Executive Compensation and Risk Taking*

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Abstract

This paper studies the connection between risk taking and executive compensation in financial institutions. A theoretical model of shareholders, debtholders, depositors and an executive demonstrates that (i) excess risk taking (in the form of risk-shifting) can be addressed by basing compensation on both stock price and the price of debt (proxied by the CDS spread), (ii) shareholders may not be able to commit to design compensation contracts in this way, and (iii) they may not want to due to distortions introduced by either deposit insurance or trusting debtholders. The paper also provides an empirical analysis that suggests that debt-like compensation for executives is believed by the market to reduce risk for financial institutions.

Keywords: Executive compensation, risk taking

JEL codes: G21, G34

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1 Introduction

It is well known that structuring CEO incentives to maximize shareholder value in a levered firm tends to encourage excess risk taking. Indeed, the value of the stock for the levered firm is like the value of a call option and is increasing in the volatility (riskiness) of the assets held by the firm. This issue is particularly troublesome for banks. While the average non-financial firm has about 40% debt, financial institutions have at least 90% debt; for investment banks it is closer to 95%. At the same time, "banks can alter the risk composition of their assets more quickly than most nonfinancial industries, and ... readily hide problems" (Levine, 2004, p.4). Excess risk-taking at financial institutions affects more than just creditors; it affects depositors, taxpayers, and potentially the financial system as a whole.

The academic literature has recognized this issue over the years and made several proposals to reduce risk-taking, none of which have been adopted in the real world (we summarize these proposals below). Moreover, the link between compensation and risk remained strong throughout recent events, as evidenced by several recent empirical studies, which are summarized in Table 1.[1] Along with a recent paper by Edmans and Liu (2010),[2] our goal is to revive the discussion on how to reduce risky behavior. We propose tying a CEO's compensation in part to the financial firm's credit default swap (CDS) spread. A high and increasing CDS spread would result in lower compensation, and vice-versa. The CDS spread provides an innovation previously unavailable as a policy instrument: a market estimate of the default risk of the firm.

We begin our analysis by examining risk taking incentives for CEOs in financial institutions in a theoretical model.[3] While it may be in shareholders' interests to commit to induce a CEO to take less risk, as a way of lowering the cost of debt, we show that if the CEO's

[1] Other papers find this relationship holds in non-crisis times and for non-financial firms as well. For example, DeFusco, Johnson and Zorn (1990) find that announcement of executive stock option plans cause firms' stock prices to rise, their bond prices to fall, and equity volatility to rise, consistent with risk shifting.

[2] Edmans and Liu (2010) show that using inside debt (such as deferred compensation or pension benefits) will correct risk-taking incentives.

[3] Although we focus on the compensation of bank CEOs, in practice the bonuses of all risk-takers can be linked to CDS spreads.

Explanatory Variable	Authors	Period	Measure of Risk	Period	Sign
Vega	Chesney, Stromberg, and Wagner (2010)	'02-'06	Writedowns	Q3 '07 - Q4 '08	Positive
	DeYoung, Peng, and Yen (2009)	'94-'06	Beta	'94-'06	Positive
		'94-'06	CAPM Residual	'94-'06	Positive
		'94-'06	Private MBS holdings	'94-'06	Positive
	Ellul and Yerramilli (2010)	'00-'07	Std. Deviation Stock Returns	'01-'08	Positive
	Mehran and Rosenberg (2008)	'93-'01	Std. Deviation Stock Returns	'94-'02	Positive
		'93-'01	Residual Volatility	'94-'02	Positive
	Chesney, Stromberg, and Wagner (2010)	'02-'06	Writedowns	Q3 '07 - Q4 '08	Positive
	DeYoung, Peng, and Yen (2009)	'94-'06	Beta	'94-'06	Positive
Delta	Mehran and Rosenberg (2008)	'93-'01	Systematic volatility	'94-'02	Positive
% comp in deferred stock and options	Balachandran, Kogut, and Harnal (2010)	'95-'07	Predicted default probability	'96-'08	Positive

Figure 1: Recent results on the relationship between equity compensation and risk taking

actions and incentive scheme[4] are unobservable, she will be induced to undertake excessive risk in equilibrium. Tying the CEO's compensation to the CDS spread, however, can align the CEO's objective with social objectives in terms of risk choice.

We then show that shareholders may not choose to implement such a compensation scheme for two basic reasons: first, a commitment problem, as shareholders can always renegotiate the compensation contract after debt has been issued; and, second, even if shareholders were able to commit to an incentive scheme, they would not want to due to the distortions in debt markets arising from deposit insurance and investors' misperceptions of risk.

To further demonstrate that linking compensation to CDS spreads can reduce risk taking, we provide an empirical analysis which indicates that market participants do indeed believe that linking executive compensation to default risk will reduce the riskiness of the firm. Specifically, we focus on the recent disclosure of deferred compensation and pension benefits in proxy statements filed with the SEC, beginning in 2007. Both deferred compensation and pension benefits have debt-like characteristics, as they are unsecured future claims. We find in particular that the CDS spread (the measure of risk) decreases with the percentage of CEO pay revealed to be in the form of deferred compensation and pensions. We interpret this finding as consistent with the hypothesis that the more debt-like is the CEO's compensation,

[4] The CEO's incentive scheme is effectively unobservable if the shareholders can renegotiate the compensation after issuing debt. We discuss renegotiation further in section 5.

the more inclined the CEO is to lower risk.

We are by no means the first to consider risk-shifting by a CEO of a levered firm who is only compensated with equity. Several other papers, beginning with Jensen and Meckling (1976) have highlighted the risk-shifting problem for levered firms. Green (1984) proposes that firms issue warrants to eliminate excess risk taking incentives. John and John (1993) suggest a default cost for the manager[5], while Brander and Poitevin (1992) propose a bonus contract (without equity compensation). John, Saunders and Senbet (2000) specifically focus on banks and show that well-priced deposit insurance can possibly eliminate risk shifting. Most recently, Edmans and Liu (2010) demonstrate that giving the manager debt (either straight debt or deferred compensation) can solve the risk shifting problem. They add effort choice to the risk shifting problem for a richer understanding of the contracting problem. Bebchuk and Spamann (2010) also advocate linking pay to debtlike instruments.

Our paper advances this literature in several ways:

First, in the spirit of Holmstrom and Tirole (1993) we rely on a market-based approach: just as linking compensation to stock returns helps motivate management to supply costly effort (as in their model), linking compensation to CDS spreads helps motivate managers to avoid excess risk-taking. Interestingly, several recent papers suggest incorporating CDS spreads into other forms of regulation. Hart and Zingales (2010) suggest CDS spreads as a trigger for when financial firms should be asked to increase capital. Greenlaw, Kashyap, Schoenholtz, and Shin (2011) also propose CDS spreads as a macroprudential tool.

Second, we show why optimal risk taking incentives will not be implemented by shareholders: Shareholders suffer from a commitment problem in the model, which may be exacerbated by either the renegotiation of compensation contracts, deposit insurance, or naive debtholders. Consequently, regulation may be necessary for implementation.

Third, we discuss the advantages of using CDS-based compensation over other debt-like compensation: In our model and those mentioned above, debt-like compensation generally

[5] John, Mehran, and Qian (2010) finds supporting evidence in the banking sector for the predictions on the determinants of the pay-performance ratio from John and John's (1993) model.

lowers risk taking. Empirically, Wei and Yermack (2011) and our paper show that the market believes debt-like compensation reduces risk taking.[6] Still, as we argue, CDS-based compensation may be cheaper and easier to implement than other debtlike instruments.

The issue of risk taking is particularly acute in the banking sector, as banks are highly levered and compensation in banks does not reflect the interests of all the different stakeholders involved. Macey and O'Hara (2003) argue that "the scope of the duties and obligations of corporate officers and directors should be expanded in the special cases of banks. Specifically, directors and officers of banks should be charged with heightened duty to ensure the safety and soundness of these enterprises. Their duties should not run exclusively to shareholders ... and to include creditors". Adams and Mehran (2003) point out that bank compensation policy may conflict with policy objectives that seek to protect the non-shareholding stakeholders, such as depositors and taxpayers in financial firms. Therefore, when designing compensation for bank executives, it is critical to take into account the interest of creditors and tax payers, in addition to equity holders. This is particularly important because of the deposit insurance subsidy, which reduces the firm's borrowing rate. Bebchuk and Spamann (2010) also have recognized that banks are highly levered and as such executive compensation should be designed to protect taxpayers and motivate executives to enhance the value of the firm rather than the value of equity.

The paper is organized as follows: In Section 2, we write down the model. In Section 3, we analyze the optimal risk choice for a firm under concentrated ownership. Section 4 considers CEO risk choice under separation of ownership and control. Section 5 characterizes optimal CDS-based compensation. Section 6 extends the model to allow for endogenous leverage. Section 7 details our empirical analysis. Section 8 discusses the tradeoffs of using other forms of debtlike compensation. Section 9 examines how CDS-based pay would be implemented. Finally, Section 10 concludes.

[6] Wei and Yermack (2011) uses a sample of non-financial firms, while we use financial firms. Sundaram and Yermack (2007) find a significant positive effect of inside debt on the distance to default measure for a sample of 237 of the Fortune 500 firms from 1996-2002.

2 The Model

We consider a bank that is run by a CEO hired by shareholders under an incentive package designed to align the CEO's objectives with shareholders. The CEO chooses the underlying riskiness of the bank's investments and that risk may be unobservable. We consider a classical incentive contract, where the CEO receives a fixed wage and a payment that depends on the price of the bank's stock, augmented by a payment that depends on the price of a credit default swap, and show that adding such a payment this is welfare improving. We also add deposit insurance to the basic model to examine how the implicit subsidy in deposit insurance affects the bank's choice of risk.

2.1 Investment Characteristics

The bank has access to an investment technology with the following characteristics. By investing an amount I the bank can get a gross return $\tilde{x}$, where $\tilde{x}$ can take three possible values:

- a high return $x + \Delta$ with probability q,
- a medium return x with probability $1 - 2q$, and
- a low return of $x - \delta$ with probability q.

We restrict q to be in the interval $[0, \frac{1}{2}]$. An increase in q thus increases the likelihood of both the high and low return outcomes.[7]

The CEO can raise q at a cost $c(q)$ per unit of investment. We assume for simplicity that $c(q)$ takes the following quadratic form $c(q) = \frac{1}{2}\alpha q^2$. In contrast to the standard principal-agent model, we take this cost to be a cost borne by the bank. A natural interpretation is that $c(q)$ is the per unit cost of originating assets with risk characteristics q.

[7] Having three outcomes makes it possible for q to be a direct measure of risk, i.e. the variance of the outcomes is strictly increasing in q for all $q \in [0, \frac{1}{2}]$.

The bank raises funds through deposits and subordinated debt.[8] For a total amount I of deposits and subordinated debt, it promises a return of $I(1+R)$. We assume that all lenders to the bank have an outside option of investing their money in an alternative that yields a safe return of $1+r_s$, say treasury bills. To simplify the algebra and notation we assume that all agents are risk-neutral and we set the discount rate to zero.

2.2 Timing

The timing of our model is as follows:

1. Incumbent equity holders hire a manager under a linear incentive contract $(\bar{w}, s_E, s_D)$, where $\bar{w}$ is the base pay, s_E is the shares of equity, and s_D is the loading on the credit default swaps (CDS) of the bank.

2. The manager chooses the bank's risk q,

3. The bank raises I to fund the asset from bondholders or depositors, with a promised return of $I(1+R)$,

4. The equity of the firm is priced at P_E and the CDS spread on the firm is priced at P_D.

5. The returns on the asset $\tilde{x}$ are realized. Depositors and bondholders get paid first. If there are returns left over, the equity holders get the residual value.

For the majority of the analysis we exogenously fix I and assume that the bank already has sufficient funds at stage 3. We relax this assumption in the section on leverage (section 6).

2.3 First-Best

We begin by characterizing the first best outcome. The choice of q by a social planner maximizes the net expected return from choosing q, which takes the following simple expression:

[8] In this section, we will treat deposits and subordinated debt as equivalent. In section 5.2 on deposit insurance, we model them separately.

$$\max_q \quad [x + q(\Delta - \delta)] - \frac{1}{2}\alpha q^2$$

It is immediate to see that the first best q is given by

$$q^{FB} = \frac{\Delta - \delta}{\alpha}$$

when $\Delta > \delta$ and $q^{FB} = 0$ otherwise.

In other words, as long as there is upside (from a risk-neutral perspective) there are gains to exposing the bank to some risk.

3 Ownership Concentration

We consider next the case where incumbent shareholders manage the firm with one voice. Shareholders choose q to maximize shareholder value net of the cost of debt. The cost of debt will reflect the market's assessment of the risk the bank is taking. The market may or may not be able to observe the true risk q the bank is taking. Accordingly, we distinguish between two subcases. We first allow bond prices to reflect the perfectly observed risk q, and then we consider the case where q is not observed and where the market rationally expected the bank to choose a level of risk $\widehat{q}$.

3.1 Observable risk

We focus on the most interesting case, where risk-taking by the bank may lead to a default on its debt only when the low return $x - \delta$ occurs. We make the natural assumption that there is a deadweight cost of default such that only $\lambda \in (0, 1)$ of the returns $(x - \delta)$ can be recovered. This may consist of legal and operational costs, or costs in terms of lost reputation.For default to be restricted to the low state, the following two conditions must hold:

$$1 + r_s > \lambda(x - \delta) \tag{A1a}$$

$$x > 2(1 + r_s) - \lambda(x - \delta) \tag{A1b}$$

where the first condition means that the amount in recovery is not sufficient to avoid default in the low state and the second condition[9] means that there is a sufficient return in the middle state to avoid default.

Under these assumptions, the optimization problem for shareholders when q is observable is:

$$\max_q \quad q(x + \Delta) + (1 - 2q)x - (1 - q)(1 + R) - \frac{1}{2}\alpha q^2$$

subject to the constraint that risk-neutral depositors obtain a return R equal to or larger than their safe return r_s:

$$(1 - q)(1 + R) + q\lambda(x - \delta) \geq 1 + r_s$$

or, rewriting the constraint:

$$R \geq \frac{1 + r_s - q\lambda(x - \delta)}{1 - q} - 1.$$

In equilibrium, the cost of debt $R(q)$ is set so that this constraint binds, and increases with the risk q taken by the bank. Substituting for $R(q)$ in the shareholders' maximization problem, we then get the unconstrained problem:

$$\max_q \quad q(x + \Delta) + (1 - 2q)x - (1 + r_s - q\lambda(x - \delta)) - \frac{1}{2}\alpha q^2$$

[9] We calculate this by setting the middle state x larger than the largest possible return on debt $1 + R(\frac{1}{2})$, where $R(q)$ is defined below.

The first order condition for the shareholders' problem is:

$$\Delta - x + \lambda(x - \delta) - \alpha q = 0 \tag{1}$$

which gives the optimal choice

$$q^o = \frac{\Delta - x + \lambda(x - \delta)}{\alpha}$$

when $\Delta - x + \lambda(x - \delta) > 0$ and $q^o = 0$ otherwise.

As one would expect, the observability of q induces shareholders to limit their risk-taking. The only divergence with respect to the first-best solution comes from the inefficient loss of resources when default occurs. As a result of this deadweight loss shareholders of a debt-financed bank will be more conservative than an "all equity bank":

$$q^o = \frac{\Delta - x + \lambda(x - \delta)}{\alpha} < q^{FB} = \frac{\Delta - \delta}{\alpha}$$

for $\lambda < 1$.

3.2 Unobservable Risk

Consider next the more realistic case where the choice of risk q is not observable to bondholders. In this case, the best bondholders can do is to form rational expectations about the bank's optimal choice of q. This means, in particular, that if the bank changes its risk exposure at the margin this change will not be reflected in the price of debt. As a result, the bank may be induced to take excessive risk when risk is unobservable.

With an expected risk level of $\hat{q}$, bondholders require a return of at least $R(\hat{q})$, where:

$$R(\hat{q}) \geq \frac{1 + r_s - \hat{q}\lambda(x - \delta)}{1 - \hat{q}} - 1.$$

The bank then chooses q knowing that it is unobservable and a change in q doesn't affect the cost of debt directly:

$$\max_q \quad q(x+\Delta)+(1-2q)x-(1-q)(1+R(\hat{q}))-\frac{1}{2}\alpha q^2$$

This gives a first order condition of:

$$\Delta - x + 1 + R(\hat{q}) - \alpha q = 0 \tag{2}$$

In a *rational expectations equilibrium* the choice of risk by the bank must be the same as depositors' expectations, so that $q = \hat{q}$. This implies that the equilibrium choice of risk is determined by the intersection of the depositors' and the banks optimal responses:

$$\Delta - x + \frac{1 + r_s - \hat{q}\lambda(x-\delta)}{1-\hat{q}} = \alpha\hat{q} \tag{3}$$

The solution is implicitly given by equation 3. For a solution, we can show that $\hat{q} > q^o$. Indeed, recall that

$$q^o = \frac{\Delta - x + \lambda(x-\delta)}{\alpha}.$$

The left hand hand side of equation 3 is $\Delta - x + 1 + r_s$ when $\hat{q} = 0$ and is increasing in $\hat{q}$ (given A1). We depict this in Figure 2, which demonstrates that $\hat{q} > q^o$.

Using the quadratic formula on equation 3, we find that the solution exists as long as

$$(\alpha + \lambda(x-\delta) + \Delta - x)^2 - 4\alpha(\Delta - x + 1 + r_s) > 0.$$

Given existence, there are actually two solutions to equation 3, both of which satisfy the property that $\hat{q} > q^o$. Only the smaller solution, however, is stable.

Therefore, unobservable choices, although rationally expected, are riskier than observable choices. This is because the sensitivity of debt to risk is only taken into account when the risk choice is observable. The bank's shareholders are worse off with the riskier unobservable choice. This worse outcome is due to an inability of the bank's shareholders to commit to a

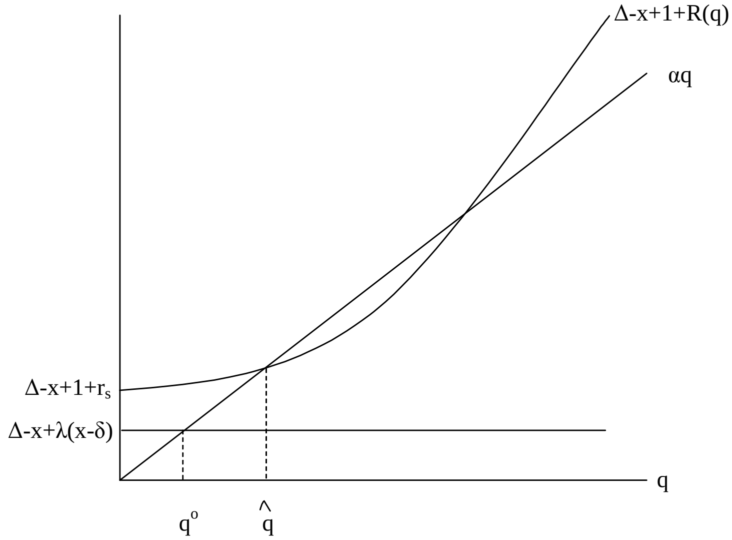

Figure 2: Excess risk taking: $\hat{q} > q^o$

lower risk exposure. We will see in the next section that under separation of ownership and control the incentive contracting problem between the bank's shareholders and the CEO involves both the classical problem of aligning the shareholders' and CEO objectives and a commitment problem with respect to the bank's bondholders. This joint contracting problem for a levered financial institution is an important conceptual difference with respect to the classical moral hazard incentive contracting problem of Mirrlees (1975) and Holmstrom (1979).

4 Separation of Ownership and Control and the choice of unobservable risk

Suppose now that a manager decides on the level of risk. The manager's contract, as we stated before, is composed of three components: a fixed wage, a loading on equity as well as a loading on the CDS spread. The equity part is standard and represents shares given to the manager as compensation. The CDS part is the innovation. In this section we show that it can restore optimal risk-taking incentives. In section 7, we discuss the advantages of using the CDS spread over other forms of debt.

We take the price of debt to be a credit default swap (CDS) spread, which is liquid and should reflect fundamental risk. Rather than directly sell CDSs for the manager, we envision the firm setting aside a pool of money that can be paid out to the manager according to the market price of the CDSs. Therefore the contract takes the following form:

$$Compensation = \bar{w} + s_E P_E + s_D(\bar{P} - P_{CDS})$$

Since the CDS spread is increasing in the probability of default, it is judged relative to a high benchmark $\bar{P}$ in order to align the manager's incentives. This benchmark may come from a weighted industry CDS spread or from a reference spread under a given risk exposure q.

In order to analyze the optimal contract we must first define the prices. The price of equity is given by the present discounted value of equity cash flows net of origination costs $c(q)$ and expected debt repayments $(1-q)(1+R(q^T))$. Note that in the low return state the bank defaults and shareholders get nothing, so that the price of equity is given by:

$$P_E = q(x+\Delta) + (1-2q)x - (1-q)(1+R(q^T)) - \frac{1}{2}\alpha q^2$$

Here, q^T represents the risk level that bondholders believe the bank will implement through the compensation contract.

The CDS spread, in turn, is equal to:[10]

$$q(1 - \frac{\lambda(x-\delta)}{1+R(q^T)})$$

[10] More generally, if p is the CDS spread and β is the discount factor, the no-arbitrage condition is

$$p(1+R(q^T))\sum_{i=0}^{n}\beta^i(1-q)^i = q(1+R(q^T) - \lambda(x-\delta))\sum_{i=0}^{n}\beta^i(1-q)^i$$

where $1+R(q^T)$ is the face value and $\lambda(x-\delta)$ is the amount recovered in default. In our basic model, $n=0$, but one can observe that if periods were added, the result would be the same.

where $\frac{\lambda(x-\delta)}{1+R(q^T)}$ is the recovery rate of the investment.

Note that we are implicitly assuming here that the CDSs are being traded by informed traders who observe signals that are perfectly correlated with the bank's actual risk exposure q, as in Holmstrom and Tirole (1993). Thus, although the bank's actual risk choice is not observable ex-ante when the bank issues bonds it becomes observable to analysts trading CDS ex-post. In principle, this ex-post observability of q through the CDS price could be incorporated into bond contracts ex-ante, but this is typically not done in practice. Accordingly, we shall not introduce this contractual contingency into bond contracts. Note that if we were to allow R to depend on the CDS spread we would introduce a potentially complex fixed-point problem for the equilibrium risk choice q.

Consider first the case where the manager's compensation package only contains stock, so that $s_D = 0$. Then, the manager's objectives with respect to the choice of risk q are perfectly aligned with shareholders', so that the manager chooses chooses $\hat{q}$ as one would expect and therefore takes socially excessive risk.

If instead we allow for the compensation package to be based on CDS spreads as well, the manager maximizes his compensation by choosing q, giving us the following first order condition:

$$\Delta - x + (1 + R(q^T)) - \alpha q - \frac{s_D}{s_E}(1 - \frac{\lambda(x-\delta)}{1 + R(q^T)}) = 0$$

Notice that the second order condition is negative.

In a rational expectations equilibrium bondholders have correct expectations about the choice of q, so that $q^T = q$. Using this equality, we can rewrite the first order condition as follows:

$$\frac{s_D}{s_E} = \frac{\Delta - x + (1 + R(q^T)) - \alpha q^T}{1 - \frac{\lambda(x-\delta)}{1+R(q^T)}} \tag{4}$$

Can the bank implement the first best through contracting? Setting $q^T = q^o$ and simplifying, we find that:

$$\frac{s_D}{s_E} = 1 + R(q^o) \tag{5}$$

In other words, the ratio of the equity and debt loadings should be set equal to the rate of return promised to bondholders at the optimal risk level. Although the optimal risk level may be difficult to calculate, this provides a simple framework for thinking about how to balance incentives. Moreover, opening up the black box by substituting for q^o provides further understanding:

$$1 + R(q^o) = \frac{1 + r_s - (\frac{\Delta - x + \lambda(x-\delta)}{\alpha})\lambda(x-\delta)}{1 - \frac{\Delta - x + \lambda(x-\delta)}{\alpha}}$$

The RHS of this equation is increasing in the return on the safe investment $1 + r_s$. As the need to satisfy depositors with higher returns increases and depositors themselves are less sensitive to local change in risk, the manager will take on more risk. This is then reined in by pushing up the loading on the CDS portion of the manager's contract. The expression $(\Delta - x + \lambda(x - \delta))$ is the marginal return on a unit increase of risk. Assuming this is positive (otherwise $q^o = 0$), an increase in the marginal return increases the expression. With the returns to risk-taking higher, the manager is controlled by exposing him/her to the downside of default risk more. The term $\lambda(x - \delta)$ which does not represent part of the marginal returns is the default recovery amount. The expression is decreasing in this term. When less resources are lost to default, the need to dampen risk is lower. Lastly, the expression is decreasing in α, the direct cost of increasing q. If it is more costly to increase risk, there won't need to be as much oversight through contracting incentives.

5 Optimal and Equilibrium CDS-based compensation

Although it is in principle possible to make use of CDS prices to induce a levered bank's CEO to choose a socially optimal level of risk, it is far from obvious that a levered bank's shareholders will make use of such incentive contracts to align the CEO's risk-taking objectives. There are at least three reasons why we should not expect shareholders to offer socially optimal incentive contracts to their CEOs: renegotiation, deposit insurance, and naive bondholders.[11] We explore these below.

5.1 Renegotiation

The first reason is related to the limited commitment power of contracts. As has been pointed out in the literature on the strategic role of incentive contracts (e.g. Katz, 1991, and Caillaud, Jullien, Picard, 1995) the optimal contract such that

$$\frac{s_D}{s_E} = 1 + R(q^o)$$

may not have much commitment value if shareholders can (secretly) undo the contract once the bonds have been issued. If that is the case, shareholders will simply offer a new contract to the CEO after the bond issue, inducing him to change the bank's risk exposure away from q^o.[12] If that is possible, then the CDS based contract will have no value and will therefore not be offered by shareholders. Although this issue is likely to be relevant in practice, we have not allowed for this possibility of renegotiation and revision of the bank's risk choice in our model. One reason why we do not emphasize this problem is that disclosure of

[11] There is a fourth more subtle reason: while the shareholders prefer q^o when there is no manager and when a manager has stock based compensation, they don't prefer q^o once there is compensation based on debt because their objective function has changed to incorporate the fact that the wage paid is based on the CDS spread as well.

[12] What the equilibrium risk choice is depends on how the problem is formulated. One logic is that rational investors anticipate renegotiation and therefore pay no attention to the incentive contract in the first place. They act as if shareholders had no commitment power (as in Katz (1991)). Another logic is that they are naive and get fooled, in which case the final outcome is like the outcome in the section on naive bondholders.

CEO compensation can to a large extent reduce the benefits of this strategic renegotiation. Still, it is worth emphasizing that some minimal form of regulation (such as mandatory disclosure) is required to make it worthwhile for shareholders to add this CDS exposure to CEO compensation contracts.

The next two reasons why shareholders may not offer the socially optimal contract to their CEO are valid even if contracts can have full commitment power.

5.2 Deposit Insurance

Suppose now that, as is true in practice, the bank funds its investments partly with deposits that are fully insured. Concretely, consider a fixed amount of debtholders B and a fixed amount of depositors L. The premium charged by the deposit insurance authority is P. Therefore the total amount of funds the firm has to invest[13] is $B + L - P$. Depositors are guaranteed the safe payoff by the bank $1 + r_s$.

The premium P set by the deposit insurance authority is set fairly, i.e. it covers expected losses. It is defined as:

$$P = q(L(1 + r_s) - (B + L - P)\lambda(x - \delta))$$

The premium depends on itself, as it affects the level of investment. In equilibrium, it is therefore:

$$P = \frac{q(L(1 + r_s) - (B + L)\lambda(x - \delta))}{1 - q\lambda(x - \delta)} \tag{6}$$

We assume in this formulation that the amount recovered in default goes only to depositors, but is not enough to cover their obligations, which is equivalent to assuming that

[13] John, Saunders, and Senbet (2000) have a model of risk shifting in which deposit insurance restores first best incentives for risk-taking to shareholders (who then induce the manager to take the first best risk choice). Our model differs along several dimensions. First, we posit that the money paid for deposit insurance up front comes from deposits and debt raised. Second, as the deposit insurance authority sets its premium first, the risk level is not responsive to the risk choice (although it will be accurate given rational expectations). Third, we allow for the return demanded by bondholders to depend on expectations of risk.

the premium is positive. Formally, it amounts to the following condition, which supersedes assumption A1a:[14]

$$L(1 + r_s) - (B + L)\lambda(x - \delta) > 0 \tag{A2a}$$

We also assume that the analogue of assumption A1b, that there will not be a default in the middle state, is true:

$$x > \frac{(B + L(1 - q))(1 + r_s)}{B + L - Lq(1 + r_s)} \frac{1 - q\lambda(x - \delta)}{1 - q} \tag{A2b}$$

Lastly, we assume that the total amount of funds invested $B + L - P$ is positive for all q, which is equivalent to:

$$B + L - \frac{1}{2}L(1 + r_s) > 0 \tag{A3}$$

The expected return of debtholders depends on how much they will recover and is:

$$(1 - q)(1 + R) \geq 1 + r_s$$

The timing is now:

1. Incumbent equity holders hire a manager under a linear incentive contract $(\bar{w}, s_E, s_D)$, where $\bar{w}$ is the base pay, s_E is the shares of equity, and s_D is the loading on the credit default swaps (CDS) of the bank.

2. The deposit insurance authority sets fees for deposit insurance.

3. The CEO chooses the probability q for the asset.

4. The bank raises B and L to fund the assets from debtholders and depositors respectively, with a promised return $1 + R$ and $1 + r_s$ respectively. It pays the deposit

[14] This condition implies that both the numerator and the denominator of the premium P in equation 6 are positive (given that $q \in [0, \frac{1}{2}]$ and $r_s \in (0, 1)$).

insurance fee.

5. The equity of the firm is priced at P_E and the CDS spread on the firm is priced at P_D.

6. The returns on the asset $\tilde{x}$ are realized. Depositors and debtholders and get paid first. In case of default, the recovery amount is distributed to depositors. The deposit insurance authority compensates depositors for any shortfall below $1 + r_s$. If there are returns left at any point, the equity holders get the residual value.

Our first benchmark is the situation where q is perfectly observed by debtholders and the deposit insurance authority can set its fees after perfectly observing q.

In this case, the manager with a contract based on the price of equity maximizes:

$$\max_q \quad (B + L - P(q))\{q(x + \Delta) + (1 - 2q)x - \frac{1}{2}\alpha q^2\}$$
$$-(1 - q)(1 + R(q))B \qquad -(1 - q)(1 + r_s)L - P(q)$$

We can rewrite the problem as:

$$\max_q \quad (B + L - P(q))\{q(x + \Delta) + (1 - 2q)x + q\lambda(x - \delta) - \frac{1}{2}\alpha q^2\} - (1 + r_s)(B + L)$$

Not surprisingly, this expression represents total surplus. The difference with our previous model is that P is present and depends on q.

Lemma 1 *In the case where risk is observable to debtholders and the deposit insurance authority, there is a unique optimum q^{oDI}. Furthermore $q^{oDI} < q^o$.*

The proof is in the appendix. The bank takes less risk when it is observable than in the previous model because the deposit insurance premium increases with risk and therefore reduces the bank's returns.

In our second benchmark, we maintain the observability of q to debtholders, but impose that the deposit insurance authority set its fees in advance. The bank thus takes the fee it pays for deposit insurance as fixed, but the deposit insurance authority rationally foresees the level of risk and sets the premium fairly. The maximization problem for the manager is therefore:

$$\begin{aligned} &\max_q \quad (B + L - P(q^{2DI}))\{q(x+\Delta) + (1-2q)x - \frac{1}{2}\alpha q^2\} \\ -(1-q)(1+R(q))B \quad &-(1-q)(1+r_s)L - P(q^{2DI}) \end{aligned}$$

We solve and find the following result:

Lemma 2 *In the case where risk is observable to debtholders but not the deposit insurance authority, the optimum* q^{2DI} *satisfies the property* $q^{oDI} < q^o < q^{2DI}$*.*

The proof is in the appendix.

The level of risk q^{2DI} is larger than q^o and q^{oDI}. When the bank is not sensitive to the cost it pays for deposit insurance, it increases the risk level.

Now consider the case where q is unobservable to the deposit insurance authority and debtholders. Here, the bank takes both $R(q)$ and deposit insurance as fixed.[15] This gives us the following objective function:

$$\begin{aligned} &\max_q \quad (B + L - P(\hat{q}^{DI}))\{q(x+\Delta) + (1-2q)x - \frac{1}{2}\alpha q^2\} \\ -(1-q)(1+R(\hat{q}^{DI}))B \quad &-(1-q)(1+r_s)L - P(\hat{q}^{DI}) \end{aligned}$$

This problem gives us the following result:

[15] Although the deposit insurance authority and the debtholders act at different times, the bank takes both of their actions as fixed. Nevertheless we assume that both are rational and must be correct in equilibrium about the level of risk.

Lemma 3 *In the case where risk is unobservable to both debtholders and the deposit insurance authority, the optimum $\hat{q}^{DI}$ satisfies the property $q^{oDI} < q^{o} < q^{2DI} \leq \hat{q}^{DI}$.*

In the appendix we demonstrate that an optimum exists, although it may not be unique. Any solution, however, has the property that it is larger than the first benchmark q^{oDI} and at least as large as the second benchmark q^{2DI} (strictly larger if the second benchmark is an interior solution).[16] This is in line with our main model - making risk unobservable to debtholder increases the risk level the manager takes.

Using the price of debt to discipline the manager can restore the optimum of q^{oDI} here as well. The formula for the ratio of the share of debt to the share of equity is now more complicated:

$$\begin{aligned}\frac{s_D}{s_E} &= (1 + R(q^{oDI}) - \lambda(x-\delta))B + (1 + r_s - \lambda(x-\delta))L \\ &\quad + P(q^{oDI})\lambda(x-\delta) + \frac{1}{q^{oDI}(1 - q^{oDI}\lambda(x-\delta))}P(q^{oDI})\Pi\end{aligned}$$

where Π is value of the surplus per unit $(q^{oDI}(x+\Delta) + (1-2q^{oDI})x + q^{oDI}\lambda(x-\delta) - \frac{1}{2}\alpha(q^{oDI})^2)$.

Importantly, without the proper incentives, shareholders will not want to implement q^{oDI} and implement the CDS contract. Given the friction that the deposit authority can't observe risk directly, it is only in the interest of shareholders to implement q^{2DI} (if they could commit to it), and thus take excess risk. Consequently, regulatory intervention is required in the presence of deposit insurance to be able to implement the socially desirable level of risk. In other words, the regulator has to step in to reduce the bank's shareholders' incentives to take excess risk so as to maximize the subsidy from deposit insurance.

[16] This holds as long as we consider stability as the selection criteria for equilibria. This criteria is applied in the appendix.

5.3 Naive debtholders

Until this point, we have considered debtholders who are completely rational. We now suppose that they may be naive and overly optimistic. By naive, we mean that debtholders do not consider the incentives of the CEO regarding risk. By optimistic, we mean that debtholders expect the risk level to be equal to the optimal level q^o. For a CEO whose contract does not have the debt component, the maximization problem is then:

$$\max_q \; q(x+\Delta)+(1-2q)x-(1-q)(1+R(q^o))-\frac{1}{2}\alpha q^2$$

with the first order condition:

$$\Delta - x + (1+R(q^o)) = \alpha q \tag{7}$$

From figure 1, it should be clear that the solution to equation 7, q^N, has the property that it is larger than the optimal risk ($q^N > q^o$). Therefore, naivete encourages risk taking. At the same time, the risk level is lower than the amount a manager would take when debtholders are rational but risk is unobservable ($q^N < \hat{q}$). From a social surplus perspective, it is thus better to have the naive debtholders than rational ones when q is unobservable.

This logic only goes so far. From the perspective of shareholders and the CEO this increases returns. However, the increase in returns comes from two sources - an increase in actual expected returns, and a transfer of expected returns from debtholders to shareholders. Debtholders expect (incorrectly) that their returns will be equal to $1+r_s$, when in fact their expected returns will be less because of risk taking by the manager. So although returns are higher, debtholders are worse off in this scenario.

Can this be corrected by the modification in the compensation package proposed in the previous subsection? The answer is yes, and in fact, the solution is identical to before, $\frac{s_D}{s_E} = 1 + R(q^o)$. This is simple to see from the derivation of the rule for rational investors. Again, however, it is not in shareholders' interest to implement such a correction. Regulatory intervention is required to achieve this reduction in risk taking.

What about bondholders who are naive, but pessimistic? Consider, for example, bondholders who do not take into account the manager's incentives, but expect risk to be high, say $\hat{q}$. In this case, the bondholders' beliefs are self-fulfilling. Switching q^o to $\hat{q}$ in equation 7 and comparing to equation 3 demonstrates that the risk level chosen by the CEO will be $\hat{q}$. The CEO thus takes more risk here than when debtholders are optimistic. Overall returns are down, and the amount expropriated from an individual debtholder is zero, as he gets an expected return of $1 + r_s$. The debtholder protects herself with the low expectations of the manager's performance, but increases risk taking.

In order to mitigate this risk taking, a contract based on debt can be implemented here as well, although the rule would be slightly different. The ratio of the shares of debt to equity will be larger to take into account the excess risk, $\frac{s_D}{s_E} = 1 + R(\hat{q})$. Regulatory intervention is also required here to implement this lower level of risk.

6 Leverage

Suppose the CEO now has to raise funds and that the number of debtholders and hence the amount of debt to hold is no longer fixed. What is the effect of leverage on risk taking? We will assume that the project returns exhibit decreasing returns to scale - the more debt, the lower the expected returns.[17] Specifically, for an amount of debt $I \in [0, \bar{I}]$ we make the loss in case of default δ an increasing and convex function of I. One way to think about these decreasing returns are that as more projects default, it becomes more difficult to process and recover value, as in the case for mortgages and foreclosures in the recent crisis.

Our benchmark here is the scenario where both q and I are observable and the bank takes into account the opportunity cost of debtholders. The bank maximizes:

[17] We will assume the project cost is still constant returns to scale, however.

$$\max_{I,q} \quad I\{q(x+\Delta)+(1-2q)x-(1+r_s-q\lambda(x-\delta(I)))-\frac{1}{2}\alpha q^2\}$$

The first order condition with respect to q yields a similar result to before:

$$q^{oL}=\frac{\Delta-x+\lambda(x-\delta(I))}{\alpha}$$

Note that the optimal level of risk is decreasing in leverage.

The first order condition with respect to I is:

$$\{q(x+\Delta)+(1-2q)x-(1+r_s-q\lambda(x-\delta(I)))-\frac{1}{2}\alpha q^2\}=Iq\lambda\delta'(I)$$

We will call the optimal level of leverage I^{oL}.

Now consider the case where both q and I are unobservable. The bank maximizes:

$$\max_{I,q} \quad I\{q(x+\Delta)+(1-2q)x-(1-q)(1+R(\hat{q}^L,\hat{I}^L))-\frac{1}{2}\alpha q^2\}$$

The bank's choice of leverage now does not affect the cost of debt. This implies that for positive equity prices, the bank chooses the maximum amount of leverage $\bar{I}$. How much risk does the bank take for this amount of leverage? The first order condition is the analogue of equation 3:

$$\Delta-x+\frac{1+r_s-\hat{q}^L\lambda(x-\delta(I))}{1-\hat{q}^L}=\alpha\hat{q}^L$$

Assuming that a solution exists as in Figure 1, we observe that risk is increasing in leverage ($\hat{q}^L$ is increasing in I).[18] More leverage decreases the size of the assets recovered in default, meaning that the bank has to pay out more when not defaulting, encouraging it to take more risk.

[18] The left hand side of the equation is increasing in I, holding q fixed. In figure 1, we can see that this moves the curve upward, so the stable solution increases.

Will linking compensation to the price of debt reduce risk and leverage? We now show that we can restore the first best. First, notice that the CDS spread is increasing with leverage:

$$P_{CDS} = q(1 - \frac{\lambda(x - \delta(I))}{1 + R(q^{TL}, I^{TL})})$$

The manager maximizes:

$$\max_{I,q} \quad [s_E I\{q(x + \Delta) + (1 - 2q)x - (1 - q)(1 + R(q^{TL}, I^{TL})) - \frac{1}{2}\alpha q^2\} - \\ s_D q(1 - \frac{\lambda(x - \delta(I))}{1 + R(q^{TL}, I^{TL})})]$$

Which yields the following first order conditions:

$$\begin{aligned} q &: I^{TL}\{\Delta - x + (1 + R(q^{TL}, I^{TL})) - \alpha q^{TL} - \frac{s_D}{s_E}(1 - \frac{\lambda(x - \delta)}{1 + R(q^{TL}, I^{TL})}) = 0 \\ I &: \{q^{TL}(x + \Delta) + (1 - 2q^{TL})x - \end{aligned}$$

$$(1 + r_s - q^{TL}\lambda(x - \delta(I^{TL}))) - \frac{1}{2}\alpha(q^{TL})^2\} - \frac{s_D}{s_E}\frac{q^{TL}\lambda\delta'(I^{TL})}{1 + R(q^{TL}, I^{TL})} = 0$$

It is straightforward to demonstrate that the solution is the analogue of the one in the main model:

$$\frac{s_D}{s_E} = I^{oL}(1 + R(q^{oL}, I^{oL}))$$

7 Empirical Analysis

Although our model is normative and proposes modifying compensation in a new way, this section offers evidence suggesting that linking pay to credit quality is likely to produce results supporting the paper's thesis. We focus on the recent disclosure of deferred compensation and pension benefits in proxy statements filed with the SEC. Below, we discuss our data and our methodology.

7.1 Data

Enhancing transparency of managers' deferred compensation holdings and pension benefits was a key feature of the Securities and Exchange Commission's expansion of executive compensation disclosure at the end of 2006. We use this information to study CDS investor reactions to disclosure of CEO deferred compensation and pension benefits at listed financial institutions that reported compensation to shareholders in 2007.

Specifically, we focus on banking firms. We collected deferred compensation and pensions as well as equity compensation from proxy filings in EDGAR. CEO pension benefits may sometimes be negotiated, but they usually accrue to managers under company-wide formulas established by each company. Deferred compensation is generally paid out to the executive at retirement. We collected additional data from COMPUSTAT and CRSP for calculating the Black-Scholes stock option values as well as the value of CEO equity holdings. Lastly, we required banks in our sample to have CDS quotes data from Markit, our data source for daily CDS spreads.The spreads are for five-year, senior unsecured CDS with a "Modified Restructuring" clause, which was usually embedded in a firm's most widely traded contract before 2009. To enter the final sample, a bank must have CDS daily quotes on the disclosure day (event day 0) and the subsequent trading day (event day 1). Overall, this sampling procedure gives us 27 banks for our final sample.

7.2 Methodology

We follow a methodology similar to that of Wei and Yermack (2011) to produce a CDS event study of the first-time disclosure of deferred compensation and pensions in banks.[19]

[19] Wei and Yermack (2011) study non-financial firms and find that the revelation of more CEO inside debt increases debt prices, decreases equity prices, and lowers the CDS spread for non-financial firms. Sundaram and Yermack (2007) find a significant positive effect of inside debt on the distance to default measure for a

In a standard event study, security returns (equity or bond) are analyzed to estimate the unexpected component (abnormal return) in the returns within a window surrounding the event. The abnormal return (AR) on the event day is calculated by adjusting the return to exclude changes due to market movement. Both AR and the cumulative abnormal return (CAR) through several days surrounding the event provide an assessment of the event's impact on the security value. In the CDS market, however, spread is the main valuation metric. To follow the standard approach as closely as possible, we use daily percentage changes of CDS spread in the event analysis. Specifically, the daily "spread" return (SR) for firm i on day t, is calculated as

$$SR(i,t) = \frac{[Spread(i,t) - Spread(i,t-1)]}{Spread(i,t-1)} \tag{8}$$

To control for the market movement, we next define the market "spread" return (SR_m) as the equally weighted average of daily *CDS spreads* for all financial firms[20] (with n denoting the total number of firms).

$$SR_m(t) = \frac{\sum_{i=1}^{n} SR(i,t)}{n} \tag{9}$$

To calculate daily abnormal "spread" returns (ASR), we deduct the CDS market spread return from the individual CDS spread return on each day t.

$$ASR(i,t) = SR(i,t) - SR_m(t) \tag{10}$$

Lastly, the cumulated abnormal "spread" return (CASR) between event day 0 and day 1 is calculated as the sum of ASR on event day 0 and 1. $CASR$ is the key measure used in the cross-section analysis as reported in **Table 2**.

sample of 237 of the Fortune 500 firms from 1996-2002.

[20] The total number of financial firms is 125.

$$CASR(i) = ASR(i,0) + ASR(i,1) \tag{11}$$

7.3 Results

Table 1 presents CEO total wealth, which is the sum of the value of stock holdings, options and restricted stock holdings, pensions, and deferred compensation. On average, a bank CEO's wealth is about $287 million (with a median of $95 million). The average value of CEO equity holdings is about $265 million (with a median of $61 million). Bank CEOs have nearly $10 million in pensions and another $10 million in deferred compensation (with medians of nearly $5 million and $6 million in deferred bay and pensions, respectively). The percentage of CEOs' total wealth in deferred pay and pensions is about 7% and 11%, respectively. On average, the ratio of a bank CEOs' sum of deferred compensation and pensions to their equity holdings is 26% (median of 29%), with the ratio of deferred pay to equity holdings of 10% (median of 7%) and pension to equity holdings of 16% (median of 14%).

Ratios of deferred pay and pensions to total wealth or equity holdings are critical in our analysis. We expect more CEO conservatism the higher these ratios are. Wei and Yermack (2011) and Edmans and Liu (2010) argue that both deferred pay and pensions are unsecured in the event of default. As a result, CEOs with large holdings in deferred pay and pensions are unlikely to undertake risky investment choices. If available, the information on both deferred pay and pensions can prove helpful to credit market analysts. Firms were first required to disclose this information in their proxy filings in the beginning of 2007. Therefore, we anticipate that the credit market reacted to the news in proxy filings since disclosure began.

We estimate announcement credit market CDS spreads over the window of (0,1) for the 27 banks with actively traded CDS. The announcement returns by themselves are not very informative as proxy fillings contain other information as well. We perform a cross-sectional test of the returns and the results are reported in **Table 2**. It should be noted that in our OLS estimates, we do not control for firm-specific characteristics. The main reason is that we have only 27 banks and consequently few degrees of freedom in our analysis. However, this may not be relevant for the following reasons. First, we are using a highly homogeneous industry. All the banks are very large. Furthermore, the average (median) book debt to assets ratio in these large banks is about 92%. Also, these banks arguably face similar investment opportunity sets, and as Smith and Watts (1992) have pointed out, the investment opportunity set drives other corporate polices.

We estimate four models[21] which are presented in **Table 2**. In model (1), we estimate the effect of the ratio of the sum of deferred pay and pensions to equity holdings on CDS cumulative abnormal returns. The coefficient is negative and significant, suggesting that firms with a higher investment in deferred compensation and pensions experience a larger reduction in their credit spreads. In model (2), we estimate the effect of deferred compensation and pensions separately. However, the estimates are not significant. In model (3), we create a (0,1) dummy for the ratio of the sum of deferred compensation and pensions to equity holdings. The dummy takes the value 1 whenever the firm's ratio is above the median value of the ratio in the sample (29%). We find that firms with an investment in deferred pay and pensions relative to equity holdings above the median, experience a lower credit spread at the proxy announcement. We create two more dummies separately for the ratios of deferred pay to equity holdings and pensions to equity holdings, equal to 1 for observations above the median of the sample (7% and 14%, respectively), and these estimates are reported in model (4). We find firms with higher than median investment in deferred compensation experience 2.6% larger reduction in their CDS spreads net of market movements relative to firms below

[21] Wei and Yermack (2011) also use a slightly different independent variable, which was suggested by the work of Edmans and Liu (2010): they normalize the inside debt and equity holdings of the CEO by the debt and equity levels of the firm. With this variable, our results are qualitatively similar, but less significant. The reason is that all bank CEO personal leverage ratios are below the corresponding bank leverage ratios because of the typically high leverage in banks. Moreover, deposit insurance and too-big-to-fail concerns make it unclear what ratio we should use to capture the "risky" debt part of bank liabilities.

the median investment. The high pension dummy is not significant, however.

Overall, we find some results suggesting that the disclosure of deferred compensation and pension benefits is priced in credit markets. Firms with larger investments in CEO deferred compensation experience a reduction in the CDS spreads at proxy announcements. A plausible reason for this reduction may be that banks are likely to be more conservative in terms of the riskiness of their investment choices.

8 Why not use other debt-based compensation?

Our model demonstrates the efficacy of CDS-based compensation in reducing risk taking. In the model, other debt-like instruments (including debt itself) would reduce risk taking as well. This raises the natural question of why the focus should be on CDS-based compensation rather than on other instruments tied to debt. In this section we address this question directly. We begin by demonstrating that CDS-based compensation will be less costly to use than deferred compensation. We then discuss the practical difficulties of including debt in compensation rather than basing it on the CDS spread.

8.1 Deferred Compensation

Deferred compensation is a debt-like instrument since it is unsecured and hence its payoff depends on the probability of default. In this subsection, we slightly extend the model to demonstrate that deferred compensation is not as effective as using CDS based compensation. The model is extended in a very natural way. Previously, the CEO implicitly consumed his wage subsequent to the market pricing the firm's financial instruments. Now, we allow for two periods ($t = 1, 2$) of consumption for the CEO and introduce a discount factor β. The first period is subsequent to market pricing but before the realization of the state. The second period follows the realization of the state.

Consider first a CEO receiving only deferred equity compensation, i.e. all of the compensation is in equity and is deferred until $t = 2$. In the current model, the CEO would still choose the excessively high risk level of $\hat{q}$. Moreover, to provide a fixed consumption target level (e.g. if the participation constraint of the CEO were made to bind), the firm would have to compensate the CEO with more equity than if the equity compensation were not deferred. This would make shareholders even more resistent to adopting such a scheme, and potentially cause more distortion.

Next, consider deferred cash compensation C given in addition to (non-deferred) equity compensation. Assuming linear utility for the CEO, the CEO maximizes:

$$\max_{q} s_E^{cash} P_E + \beta(1-q)C$$

It is important to note that giving cash that can be consumed at period $t = 1$ would not affect risk taking at all. The key here is that it is deferred, so the CEO will lose it if the low state occurs. While in reality the CEO may not lose all of her deferred cash in the low state (this depends on negotiations with other creditors) as we have assumed here, partial loss will not make a difference for the qualitative results.

Using the results of the maximization problem, the optimal level of risk taking q^o can be achieved by setting the equity weighting and cash levels such that:

$$\frac{C}{s_E^{cash}} = \frac{1 + r_s - \lambda(x - \delta)}{\beta(1 - q^o)}$$

The CEO therefore consumes:

$$s_E^{cash} P_E(q^o) + \beta(1 - q^o)C(q^o)$$

which when simplifying is:

$$s_E^{cash}(P_E(q^o) + 1 + r_s - \lambda(x - \delta))$$

The consumption of the CEO when CDS-based compensation is given is:

$$s_E^{CDS} P_E(q^o) + s_D(\bar{P} - P_{CDS}(q^o))$$

Since $\bar{P}$ is a free parameter, we can set it equal to $P_{CDS}(q^o)$, implying that consumption for the CEO is simply $s_E^{CDS} P_E(q^o)$. Assuming that the CEO has a binding participation constraint with outside option $\bar{U}$, the equity weights s_E^{cash} and s_E^{CDS} are pinned down, and the CEO is indifferent between the two schemes. The firm, however, may not be indifferent between the two schemes. Firstly, if the firm must set aside the cash upfront, it is paying more than the CEO is receiving in consumption value due to discounting. Second, since cash may be strictly more expensive for a firm than granting equity[22], the cost to the firm of the CEO's compensation is larger with deferred compensation than CDS-based compensation.[23] Notice that the CDS-based compensation can be implemented by cash (rather than giving the CEO CDS contracts), but it ends up being very low cost (or costless if we set $\bar{P}$ perfectly). It is also interesting to point out that deferred CDS-compensation would work equally well as upfront CDS compensation in this model.

8.2 Debt

In our model, we focus on the use of CDS spreads as the tool to moderate risk taking incentives. We specifically use CDS based compensation because it is market based and can be chosen optimally. Several other methods of compensation have been proposed that rely on other debt instruments. We view theses as helpful but subject to practical problems of implementation. Specifically, the practical problems lie in the structuring and valuation of the debt, as well as in its tax treatment.

Structuring and Valuation – Depending on the type of debt used, it may be difficult

[22] One reason would be tax benefits, as in Babenko and Tserlukevich (2009).

[23] This in some sense a thought exercise, as we have shown earlier that shareholders would not implement q^0 given their commitment problem. This implies they prefer not to have either CDS-based or deferred compensation to correct risk taking incentives. If they were offered a choice, we demonstrate that CDS-based compensation is cheaper for them.

and/or costly to value the debt instrument at issuance and on an on-going basis. Individual debt issues vary by maturity, seniority, and specific covenants, while the CDS spread does not. Actual debt credit spreads may reflect liquidity and taxes (see Longstaff, Mithal, and Neis (2005)) and may lag CDS spreads (see Norden and Weber (2009), Blanco, Brennan, and Marsh (2005), Forte and Peña (2009)). As credit default swaps become even more standardized and liquid by being moved onto exchanges, their benefits may be magnified.

Other key issues are deciding on the maturity of the debt (employees may prefer shorter maturity rather than be exposed to interest rate risk, while the bank may prefer longer maturity) and its seniority. It is also unclear how rating agencies would view this debt in their overall credit analysis. On top of this, it is not known whether regulators would treat employee-held debt as regulatory capital.

Tax issues – First, paying an employee in debt is a compensation contract as well as a debt contract and is difficult to design and manage given human resources guidelines and the Federal tax laws and employment laws. Careful analysis is needed to determine whether the deductibility of wage payments from corporate taxation can be made equivalent to the deductibility of interest payments. Second, would debt be treated as ordinary income to an employee, and how would vesting work? Does the employee have income on day 1 equal to the principal amount of the debt awarded to the employee, without having the ability to sell a portion of the debt to cover his/her tax liability (i.e., phantom income)? If so, this could effectively erode a portion of the employee's cash compensation for the year (in the amount of the additional tax liability).

9 Implementation of CDS-based compensation

Concretely, how should bank CEO compensation be tied to CDS spreads in practice? One way may be to require that CEOs write a given amount of CDS (or buy swaps written by other insurers) for the duration of their employment contract. Alternatively and more efficiently, using money set aside by the bank, their deferred bonuses may be reduced under a pre-specified formula as the bank's CDS spread deviates from the average bank spread[24]: bonuses would be increased if the spread is below average and decreased if it is above average.

A potential argument against tying bonuses to CDS spreads is that CDS spreads were not immediately responsive to the deterioration of bank capital during the crisis. For example, the average market value of equity to assets of 18 large institutions that participated in the U.S. SCAP program started to decline in Q4 2006 but the CDS spreads (on average) only began to react in Q2 2007.[25] Firstly, linking payments to an average CDS diminishes this issue[26]. Secondly, despite the onset of the crisis, major financial institutions initiated oversized bonus payments in 2008 and 2009. Public pressure forced banks to forgo paying a large fraction of their contractual bonuses.[27] Meanwhile, in the period from Q2 2007 to Q2 2008, the eighteen firm average CDS spread increased from about 20 to 280 basis points, and to 308 at the end of Q1 2009. Using our approach of tying bonuses to the CDS spread surely could have prevented the firms from initiating bonus payouts (without regulatory intervention or public pressure). Thirdly, one side-benefit of our approach is that it creates a built-in stabilizer using compensation that would have been useful in the crisis. When banks' performance deteriorates and their credit quality weakens (and they experience an increase in their CDS spread), the banks will be forced to conserve capital through the automatic adjustment of bonuses. Our approach is thus in a sense analogous to cutting dividends to protect the bank and its creditors. While cutting dividends imposes a cost on all equity holders, our approach imposes a direct cost on risk-taking managers as well.

[24] In the section on deferred compensation, we suggest another possible benchmark: the CDS spread evaluated at the optimal level of risk. In this case, in expectation there would be zero cost for the bank.

[25] This can be seen in Figure 4 in Flannery (2010).

[26] In the section comparing CDS spreads with debtlike instruments, we suggest that deferred pay such as debt will be costly. We also point out that deferred CDS may be less costly, depending on where the benchmark is set.

[27] Arguably, banks would have been unable to pay the bonuses in the absence of government support during the crisis (such as the TARP capital infusion).

10 Conclusion

In this paper we propose using a recent innovation in financial markets, the credit default swap, to reduce risk taking of executives at highly levered financial firms. The CDS provides a market price for risk, which, when weighted correctly in a compensation contract that includes an equity component, can provide first best risk incentives. We demonstrate that while in their interest, shareholders would be reluctant to adopt this type of contract due to a commitment problem that may be exacerbated by renegotiation, deposit insurance, and/or naive debtholders. We provide evidence that the market believes that including debtlike instruments in CEO compensation packages will reduce risk. While other debtlike instruments are available, basing compensation on the CDS spread is likely to be (i) cheaper, because it does not need to be deferred and (ii) easier to implement, because it is relatively more liquid.

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A Appendix

A.1 Proof of Lemma 1

Taking the first order condition of the objective function yields:

$$\begin{aligned} 0 &= -P'(q)\{q(x+\Delta)+(1-2q)x+q\lambda(x-\delta)-\frac{1}{2}\alpha q^2\}+ \\ &\quad (B+L-P(q))\{\Delta-x+\lambda(x-\delta)-\alpha q\} \end{aligned} \tag{12}$$

First note that $P'(q)=\frac{1}{q(1-q\lambda(x-\delta))}P(q)>0$. We will assume that $q(x+\Delta)+(1-2q)x+q\lambda(x-\delta)-\frac{1}{2}\alpha q^2>0$ for all $q\in[0,\frac{1}{2}]$, which says the project has positive NPV for all q. This then implies, from equation 12, that for any solution, $\Delta-x+\lambda(x-\delta)-\alpha q>0$.

Taking the derivative of the FOC, we get:

$$\begin{aligned} &-P''(q)\{q(x+\Delta)+(1-2q)x+q\lambda(x-\delta)-\frac{1}{2}\alpha q^2\} \\ &-2P'(q)\{\Delta-x+\lambda(x-\delta)-\alpha q\}-\alpha(B+L-P(q)) \end{aligned}$$

The expression $P''(q) = \frac{2q\lambda(x-\delta)}{q^2(1-q\lambda(x-\delta))^2}P(q) > 0$. Assumption A3 ensures that $B + L - P(q) > 0$. As we noted above, the FOC implies that $\Delta - x + \lambda(x-\delta) - \alpha q^{oDI} > 0$. Remember that q^o from our original model satisfied the condtion $\Delta - x + \lambda(x - \delta) - \alpha q^o = 0$. This implies that $q^{oDI} < q^o$. Furthermore, it implies the objective function is strictly concave over the interval $[0, q^o]$. It may not be concave over the interval $[q^o, \frac{1}{2}]$, but as there is no inflection point in that interval, meaning that q^{oDI} must be the global maximum.

A.2 Proof of Lemma 2

Taking the first order condition of the objective function and then setting $q = q^{2DI}$ yields:

$$0 = (B + L - P(q^{2DI}))\{\Delta - x - \alpha q^{2DI}\} + (1 + r_s)L \tag{13}$$

Rewriting this equation, we get:

$$B + L - P(q^{2DI}) = \frac{(1 + r_s)L}{\alpha q^{2DI} - (\Delta - x)} \tag{14}$$

First, examine the left hand side. At $q^{2DI} = 0$, it is equal to $B + L$. As we showed in Lemma 1, it is decreasing and concave, and assumption A3 assures it is positive.

Next, examine the right hand side and for now, take $\frac{\Delta-x}{\alpha} < \frac{1}{2}$. When $q^{2DI} < \frac{\Delta-x}{\alpha}$, the right hand side is negative, decreasing, concave, and approaching negative infinity as q^{2DI} approaches $\frac{\Delta-x}{\alpha}^-$. When $q^{2DI} > \frac{\Delta-x}{\alpha}$, the right hand side is positive, decreasing, and concave (and approaching positive infinity as q^{2DI} approaches $\frac{\Delta-x}{\alpha}^+$). Therefore the right hand side may intersect the left hand side when $q^{2DI} > \frac{\Delta-x}{\alpha}$ 0,1, or 2 times. If it does not intersect, that implies the solution is for the manager to choose the maximum $q^{2DI} = \frac{1}{2}$ as the first order condition in equation 13 is positive holding fixed the deposit insurance authority expectations at $q^{2DI} = \frac{1}{2}$. If it intersects twice, both intersections are rational expectations equilibria, but only the smaller one is stable.

If $\frac{\Delta-x}{\alpha} > \frac{1}{2}$, the solution would be $q^{2DI} = \frac{1}{2}$.

Now we prove that $q^{oDI} < q^o < q^{2DI}$. Clearly, this must be the case if $q^{2DI} = \frac{1}{2}$. Otherwise, we can rewrite equation 13 by adding and subtracting $\lambda(x-\delta)(B+L-P(q^{2DI}))$:

$$0 = (B+L-P(q^{2DI}))\{\Delta - x + \lambda(x-\delta) - \alpha q^{2DI}\} + (1+r_s)L - \lambda(x-\delta)(B+L-P(q^{2DI}))$$

Simplifying, we get:

$$0 = (B+L-P(q^{2DI}))\{\Delta - x + \lambda(x-\delta) - \alpha q^{2DI}\} + \frac{1}{q}P(q^{2DI})$$

This implies that $\Delta - x + \lambda(x-\delta) - \alpha q^{2DI} < 0$, which proves our statement.

A.3 Proof of Lemma 3

The first order condition of the problem is (we also set $q = \hat{q}^{DI}$):

$$0 = (B+L-P(\hat{q}^{DI}))\{\Delta - x - \alpha\hat{q}^{DI}\} + (1+r_s)(\frac{B}{1-\hat{q}^{DI}} + L) \tag{15}$$

We proceed with a similar approach to Lemma 2.

Rewriting the FOC, we get:

$$B + L - P(\hat{q}^{DI}) = \frac{(1+r_s)(\frac{B}{1-\hat{q}^{DI}} + L)}{\alpha\hat{q}^{DI} - (\Delta - x)} \tag{16}$$

First, examine the left hand side. At $q^{2DI} = 0$, it is equal to $B + L$. As we showed in Lemma 2, it is decreasing and concave, and assumption A3 assures it is positive.

Next, examine the right hand side and take $\frac{\Delta-x}{\alpha} < \frac{1}{2}$. When $\hat{q}^{DI} < \frac{\Delta-x}{\alpha}$, it is negative and approaching negative infinity as $\hat{q}^{DI}$ approaches $\frac{\Delta-x}{\alpha}^{-}$. When $\hat{q}^{DI} > \frac{\Delta-x}{\alpha}$, it is positive (and coming from positive infinity as $\hat{q}^{DI}$ approaches $\frac{\Delta-x}{\alpha}^{+}$). Furthermore, for any $\hat{q}^{DI}$ such that $\hat{q}^{DI} > \frac{\Delta-x}{\alpha}$, the right hand side is strictly larger than the right hand side in equation 14. Therefore if there are zero intersections for equation 14, there are zero for the current equation and $\hat{q}^{DI} = \frac{1}{2}$. If there is one intersection for equation 14, then the solution $\hat{q}^{DI}$ is strictly larger than q^{2DI} and may be equal to $\frac{1}{2}$.[28] If there are two intersections for equation 14, than the solution $\hat{q}^{DI}$ is strictly larger than the stable rational expectations equilibria q^{2DI}.

If $\frac{\Delta - x}{\alpha} > \frac{1}{2}$, the solution would be $q^{2DI} = \frac{1}{2}$.

[28] There may be multiple solutions here, but all will be larger than q^{2DI}.

Table 1: Summary Statistics of CEO Compensation Disclosed in Proxy Statements for the 27 banks with CDS spreads

Total wealth is the sum of the value of stock holdings, option holdings, deferred compensation, and pension balance. Stock holdings are valued by multiplying the number of shares times the stock price at the end of 2006. The figure includes restricted and performance shares. Options are valued by the number of options times the Black-Scholes value of each option using data from Compustat and CRSP. Equity is the sum of the value of stock holdings and option holdings. Deferred compensation, equity holdings, and pension balance are from proxy statements filed with the SEC.

Variable	Obs.	Mean	Median	Standard Deviation	Minimum	Maximum
Total Wealth ($MM)	27	287.26	95.24	839.37	27.57	4463.64
Value of Stock Holdings ($MM)	27	230.81	39.87	837.14	11.34	4407.67
Value of Option Holdings ($MM)	27	35.13	21.59	30.83	0	96.69
Deferred Compensation ($MM)	27	10.70	4.82	17.71	0	86.12
Pension Balance ($MM)	27	10.61	6.14	11.77	0	49.15
Deferred Compensation / Total Wealth	27	0.07	0.06	0.08	0	0.28
Pension Balance / Total Wealth	27	0.11	0.11	0.10	0	0.27
Deferred Comp + Pensions / Equity	27	0.26	0.29	0.22	0	0.64
Deferred Comp / Equity	27	0.10	0.07	0.12	0	0.44
Pension / Equity	27	0.16	0.14	0.14	0	0.41

Table 2: Cross-Section Regression of Cumulative CDS Abnormal Spread Changes on Newly Disclosed CEO Compensation

Dependent variable: cumulative CDS abnormal spread changes between the day of disclosure (event date 0) and the subsequent trading day (event date 1). The CDS contracts are five-year, senior unsecured CDS with a "Modified Restructuring" clause and spreads are collected from Markit. Total wealth is the sum of the value of stock holdings, option holdings, deferred compensation, and pension balance. Stock holdings are valued by multiplying the number of shares times the stock price at the end of 2006. The figure includes restricted and performance shares. Options are valued by the number of options times the Black-Scholes value of each option using data from Compustat and CRSP. Equity is the sum of the value of stock holdings and option holdings. Deferred compensation, equity holdings, and pension balance are from proxy statements filed with the SEC. High indicates above the median value for the sample.

	(1)	**(2)**	**(3)**	**(4)**
Constant	0.016*	0.016	0.011	0.021**
	(1.83)	(1.69)	(1.16)	(2.49)
Pension + Deferred Comp / Equity	-0.055**			
	(2.77)			
Deferred Comp / Equity		-0.058		
		(1.36)		
Pension / Equity		-0.052		
		(1.14)		
High (Pension + Deferred Comp) / Equity			-0.021*	
			(1.90)	
High Deferred Comp / Equity				-0.026*
				(1.84)
High Pension / Equity				-0.018
				(1.34)
Observations	27	27	27	27
r-squared	13%	13%	11%	33%

Robust t statistics in parentheses: * significant at 10% ** significant at 5% *** significant at 1%