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Executive Compensation and Risk Taking

Patrick Bolton
Hamid Mehran
Joel Shapiro

Staff Report no. 456
June 2010

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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 suggests that 1) in principle, excessive risk taking (in the form of risk shifting) may be addressed by basing compensation on both stock price and the price of debt (proxied by the credit default swap spread), but 2) shareholders may be unable to commit to designing compensation contracts in this way and indeed may not want to because of distortions introduced by either deposit insurance or naive debtholders. The paper then provides an empirical analysis that suggests that debt-like compensation for executives is believed by the market to reduce risk for financial institutions.

Key words: executive compensation, risk taking

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1 Introduction

Most of the existing theory of executive compensation has been cast in a framework where an all-equity firm provides incentives to a CEO (see e.g. Holmstrom and Tirole 1993). As such this theory does not directly apply to levered firms, that is unless debt is perfectly safe. For risky debt, however, shareholders have an incentive towards inefficient risk-shifting, as Jensen and Meckling (1976) have pointed out. For levered firms with risky debt the CEO compensation problem is therefore different. The CEO's compensation for such firms ought to be structured to maximize the whole value of the firm - equity and debt value - and not just the value of equity. This obvious observation has, alas, not filtered through to practice. Executive compensation is still mostly viewed through the lens of shareholder value maximization, whether the firm is levered or not.

Not surprisingly, structuring CEO incentives to maximize shareholder value in a levered firm tends to encourage excess risk taking. Indeed, the value of the stock is then 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 relevant for banks. The average non-financial firm in the U.S. has nearly 60% equity – and thus about 40% debt. However, for highly levered financial institutions, at least 90% of the balance sheet is debt; for investment banks it is closer to 95%.

In this paper, we examine risk taking incentives for CEOs in such institutions in a theoretical model. While it may be in shareholders' interests to induce a CEO to take less risk to lower the cost of debt, we show that if the CEO's actions are unobservable, she will undertake excessive risk due to risk shifting. To align the CEO's objective with social objectives in terms of risk choice, we propose tying a CEO's compensation at least in part to a measure of default riskiness of the firm. Specifically, excess risk taking may be controlled by tying CEO compensation to the bank's CDS spread over the performance evaluation period. A high, and increasing, CDS spread would result in a lower compensation, and vice-versa. We then demonstrate that shareholders would not choose to implement such a compensation

scheme, instead preferring excess risk. Shareholders suffer from a commitment problem due to multiple factors: the ability to renegotiate the compensation contract and distortions in debt markets arising from deposit insurance and investors' misperceptions of risk. Although we model the compensation of bank CEOs, in practice the bonuses of all risk-takers can be linked to CDS spreads.

In order to demonstrate that linking compensation to CDS spreads can reduce risk taking, we provide an empirical analysis that shows that market participants believe that exposing executives to risk will reduce the riskiness of the firm. Specifically, we focus on the recent disclosure of deferred compensation in proxy statements filed with the SEC, beginning in 2007. 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 long-term is the CEO's compensation, the more inclined the CEO is to lower risk.

One side-benefit of this approach is that it creates a built-in stabilizer using compensation. When banks are performing well and their credit quality is strong, bonuses will be paid out. However, when their 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 is analogous to cutting dividends to protect the bank and its creditors. While cutting dividends imposes a cost on equity holders, our approach imposes a cost on risk-takers.

A potential argument against tying bonuses to CDS spreads is that CDS spreads were not 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 2007.¹ However, there are two reasons why this argument is flawed. First, the CDS market did not react initially partly due to the fact that banks seemed to have

¹This can be seen in Figure 4 in Flannery (2010).

a large amount of equity capital that was above their regulatory requirements. Second, our approach effectively makes bonus payments contingent on ex-post performance. For example, the oversized bonus payments by major financial institutions for the year 2008 and 2009 were questioned by all stake-holders except their employees. Public pressure forced banks to forgo paying a large fraction of their contractual bonuses.² 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).

The model has a similar structure to John and John (1993), Brander and Poitevin (1992), and John, Saunders and Senbet (2000). In these papers, a firm issues debt and contracts with a CEO who makes an unverifiable project choice. The focus in these models is how risk-shifting affects executive compensation. John, Saunders, and Senbet (2000) specifically focus on banks, and show that well priced deposit insurance can eliminate risk shifting. John, Mehran, and Qian (2010) finds supporting evidence in the banking sector for John and John's (1993) predictions. More recent evidence by Cheng, Hong and Scheinkman (2009) also highlights the extent to which financial firms' CEO compensation is tied to the firm's exposure to systematic risk. The study of U.S. financial firms during the crisis by Balachandran, Kogut and Harnal (2010) shows how CEO equity-based pay increases the probability of the bank's default. Our paper enriches the contracting space to allow for compensation based on CDS spreads. Such risk-based compensation can provide optimal risk taking incentives, but it may need to be imposed by regulation as we also demonstrate that shareholders would be averse to this type of contract.

There has been some recognition recently that compensation in banks does not reflect 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

²Arguably, banks would have been unable to pay the bonuses in the absence of government support during the crisis (such as the TARP capital infusion).

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 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. They indicate that pay should be related to value of a firm’s debtlike instruments. While this approach is likely to produce the same outcome as tying pay to the CDS spread, in practice estimating the value of debt for firms (and particularly for financial institutions) is difficult.

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. Finally, Section 8 concludes.

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 both debt issuance and the underlying riskiness of the bank’s investments. 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 leverage and 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 .

An increase in $q \in [0, 1)$ thus increases the likelihood of both the high and low return outcomes.³

The CEO can raise q at a cost $c(q)$. 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 of the bank. A natural interpretation is that $c(q)$ is the cost of originating assets with risk characteristics q .

The bank raises funds through deposits and subordinated debt.⁴ 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.

³In addition, 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 $q \in [0, 1)$. A necessary and sufficient condition for this is $2\Delta\delta > (\Delta - \delta)^2$.

⁴In this section, we will treat deposits and subordinated debt as equivalent. In section 5.2 on deposit insurance, we model them separately.

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:

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

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 \hat{q} .

3.1 Observable risk

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.

Given this, we shall focus on the interesting situation, where risk-taking by the bank may lead to a default on its debt in the bad return outcome $x - \delta$. Formally, this means that the following assumption holds:

$$x > 1 + r_s > \lambda(x - \delta) \tag{A1}$$

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:

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

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. As long as a solution exists, we can show

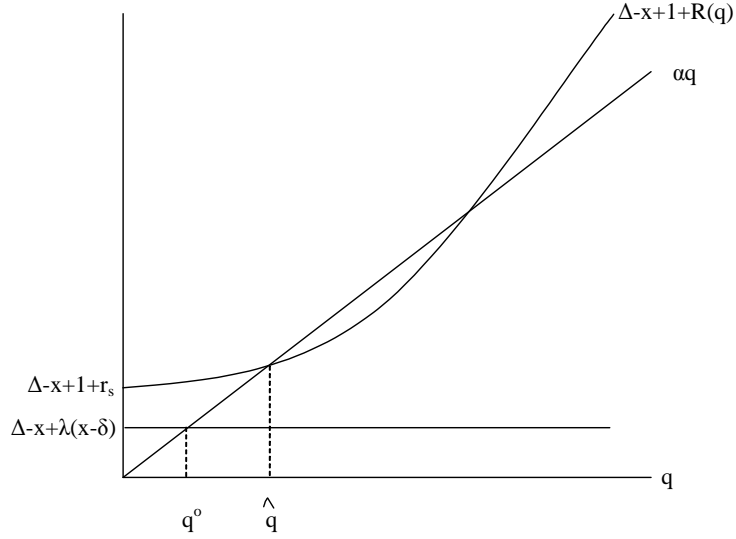


Figure 1: Excess risk taking: $\hat{q} > q^o$

that $\hat{q} > q^o$. Indeed, recall that

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

The left 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 1, which demonstrates that $\hat{q} > q^o$.

Using the quadratic formula in 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

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.

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 purchase 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:

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

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 that bondholders believe the bank will implement through the compensation contract.

The CDS spread, in turn, is equal to:⁵

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

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

⁵More 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.

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:

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

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:

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

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

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

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:

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

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 of debt in 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.⁶ 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,

⁶There 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.

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 .⁷ 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 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 . Depositors are guaranteed the safe payoff by the bank $1 + r_s$. The amount recovered in a default $(B + L)\lambda(x - \delta)$ is split between depositors and debtholders such that debtholders receive a fraction γ of the amount. This allows for situations where (i) depositors receive the whole recovery amount ($\gamma = 0$), (ii) depositors are fully compensated

⁷What 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.

with the remainder going to debtholders ($\gamma = 1 - \frac{L(1+r_s)}{(B+L)\lambda(x-\delta)}$, when this is between 0 and 1), and (iii) debtholders hold repo debt and are able to collect some amount on the eve before a bank failure.

We assume that there is a deposit insurance authority which charges a fairly priced fee up front that covers expected costs. Depositors are then entirely bailed out using the amount recovered from the default and the fee.

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.
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 and debtholders. If there are returns left at any point, the equity holders get the residual value.

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

$$(1 - q)(1 + R) + q\lambda(x - \delta)\gamma\left(\frac{B + L}{B}\right) \geq 1 + r_s$$

The fee the deposit insurance authority will set is equal to the amount they must compensate depositors minus what they can recover from the default:

$$Lq(1 + r_s) - q\lambda(x - \delta)(1 - \gamma)(B + L)$$

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:

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

It is straightforward to show that

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

This is not surprising. As the deposit insurance authority can respond perfectly to changes in risk and anticipates the recovery amount, it can keep the rents evenly balanced.

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. The optimal level of risk for shareholders is then:

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

This is larger than q^o .⁸ When the bank is not sensitive to the cost it pays for deposit

⁸A direct comparison proves this is true as long as $(1 + r_s)L > \lambda(x - \delta)(1 - \gamma)(B + L)$. If this inequality didn't hold, there would be no fee for deposit insurance (the recovery amount would be sufficient to

insurance, it increases the risk level. Moreover, since q^{oD} is increasing in γ , more default recovery given to debtholders leads to higher risk taking. This is because the return to debtholders when there is a default is larger, making them demand a lower return for the same amount of risk from the bank.

Now consider the case where q is unobservable to the deposit insurance authority and debtholders. Here, the bank takes $R(q)$ and deposit insurance as fixed.⁹ This gives us the following first order condition:

$$B\{\Delta - x + 1 + R(\hat{q}^D) - \alpha q\} + L\{\Delta - x + 1 + r_s - \alpha q\} = 0$$

Setting $q = \hat{q}^D$ and rearranging, yields:

$$\Delta - x + \frac{B}{B+L} \left(\frac{1 + r_s - \hat{q}^D \lambda(x - \delta) \gamma \left(\frac{B+L}{B} \right)}{1 - \hat{q}^D} \right) + \frac{L}{B+L} (1 + r_s) = \alpha \hat{q}^D \quad (6)$$

This equation has the same properties as equation 3 depicted in figure 1.

Assuming that a solution exists, we explore the characteristics of this solution:

First, $\hat{q}^D > q^{oD} > q^o$, meaning that there is excess risk-taking. This follows from the same reasoning as the proof that $\hat{q} > q^o$ in section 3.2. Furthermore, we can also demonstrate¹⁰ that $\hat{q}^D < \hat{q}$, which implies that risk-taking is less than in the model without deposit insurance. This is because the benefits to be paid out when the bank does not default are smaller here, since depositors only require a payment of $1 + r_s$. This makes not defaulting more valuable.

Second, as the share of the recovery amount given to debtholders γ increases, risk taking decreases. This is a surprising result, as it flips the observable case (our second benchmark)

compensate depositors). As this is an uninteresting case, we assume the inequality holds.

⁹Although 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.

¹⁰The proof is straightforward. The LHS of equation 3 and the LHS of equation 6 are equal when $\hat{q} = \hat{q}^D = 0$. The derivative of the LHS of equation 3 is $\frac{1+r_s-\lambda(x-\delta)}{(1-q)^2}$, which is larger than the derivative of the LHS of equation 6, which is $\frac{(1+r_s)\left(\frac{B}{B+L}\right)-\lambda(x-\delta)\gamma}{(1-q)^2}$. This holds due to the fact that $(1+r_s)L > \lambda(x-\delta)(1-\gamma)(B+L)$, i.e. the amount owed depositors must exceed the recovery amount for depositors.

on its head; the more assets the debtholders get, the less risk the bank takes. Moreover, the only link this has with deposit insurance is that depositors are willing to participate in this because of insurance. The intuition behind this result is that debtholders are no longer sensitive to risk, since it is unobservable. The bank therefore only cares about the fact that it pays out when there is no default. That payout is smaller when debtholders get a larger recovery value, therefore the bank is happier to avoid to the default state and takes on less risk.

Using the price of debt to discipline the manager can restore the optimum of q^0 here as well. The formula for the ratio of the share of debt to the share of equity is now more complicated:

$$\frac{s_D}{s_E} = (1 + R(q^o))(B + L \frac{(1 - q^o)(1 + r_s)}{1 + r_s - \lambda(x - \delta)\gamma(\frac{B+L}{B})})$$

Importantly, however, shareholders will not want to implement q^o . It is only in their interest to implement q^{oD} . Thus, 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.

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 first best 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.¹¹ 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:

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

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:

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

¹¹We will assume the project cost is still constant returns to scale, however.

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

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

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

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).¹² 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.

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:

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

The manager maximizes:

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

¹²The 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.

Which yields the following first order conditions:

$$q : I^{TL} \left\{ \Delta - x + (1 + R(q^{TL}, I^{TL})) - \alpha q^{TL} - \frac{s_D}{s_E} \left(1 - \frac{\lambda(x - \delta)}{1 + R(q^{TL}, I^{TL})} \right) \right\} = 0$$

$$I : \{ q^{TL}(x + \Delta) + (1 - 2q^{TL})x -$$

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

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 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 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 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. In particular, 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 the methodology outlined by Wei and Yermack (2010) to produce a CDS event study of the first-time disclosure of deferred compensation and pensions in banks. 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

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

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 firms¹³ (with n denoting the total number of firms).

¹³The total number of financial firms is 125.

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

To calculate daily abnormal “spread” returns (ASR), we follow the Market Adjusted Model approach by deducting the CDS market spread return from the individual CDS spread return on each day t .

$$ASR(i, t) = SR(i, t) - SR_m(t) \quad (10)$$

Another widely used approach to abnormal return calculation employs two-stage estimation, where the market beta of each security is first estimated in a pre-event “estimation window”. The estimated market model of each security is applied to calculating the expected return of the security in the event window. In our approach, the Market Adjusted Model approach is essentially a reduced-form two-stage estimation, omitting the first-stage beta estimation by assuming all beta’s equal to 1.

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**.

$$CASR(i) = ASR(i, 0) + ASR(i, 1) \quad (11)$$

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 (median of \$95 million). The average value of CEO equity holdings is about \$265 million (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 (2010) define inside debt as the ratio of the sum of deferred compensation and pensions to CEO total wealth. They argue that both deferred pay and pensions are unsecured in the event of default. As a result, CEOs with high 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 2007.

We follow Wei and Yermack's approach, but we focus on banks instead of industrial firms. We estimate announcement credit market CDS spreads over the window of (0,1) for the 27 banks with CDS. The announcement returns by themselves are not very informative as proxy filings 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 small degrees of freedom in our analysis. However, this may not be highly critical 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 policies.

We estimate four models 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 cu-

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

Overall, we find some results suggesting that disclosure of deferred compensation 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 Conclusion

The problem of executive compensation for highly levered firms with *subsidized* debt financing (whether through deposit insurance or an implicit bailout guarantee) is fundamentally different from the classic principal-agent problem considered by Jensen and Murphy (1990) and Holmstrom and Tirole (1993) for a publicly traded, all-equity, firm with dispersed ownership. For such highly levered firms, shareholder value maximization can mean excess

risk-taking, so that it is in shareholders' interest to hire risk-loving executives and to reward them for taking risks. However, enterprise value maximization requires limiting the firm's risk exposure. Regulatory intervention, and not more 'say on pay' may then be required to structure CEO pay. This intervention would take the form of imposing greater risk-sensitivity on CEO pay so as to reduce the CEO's appetite for risk-taking. Structuring CEO pay towards greater deferred compensation (longer vesting periods, escrow accounts and claw-back provisions) is an important step in that direction. In this paper we propose another, complementary, approach, which is to tie CEO compensation to (long-term) CDS spreads. At least for the largest financial institutions, with highly liquid CDS markets, this is as operational and easily implementable as granting CEOs an equity stake or stock-options in the firm.

Concretely, how should bank CEO compensation be tied to CDS spreads in practice? At a minimum, bank regulators could simply recommend that bank compensation committees study ways in which compensation could be tied to the bank's CDS spread. The simplest 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: bonuses would be increased if the spread is below average and decreased if it is above average. Another direction could be to include a CDS exposure requirement as a bond covenant and to link the presence of such an exposure to the credit rating of the bank. Finally, to the extent that shareholders also benefit from such a commitment to reduced risk-taking they may want to pressure the compensation committee to introduce CDS spread exposure into the CEO compensation contract.

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

Variable	Mean	Median	Standard Deviation
Total Wealth (\$MM) ²	287.26	95.24	83.937
Value of Stock Holdings (\$MM)	230.81	39.87	83.714
Value of Option Holdings (\$MM)	35.13	21.59	30.83
PV of Deferred Comp (\$MM)	10.70	4.82	17.71
PV of Pension Balance (\$MM)	10.61	6.14	11.77
Deferred Comp / Total Wealth (%)	7	6	8
Pension / Total Wealth (%)	11	11	10
Deferred Comp + Pensions / Equity (%)	26	29	22
Deferred Comp / Equity (%)	10	7	12
Pension / Equity (%)	16	14	14

² Sum of value of equity, options and restricted stocks, pensions, and deferred compensation.

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

Dependent Variable: Cumulative CDS Abnormal Spread Changes over (0 , 1)

	(1)	(2)	(3)	(4)
Constant	0.016* (1.83)	0.016 (1.69)	0.011 (1.16)	0.021** (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 ³			-0.021* (1.90)	
High Deferred Comp / Equity				-0.026* (1.84)
High Pension / Equity				-0.018 (1.34)
<i>R-squared</i>	13%	13%	11%	33%

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

³ High implies above the median value for the sample.