Bank Regulation, CEO Compensation, and Boards*

Julian Kolm†, Christian Laux‡, and Gyöngyi Lóránth§

February 2016

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.

JEL: G21; G28.

*We thank Tim Baldenius, Jeremy Bertomeu, Hendrik Hakenes, Max Bruche, Kose John, Jean-Charles Rochet as well as seminar and conference participants at NYU, Humboldt-University Berlin, University of Bonn, University of Vienna, UPF Barcelona, the London Financial Intermediation Theory Workshop, and the Financial Intermediation Research Society Conference 2015 for valuable comments. Julian Kolm thanks the Austrian Science Fund for providing financial support through the University of Vienna.

†WU (Vienna University of Economics and Business) and Vienna Graduate School of Finance (VGSF), julian.kolm@wu.ac.at.

‡WU (Vienna University of Economics and Business) and Vienna Graduate School of Finance (VGSF), christian.laux@wu.ac.at.

§University of Vienna and Vienna Graduate School of Finance (VGSF), gyoengyi.loranth@univie.ac.at.
1. Introduction

A bank’s risk taking depends on its corporate governance structure and regulation. In order to reduce bank’s riskiness the EU has enacted regulation that constrains bonus payments for banks managers and requires that some of their compensation must be deferred (DIRECTIVE 2013/36/EU, Art. 94(m) and 94(g)). Compensation regulation enlarges the traditional toolkit of bank regulation, but little is known about how it interacts with existing regulations and banks’ corporate governance structures.

We explore the interaction of regulating bank CEO compensation with capital regulation. 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 firm. 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, compensation regulation is ineffective in dealing with underinvestment in risk reducing strategies because the board can veto such strategies to prevent a reduction in shareholder value. Compensation regulation can however prevent overinvestment in risky strategies if it eliminates the CEO’s incentives to propose excessively risky strategies. The distinction between strategies that increase risk and strategies that reduce risk is important. Most papers that analyze risk shifting problems in the spirit of Jensen and Meckling (1976) focus on the former and consider only the option to increase risk. But banks’ reluctance to implement efficient risk-reduction strategies is relevant, particularly if bank assets experience an adverse shock. For example, in the 2007–09 financial crisis, banks were reluctant to sell illiquid and distressed assets. Selling them would have reduced the probability of financial distressed, but this would have primarily benefited debtholders. Holding on to the assets involved gambling on the recovery of the economy, benefiting shareholders (Diamond and Rajan, 2011).
Capital regulation that limits bank leverage reduces shareholders’ risk shifting incentives. This can curb both overinvestment in risky strategies and underinvestment in risk-reducing strategies in the interest of shareholders. Nevertheless, risk shifting incentives, albeit muted, prevail at any positive level of leverage. This provides a rationale to combine capital regulation with compensation regulation, which can fully prevent overinvestment in risky strategies.

These results contrast with the literature on CEO compensation and risk shifting, which, following John and John (1993), assumes that the CEO’s incentives uniquely determine risk taking. If the bank’s board is passive and delegates strategic decisions to the CEO, regulating CEO compensation can implement the socially optimal level of risk taking, and no leverage regulation is necessary. Our results demonstrate that it is necessary to take into account a bank’s corporate governance when assessing the effectiveness CEO compensation regulation. Empirical work by Cerasi and Oliviero (2015) and Laeven and Levine (2009) provide evidence in this respect. They find that banks’ corporate governance structures are an important determinant of how CEO compensation and capital requirements impact on bank risk taking.

We also argue that board structures might endogenously adjust to the introduction of compensation regulation. Compensation regulation creates a wedge between the CEO’s and shareholders’ incentives. From the shareholder point of view, this makes active boards, which can limit the effect of regulation on bank strategies, more attractive.

From a regulatory point of view, passive boards appear to be an attractive corporate governance structure in our model. However, passive boards are generally not optimal when the CEO behaves opportunistically.

We develop a model where a bank CEO searches for new strategies that can include new business models (e.g., fee business, trading desk), risk management tools, the use of risk transfer instruments, or the level of proprietary trading. New strategies can increase
or decrease the bank’s risk relative to the bank’s current strategy. Upon finding a new strategy, the CEO decides whether to present it to the board. The board, representing shareholders, chooses the bank’s target leverage ratio and sets CEO compensation that incentivizes the CEO to search for new strategies and propose them to the board. An active board understands the bank’s strategy and retains the right to approve changes to the current strategy.\footnote{Demb and Neubauer (1992) report survey results on directors’ tasks. According to their findings, approximately two-thirds of directors agree that “setting the strategic direction of the company” was one of the jobs they do (p. 43). Schwartz-Ziv and Weisbach (2013) document that boards routinely discuss business strategy. Boards also requests additional information and take decisions on strategic issues. MacAvoy and Millstein (1999) suggest that boards have evolved from being “managerial rubberstamps to active and independent monitors.”} If the board does not approve a new strategy, the bank’s current strategy remains in place. 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.

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

Compensation regulation in the presence of an active board cannot eliminate under-investment in socially efficient strategies that reduce risk. The reason is that reducing risk reduces the option value of default for shareholders. For this reason, the board will not approve such strategies. Compensation regulation is ineffective in this case because compensation contracts only directly affect how shareholder value and CEO compensation are shared, not the total amount available to shareholders and the CEO. Hence, a compensation contract cannot simultaneously provide incentives for the board to approve and for the CEO to present all efficient strategies that reduce risk.

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. This compensation contract provides the CEO with incentives to present only projects that maximize the total value of the bank. Bonus caps, as introduced by the EU’s new capital requirements directive (DIRECTIVE 2013/36/EU, 2013, Art. 94(g)) can also limit the CEO’s incentive to engage in risk shifting, as a risky strategy is only worthwhile for the CEO if the compensation in the case of success is high enough. However, a bonus cap will not fully prevent overinvestment in risky strategies. A linear compensation contract does not involve such a trade-off as it ties compensation to strategies’ expected payoffs while bonus caps impose a uniform constraint on different strategies regardless of their probability of success.

Capital regulation can reduce both overinvestment in risky strategies and underinvestment in risk-reducing strategies because it targets shareholder incentives, who control the bank’s choice of strategies. This contrasts with CEO compensation regulation that targets the incentives of a particular agent of the bank, who is not the ultimate decision maker. However, to the extent that insured liquid deposits are valuable for households, it is not optimal for the regulator to eliminate insured deposits. Because risk shifting incentives exist for any positive level of insured deposits, it is optimal to combine leverage restrictions with compensation regulation. Nevertheless, even the optimal mix cannot implement the first best because some socially efficient safe strategies will not get implemented if leverage is positive.

A passive board delegates the choice of strategies to the CEO, who becomes the sole decision maker. The trade-off between active and passive boards differs for shareholders and regulators. Regulating CEO compensation provides incentives for shareholders to choose an active board because the cost of delegation rises when the CEO’s and the regulator’s incentives are aligned. From the regulator’s point of view, compensation regulation can implement efficient risk taking with a passive board. However, active boards
can provide essential oversight that prevents the CEO from engaging in opportunistic behavior that destroys the value of the bank for shareholders as well as from the social point of view. We relate these trade-offs to recent proposals that concern the regulation of bank corporate governance (BCBS, 2014; PRA and FCA, 2014).

Our model has several features that are in line with recent empirical evidence on the link between board representation, CEO compensation and risk taking. For example, Bhagat and Bolton (2011), Fahlenbrach and Stulz (2011) and Hagendorff and Vallascas (2011) show that banks whose CEO’s incentives were more aligned with shareholders’ interests took more risk and performed worse during the crisis of 2007–2009. Concerning the role of the board and corporate governance, the literature provides evidence that more shareholder friendly boards are also associated with higher risk taking and worse performance during the financial crises (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., 2014). 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.

A number of papers explore how the structure of CEO compensation can overcome incentive problems between different claimants of a firm. One of the first papers 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 discuss the role of CEO compensation for bank risk taking: Edmans and Liu (2011) advocate to combine 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

---

1A different strand of the literature focuses on the inefficiencies that arise in the labor market for
John et al. (2000) propose linking other regulatory tools to the structure of CEO compensation. They consider a fairly-priced deposit insurance premium that reflects the risk taking incentives implied by CEO compensation. This 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. Faced with these limits, it can be optimal to combine caps on risk taking and compensation regulation.

In the literature above, where the CEO directly chooses the risk, it is sufficient to ensure that the CEO’s incentives are set optimally. There is no role for an additional regulatory capital requirement. In our model, the board plays an active role in the choice of strategy and hence, the CEO compensation does not uniquely determine the bank’s investment strategy. An active board limits the effectiveness of regulating CEO compensation and provides an important role for capital regulation to shape shareholders’ incentives to reduce risk.

Several papers have looked at possible detrimental effects of regulating CEO compensation in a multi-task agency setting. 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. Our contribution 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.

---

bank CEOs (Thanassoulis, 2012; Bannier et al., 2013; Archarya et al., 2014). In these models, labor market imperfections lead to risk taking incentives that are excessive from the firm’s perspective, which provides a rationale for regulation.
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 $\phi$. A possible new strategy yields a payoff $H \in [0, \hat{H}]$ 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 $[0, \hat{H}] \times [0, 1]$. 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 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 can consist of an immediate wage and a deferred compensation. The CEO receives the immediate wage independently of whether the bank defaults or not.\(^3\) In contrast, the CEO receives the deferred wage only if the bank does not default. The deferred compensation can depend on the bank’s realized payoff, \(H\).

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 \(\omega\) 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.\(^4\)

We assume that the board cannot fire the CEO after he has presented a new strategy.

---

\(^3\)In order to pay an immediate wage, the bank has to raise capital as will be explained in Section 2.3.

\(^4\)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 \(w_i = w_d(0) = 0\).
to save the wages that the board promised to incentivize search. (For example, a very high severance pay would prevent this.) However, 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 \((H, p)\). For example, it can offer an immediate wage 

   \[
   w' = \hat{w}_i + \hat{p}\hat{w}_d,
   \]

   which makes the CEO indifferent between the old and the new strategy.

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.

Renegotiation avoids a situation where the board rejects strategies because of high CEO compensation. 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.

2.3. Bank Leverage

The bank is financed with equity \(E\) and deposits \(D\). Depositors are fully insured by deposit insurance and demand the risk-free rate of return, which we normalize to 0. We assume that deposit insurance is free and hence, shareholders prefer debt financing to
equity financing because the price of deposits does not reflect the banks’ riskiness. Other reasons why debt might be cheaper than equity include implicit guarantees, tax benefits of debt financing, and possible frictional costs of equity.

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, $\hat{H} > D + \tilde{w}_d$. 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.

2.4. Regulatory Tools

We focus on two regulatory tools. First, the regulator can impose a capital requirement, which limits the amount of deposits raised to a maximum level of $D$. Second, the regulator can constrain the structure of CEO compensation. If a bank’s success probability $p$ were contractible, first best can 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. For example, 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 bank’s success probability $p$ is not contractible, and do not consider a risk-based deposit insurance premium or risk-based capital requirements.

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 \( \gamma(D) \) is an increasing and weakly concave function and that \( \lim_{D \to 0} \gamma'(D) = \infty \) and \( \lim_{D \to 1} \gamma'(D) = 0 \) 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.

2.5. Time-Line

We summarize the interaction between the board and the CEO in Figure 1. Taking the regulatory constraints as given, the board raises deposits 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:

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

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
The CEO searches for a new strategy and, after learning its type, decides whether to present it to the board. The board decides which strategy the CEO has to implement. Uncertainty is resolved and payoffs are realized.

The regulator sets compensation and capital regulation. The board raises deposits $D$ and sets the compensation contract. The CEO searches for a new strategy and, after learning its type, decides whether to present it to the board. If the CEO presents a new strategy, the board learns the strategy's type and can make a take-it-or-leave-it offer to change the compensation contract.

The board decides which strategy the CEO has to implement. Uncertainty is resolved and payoffs are realized.

Figure 1: Time-line of events
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:

\[
p(H - D - w_d(H)) - w_i + pw_d(H) + w_i \geq \hat{p}(\hat{H} - D - \hat{w}_d) - \hat{w}_i + \hat{p}\hat{w}_d + \hat{w}_i
\]

\[
\iff p(H - D) \geq \hat{p}(\hat{H} - D) \quad (2)
\]

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.

### 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:

\[
w_i + pw_d(H) \geq \hat{w}_i + \hat{p}\hat{w}_d. \quad (3)
\]

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

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

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

\[ \phi \int_{\mathbb{P}_0} w_i \, dF(H, p) \geq c. \quad (5) \]

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.

However, a simple bonus contract might not be sufficient to provide the CEO with incentives to search if \( c \) is very high, since 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 compensation contract that provide the CEO with search incentives is more complicated, but the complication does not add to the understanding of our main arguments. Therefore, we assume that $c$ is small enough such that (5) can be satisfied. This assumption implies that it is optimal for the board to provide the CEO with search incentives since the CEO only receives a compensation 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 payoff

$$pH \geq \hat{p}H.$$ (6)

which in our model corresponds to the social value. We define the sets of socially optimal new strategies as $S \equiv \{(H, p) \mid pH \geq \hat{p}H\}$. Given the outstanding claims of depositors, the set of strategies that are optimal for shareholders $P$ does not coincide with the set of socially efficient strategies $S$. 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.

Figure 2a depicts the set of possible strategies. The area to the north-east of the full line encompasses the set of strategies that increase the social value relative to the current strategy. The area to the north-east of the dashed line consists of the set of strategies that increase the sum of shareholder value and expected CEO compensation relative to...
the current strategy.

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 the failure probability. These strategies are depicted by the shaded area to the north-west of the current strategy in Figure 2b, which consists of strategies that 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 lie in the shaded area to the south-east of the current strategy in Figure 2b, which consists of strategies that decrease shareholder value, but increase social value. 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 ultimate decision about the bank’s investment strategy.

The extent of risk shifting depends on the bank’s leverage. Given deposit insurance,
debt is preferred to equity because it increases the deposit insurance subsidy. Hence, an unregulated bank will maximize the amount of deposits, which maximizes risk shifting incentives.

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. \( \square \)

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. 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 the 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 introduces 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 \( w_i = w^\ast_i = 0 \), because immediate compensation cannot control risk shifting as explained in Section 6.1. The case of bonus caps with partially deferred compensation is discussed in Appendix B.

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

A bonus cap \( w_d(H) \leq bw^fix\), which implies \( w_d(H) \leq b\hat{w}_d \), constrains the maximum expected compensation that the CEO can obtain when switching to a new strategy to \( pb\hat{w}_d \). 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.

While a bonus cap reduces overinvestment in risky strategies, it also reduces the CEO’s incentives to present some socially efficient strategies. The reason is that the constraint
imposed by bonus caps does not depend on $H$, but the social value does. Figure 3 depicts the effects of a bonus cap: the CEO will never present strategies to the left of the vertical dash-dotted line. 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 firm’s financing structure 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,

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 \( \alpha \) and \( \hat{w}_i. \) Given this regulation, 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 total shareholder value and CEO compensation, which implies part 2 of the proposition.

The CEO will engage in search if \( \alpha \) is high enough to satisfy the incentive constraint and the board will choose a contract that satisfies the incentive constraint when \( c \) is small enough.

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, it would not be optimal for the regulator to prohibit renegotiation.

6.4. Cost of CEO Compensation and Search Incentives

The general press (Economist, 2013; Schäfer, 2013) voiced concerns that bonus caps will 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.

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 C.

Reduced incentives to search for a new strategy are socially optimal if, without compensation regulation, search was mainly valuable because of risk shifting. However, reduced incentives for search that stem from the higher rent that the CEO earns with compensation regulation can be socially costly because the bank forgoes the option to find and implement new strategies that increase social value.

7. Leverage Regulation

7.1. Privately Optimal Leverage

The 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 $\mathcal{S} \cap \mathcal{P}_0$. It follows that, in order to satisfy the CEO’s incentive constraint,

$$\alpha \phi \int_{\mathcal{S} \cap \mathcal{P}_0} (pH - \hat{p}\hat{H}) dF(H,p) \geq c$$  \hspace{1cm} (7)

the board must choose a higher $\alpha$ as leverage increases. The incentive constraint also shows that, when the search costs approach zero, the CEO’s share $\alpha$ goes to zero as well. Hence, changes in the value of the deposit insurance subsidy dominate changes of the CEO’s rent for small $c$. 

23
Lemma 2. When compensation regulation requires a linear compensation, an active board chooses the maximum possible leverage for small $c$.

Proof. see Appendix A.1.

We focus on the case where $c$ is small enough so that the board maximizes bank leverage also 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, including the bank’s shareholders, the CEO, depositors and the deposit insurance corporation. The payment from the deposit insurance corporation to depositors does not enter the objective, as it is a pure transfer. Thus, the regulator’s objective function is

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

where $I$ denotes the set of new strategies that the CEO implements under regulation.

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, optimal regulation must constrain leverage. Compensation regulation remains optimal for any level of positive leverage because it can fully eliminate overinvestment in risky strategies.

5The regulator can use different instruments to reduce bank leverage, such as capital regulation, a tax on leverage, or compensation regulation that depends on leverage and destroys the CEO’s search incentives if the bank deviates from the target leverage.
Proposition 4. The optimal regulation constrains leverage and regulates compensation.

Proof. See Appendix A.2.

The optimal combination of capital and compensation regulations does not fully prevent underinvestment in safe strategies. Proposition 2 shows that there are safe, socially efficient strategies that will be rejected by the board for any \( D > 0 \). Because optimal capital regulation always entails \( D > 0 \) when the social value of deposits is high enough, we obtain the following proposition.

Proposition 5. The optimal regulation of leverage and CEO compensation cannot implement the first best.

The mechanism behind these results is very general. Regulating the incentives of a bank’s agents, such as the CEO, can be very effective in targeting specific behaviors, such as active risk shifting. To the extent that shareholders retain some control over the bank, their preferences will continue to shape the bank’s strategy. And as long as shareholders preferences are not perfectly aligned with those of the regulator, there will be reluctance to risk-reduction. Thus an optimal regulation will include elements that directly target shareholders’ incentives.

The introduction of compensation regulation increases the socially optimal level of leverage. The reason is that compensation regulation curtails overinvestment in risky strategies independently of leverage. This 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 can 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. Boards may be passive for different reasons, for example, for lack of expertise or capture by the CEO.\footnote{A captured board may also set higher compensation for CEO. To the extent that this is done without changing the CEO’s incentives to implement certain strategies, this is a transfer that does not concern the regulator in our model.}

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

**Proposition 6.** With a passive board, compensation regulation that requires the compensation contract to be linear in the bank’s payoff implements the socially optimal set of strategies.

**Proof.** See the following discussion.

If the CEO receives a fixed fraction $\alpha$ 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:

$$\alpha H > \hat{\alpha} \hat{H} \iff p H > \hat{p} \hat{H}.$$
Propositions 2 and 6 highlight the fact that the role of the board is important when it comes to the effectiveness of regulating CEO compensation. Regulating compensation is effective if the ultimate decision about a strategy rests with the CEO. 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 corporate governance.

8.2. Banks’ Choice between Active and Passive Boards

The costs and benefits of active versus passive board 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 $\kappa \in [0, \bar{\kappa}]$. We assume that $\bar{\kappa} \leq \hat{\rho} \hat{H} - I$ so that a bank with an active board has a positive value. Banks differ in the implementation cost $\kappa$ associated with an active board and the CEO’s search cost $c$. The board and the CEO know the bank’s type $(c, \kappa)$, 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 $\alpha \hat{\rho} (\hat{H} - D)$, where $\alpha$ depends on the CEO’s search costs $c$. Shareholders trade off the the cost of
delegation and the cost of implementing an active board $\kappa$.

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 $S \setminus P$. Because the compensation contract is linear the CEO always earns a rent $\alpha \tilde{H}$. But an active board must choose a steeper compensation contract (higher $\alpha$) 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 $S \cap P_0$ is smaller than the set of strategies $S$ the CEO implements with a passive board.

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

**Proposition 7.** There exists a set of bank types $(c, \kappa)$ for which the introduction of linear compensation regulation alters the shareholders’ choice of board from passive to active.

**Proof.** See Appendix A.3.

Hence, the introduction of compensation regulation increases the prevalence of active boards when shareholders’ incentives to underinvest into efficient risk-reduction strategies dominate the costs of implementing an active board and providing search incentives. This adaption of the corporate governance structure reduces the effectiveness 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.\(^7\)

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 \(\beta H\), 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 8.** If \(\rho\) and \(\beta\) 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.4. □

If \(\beta\) 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 \(\rho\) is sufficiently high,\(^7\) Burkart et al. (1997) discuss the impact of board monitoring on a CEO’s effort provision. They show that board monitoring can optimally coexists 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.
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 rent extraction and otherwise not intervene in the choice of strategies. However, these two functions might inherently be linked. The possibility of rent extraction might be related to a bank’s strategy, and to prevent rent extraction the board needs 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 into the board’s conduct. Further, to the extent that board members also provide strategic advise 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 have discussed in Section 6.3.2. Alternatively, increased liability of directors in cases of banks’ bankruptcy can also provide incentives against risk shifting.\footnote{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}
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 were akin to the regulator taking direct control of the bank, employing his own agents to run the bank. In this case, the bank would ceases to function as a privately owned firm. The outcome of such a 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. Such a 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 those of inside directors, whose interests may be more aligned with those of the CEO. In our framework, this would tend to increase the underinvestment in safe strategies that is caused by directors maximizing shareholder value. In contrast, 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 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. Implementing such a regulation is difficult. First, it is difficult to assess whether a board is active (monitors) or is passive as it requires detailed information about its conduct and the internal operation of 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 \((c, \kappa, \rho, \beta)\). 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. Discussion and Conclusion

We have identified the 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 risk reduction strategies.

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. As long as shareholders retain control of the bank, their interests will affect banks’ decision-making process and hence specific corporate governance reforms will only provide a partial solution.

Another possibility to reduce risk shifting is to reduce shareholders’ appetite for risk. This can be achieved by limiting a bank’s leverage. We show that with an active board, combining regulation of bank capital and CEO compensation is more efficient than using any of the two tools in isolation. Requiring a CEO compensation that is linear in total bank value effectively curtails overinvestment in a risky strategy while capital regulation
ensures that the board is more willing to accept strategies that reduce the bank’s risk.

References


A. Proofs

A.1. 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 \( S \cap P \). Hence, we can write the
shareholder value as

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

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

\[ (1 - \hat{p}) + \phi \int_{\frac{\hat{p}H}{\hat{p}(H)}}^{\hat{H}} \int_{\frac{p(H)}{\hat{p}(H)}}^{1} (-p + \hat{p}) f(H, p) \, dp - \frac{\partial p(H)}{\partial D} (p(H - D) - \hat{p}(\tilde{H} - D)) f(H, p(H)) \, dH \\
- \phi \frac{\partial H}{\partial D} \int_{\frac{\hat{p}H}{\hat{p}(H)}}^{\hat{H}} \int_{\frac{p(H)}{\hat{p}(H)}}^{1} (p(H - D) - \hat{p}(\tilde{H} - D)) f(H, p) \, dp + \phi \int_{\frac{\hat{p}H}{\hat{p}(H)}}^{\hat{H}} \int_{\frac{p(H)}{\hat{p}(H)}}^{1} (-p + \hat{p}) f(H, p) \, dp \, dH - \hat{p} \frac{\partial \hat{w}_d}{\partial D} \]

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

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 \( S \cap \mathbb{P}_0 \) without renegotiating the compensation contract. Hence, we can write the CEO’s incentive constraint as

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

where \( H = \hat{p}\tilde{H} + (1 - \hat{p})(1 - \hat{w}_d / \hat{H})D \) and \( p(H) = \hat{p}\frac{(1 - \hat{w}_d / \hat{H})\tilde{H} - D}{(1 - \hat{w}_d / \hat{H})\tilde{H} - D} \). Applying the implicit
function theorem yields

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

From the CEO’s incentive constraint it follows that \(\lim_{c \to 0} \hat{w}_d = 0\). Inspection of terms in the above expression then shows that \(\frac{\partial \hat{w}_d}{\partial D}\) approaches zero as \(\hat{w}_d \to 0\). Hence the board maximizes leverage when \(c\) is sufficiently small to ensure that (9) is positive.

\(\Box\)

A.2. Proof of Proposition 4

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

\[
\hat{p}\hat{H} + \phi \int_{H}^{\hat{H}} \int_{p(H)}^{1} (pH - \hat{p}\hat{H})f(H, p) \, dp \, dH \\
\phi \int_{H}^{\hat{H}} \int_{p(H)}^{1} (pH - \hat{p}\hat{H})f(H, p) \, dp \, dH - I - c + \gamma(D)
\]

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

\[
\phi \int_{H}^{\hat{H}} \frac{\partial p(H)}{\partial D} (p(H)H - \hat{p}\hat{H})f(H, p(H)) \, dH = \gamma'(D)^{10}
\]
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 upon any regulation that relies exclusively on constraining bank leverage. Thus, combining compensation regulation with leverage constraints is socially optimal.

\[ A.3. \text{ Proof of Proposition 7} \]

To shorten notation, denote total expected bank payoff by

\[ V(\Pi) = \hat{p}H + \phi \int_{\Pi} pH - \hat{p}H \, dF(H, p). \]

Similarly denote the expected shareholder payoff gross of compensation costs by

\[ R(\Pi) \equiv \hat{p}(\hat{H} - D) + \phi \int_{\Pi} (p \max\{0, H - D\} - \hat{p}(\hat{H} - D)) \, dF(H, p) \]

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

\[ \kappa > \kappa(c) = c \frac{\hat{p}(\hat{H} - D)}{R(\Pi) - \hat{p}(\hat{H} - D)}. \]

**Proof.** A passive board can choose a linear equity compensation contract for the CEO

\[ \text{Note that } \phi \int_{\Pi} (pH - \hat{p}H) f(H, p) \, dp = 0 \text{ because } f(H) = 1. \]
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 \( \alpha \) 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 CEO’s rent and the shareholder value is \( R(\mathbb{P}) - c - \kappa \) as discussed in Section 4. The Lemma follows from comparing shareholder profits with active and passive boards. \( \square \)

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

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

where \( \alpha^* \) is the lowest value that satisfies the CEOs incentive constraint for search with an active board.

**Proof.** With a linear compensation contract and a passive board the set of socially optimal strategies \( \mathbb{S} \) gets implemented. Shareholder value is given by \( R(\mathbb{S}) - c - \alpha \hat{p}\hat{H} \), where \( \alpha \) 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
The incentive constraint is given by
\[
\alpha \phi \int_{S \cap P_0(\alpha)} pH - \hat{p}H \, dF(H, p) \geq c \Rightarrow \alpha = \frac{c}{V(S \cap P_0(\alpha)) - \hat{p}H}.
\]

The set of strategies that get implemented without renegotiation \(S \cap P_0\) is a function of \(\alpha\). The board chooses the lowest value that satisfies the incentive constraint \(\alpha^*\). Shareholder value with an active board is thus given by
\[
R(S \cap P) - c - \alpha^*\hat{p}H - \kappa.
\]
Comparing shareholder value with active and passive boards yields the Lemma.

**Proof of Proposition 7.** Lemma 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 \(\{(c, \kappa) \mid \kappa(c) < \kappa < \hat{\kappa}(c)\}\). This set is non-empty if \(\hat{\kappa}(c) > \kappa(c)\) for some \(c\). This condition can be rewritten as
\[
R(S \cap P) - R(S) + c \left( \frac{\hat{p}H}{S(S) - \hat{p}H} - \frac{\hat{p}H}{S(S \cap P_0(\alpha^*)) - \hat{p}H} - \frac{\hat{p}(\hat{H} - D)}{R(P) - \hat{p}(\hat{H} - D)} \right) > 0 \quad (10)
\]

The first part of this expression \(mR(S \cap P) - R(S)\) is positive because strategies in \(S \setminus P\) reduce shareholder value. The second part of this expression is negative because \(V(S) \geq V(S \cap P_0(\alpha^*)) \geq \hat{p}H\) and \(R(P) \geq \hat{p}(\hat{H} - D)\). The inequality is satisfied for small \(c\) because the absolute value of the wage costs tends to zero as \(c \to 0\).

**A.4. Proof of Proposition 8**

**Proof.** First, assume that \(\rho > 1 - (I - D)/(\hat{H} - D)\). 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 \((p, H)\) and any compensation contract \(w_d(H) < \beta H\) is
\[
(1 - \rho)p(H - D - w_d(H)) - w_i \leq (1 - \rho)(\hat{H} - D) < I - D
\]
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 rent, 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 \((p, H) \neq (1, \bar{H})\), 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.

\[ \square \]

**B. Bonus Caps with Partially Deferred Compensation**

The EBA (2015, p.59) requires that bonus caps must hold separately for every performance year. We assume that immediate compensation and deferred compensation are paid in different performance years to account for the time it takes for a new strategies to change the banks performance. Thus a bonus cap for deferred can 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 \( w_d(H) + w_i \leq b(\hat{w}_d + \hat{w}_i) \leq b(1 + d^{-1})\hat{w}_d \).\(^{11}\) Rearranging the terms in the CEO’s incentive constraint for presenting a new strategy (3) and substituting the constraints imposed by bonus caps

\(^{11}\)These inequalities use that \( w_{d}^{fix} \leq \hat{w}_d \) by definition.
and deferred compensation yields

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

Hence, bonus caps allow the regulator to limit the maximum probability of default to
\[ 1 - (\hat{p} + (1 - b)d^{-1})b^{-1}. \]
Inspection of this condition shows that it only 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.

\section*{C. Compensation Regulation Destroys Search Incentives}

To show how compensation regulation can destroy search incentives we set \( c = a\phi \) and compare a linear compensation contract with the privately optimal contract discussed in Section 4. Suppose that for both contracts the CEO’s IC constraint (4) can be satisfied.

Because \( c = a\phi \) the IC constraint can be rewritten as

\[ \int_{\phi} \max\{w_i + pw_d(H) - \hat{w}_i - \hat{p}\hat{w}_d, 0\} dF(H, p) \geq a \]

which does not depend on \( \phi \) for all \( \phi > 0 \).

The shareholders profits from search in the unregulated case are given by

\[ \phi \int_{\hat{p}} p(H - D) - \hat{p}(\hat{H} - D) dF(H, p) - a\phi \]

Because the CEO only receives a compensation when a new project is implemented without renegotiation this expression must always be (weakly) positive when the IC constraint is satisfied, which does not depend on \( \phi \).
With a linear compensation contract the shareholders profits from search are given by

\[
\phi \int_{\mathbb{S} \cap \mathbb{P}} p(H - D) - \hat{p}(\hat{H} - D) dF(H, p) - a\phi - \alpha \hat{p}\hat{H}.
\]

(11)

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