strategies that increase risk, but it is ineffective in preventing underinvestment in strategies that reduce risk. The regulator optimally combines compensation and capital regulations. In contrast, if the board delegates the choice of strategy to the CEO, compensation regulation is sufficient to prevent both types of risk shifting. Compensation regulation increases shareholders' incentives to implement an active board, which reduces the effectiveness of compensation regulation.

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1 Introduction

Banks' risk taking depends on their corporate governance and regulation. Bank compensation regulation is a new tool for bank regulation that intervenes in banks' corporate governance.[1] We explore the interaction of regulating banks' CEO compensation and capital regulation, when the regulator attempts to reduce banks' risk shifting. To do so, we study the limits of compensation regulation that arise from corporate governance structures in which CEO compensation is not the only instrument shareholders use to control the bank. Specifically, we consider active boards that monitor and intervene in the CEO's strategy choice in accordance with shareholders' preferences.

We show that, in the presence of active boards, the effectiveness of compensation regulation depends on the type of risk shifting. Compensation regulation can prevent active risk shifting, where the bank chooses excessively risky investments by eliminating the CEO's incentives to propose such investment strategies to the board. However, it cannot prevent passive risk shifting where the bank forgoes efficient risk reducing investments, because a shareholder friendly board will veto such strategies. Moreover, compensation regulation creates a wedge between the CEO's and shareholders' objectives, which gives shareholders an incentive to choose active boards, reducing the effectiveness of compensation regulation. It is optimal to combine compensation regulation with capital regulation that directly reduces shareholders' risk-shifting incentives.

We develop a model where a board, representing shareholders, sets CEO compensation to incentivize the CEO to search for new investment strategies and present them to the board. New investment strategies encompass a shift in the business model as well as the use of financial instruments, which can increase or decrease the bank's risk and expected payoff relative to the bank's current strategy. We assume that it is not verifiable whether the CEO exerted effort and found a new strategy, but it is possible to contract upon its implementation and the bank's realized payoff. An active board understands the bank's investment strategy and retains the right to approve or reject changes to the current strategy.

The bank is financed by a mix of equity and (insured) deposits, which gives shareholders an incentive to engage in risk shifting due to the option value of default. Thus, in the absence of any compensation regulation, the board provides the CEO with a compensation contract that reflects these risk-taking incentives. The board and the CEO will pursue strategies that involve excessively high risk and forgo risk-reducing strategies that are socially optimal.

Regulating CEO compensation can eliminate the problem of overinvestment in risky strategies by requiring deferred compensation that is linear in the bank's total payoff. Such a compensation contract provides the CEO with incentives to present only strategies that maximize the total value of the bank. However, compensation regulation in the presence of an active board cannot eliminate underinvestment in socially efficient strategies that reduce risk, because,

[1] Compensation regulation has become a part of the regulatory framework in Europe (Directive 2013/36/EU, Art. 94(m) and 94(g)) and the US (Dodd-Frank, 2010, section 956; OCC et al., 2016).

for a given strategy, compensation contracts cannot change the total surplus available to the CEO and shareholders. Hence, compensation regulation cannot simultaneously provide incentives for the board to approve and for the CEO to present all efficient strategies that reduce risk due to the reduction of the option value of default that goes along with a reduction in risk.

Capital regulation can reduce both types of risk shifting by reducing the option value of default. However, risk-shifting incentives pertain to any positive level of insured deposits. Thus, to the extent that insured liquid deposits are valuable for households, it is optimal to combine a leverage restriction with compensation regulation. Nevertheless, while compensation regulation fully prevents active risk shifting, even the optimal combination with capital regulation cannot implement the first best because some socially efficient safe strategies will not be implemented if leverage is positive.

If the board is passive instead of active, it delegates the choice of strategy to the CEO, who becomes the sole decision maker. In this case, the CEO's incentives uniquely determine risk taking and compensation regulation can implement the first best. At the same time, regulating CEO compensation increases the benefits of an active board to shareholders because the cost of delegation rises when the CEO's and the regulator's incentives are aligned.

A number of papers explore how the structure of CEO compensation can overcome incentive problems between different claimants of a firm or bank. One of the first papers in this literature is by John and John (1993), who show that combining a fixed wage that is only paid in case of solvency with an equity stake can provide CEOs with incentives to select the socially optimal set of investment projects. Several recent papers also discuss the role of CEO compensation for bank risk taking: Edmans and Liu (2011) advocate combining equity stakes with debt-like instruments such as uninsured pension schemes, Bolton et al. (2015) propose making CEO compensation a function of a bank's CDS spreads, and Hakenes and Schnabel (2014) discuss the role of a bonus cap to curb risk-taking incentives.[2] John et al. (2000) propose linking banks' deposit insurance premia to the risk-taking incentives implied by CEO compensation. A fairly priced premium gives shareholders an incentive to choose the CEO compensation that maximizes the total value of the bank. Eufinger and Gill (2012) provide a similar mechanism linking capital requirements to CEO compensation. Hilscher et al. (2015) consider exogenous limits on the regulator's ability to control bank risk taking and measurement error regarding the CEO's compensation structure. These contributions generally assume that the board is passive and the CEO directly chooses the bank's risk. In this case, it is sufficient to ensure that the CEO's incentives are set optimally. Our results demonstrate the importance of taking banks' corporate governance into account when assessing the effectiveness and limits of CEO compensation regulation.

Our results also show that it is important to distinguish between risk shifting

[2] A different strand of the literature focuses on the inefficiencies that arise in the labor market for bank CEOs (Thanassoulis, 2012; Bannier et al., 2013; Archarya et al., 2016). In these models, labor market imperfections lead to risk-taking incentives that are excessive from the bank's perspective, which provides a rationale for regulation.

through overinvestment in risky strategies and underinvestment in safe strategies. Most papers that analyze risk-shifting problems in the spirit of Jensen and Meckling (1976) consider only the option to increase risk. An exception is Diamond and Rajan (2011), who discuss banks' reluctance to sell illiquid and distressed assets in the 2007–09 financial crisis. Selling the assets would have reduced the probability of financial distress, but primarily benefiting debt holders. Holding on to the assets involved gambling on the recovery of the economy, benefiting shareholders.

Our model has several features that are in line with recent empirical evidence on the link between corporate governance, CEO compensation, and risk taking. Cerasi and Oliviero (2015) and Laeven and Levine (2009) find that a banks' corporate governance structure is an important determinant of how CEO compensation and capital requirements impact on bank risk taking. Bhagat and Bolton (2011), Fahlenbrach and Stulz (2011) and Hagendorff and Vallascas (2011) show that banks whose CEOs' incentives were more aligned with shareholders' interests took more risk and performed worse during the crisis of 2007–09. More shareholder friendly boards are also associated with higher risk taking and worse performance during the financial crisis (e.g., Gropp and Köhler, 2010; Aebi et al., 2012; Beltratti and Stulz, 2012; Erkens et al., 2012; Peni and Vähämaa, 2012; Ellul and Yerramilli, 2013; Berger et al., 2016). Minton et al. (2014) find that banks with a higher representation of financial experts on their board performed slightly better before the financial crisis and slightly worse during the financial crisis. They argue that this evidence is consistent with higher risk taking in these banks. Concerning the role of boards in general, MacAvoy and Millstein (1999) suggest that boards have evolved from being "managerial rubber-stamps to active and independent monitors." Schwartz-Ziv and Weisbach (2013) document that boards routinely discuss business strategy, request additional information, and take decisions on strategic issues. Demb and Neubauer (1992) report survey results in which approximately two-thirds of directors agree that "setting the strategic direction of the company" was one of the jobs they do (p. 43).

Several papers have looked at possible detrimental effects of regulating CEO compensation in a multi-task agency setting and the potential adverse effect on incentives. Hakenes and Schnabel (2014) show that restricting bonuses to avoid risk taking can result in suboptimal effort provision. Inderst and Pfeil (2013) and Hoffmann et al. (2014) show that mandating deferred compensation or longer deferral periods can reduce the screening of new loans. The reason is that deferred compensation makes it more costly to provide loan officers with screening incentives. Regulation can also reduce incentives to search for new strategies in our paper. However, the focus and contribution of our paper is to show that, in the presence of an active board, there is an important limit to what regulating CEO compensation can achieve even when looking only at the risk-shifting problem.[3]

[3] A negative effect of regulation on incentives can be observed in other settings. For example, Aghion and Tirole (1994) analyze privately optimal contractual arrangements for innovation. In their setting, regulation of the contracting space can destroy initiative to innovate.

2 The Model

2.1 Bank Strategy

We consider a bank with a board of directors and a CEO. The board represents shareholders; the CEO maximizes his own utility. The board and the CEO are risk neutral, the outside option yields zero utility. In a changing economic and competitive environment, the CEO is responsible for searching for new opportunities to increase the value of the bank, which constitutes the bank's strategy. In a broad sense, a bank's strategy could comprise its business model (interest or fee business), its risk management and lending standards, the use of risk transfer instruments, level of proprietary trading etc.

The level of total assets (investment) I is given and there are two states of nature, success and failure. The bank's current strategy yields a payoff $\hat{H}$ with probability $\hat{p}$ and a payoff of zero in the case of failure. If the CEO exerts effort, he uncovers an alternative strategy with probability ϕ. A possible new strategy yields a payoff $H \in [0, \bar{H}]$ with probability $p \in [0, 1]$ and zero in the case of failure. Thus, strategies are fully characterized by their probability of success p and the payoff in the case of success, H. Conditional on finding a strategy, its characteristics are drawn from a joint distribution $f(H, p)$ over the set of strategies $[0, \bar{H}] \times [0, 1]$. The current strategy lies in the interior of this set. The distribution $f(H, p)$ and the characteristics of the current strategy $(\hat{H}, \hat{p})$ are common knowledge. After exerting effort, the CEO learns whether a new strategy is available and if so, its characteristics (H, p). The new strategy may or may not be associated with a higher expected payoff than the current strategy. We use a bank's default probability $(1 - p)$ or $(1 - \hat{p})$ as the risk measure throughout the paper. Searching for new alternative strategies involves a personal cost c for the CEO and is not observable.

If the CEO presents a strategy to the board, an active board understands the characteristics of the new strategy, (H, p). However, the CEO can strategically withhold information and claim that he found no new strategy. The board provides the CEO with incentives to search for new strategies and to present them to the board. The board retains the right to approve a new strategy. Thus, the CEO's power stems from access to information that he can withhold, while the board's power stems from its formal authority to oppose a new strategy.

2.2 CEO Compensation

A wage contract consists of an immediate wage and a deferred compensation. The CEO receives the immediate wage independently of whether the bank defaults or not.[4] In contrast, the CEO receives the deferred wage only if the bank does not default. The deferred compensation may depend on the bank's realized payoff, H.

[4] In order to pay an immediate wage, the bank has to raise capital, as will be explained in Section 2.3.

The CEO's search effort, a strategy's success probability p, or the pure availability of a new strategy are not contractible. However, the wage contract can depend on whether the CEO implements a new strategy. We denote the immediate wage and the deferred compensation that the CEO receives from the current strategy by $\hat{w}_i$ and $\hat{w}_d$, respectively. The immediate wage and the deferred compensation with a new strategy are w_i and $w_d(H)$. The wage contract contains w_i, $\hat{w}_i$, $w_d(H)$, and $\hat{w}_d$. Although the immediate wage does not depend on the bank's future payoff, it can still change (and thus be variable) if the board approves a new strategy and $w_i \neq \hat{w}_i$. The CEO is protected by limited liability so that the total wage payment cannot be negative. We restrict our analysis to the case without claw back arrangements and assume $w_d(0) \geq 0$ without loss of generality.[5]

We assume that the board cannot fire the CEO after he has presented a new strategy to save the wages that the board promised to incentivize search. For example, a very high severance pay would prevent this. But, we allow for renegotiation of the wage contract if both the CEO and the board agree to change the contract. Renegotiation takes the following form:

1. The CEO decides whether to propose a new strategy.

2. The board decides whether to offer the CEO a new wage after observing the new strategy's characteristics (H, p).

3. The CEO decides whether to accept or reject the new offer. If the CEO rejects, the old contract stays in place.

4. The board decides whether to implement the new strategy or not.

With renegotiation, the board eventually approves all strategies that maximize the sum of shareholder value and CEO compensation. Thus, the board never rejects strategies because of high CEO compensation. Instead, it can offer an immediate wage $w_i' = \hat{w}_i + \hat{p}\hat{w}_d$, which makes the CEO indifferent between the old and the new strategy. Given the structure of renegotiation, the assumption that the board has all the bargaining power is without loss of generality in the case without compensation regulation.

The flexibility of renegotiation is also important with compensation regulation to avoid detrimental effects from CEO compensation on the implementation of safe strategies. There exists no renegotiation proof compensation contract that implements the same strategies as renegotiation. The reason is that the compensation contract cannot explicitly depend on a strategy's success probability. In contrast, compensation after renegotiation depends on the strategy's success probability because the board observes the characteristics of the strategy that the CEO proposes.

[5] With a claw back arrangement, the CEO could lose the immediate wage w_i if the bank fails. However, any wage structure with $w_i' > 0$, $w_d'(H)$, and $w_d'(0) = -k$ (with $k \leq w_i'$ because of limited liability) yields the same payoff for the CEO as a wage structure where $w_i = w_i' - k$, $w_d(H) = w_d'(H) + k$, and $w_i = w_d(0) = 0$.

2.3 Bank Leverage and Regulation

The bank is financed with equity E and debt (deposits) D. We assume that shareholders prefer debt financing to equity financing. Possible reasons include deposit insurance, implicit and explicit government guarantees and bailouts, tax benefits of debt financing, and possible frictional costs of equity. Because of the benefits of debt financing, the bank uses a high level of debt that provides incentives to engage in risk shifting. We model the benefits of debt financing and resulting incentives to engage in risk shifting in the simplest way possible by assuming that the bank has access to deposits that are fully insured by deposit insurance. Thus, depositors demand a return on their deposits that is equal to the risk-free rate of return, which we normalize to 0.

We assume that the bank cannot increase its book leverage above 100% (i.e., $D/I \leq 1$), even in the absence of regulation. Moreover, we posit that the current strategy's payoff $\hat{H}$ is sufficiently high so that the bank will not default on CEO compensation or depositors in the success state with the current strategy, $\hat{H} \geq D + \hat{w}_d$. These assumptions imply that the bank cannot transfer wealth to shareholders by financing dividends with debt and that, in equilibrium, CEO compensation does not cause default for any of the strategies that the CEO implements.

If a bank's success probability p were contractible, first best could be achieved by, for example, imposing a risk-based deposit insurance premium. While proxies for banks' risk taking are available, they are far from perfect. Laeven (2002) and Demirgüç-Kunt and Kane (2002) find that deposit insurance pricing is, if at all, only weakly related to loan portfolio riskiness. In this spirit, we assume that a bank's success probability p is not contractible, and do not consider a risk-based deposit insurance premium or risk-based capital requirements.

In practice, not all deposits are insured and there is a cost of bank failure for depositors even in the presence of deposit insurance. Depositors will thus react to information regarding the bank's failure probability. Even if the failure probability itself is not observable, the leverage ratio or the compensation contract can reflect risk-taking incentives by the bank. However, as long as the discipline imposed by depositors and debt holders is not sufficient to prevent the bank from risk shifting, there is a role for bank regulation.

We focus on two regulatory tools. First, the regulator can impose a regulatory capital requirement, which limits the maximum level of debt D.[6] Second, the regulator can constrain the structure of CEO compensation.

The regulator maximizes total expected social value. We assume that depositors (households) associate a positive value with publicly insured liquid deposits, which provide money-like claims. Stein (2012), for example, provides a model that explicitly introduces the value of guaranteed deposits into households' utility function. Following Stein, we assume that $\gamma(D)$ is the monetary equivalent value of households' utility from insured deposits. For tractability, we assume that

[6] The regulator can use different instruments to reduce bank leverage, such as direct leverage constraint, a tax on leverage, or compensation regulation that depends on leverage. Without loss of generality, we focus on a direct leverage constraint.

$\gamma(D)$ is an increasing and weakly concave function and that $\lim_{D\to 0}\gamma'(D) = \infty$ and $\lim_{D\to I}\gamma'(D) = 0$ to rule out boundary solutions. Thus, it is not socially optimal to prohibit funding with insured deposits or to give up deposit insurance. Alternatively, following Diamond and Dybvig (1983), a large literature justifies the presence of deposit insurance with the social cost of bank runs.

2.4 Time-Line

We summarize the interaction between the board and the CEO in Figure 1. Taking the regulatory constraints as given, the board sets the leverage target and designs the CEO's compensation contract at $t = 1$. At $t = 2$, the CEO decides whether to search for a new strategy. If he discovers a new strategy, he learns about its characteristics and decides whether to present it to the board. At $t = 3$, if the CEO presents a new strategy, the board learns the characteristics of this strategy and can make a take-it-or-leave-it offer to change the CEO's compensation contract, which the CEO either accepts or rejects. At $t = 4$, the board decides whether to approve a potential new strategy or stay with the current strategy. At $t = 5$, uncertainty is resolved and payoffs are realized.

3 Strategy Choice

3.1 Strategy Approval and Renegotiation

The board will only approve a new strategy if it increases shareholder value:

$$p(H - D - w_d(H)) - w_i \geq \hat{p}(\hat{H} - D - \hat{w}_d) - \hat{w}_i. \tag{1}$$

If (1) is not satisfied, the board can renegotiate the CEO's compensation contract. The CEO knows that in this case the board will not approve the new strategy without renegotiation and thus accepts any new wage contract that guarantees at least the same expected wage as the initial contract. If (1) is satisfied for the initial contract, the board cannot renegotiate the contract because the board cannot make a credible threat not to implement the new strategy.

Given renegotiation with symmetric information, the board and the CEO will always implement a strategy that maximizes the sum of shareholder value and CEO compensation:

$$\begin{aligned} p(H - D - w_d(H)) - w_i + pw_d(H) + w_i \geq \hat{p}(\hat{H} - D - \hat{w}_d) - \hat{w}_i + \hat{p}\hat{w}_d + \hat{w}_i \\ \Leftrightarrow p(H - D) \geq \hat{p}(\hat{H} - D). \end{aligned} \tag{2}$$

We define the set of privately optimal new strategies that increases the sum of shareholder value and expected CEO compensation as $\mathbb{P} = \{(H, p) \mid p(H - D) \geq \hat{p}(\hat{H} - D)\}$. We can thus directly state the following Lemma.

Lemma 1. *The board approves any new strategy that the CEO presents and that increases the sum of shareholder value and expected CEO compensation.*

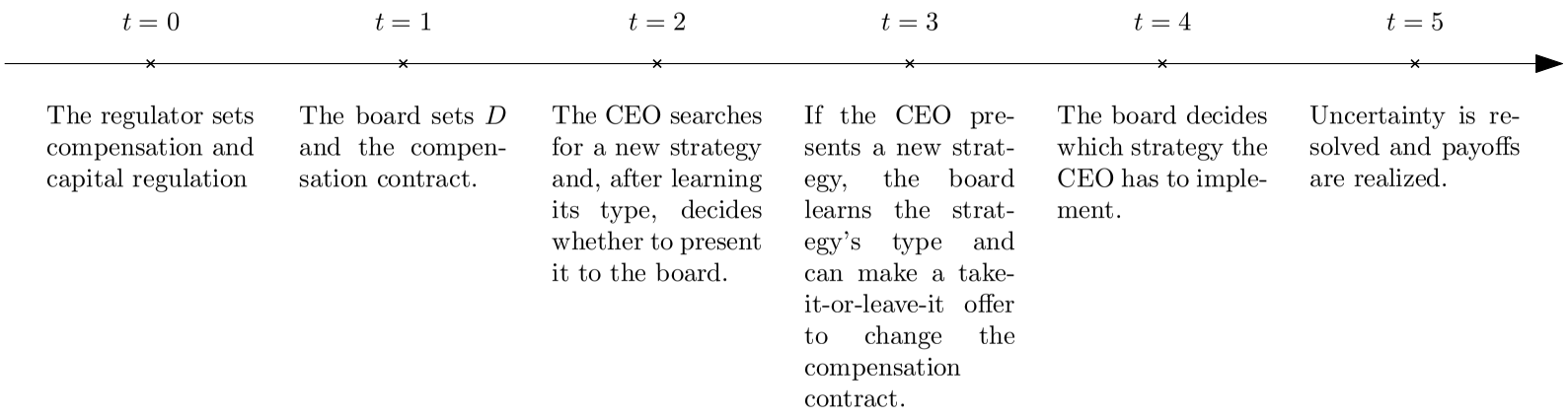

Figure 1: Time-line of events.

3.2 Search and Proposal of a New Strategy

The CEO is willing to present a new strategy to the board if his expected compensation with the new strategy is not lower than the expected compensation with the current strategy:

$$w_i + pw_d(H) \geq \hat{w}_i + \hat{p}\hat{w}_d. \tag{3}$$

The CEO also presents strategies to the board that involve renegotiation because he is never worse off after renegotiation than with the current strategy.

The CEO receives a reward for search only when the board approves a new strategy without renegotiation, which occurs whenever (1) is satisfied. We define the set of privately optimal new strategies that the board approves without renegotiation as $\mathbb{P}_0 = \{(H,p) \mid p(H - D - w_d(H)) - w_i \geq \hat{p}(\hat{H} - D - \hat{w}_d) - \hat{w}_i\}$.

The CEO's incentive constraint for engaging in search is thus given by

$$\phi \int_{\mathbb{P}_0} \max\{w_i + pw_d(H) - \hat{w}_i - \hat{p}\hat{w}_d, 0\}\, dF(H,p) \geq c. \tag{4}$$

The maximum inside the integral follows from the fact that the CEO will only present strategies that do not decrease his expected compensation. Given limited liability, the CEO's incentive constraint implies the CEO's participation constraint. The CEO's total expected compensation with search is

$$\hat{w}_i + \hat{p}\hat{w}_d + \phi \int_{\mathbb{P}_0} \max\{w_i + pw_d(H) - \hat{w}_i - \hat{p}\hat{w}_d, 0\}\, dF(H,p).$$

4 Privately Optimal Contract

Since the board retains the right to approve a new strategy, it only needs to provide the CEO with incentives to search for new strategies and to present them. With a contract that pays a bonus for implementing a new strategy, i.e., $w_i > 0$ and $\hat{w} = \hat{w}_i = w_d(H) = 0$, the CEO will present any new strategy that he finds and engage in search if

$$\phi \int_{\mathbb{P}_0} w_i\, dF(H,p) \geq c. \tag{5}$$

A simple bonus contract is sufficient to provide search incentives if c is small relative to the expected value that a new strategy can potentially create. It is then optimal for the board to set w_i such that (5) is satisfied with equality. As a result, the expected CEO compensation equals the search cost and the CEO does not earn any rent.

A simple bonus contract might not be sufficient to provide the CEO with incentives to search if c is very high. The reason is that the left-hand-side of (5) is not monotonically increasing in w_i as the likelihood of renegotiation increases in w_i. If c is large, a privately optimal contract that provides the CEO with search incentives requires that part of the compensation increases in H. However,

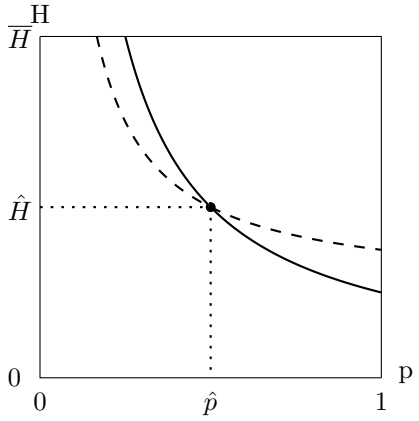

Figure 2: Preferences over new strategies. The figure depicts agents' preferences over new strategies relative to the current strategy. The area to the north-east of the solid line encompasses the set of strategies that increase the social value $\mathbb{S}$. The area to the north-east of the dashed line encompasses the set of strategies that increase the sum of shareholder value and expected CEO compensation $\mathbb{P}$.

this complication does not add to the understanding of our main arguments, and we assume that c is sufficiently small such that (5) can be satisfied. This assumption also implies that it is optimal for the board to provide the CEO with search incentives since the CEO receives a compensation only when switching to a new strategy that increases shareholder value.

5 Risk Shifting

A new strategy is efficient if it increases the bank's total expected payoff

$$pH \geq \hat{p}\hat{H}, \tag{6}$$

which in our model corresponds to the social value. We define the sets of socially optimal new strategies as $\mathbb{S} = \{(H, p) \mid pH \geq \hat{p}\hat{H}\}$. Given the outstanding claims of depositors, the set of strategies that are optimal for shareholders $\mathbb{P}$ does not coincide with the set of socially efficient strategies $\mathbb{S}$. Both sets of strategies are depicted in Figure 2. Shareholders do not bear the consequences of their bank's strategy on the repayment of depositors as they do not have to repay depositors in the case of bank failure. This option value of bankruptcy increases in the probability of default, which, ceteris paribus, makes more risky strategies more profitable for shareholders. Hence, the board has an incentive to engage in risk shifting and the privately optimal contract derived in Section 4 implements this risk shifting.

There are two types of risk shifting, which are important to distinguish. First, the board has an incentive to overinvest in risky strategies that increase

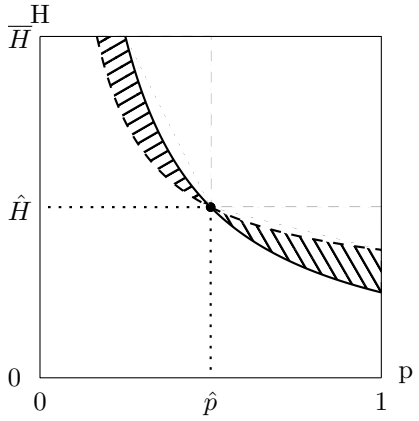

Figure 3: Risk shifting. The figure depicts the different types of risk shifting. The shaded area to the north-west of the current encompasses the set of strategies that increase shareholder value, but decrease the social value $\mathbb{P} \setminus \mathbb{S}$. The shaded area to the south-east of the current strategy encompasses the set of strategies that decrease shareholder value, but increase social value $\mathbb{S} \setminus \mathbb{P}$.

the failure probability. These strategies ($\mathbb{P} \setminus \mathbb{S}$) increase shareholder value, but decrease the social value. Second, the board is inclined to underinvest in (forgo) safer strategies that decrease the failure probability. These strategies ($\mathbb{S} \setminus \mathbb{P}$) decrease shareholder value, but increase social value. Both types of risk shifting are depicted in Figure 3. While standard risk-shifting models typically focus on the case of overinvestment in risky strategies (active risk shifting), reluctance to reduce risk (passive risk shifting) is important for banks. For example, banks have an incentive to hold on to distressed assets and gamble on the recovery of the asset value rather than removing these risks from their balance sheets (Diamond and Rajan, 2011). The distinction between the two types of risk shifting is crucial for understanding the effectiveness of regulating CEO compensation in the presence of active boards, which retain the right to decide the bank's investment strategy.

6 Compensation Regulation

6.1 Reducing Risk Shifting

Regulating CEO compensation can limit excessive risk taking by making it optimal for the CEO not to present high-risk strategies to the board. If the CEO's compensation from a new risky strategy is lower than the expected compensation from the current strategy, the CEO will not present such a strategy to the board, which prevents overinvestment in risky strategies. A prerequisite for the CEO to present only socially efficient risky strategies is that he bears some of the risk. This can only be achieved with deferred compensation that is forgone if

the bank fails. Without deferred compensation, the CEO will present either all new strategies or none at all. For example, with a fixed bonus for implementing a new strategy as in Section 4, the CEO has an incentive to present all new strategies.

Proposition 1. *For any compensation contract without deferred compensation, either all risky strategies that increase shareholder value or no new strategy will be implemented.*

Proof. For $\hat{w}_d = w_d(H) \forall H$, the CEO is either willing to present all new strategies ($w_i \geq \hat{w}_i$) or no new strategies ($w_i < \hat{w}_i$). If the CEO presents all new strategies, the board will approve all strategies that increase shareholder value. □

The latest EU capital requirements directive, known as CRD IV (Directive 2013/36/EU, Art. 94(m)), introduced regulatory requirements to defer compensation in the European bank regulation framework. Recent regulatory proposals in the US also contain requirements to defer compensation (OCC et al., 2016, §7). Compensation regulation proposals that do not require deferred compensation instead rely on forward looking risk measures, such as CDS spreads, to reduce risk shifting. In theory, this allows the contracting parties to condition contracts directly on the default probability, as in Bolton et al. (2015). The effectiveness of such regulation hinges on the accuracy of the available risk measures.

6.2 Limits of Compensation Regulation

Compensation regulation has a limited effect in preventing passive risk shifting. The reason is that both the CEO and the board must find a new strategy profitable. Any compensation contract can only redistribute the shareholder value between shareholders and the CEO. If a strategy decreases the shareholder value, there exists no compensation contract such that the incentive constraints of the board (1) and the CEO (3) are both satisfied.

Proposition 2. *With an active board, there exists no compensation contract that prevents underinvestment in safe, socially efficient strategies for $D > 0$.*

Proof. For any compensation contract, a strategy can only satisfy both (1) and (3) if (2) is satisfied. Hence, irrespective of compensation regulation, the board will not approve any strategy that decreases shareholder value. □

With an active board, it is not sufficient that a compensation contract aligns the incentives of the CEO with those of the regulator. The board will not approve a strategy that reduces risk at the expense of shareholders. Thus, there exists no compensation contract for the CEO that solves the underinvestment in safe strategies.

This result contrasts with the literature that addresses the role of regulating CEO compensation to reduce risk-shifting incentives, where regulating CEO compensation can typically ensure efficient risk taking behavior. The main reason for this difference is that, in this literature, the bank manager (CEO) chooses

the level of risk, while in our setting, risk taking is a result of decisions by both the CEO and the board. The limits of compensation regulation in our model stem from considering both an active board and passive risk shifting (forgoing strategies that reduce risk). We discuss corporate governance structures that differ from our main model in Section 8.

6.3 Bonus Caps and Linear Compensation Contracts

6.3.1 Bonus Caps

In an attempt to prevent the board from rewarding the CEO for high-risk strategies, the EU's CRD IV introduced bonus caps (Directive 2013/36/EU, Art. 94(g)). Bonus caps limit the amount of variable pay that can be awarded to the CEO to some multiple of fixed compensation.

We focus on the case where all compensation is deferred (i.e., $w_i = \hat{w}_i = 0$), because immediate compensation cannot control risk shifting, as explained in Section 6.1. The results are robust to combining deferred and immediate compensation, as we show in Appendix A.1.

We define fixed deferred compensation as the CEO's minimum deferred wage $w_d^{fix} \equiv \min\{\hat{w}_d, \min_H w_d(H)\}$. A bonus cap is a multiple $b > 1$ such that $w_d(H) \leq b w_d^{fix} \forall H$. This definition resembles EU regulation, which requires that variable deferred compensation $w_d(H) - w_d^{fix}$ must satisfy $w_d(H) - w_d^{fix} \leq (b-1) w_d^{fix} \forall H$.

A bonus cap $w_d(H) \leq b w_d^{fix}$ implies $w_d(H) \leq b\hat{w}_d$. Thus, the maximum expected compensation that the CEO can obtain when switching to a new strategy cannot exceed $pb\hat{w}_d$. Substituting $pb\hat{w}_d$ into the CEO's incentive constraint (3) shows that the CEO is never willing to present strategies with $p < \hat{p}/b$. The regulator can thus use bonus caps to limit the maximum probability of default for new strategies to $(1 - \hat{p}/b)$ by limiting the CEO's incentives to present more risky strategies to the board. The effect of bonus caps is thus comparable to a regulation that limits banks maximum default probability.

While a bonus cap reduces overinvestment in risky strategies, it also reduces the CEO's incentives to present socially efficient strategies. This effect is depicted in Figure 4. The reason is that the constraint imposed by bonus caps does not depend on H, but the social value does. Increasing b increases the set of efficient strategies that the CEO proposes, but at the same time, it also increases the set of strategies that involve risk shifting. Decreasing b has the opposite effect.

6.3.2 Linear Compensation

In contrast to a bonus cap, a CEO compensation that is linear in the bank's payoff H can fully align the CEO's incentives with those of the regulator. For example, a compensation package that consists of both stock and debt-like claims that mimic the bank's financing structure will implement a linear sharing rule.

Proposition 3. *Consider a compensation regulation that requires the compensation contract to be linear in the bank's payoff. Then, for any leverage,*

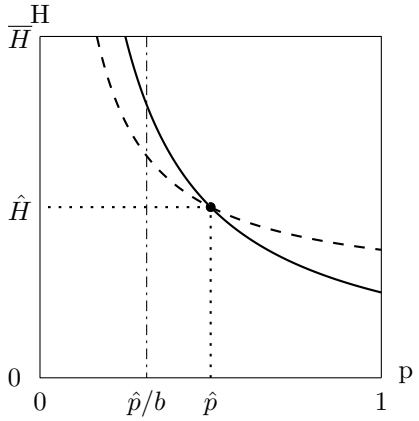

Figure 4: Bonus caps. The figure depicts the effect of a bonus cap b: the CEO will never present strategies to the left of the vertical dash-dotted line.

1. *the CEO will propose new strategies only if they are socially efficient, and the board approves all strategies that increase shareholder value;*

2. *there exists no other compensation contract where the board approves a larger set of efficient new strategies.*

Proof. Consider a compensation regulation that requires $w_d(H) = \alpha H$, $\hat{w}_d = \alpha\hat{H}$, and $\hat{w}_i = w_i$, The board chooses α and $\hat{w}_i$. Given such a contract, the CEO will only present strategies where $p\alpha H \geq \hat{p}\alpha\hat{H}$. This expression is equivalent to (6), which proves part 1 of the proposition.

Since renegotiation is possible, the board will implement any strategy that the CEO presents and that satisfies (2). Thus, the board approves all strategies that increase the sum of shareholder value and CEO compensation, which implies part 2 of the proposition. □

The CEO will engage in search if α is sufficiently high to satisfy the incentive constraint and the board will choose a contract that satisfies the incentive constraint when c is sufficiently small.

The ability to renegotiate the linear contract is important. After renegotiating the compensation for safe strategies, the board is willing to implement all safe strategies that increase the sum of shareholder value and CEO compensation. In our setting, where the board is informed and has all the bargaining power, it would not be optimal for the regulator to prohibit renegotiation.[7]

With linear compensation regulation, the set of efficient new strategies that the board will approve does not depend on α. Thus, the regulator can leave the choice of α to the board and does not need to know c, $\hat{p}$, $\hat{H}$, and $F(H, p)$. In contrast, with a bonus cap, the regulator needs to set the optimal level of the

[7]We discuss settings where it can be optimal to restrict renegotiation in Sections 10.1 and 10.3.

bonus cap and trade off reductions in risk shifting and inefficient underinvestment in risk reduction, which depend on $\hat{p}$, $\hat{H}$, and $F(H, p)$.

6.3.3 Cost of CEO Compensation and Search Incentives

The general press (Economist, 2013; Schäfer, 2013) voiced concerns that bonus caps would increase the size of bankers' fixed pay and their overall compensation package. This effect is present in our model. Compensation regulation can only be effective if the CEO receives a positive wage from the current strategy (i.e., $\hat{w}_d > 0$). Otherwise, the CEO will never lose anything when switching to a riskier strategy. A positive wage from the current strategy implies that the CEO earns a rent in our model since the current strategy is always available. Thus, the expected wage costs of providing the CEO with incentives to search for a new strategy increase when the regulator imposes compensation regulation. The CEO's wage increase is larger when c is high because the share of bank value α that is necessary to provide search incentives increases in c.

If the increase in CEO compensation is a pure transfer from shareholders to the CEO, it is of no concern for the regulator. However, the board might no longer provide the CEO with incentives to search. First, the increase in CEO pay makes it more costly to provide the CEO with search incentives. Second, compensation regulation reduces the set of risky strategies that the CEO will propose to the board, which decreases the expected benefit of search for shareholders. We provide an example where it is no longer optimal to provide search incentives with compensation regulation in Appendix A.2.

Reduced incentives to search for a new strategy are socially optimal if search was mainly motivated by risk shifting. However, reduced incentives for search that stem from the higher rent that the CEO earns with compensation regulation can be socially costly if the bank forgoes the option to find and implement new strategies that increase social value.

7 Leverage Regulation

7.1 Privately Optimal Leverage

Privately optimal leverage maximizes shareholder value. Without compensation regulation, the CEO always earns c and shareholders have an incentive to maximize leverage. Under linear compensation regulation, leverage increases the CEO's rent because leverage reduces the set of strategies that the board approves without renegotiation $\mathbb{S} \cap \mathbb{P}_0$. It follows that, in order to satisfy the CEO's incentive constraint

$$\alpha\phi \int_{\mathbb{S}\cap\mathbb{P}_0} (pH - \hat{p}\hat{H})\, dF(H, p) \geq c \tag{7}$$

the board must choose a higher α as leverage increases. The incentive constraint also shows that, when the search cost approaches zero, the CEO's share α goes

to zero as well. Hence, changes in the value of the deposit insurance subsidy dominate changes of the CEO's rent for small c.

Lemma 2. *When compensation regulation requires a linear compensation, an active board chooses the maximum possible leverage for small c.*

Proof. see Appendix A.3. □

If c is large, the trade-off between higher leverage and a higher CEO rent becomes more important. Hence, the board might reduce leverage to reduce the CEO's rent. In this case, the optimal capital regulation, which we derive in the next section, might not be binding. We focus on the case where regulatory capital regulation is binding and assume that c is sufficiently small so that the board also maximizes bank leverage with compensation regulation.

7.2 Socially Optimal Leverage

The regulator maximizes social value, which is equivalent to the total value of the bank to its stakeholders: the bank's shareholders, the CEO, and depositors, who also derive utility $\gamma(D)$ from insured deposits. Thus, the regulator's objective function is

$$\hat{p}\hat{H} + \phi \int_{\mathbb{I}} (pH - \hat{p}\hat{H})\, dF(H,p) - I - c + \gamma(D), \tag{8}$$

where $\mathbb{I}$ denotes the set of new strategies that the CEO implements. The payment from the deposit insurance corporation to depositors does not enter the objective function, as it is a pure transfer.

The combination of a leverage constraint and compensation regulation allows the regulator to achieve higher welfare than each measure in isolation. The reason is that leverage regulation affects shareholders' incentives. With an active board, there is always underinvestment in risk-reducing strategies. The extent of this underinvestment depends on shareholders' risk-shifting incentives. Lower leverage reduces shareholders' risk-shifting incentives and thereby reduces underinvestment in risk-reducing strategies. Hence, the optimal regulation must constrain leverage. Compensation regulation remains optimal for any level of positive leverage because it can fully eliminate overinvestment in risky strategies. But for any positive leverage there are safe, socially efficient strategies that the board rejects (Proposition 2). Hence, even the optimal combination of capital and compensation regulations does not fully prevent underinvestment in safe strategies.

Proposition 4. *The optimal regulation constrains leverage and regulates compensation, but cannot implement the first best.*

Proof. See Appendix A.4. □

The mechanism behind our results is very general. Regulation that provides incentives to a bank's agents, such as the CEO, can be very effective when theses agents have real control. But to the extent that shareholders retain some control

over the bank, their preferences will continue to shape the bank's strategy. Thus, an optimal regulation will include elements that directly target shareholders' incentives.

Optimal capital regulation generally requires much more information than compensation regulation, because the regulator needs to understand the trade-off between the social value of deposits and the cost of risk shifting. However, with linear compensation regulation, the regulator does not need to take care of overinvestment in risky strategies when setting the maximum leverage ratio.

Introducing compensation regulation increases the socially optimal level of leverage. The reason is that compensation regulation curtails overinvestment in risky strategies independently of leverage, which diminishes the marginal value of reducing leverage. However, the model does not suggest that introducing regulation of CEO compensation justifies a reduction of the level of required regulatory capital that we observe in practice. Capital requirements in the past might have been too low so that increasing them may still be appropriate.

8 Passive versus Active Boards

8.1 Compensation Regulation with Passive Boards

The limit of compensation regulation in preventing risk shifting is due to the board's involvement in the selection of the bank's strategy. In contrast, the literature on regulating bank CEO compensation generally assumes that the CEO (manager) chooses the level of risk. In our setting, this corresponds to a situation where the board is passive and delegates the choice of strategy to the CEO. One reason why a board could remain passive is because it does not have sufficient expertise to acquire information about the strategies that the CEO presents.[8] If the board does not possess any information about new strategies, it can either approve all or no strategies that the CEO presents. Hence, such a board loses its real authority in the sense of Aghion and Tirole (1997) even if it retains the formal right to approve and reject new strategies. A bank's board will not acquire the necessary expertise and information if this is too costly. We formally introduce such costs in the next subsection.

With a passive board, compensation regulation is more effective, since only the CEO's incentives influence which strategy is implemented. Indeed, with delegation, compensation regulation can ensure that the CEO implements a new strategy if and only if it is socially optimal.

Proposition 5. *With a passive board, compensation regulation that requires the compensation contract to be linear in the bank's total payoff implements the socially optimal set of strategies if*

$$\phi \int_{\mathbb{S}} p(H-D) - \hat{p}(\hat{H}-D)\, dF(H,p) - c - \alpha\hat{p}\hat{H} > 0, \tag{9}$$

[8] This also excludes information acquisition through messages and contract renegotiation, which we discuss in Section 10.1.

where $\alpha = c[\phi \int_{\mathbb{S}} pH - \hat{p}\hat{H}\, dF(H,p)]^{-1}$.

Proof. See the following discussion. □

If the CEO receives a fixed fraction α of the bank's total payoff, it is optimal for the CEO to pursue only strategies that are socially optimal and maximize total bank value. Formally, a new strategy increases the CEO's expected compensation with a linear contract if and only if the strategy increases social value:

$$p\alpha H > \hat{p}\alpha\hat{H} \Leftrightarrow pH > \hat{p}\hat{H}.$$

Equation (9) ensures that the expected increase in shareholder value exceeds the compensation costs from search. Hence, the board is willing to provide search incentives and implement all new strategies the CEO proposes.

Propositions 2 and 5 highlight the fact that the role of the board is important when it comes to the effectiveness of regulating CEO compensation. Regulating compensation is more effective if the ultimate decision about a strategy rests with the CEO and not with an active board. If the CEO has to seek approval from the board, the effectiveness of regulating CEO compensation is limited. This result resembles the findings by Cerasi and Oliviero (2015) who show that the impact of CEO compensation on bank risk taking depends on the bank's corporate governance. In a similar vein, Laeven and Levine (2009) find that the effect of capital regulation depends on the bank's corporate governance.

8.2 Banks' Choice between Active and Passive Boards

The costs and benefits of active versus passive boards depend on the regulatory framework. Banks choose their corporate governance structure and will adapt it following the introduction of compensation regulation in order to maximize shareholder value. To analyze shareholders' trade-off between choosing different board structures, we introduce a private cost of implementing an active board $\kappa \in [0, \bar{\kappa}]$, which can be interpreted as an information cost. We assume that $\bar{\kappa}$ is sufficiently low so that a bank with an active board is viable and has a positive value. Banks differ in the implementation cost κ associated with an active board and the CEO's search cost c. The board and the CEO know the bank's type (c, κ), but the regulator cannot observe it.

Without compensation regulation, an active board allows shareholders to implement their privately optimal set of strategies without paying a rent to the CEO. A passive board delegates the choice of strategy to the CEO. This delegation is costly because it involves higher wage costs and higher opportunity costs that arise from the CEO implementing some strategies that reduce shareholder value. Note that a passive board can implement the same set of strategies as an active board by choosing a compensation contract that is linear in shareholder value. If it does so the CEO's rent is $\alpha\hat{p}(\hat{H} - D)$, where α depends on the CEO's search cost c. Shareholders trade off the cost of delegation and the cost of implementing an active board κ.

With compensation regulation, the CEO presents all strategies that increase social value. An active board prevents the CEO from implementing strategies that decrease shareholder value $\mathbb{S} \setminus \mathbb{P}$. Because the compensation contract is linear, the CEO always earns a rent $\alpha \hat{p} \hat{H}$. But an active board must choose a steeper compensation contract (higher α) and pay a higher rent in order to provide search incentives than a passive board. The reason is that the set of strategies that an active board approves without renegotiation $\mathbb{S} \cap \mathbb{P}_0$ is smaller than the set of strategies $\mathbb{S}$ the CEO implements with a passive board.

When the CEO's search cost is small, the rent earned by the CEO will be small in all cases discussed above. Hence, without compensation regulation, the cost of an active board κ will be higher than the cost of delegation and a passive board will be privately optimal. With compensation regulation, shareholders trade off the cost of implementing strategies in $\mathbb{S} \setminus \mathbb{P}$ and the cost of an active board κ. When κ is smaller than the cost of implementing $\mathbb{S} \setminus \mathbb{P}$, then shareholders will alter the board from passive to active following the introduction of compensation regulation.

Proposition 6. *There exists a set of bank types (c, κ) for which the introduction of linear compensation regulation alters the shareholders' choice of board from passive to active.*

Proof. See Appendix A.5. □

Hence, the introduction of compensation regulation increases the prevalence of active boards when shareholders' incentives to underinvest in efficient risk-reducing strategies dominate the costs of implementing an active board and providing search incentives. This adaptation of the corporate governance structure reduces the effectiveness of compensation regulation.

Underlying Proposition 6 is the assumption that c is small, as discussed above. If c is sufficiently large, the CEO's rent becomes important and the effect on the CEO's rent could reverse the effect described in Proposition 6 because the difference in CEO rents between active and passive boards decreases with the introduction of compensation regulation.

8.3 Indispensable Active Boards

Our analysis in Section 8.1 suggests that active boards reduce social value. However, active boards not only monitor the CEO's choice of strategies, but often provide other essential forms of oversight. In this subsection, we provide an extension to our model in which an active board is essential for both shareholder value and social value.[9]

[9] Burkart et al. (1997) discuss the impact of board monitoring on a CEO's effort provision. They show that board monitoring can optimally coexist with monetary incentives if the agency problem is sufficiently severe. Adams and Ferreira (2007) discuss the impact of more or less active boards on information sharing between the CEO and the board. While it can be optimal in their model not to fully align the board with shareholders' interests, the board always monitors the CEO with positive probability.

Suppose that, with probability $\rho \in [0,1]$, the CEO has the opportunity to mismanage the bank and extract private benefits. We model the rent extraction as the possibility of the CEO to transfer the bank's payoff H to himself, which results in certain failure of the bank, i.e., the payoff is zero in both states. Rent extraction is inefficient as the CEO's utility increases by only βH, where $\beta < 1$ measures the efficiency of rent extraction.

The CEO observes whether he can extract a rent after signing the contract with the board, but before he engages in search. An active board that monitors the CEO can prevent mismanagement and rent extraction. A passive board, on the other hand, cannot observe whether the CEO can extract a rent and can prevent rent extraction only by setting $\hat{w}_d \geq \beta \hat{H}$ and $w_d(H) \geq \beta H$ for all H. Alternatively, if the passive board chooses not to pay a wage to prevent rent extraction, the CEO will mismanage the bank if he has the opportunity to do so.

Proposition 7. *If ρ and β are sufficiently high, a bank is viable only if it has an active board. In this case, an active board is privately and socially optimal.*

Proof. see Appendix A.6. □

If β is high, it is too costly for the board to provide the CEO with incentives not to extract any rent. If, in addition, the probability of rent extraction ρ is sufficiently high, the bank's participation constraint is not satisfied and shareholders are not willing to finance banks with a passive board. Hence, if some banks face sufficiently severe moral hazard problems, passive boards are generally not socially optimal because this would destroy the entire social value of these banks' operations.

9 Additional Regulatory Tools

9.1 Functions of the Board

A regulator could attempt to require bank boards to exclusively focus on preventing rent extraction and otherwise not intervene in the choice of strategies. However, these two functions might be inherently linked. The possibility of rent extraction might be related to a bank's strategy, and to prevent rent extraction, the board might need to understand the bank's business model and control strategic decisions. Hence, designing such a regulation is very difficult and would require a very delicate intervention in the board's conduct. Further, to the extent that board members also provide strategic advice to the CEO (e.g., Adams and Ferreira, 2007), this regulation would introduce an important downside that might easily outweigh its intended benefit.

9.2 Directors' Incentives

A regulator could also attempt to provide incentives to board members that align their objectives with the bank's social value. The regulator could, for example, impose compensation contracts for board members that are linear in the total

value of the bank, and thus resemble the CEO compensation that we discussed in Section 6.3.2. Alternatively, increased liability of directors in cases of banks' bankruptcy can also provide incentives against risk shifting.[10] The effectiveness of such regulation depends on the degree to which the regulatory incentives outweigh shareholders' influence. As long as shareholders retain some influence in the bank, their preferences will continue to impact on the choice of the bank's strategy. Shareholders could, for example, prevent directors from implementing certain strategies by threatening to remove them from their position at the next opportunity. The interaction between a regulated board and shareholders could thus resemble the interaction between CEOs and boards that we have analyzed.

If, however, the regulator fully succeeded in controlling the boards' incentives, then banks' directors would be transformed from shareholders' agents into agents of the regulator. This would be akin to the regulator taking direct control of the bank, employing his own agents to run the bank. In this case, the bank would cease to function as a privately owned firm. The outcome of such regulation depends on whether the regulator has the information, the expertise, and the right incentives to run the banking system in an efficient way. Similar considerations pertain to direct oversight by the regulator that permits micromanagement of a bank's decisions.

9.3 Board Composition

Another approach to align boards' decisions with the social value of the bank is to give other stakeholders, such as employees, debt holders, and regulators, the right to appoint directors. These directors will presumably limit the influence of directors representing shareholders, who attempt to suppress efficient risk-reduction strategies.[11] Such regulation must ensure that the composition of the board leads to an appropriate balance of different interests.

Several corporate governance reform proposals (BCBS, 2014; PRA and FCA, 2014) attempt to increase the number and influence of independent directors. The literature commonly assumes that independent directors are more aligned with shareholders' interests than are inside directors, whose interests may be more aligned with those of the CEO. In our framework, increasing the share of independent directors that maximize shareholder value would tend to increase the underinvestment in safe strategies if directors are informed. However, Adams (2012) argues that, in financial firms, independent directors are likely to have little or no experience in the finance industry and thus are less informed. An

[10] Proposed regulation in the UK (PRA and FCA, 2014) introduces criminal liability for board members in the case of bank failure. In addition, the regulator can fine individuals and suspend their regulatory approval, which is required to hold a senior management position in a bank.

[11] The Basel Committee on bank corporate governance proposes that "[...] the board should take into account the legitimate interests of depositors, shareholders and other relevant stakeholders." (BCBS, 2014, p. 8) Existing regulations in Germany and Austria require board representation of employees. In Austria representatives of the Financial Market Authority can take part in all meetings of a bank's supervisory board and have to veto decisions that violate regulations.

uninformed board makes compensation regulation more effective in our model, but may fail to prevent inefficient, opportunistic behavior by the CEO. Thus, increasing the number of independent directors may either not be effective in reducing a bank's risk shifting or reduce the board's ability to monitor the CEO.

9.4 Linking Regulation to Corporate Governance

Regulation could become more effective when it differentiates between active and passive boards. However, implementing such regulation is difficult. First, it is difficult to assess whether a board is active (monitors) or is passive, as this requires detailed information about its conduct and the internal operation of its corporate governance. Second, the incentives to choose passive boards must not prevent active boards when they are necessary for the profitable operation of banks. The regulator must thus ensure that choosing active boards remains sufficiently profitable, which limits the incentives that the regulator can provide for choosing a passive board. The regulator could implement a mechanism that gives banks incentives to reveal their type (c, κ, ρ, β). However, in practice, banks' types are more complex than in our model and the regulator will not be able to elicit all the relevant information. This contrasts with the simple linear compensation regulation that can be applied uniformly to all banks and does not rely on individual bank's characteristics.

10 Extensions

10.1 Imperfectly Informed Board

In this section, we consider an imperfectly informed board and assume that, when the CEO presents a new strategy, the board observes the strategy's risk p, but not its payoff H. This setting captures an intermediate case between a fully informed active board and an uninformed passive board.

An unregulated imperfectly informed board can elicit the CEO's information about a new strategy's payoff H and implement $\mathbb{P}$ like a fully informed active board. The board uses its ability to renegotiate contracts to provide incentives for the CEO to truthfully report a strategy's payoff. In particular, the board can offer a new contract that only pays a wage when the bank's payoff coincides with the CEO's report. We provide a detailed description of a truth telling equilibrium where the bank implements $\mathbb{P}$ and the CEO does not earn a rent in Appendix A.7.

In this setting, it can be optimal for the regulator to implement compensation regulation that does not allow the board to renegotiate the compensation contract, as this prevents the board from eliciting the CEO's information. Without renegotiation, the CEO only presents new strategies that increase his expected compensation, and the board can only approve or reject a new strategy. Therefore, linear compensation regulation without renegotiation can turn an imperfectly informed board into a passive board that implements the socially efficient set of

strategies if (9) holds and

$$\mathbb{E}[p(H - D - \alpha H) - \hat{p}(\hat{H} - D - \alpha \hat{H}) \mid p \wedge (H, p) \in \mathbb{S}] \geq 0 \forall p.$$

This condition ensures that an imperfectly informed board that cannot renegotiate the CEO's compensation contract implements all new strategies when the CEO presents $\mathbb{S}$, regardless of p.

Compensation regulation that restricts renegotiation can render an imperfectly informed board less active if the board cannot become fully informed. At the same time such regulation increases shareholders' willingness to pay for the board to become fully rather than imperfectly informed, analogously to Section 8.2.

10.2 Private Costs of Bankruptcy

We now assume that the CEO incurs a reputation loss in case of bankruptcy, equal to private costs B.[12] This cost must be accounted for in the social value of a bank's strategy $pH - (1-p)B$. Hence, the set of socially optimal strategies is

$$\mathbb{S}_B = \{(H, p) \mid p(H + B) \geq \hat{p}(\hat{H} + B)\}.$$

The sum of shareholder value and CEO payoff is $p(H - D) - (1-p)B$, which defines the set of privately optimal strategies

$$\mathbb{P}_B = \{(H, p) \mid p(H + B - D) \geq \hat{p}(\hat{H} + B - D)\}.$$

Because the CEO's personal costs of bankruptcy is internalized by the regulator as well as shareholders, it does not reduce the wedge between the private and the social optimum. The effect of bankruptcy costs on the choice of (privately as well as socially optimal) strategies is comparable to an increase of all payoffs by B.[13]

Without compensation regulation, an active board will again implement the set of privately optimal strategies $\mathbb{P}_B$. The wage that the CEO receives when implementing the default strategy must compensate the CEO for the expected cost of default. That is, $\hat{w}_i + \hat{p}\hat{w}_d - (1-\hat{p})B \geq 0$.

Private bankruptcy costs alter the CEOs' participation constraints. After the board has decided to implement a new strategy, the CEO's participation constraint is

$$w_i + pw_d(H) - (1-p)B \geq 0.$$

Since a CEO is necessary to run the bank and has the option to quit, the board will renegotiate the CEO's contract when his participation constraint is not

[12] For recent empirical evidence on the effect of bankruptcy on CEO's careers, see Eckbo et al. (2016).

[13] We assume that the default strategy has a positive value $\hat{p}\hat{H} - (1-\hat{p})B > I$, so that it is optimal for shareholders to implement it.

satisfied.[14] Thus, the CEO will present a new strategy if

$$\max\{w_i + pw_d(H) - (1-p)B, 0\} \geq \hat{w}_i + \hat{p}\hat{w}_d - (1-\hat{p})B. \tag{10}$$

The set of new strategies that the board approves without renegotiation (either because the CEO would otherwise quit or because the board would otherwise not approve the strategy) is

$$\mathbb{P}_{B0} = \mathbb{P}_0 \cap \{(H,p) \mid w_i + pw_d(H) - (1-p)B \geq 0\}.$$

A privately optimal contract is given by $w_d(H) = \hat{w}_d = 0$, $\hat{w}_i = (1-\hat{p})B$, and $w_i > 0$ such that the incentive constraint

$$\phi \int_{\mathbb{P}_{B0}} w_i - (1-p)B \, dF(H,p) \geq c$$

is satisfied with equality. Because the CEO's expected payoff from the default strategy is zero, the right-hand-side of (10) is zero and the CEO will present every new strategy he discovers. With this compensation contract, the CEO does not earn a rent and the privately optimal set of strategies is implemented. As is the case without private bankruptcy costs, such a contract exists if c is sufficiently small. Moreover, the incentive constraint implies that the CEO's participation constraint is satisfied.

Linear compensation regulation is no longer optimal since the CEO fully bears his personal costs of financial distress B, but shares only partially in the payoff H. Compensation regulation must take the CEO's private bankruptcy costs and resulting incentives into account. An adapted optimal compensation regulation is given by $w_i = \hat{w}_i = 0$,

$$w_d(H) = \frac{\hat{w}_d + B}{\hat{H} + B} \max\left\{H - \frac{\hat{H} - \hat{w}_d}{\hat{w}_d + B}B, 0\right\}, \text{ and } \hat{w}_d > \frac{1-\hat{p}}{\hat{p}}B.$$

Hence, with private bankruptcy costs the optimal compensation regulation resembles a call option on the total bank value that is used to neutralize the CEO's risk aversion stemming from the personal costs of bankruptcy.[15] The condition $\hat{w}_d > \frac{1-\hat{p}}{\hat{p}}B$ ensures that the CEO obtains a positive expected payoff with the default strategy to avoid the CEO presenting all new strategies. The incentive constraint to present a new strategy (10) is therefore

$$pw_d(H) - (1-p)B \geq \hat{p}\hat{w}_d - (1-\hat{p})B.$$

Substituting for $w_d(H)$ shows that the CEO presents a new strategy if and only if it is in $\mathbb{S}_B$. With an active board, the bank will implement new strategies in $\mathbb{S}_B \cap \mathbb{P}_B$.

[14] If the CEO were to quit, the board could hire a new CEO, but would need to satisfy the same participation constraint.

[15] The idea that options could be used to neutralize CEO risk aversion appears as early as Jensen and Meckling (1976).

10.3 CEO Bargaining Power and Captured Boards

CEOs typically have considerable bargaining power and exercise influence over their boards (e.g., Bebchuk and Fried, 2004, Part II). A CEO's bargaining power determines how the available surplus is shared, both when setting the initial compensation contract and when renegotiating the initial contract after the CEO has discovered a new strategy. Obviously, the board must exercise sufficient control over the CEO's compensation to ensure that shareholders' participation constraint is satisfied. Otherwise, if the CEO has the power to extract excessive amounts of compensation from the bank, shareholders will no longer be willing to invest in the bank.

Bargaining between the board and the CEO ensures that the board still approves strategies and implements a CEO compensation that maximize the sum of shareholder value and CEO compensation in most prominent bargaining games, irrespective of the CEO's bargaining power.[16] Thus, for an unregulated bank, where the initial contract can be written such that the CEO presents all new strategies, bargaining ensures that the bank implements the privately optimal set of strategies.

If the CEO has high bargaining power, linear compensation regulation can no longer prevent excessive risk taking (overinvestment in a risky strategy) if renegotiation is allowed. The reason is that a powerful CEO can renegotiate his compensation contract to obtain a higher wage after he presents a new strategy that increases shareholder value. Hence, the CEO is willing to present some strategies for which the initial compensation contract yields a lower expected wage than the default contract, i.e., (3) is violated. As a consequence, a CEO with a linear compensation contract and bargaining power presents additional risky strategies to the board, which causes risk shifting.[17]

A regulator could adapt the compensation regulation to counteract the CEO's power in renegotiation. However, such regulation requires very detailed information, including information about the bargaining power of the CEO, and would need to be tailored to individual banks. Moreover, if the CEO has sufficient control over the board, the initial contract does not limit the amount of surplus that the CEO can extract and compensation regulation that allows renegotiation becomes ineffective. Alternatively, the regulator could prohibit the renegotiation of the compensation contract, in which case the CEO cannot appropriate surplus in excess of his initial contract after presenting a new strategy. However, such a regulation can lead to inefficient underinvestment in risk reduction, as discussed

[16] Most prominent bargain models with symmetric information imply that the parties involved in the bargaining process maximize the joint payoff, using transfers to reallocate the payoff reflecting individual bargaining power. Examples include Nash bargaining, Rubinstein-Ståhl bargaining, the generalized Nash bargaining solution, and the Kalai-Smorodinsky bargaining solution.

[17] Note that this discussion assumes that the CEO can always start renegotiation after he has presented a new strategy. If, instead, only the board can start renegotiation, a board that is weak when bargaining with the CEO, but tries to maximize shareholder surplus, will only do so if (1) is violated. In this case, even a powerful CEO will present only strategies for which (3) is satisfied.

in Section 6.3.2.

11 Discussion and Conclusion

We have identified limits of compensation regulation in the presence of an active, shareholder friendly board. Such a board retains the ultimate power to approve new bank strategies that the CEO proposes. While the regulator can limit the CEO's willingness to propose high-risk strategies to the board, compensation regulation does not affect the board's willingness to approve strategies that reduce risk.

If a passive board delegates the choice of bank strategy to the CEO, regulating the pay of the CEO has more bite and can implement efficient risk taking by the CEO. The presence of an active board can be essential, however, to deter opportunistic behavior by the CEO that would be inefficient. Compensation regulation makes it more costly for shareholders to delegate the choice of strategy to the CEO. The reason is that shareholders can no longer rely on compensation contracts to align the CEO's incentives with their own.

Reform proposals concerning banks' corporate governance generally face the tension between regulatory objectives and the objectives of shareholders. To reduce risk shifting, the regulator can constrain the compensation of CEOs and other bank managers. However, the governance structure is likely to adapt in order to preserve shareholders' interests. In our setting, boards might become more active when regulators constrain CEO compensation.

Another possibility to reduce risk shifting is to limit a bank's leverage. With an active board, combining regulation of bank capital and CEO compensation is more efficient than using either of the two tools in isolation. Requiring a CEO compensation that is linear in total bank value curtails the CEO's willingness to participate in risk shifting, while a higher regulatory capital requirement reduces the positive effect of risk shifting on shareholder value. The former avoids the CEO proposing strategies that result in inefficiently high risk, the latter ensures that a shareholder friendly board is willing to accept a larger set of strategies that reduce risk.

A Appendix

A.1 Bonus Caps with Partially Deferred Compensation

With partially deferred compensation, we impose separate bonus caps for immediate and deferred compensation. Such bonus caps reflect the EBA (2015, p.59) regulation that requires bonus caps to hold separately for every performance year. A bonus cap for deferred compensation can be defined as in Section 6.3.1 and a bonus cap for immediate compensation can be defined as $w_i \leq b\hat{w}_i$. To formalize partially deferred compensation, we require that a fraction d of the CEO's fixed compensation must be deferred, $w_d^{fix} \geq d\hat{w}_i$.

Such a combination of bonus caps and deferred compensation constrains the maximum compensation that the CEO can obtain when switching to a new strategy $w_d(H) + w_i \leq b(\hat{w}_d + \hat{w}_i) \leq b(1 + d^{-1})\hat{w}_d$.[18] Rearranging the terms in the CEO's incentive constraint for presenting a new strategy (3) and substituting the constraints imposed by bonus caps and deferred compensation yields

$$p \geq \frac{\hat{p}\hat{w}_d + \hat{w}_i - w_i}{w_d(H)} \geq \frac{\hat{p} + (1-b)d^{-1}}{b}.$$

Hence, bonus caps allow the regulator to limit the maximum probability of default to $1 - (\hat{p} + (1-b)d^{-1})b^{-1}$. This condition binds the failure probability below 1 if the fraction of deferred fixed compensation is sufficiently large $d \geq (b-1)/\hat{p}$. Taking the derivatives with respect to b and d, the maximum failure probability increases in the ratio of maximum bonuses to fixed compensation and decreases in the share of deferred compensation, respectively.

A.2 Compensation Regulation Destroys Search Incentives

We provide an example where compensation regulation destroys shareholders' incentives to provide search incentives to the CEO. To do so, we assume a search cost $c = a\phi$ and compare a linear compensation contract with the privately optimal contract discussed in Section 4. Suppose that for both contracts the CEO's incentive constraint (4) can be satisfied. For $c = a\phi$, (4) can be rewritten as

$$\int_{\mathbb{P}_0} \max\{w_i + pw_d(H) - \hat{w}_i - \hat{p}\hat{w}_d, 0\}\, dF(H,p) \geq a,$$

which does not depend on ϕ for all $\phi > 0$.

The shareholders' expected profit from search in the unregulated case is

$$\phi \int_{\mathbb{P}} p(H-D) - \hat{p}(\hat{H}-D)\, dF(H,p) - a\phi.$$

Because the CEO only receives a compensation when a new strategy is implemented without renegotiation, this expression must always be (weakly) positive when the incentive constraint is satisfied, which does not depend on ϕ.

With a linear compensation contract, the shareholders' expected profit from search is

$$\phi \int_{\mathbb{S}\cap\mathbb{P}} p(H-D) - \hat{p}(\hat{H}-D)\, dF(H,p) - a\phi - \alpha\hat{p}\hat{H}, \tag{11}$$

where α is the lowest value for which the CEO's incentive constraint is binding. Hence, regulation destroys search incentives when (11) is negative, which is always the case when $\phi \to 0$. The private net gains from engaging in search $\phi \int_{\mathbb{S}\cap\mathbb{P}_0} p(H-D) - \hat{p}(\hat{H}-D)\, dF(H,p) - a\phi$ go to zero as $\phi \to 0$. The CEO's rent $\alpha\hat{p}\hat{H}$, on the other hand, stays constant because the incentive constraint does not depend on ϕ.

[18] These inequalities use that $w_d^{fix} \leq \hat{w}_d$ by definition.

A.3 Proof of Lemma 2

Proof. When compensation regulation takes the form of imposing a linear contract $\alpha = \hat{w}_d/\hat{H}$, the CEO implements new strategies in $\mathbb{S} \cap \mathbb{P}$. Hence, we can write the shareholder value as

$$\hat{p}(\hat{H}-D) + \phi \int_{\underline{H}}^{\hat{H}} \int_{\underline{p}(H)}^{1} (p(H-D) - \hat{p}(\hat{H}-D)) f(H,p)\, dp\, dH$$
$$+ \phi \int_{\hat{H}}^{\bar{H}} \int_{\hat{p}\frac{\hat{H}}{H}}^{1} (p(H-D) - \hat{p}(\hat{H}-D)) f(H,p)\, dp\, dH - (I-D) - \hat{p}\hat{w}_d(D) - c,$$

where $\underline{H} = \hat{p}\hat{H} + (1-\hat{p})D$ and $\underline{p}(H) = \hat{p}\frac{\hat{H}-D}{H-D}$. The derivative with respect to leverage is given by

$$(1-\hat{p}) + \phi \int_{\underline{H}}^{\hat{H}} \int_{\underline{p}(H)}^{1} (-p+\hat{p}) f(H,p)\, dp - \frac{\partial \underline{p}(H)}{\partial D} (\underline{p}(H-D) - \hat{p}(\hat{H}-D)) f(H, \underline{p}(H))\, dH$$
$$-\phi \frac{\partial \underline{H}}{\partial D} \int_{\underline{p}(\underline{H})}^{1} (p(\underline{H}-D) - \hat{p}(\hat{H}-D)) f(\underline{H},p)\, dp + \phi \int_{\hat{H}}^{\bar{H}} \int_{\hat{p}\frac{\hat{H}}{H}}^{1} (-p+\hat{p}) f(H,p)\, dp\, dH - \hat{p}\frac{\partial \hat{w}_d}{\partial D}. \tag{12}$$

The first term $(1-\hat{p})$ denotes the marginal increase in the deposit insurance subsidy when the current strategy is implemented. The four middle terms account for the difference in the deposit insurance subsidy when a new strategy is implemented. The last term $-\hat{p}\frac{\partial \hat{w}_d}{\partial D}$ denotes the changes to the CEO's rent. The deposit insurance subsidy is increasing in leverage. Hence, the shareholder value is increasing in leverage when the absolute value of $\frac{\partial \hat{w}_d}{\partial D}$ is sufficiently small.

The CEO's rent $\hat{w}_d$ is determined by the CEO's incentive constraint (7). With a linear compensation contract, the CEO implements strategies in $\mathbb{S} \cap \mathbb{P}_0$ without renegotiating the compensation contract. Hence, we can write the CEO's incentive constraint as

$$\phi \int_{\underline{H}}^{\hat{H}} \int_{\underline{p}(H)}^{1} (p(\hat{w}_d/\hat{H})H - \hat{p}\hat{w}_d) f(H,p)\, dp\, dH + \phi \int_{\hat{H}}^{\bar{H}} \int_{\hat{p}\frac{\hat{H}}{H}}^{1} (p(\hat{w}_d/\hat{H})H - \hat{p}\hat{w}_d) f(H,p)\, dp\, dH = c,$$

where $\underline{H} = \hat{p}\hat{H} + (1-\hat{p})(1-\hat{w}_d/\hat{H})D$ and $\underline{p}(H) = \hat{p}\frac{(1-\hat{w}_d/\hat{H})\hat{H}-D}{(1-\hat{w}_d/\hat{H})H-D}$.

Applying the implicit function theorem yields

$$\frac{\partial \hat{w}_d}{\partial D} = \Bigg[\int_{\underline{H}}^{\hat{H}} \frac{\partial \underline{p}(H)}{\partial D}(\underline{p}(H)(\hat{w}_d/\hat{H})H - \hat{p}\hat{w}_d)f(H,\underline{p}(H))\,dH + \frac{\partial \underline{H}}{\partial D}\int_{\underline{p}(\underline{H})}^{1}(p(\hat{w}_d/\hat{H})\underline{H} - \hat{p}\hat{w}_d)f(\underline{H},p)\,dp\Bigg]$$
$$\times\Bigg[\int_{\underline{H}}^{\hat{H}}\int_{\underline{p}(H)}^{1}((p/\hat{H})H-\hat{p})f(H,p)\,dp - \frac{\partial \underline{p}(H)}{\partial \hat{w}_d}\underline{p}(\hat{w}_d/\hat{H})H-\hat{p}\hat{w}_d)f(H,\underline{p}(H))\,dH$$
$$-\frac{\partial \underline{H}}{\partial \hat{w}_d}\int_{\underline{p}(\underline{H})}^{1}(p(\hat{w}_d/\hat{H})\underline{H}-\hat{p}\hat{w}_d)f(\underline{H},p)\,dp + \int_{\hat{H}}^{\bar{H}}\int_{\hat{p}\frac{\hat{H}}{H}}^{1}((p/\hat{H})H-\hat{p})f(H,p)\,dp\,dH\Bigg]^{-1}.$$

Inspection of the above expression shows that $\frac{\partial \hat{w}_d}{\partial D}$ approaches zero as $\hat{w}_d \to 0$. From the CEO's incentive constraint it follows that $\lim_{c\to 0}\hat{w}_d = 0$. Hence, the board maximizes leverage when c is sufficiently small to ensure that (12) is positive. □

A.4 Proof of Proposition 4

Proof. With a linear compensation regulation, the CEO implements new strategies in $\mathbb{S}\cap\mathbb{P}$. Hence, we can write the regulator's objective function (8) as

$$\hat{p}\hat{H} + \phi\int_{\underline{H}}^{\hat{H}}\int_{\underline{p}(H)}^{1}(pH-\hat{p}\hat{H})f(H,p)\,dp\,dH + \phi\int_{\hat{H}}^{\bar{H}}\int_{\hat{p}\frac{\hat{H}}{H}}^{1}(pH-\hat{p}\hat{H})f(H,p)\,dp\,dH - I - c + \gamma(D),$$

where $\underline{H} = \hat{p}\hat{H} + (1-\hat{p})D$ and $\underline{p}(H) = \hat{p}\frac{\hat{H}-D}{H-D}$. It follows that the regulator's first order condition for leverage is

$$\phi\int_{\underline{H}}^{\hat{H}}\frac{\partial \underline{p}(H)}{\partial D}(\underline{p}(H)H-\hat{p}\hat{H})f(H,\underline{p}(H))\,dH = \gamma'(D).^{19}$$

The left hand side is the expected forgone social value of strategies that the board refuses to approve as leverage increases. The right hand side is the marginal value of safe deposits for households. Given the assumptions on $\gamma'(D)$, the regulator optimally chooses an interior level of $D\in(0,I)$, which implies that it is optimal to constrain leverage.

Without compensation regulation, any $D>0$ results in overinvestment in risky strategies. Requiring a linear compensation contract can thus improve

[19] Note that $\phi\frac{\partial \underline{H}}{\partial D}\int_{\underline{p}(\underline{H})}^{1}(p\underline{H}-\hat{p}\hat{H})f(\underline{H},p)\,dp = 0$ because $\underline{p}(\underline{H}) = 1$.

upon any regulation that relies exclusively on constraining bank leverage. Thus, combining compensation regulation with leverage constraints is socially optimal.

Because the optimal leverage regulation allows for positive leverage $D > 0$, Proposition 2 implies that the bank will underinvest in safe strategies. Hence, the optimal regulation cannot achieve the first best. □

A.5 Proof of Proposition 6

To shorten notation, denote the total expected bank payoff by

$$V(\mathbb{I}) = \hat{p}\hat{H} + \phi \int_{\mathbb{I}} pH - \hat{p}\hat{H}\, dF(H,p).$$

Similarly, denote the expected shareholder payoff gross of compensation costs by

$$R(\mathbb{I}) \equiv \hat{p}(\hat{H} - D) + \phi \int_{\mathbb{I}} (p \max\{0, H - D\} - \hat{p}(\hat{H} - D))\, dF(H,p),$$

where $\max\{0, H - D\}$ captures the possibility that a new strategy might be associated with a payoff $H < D$. We proceed by describing banks' trade-off between active and passive boards in two Lemmata.

Lemma 3. *Without compensation regulation, shareholders will choose a passive board if*

$$\kappa > \underline{\kappa}(c) = c \frac{\hat{p}(\hat{H} - D)}{R(\mathbb{P}) - \hat{p}(\hat{H} - D)}.$$

Without compensation regulation, shareholders choose a passive board if the cost of an active board exceeds the CEO's rent with a passive board.

Proof. A passive board can choose a linear equity compensation contract for the CEO with $w_d(H) = \alpha \max\{0, H - D\}$, $\hat{w}_d = \alpha(\hat{H} - D)$, and $w_i = \hat{w}_i = 0$. The linear equity contract is not the privately optimal contract, but it provides a lower bound for shareholder value with a passive board. With this contract, the CEO implements the set of strategies that increase shareholder value $\mathbb{P}$. Thus, the shareholder value with a passive board is at least $R(\mathbb{P}) - c - \alpha\hat{p}(\hat{H} - D)$, where α is determined by the CEO's incentive constraint

$$\alpha\phi \int_{\mathbb{P}} (p(H - D) - \hat{p}(\hat{H} - D))\, dF(H,p) \geq c \Rightarrow \alpha = \frac{c}{R(\mathbb{P}) - \hat{p}(\hat{H} - D)}.$$

With an active board, the shareholder value is $R(\mathbb{P}) - c - \kappa$ as discussed in Section 4. The Lemma follows from substituting for α and comparing the shareholder values with active and passive boards. □

Lemma 4. *With compensation regulation, shareholders will choose an active board if*

$$\kappa < \check{\kappa}(c) = R(\mathbb{S} \cap \mathbb{P}) - R(\mathbb{S}) + c \left(\frac{\hat{p}\hat{H}}{V(\mathbb{S}) - \hat{p}\hat{H}} - \frac{\hat{p}\hat{H}}{V(\mathbb{S} \cap \mathbb{P}_0(\alpha^*)) - \hat{p}\hat{H}} \right),$$

where α^* is the lowest value that satisfies the CEO's incentive constraint for search with an active board.

With compensation regulation, shareholders choose an active board if the cost of an active board is lower than the reduction in shareholder value due to the difference in strategies implemented under a passive board and the change in the CEO's rent with a passive board.

Proof. With a linear compensation contract and a passive board, the set of socially optimal strategies $\mathbb{S}$ is implemented. Shareholder value is given by $R(\mathbb{S}) - c - \alpha\hat{p}\hat{H}$, where α is determined by the CEO's incentive constraint

$$\alpha\phi \int_{\mathbb{S}} pH - \hat{p}\hat{H}\, dF(H,p) \geq c \Rightarrow \alpha = \frac{c}{V(\mathbb{S}) - \hat{p}\hat{H}}.$$

With an active board, the set of implemented strategies is given by $\mathbb{S}\cap\mathbb{P}$. Because an active board sometimes renegotiates the CEO's compensation contract, the CEO's incentive constraint is given by

$$\alpha\phi \int_{\mathbb{S}\cap P_0(\alpha)} pH - \hat{p}\hat{H}\, dF(H,p) \geq c \Rightarrow \alpha = \frac{c}{V(\mathbb{S}\cap\mathbb{P}_0(\alpha)) - \hat{p}\hat{H}}.$$

The set of strategies that is implemented without renegotiation $\mathbb{S}\cap\mathbb{P}_0$ is a function of α. The board chooses the lowest value that satisfies the incentive constraint α^*. Shareholder value with an active board is thus given by $R(\mathbb{S}\cap\mathbb{P}) - c - \alpha^*\hat{p}\hat{H} - \kappa$. Comparing shareholder value with active and passive boards yields the Lemma. □

Proof of Proposition 6. Lemmata 3 and 4 imply that a bank alters its choice of board from passive to active following the introduction of compensation regulation if its type belongs to $\{(c,\kappa) \mid \underline{\kappa}(c) < \kappa < \check{\kappa}(c)\}$. This set is non-empty if $\check{\kappa}(c) > \underline{\kappa}(c)$, which is equivalent to

$$R(\mathbb{S}\cap\mathbb{P}) - R(\mathbb{S}) + c\left(\frac{\hat{p}\hat{H}}{V(\mathbb{S}) - \hat{p}\hat{H}} - \frac{\hat{p}\hat{H}}{V(\mathbb{S}\cap\mathbb{P}_0(\alpha^*)) - \hat{p}\hat{H}} - \frac{\hat{p}(\hat{H}-D)}{R(\mathbb{P}) - \hat{p}(\hat{H}-D)}\right) > 0. \tag{13}$$

The first part of this expression $R(\mathbb{S}\cap\mathbb{P}) - R(\mathbb{S})$ is positive because strategies in $\mathbb{S}\setminus\mathbb{P}$ reduce shareholder value. The second part of this expression is negative because $V(\mathbb{S}) \geq V(\mathbb{S}\cap\mathbb{P}_0(\alpha^*)) \geq \hat{p}\hat{H}$ and $R(\mathbb{P}) \geq \hat{p}(\hat{H}-D)$, and it approaches zero for small c because the CEO's rent approaches zero as $c \to 0$. Thus, the inequality is satisfied for small c. □

A.6 Proof of Proposition 7

Proof. First, assume that $\rho > 1 - (I-D)/(\bar{H}-D)$. With a passive board that does not prevent the CEO from extracting private benefits, the bank always fails when the CEO has the opportunity to extract private benefits. The expected

shareholder payoff for a given strategy (H, p) and any compensation contract $w_d(H) < \beta H$ is

$$(1-\rho)p(H - D - w_d(H)) - w_i \leq (1-\rho)(\bar{H} - D) < I - D$$

for all $D < I$, which implies that shareholders cannot recoup their investment.

Second, assume that $\beta \in (1 - I/\bar{H}, 1)$. With a passive board that pays a wage $w_d(H) \geq \beta H$ to prevent the CEO from extracting private benefits, the shareholders also do not recoup their initial investment since the expected payoff to shareholders is

$$p(H - D - w_d(H)) - w_i \leq p((1-\beta)H - D) \leq p(I\frac{H}{\bar{H}} - D) < I - D$$

for all $D < I$ and strategies $(H, p) \neq (\bar{H}, 1)$, including the default strategy. (For high D, $p(I\frac{H}{\bar{H}} - D) < 0$ because the board would have to compensate the CEO for benefits he is exacting from debt holders.)

Thus, $\rho > 1 - (I - D)/(\bar{H} - D)$ and $\beta \in (1 - I/\bar{H}, 1)$ are sufficient conditions for a bank with a passive board to be not viable, which establishes the Proposition. □

A.7 Information Revelation with an Imperfectly Informed Board

To avoid confusion in this example, we refer to investment strategies as projects and use the term strategy in the game theoretic sense.

Consider the following perfect Bayesian equilibrium (PBE) with truth-telling. The board chooses the privately optimal contract $w_i > 0$, $\hat{w}_i = \hat{w}_d = w_d(H) = 0$, discussed in Section 4. The CEO engages in search and when he discovers a new project he presents it and sends a cheap-talk message m_H about the payoff H. The board's overall strategy is given by: If $(m_H, p) \in \mathbb{P}_0$, the board proposes a new contract to the CEO, which only pays a wage if the CEO has told the truth:

$$w_d^r(m_H, H) = \begin{cases} w_i/p & \text{for } H = m_H \\ 0 & \text{otherwise} \end{cases}$$

and $\hat{w}^r = \hat{w}_i^r = w_i^r = 0$; if $(m_H, p) \in \mathbb{P} \setminus \mathbb{P}_0$, the board offers a new contract $\hat{w}^r = \hat{w}_i^r = w_d^r(m_H, H) = w_i^r = 0$ to the CEO; if $(m_H, p) \notin \mathbb{P}$, the board does not offer a new contract and rejects the new project. In the first two cases, the CEO accepts the new contract and the board approves the new project. In this equilibrium, the privately optimal set of projects is implemented and the CEO does not earn a rent.

The CEO does not have an incentive to deviate from the equilibrium strategy. If the CEO rejects the new equilibrium wage contract, the board rejects the new project and the CEO gets a zero wage, which is a best response if at this out of equilibrium node the board believes that $H = 0$. If the CEO does not tell the truth, $w_d^r(m_H, H)$ ensures that he obtains zero wages. The CEO has an

incentive to engage in search when w_i is set such that the incentive constraint for search (5) is satisfied.

The board does not have an incentive to deviate either. If, for $(m_H, p) \in \mathbb{P}_0$, the board proposes a different contract with lower wages than $w_d^r(m_H, H)$, the CEO rejects the new off-equilibrium strategy wage contract, and the board will implement the new project with the initial contract in place. The board cannot credibly threaten to reject the project because consistent beliefs in a truth-telling equilibrium imply that $\mathbb{E}[p(H-D) - w_i \mid m_H] = p(m_H - D) - w_i \geq \hat{p}(\hat{H} - D)$. The board does not have an incentive to choose a different initial contract because the described equilibrium results in the maximum possible shareholder value. Note that this equilibrium is not the unique PBE and there exist equilibria where a different set of of strategies is implemented.

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