Incentive Compensation When Executives Can Hedge the Market: Evidence of Relative Performance Evaluation in the Cross-Section

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ABSTRACT

Little evidence exists that firms index executive compensation to remove the influence of market-wide factors. We argue that executives can in principle replicate such indexation in their private portfolios. In support, we find that market risk has little effect on the use of stock-based pay for the average executive. But executives' ability to "undo" excessive market risk can be hindered by wealth constraints and inalienability of human capital. We replicate the standard result that there is little relative performance evaluation (RPE) for the average executive, but find strong evidence of RPE for younger executives and executives with less financial wealth.

Researchers are starting to make sense of executive compensation. While there still exists controversy about whether the link between executive compensation and stock market value is sufficiently strong, there is no doubt that the link exists on average and has become stronger over time (see Jensen and Murphy (1990), Haubrich (1994), and Hall and Liebman (1998)). There is also ample evidence of heterogeneity in executive pay packages, as is suggested by contract theory. For instance, Aggarwal and Samwick (1999a) find evidence that firms tie their mangers' pay more closely to stock values when such values are less volatile, confirming a basic result of principal-agent theory.

Another important theoretical prediction comes from Holmstrom (1982), who suggests that the *market* component of a firm's returns should be removed from the compensation package since executives cannot affect the overall market by their actions and it is costly for executives to bear the related risks. Such market indexing is also referred to as relative performance evaluation (RPE), since the executive is effectively paid according to performance relative to a benchmark. However, there is little empirical evidence of RPE, either in the explicit design of compensation contracts (see Coles, Suay, and Woodbury (2000) and Deli (2002)), or in the estimated relationship between compensation and market movements (see for example, Aggarwal and Samwick (1999a), Antle and Smith (1986), and Janakiraman, Lambert, and Larcker (1992)). Thus, while total stock return volatility seems to matter for compensation, more specifically focussed, relative market-performance evaluation appears to be quite rare.[1]

We begin by recognizing that the economic problem to be addressed by RPE is to reduce the executive's exposure to market risks that would otherwise accompany stock-based incentive compensation.[2] Most research assumes that the only way to accomplish this task is to reward her performance relative to a market benchmark. However, it is readily conceivable that executives can undo any undesired market exposure from their incentive contracts by adjusting their own investment portfolios (see also Feltham and Xie (1994), Jin (2001), and Garvey and Milbourn (2001) for similar arguments). We begin by presenting a simple model which admits both RPE by the firm and managerial hedging of market risks on personal account. Holmstrom (1982) and the subsequent literature implicitly assume that RPE is costless to firms, but that it is prohibitively costly for the manager to hedge on her own account. Feltham and Xie, Jin, and Garvey and Milbourn assume to the contrary that managerial hedging is costless. Our model includes these as special cases but recognizes that (i) managerial hedging can be personally costly owing to short-selling and wealth constraints, and that (ii) RPE can be costly to the firm, not only because of direct contracting and information-processing costs, but also because indexed pay may induce unwanted managerial turnover if executives' outside opportunities fluctuate with the market (see Himmelberg and Hubbard (2000) and Oyer (2001)).

Our theoretical model has straightforward empirical implications. Firms should provide less RPE as the costs to the manager of hedging on her own account decrease. Equally important, pay-performance sensitivity should be *unaffected* by systematic risk if either managerial hedging or firm-offered RPE is costless, and decreasing in systematic risk if both are costly. Moreover, this sensitivity decreases in systematic risk more strongly as either cost increases. The model has symmetric implications for the extent of managerial hedging, but we are unable to test these predictions without access to data on managers' personal investment portfolios.

To test our model, we first extend Aggarwal and Samwick's (1999a) analysis of the effect of risk on incentive pay by decomposing risk into its systematic and idiosyncratic components. We find, as does Jin (2001) in contemporaneous work, that idiosyncratic risk has a significant negative effect on pay sensitivities while the coefficient on market risk is insignificantly different from zero.[3] We also confirm the standard result from the literature that, on average, there is little RPE for the *average* top manager.

These results suggest that the average manager can adjust her exposure to market risks at low cost. However, they mask significant heterogeneity across firms and managers. We use managerial age and a proxy for financial wealth to capture the costs managers face in hedging, reasoning that younger managers or those with less financial wealth face constraints in using their human capital as financial collateral. We use proxies for managerial mobility to capture the costs of RPE, based on Himmelberg and Hubbard (2000) and Oyer's (2001) model in which managers with good outside labor market prospects may quit if their firm removes market effects from their compensation. We find that market risk *is* an important determination of the pay-performance relationship for younger managers, which is what we would expect if these features increase the costs of managerial hedging. More important, we find strong evidence of RPE for younger and less wealthy managers. The puzzle of why there is so little RPE recedes once we recognize that some managers have cheap substitutes for such firm-provided insurance, while others do not. Most striking is our finding that the wealthiest managers in our sample have no RPE, but the pay of the least wealthy managers removes approximately 80 percent of their market risk.

The remainder of this paper is organized as follows. Section I provides the model of optimal incentive contracts when the firm and the manager can both adjust the manager's market exposure in light of the systematic risk imposed by the compensation package. Section II contains the empirical results that firm-specific risk is more costly than market risk in a stock-based compensation package. Section III presents our cross-sectional results on the provision of RPE. Concluding remarks are in Section IV.

I. A Simple Model

We model a firm managed by a single executive with negative exponential utility and a coefficient of absolute risk aversion of ρ. She exerts effort a which increases firm value at a constant rate of one, but has a positive and strictly convex cost to the manager of $C(a)$, with $C'(a)$ and $C''(a) > 0$. We normalize the risk-free rate of interest to zero and the manager's reservation utility to negative one. Himmelberg and Hubbard (2000) and Oyer (2001) assume to the contrary that reservation utility fluctuates with the market. Below, we capture the implications of this approach in reduced-form through the costs to the firm of insulating the manager from market movements. We denote the market risk premium by r_m and following the existing principal-agent literature, we assume that shareholders are risk-neutral and that $r_m \sim N(0, \sigma_m^2)$.

Compensation contracts can be written directly on the terminal value of the firm, which is given by

$$X = a + \Psi K, \tag{1}$$

where Ψ is the gross return on the firm's initial investment in capital of $\$K > 0$. Gross returns are determined by the Capital Asset Pricing Model (CAPM), so that

$$\Psi = 1 + \beta r_m + \varepsilon, \tag{2}$$

where $\varepsilon \sim N(0, \sigma_\varepsilon^2)$ represents the firm's idiosyncratic risk.

A. Derivation of the Compensation Contract

Drawing on Holmstrom and Milgrom's (1987) analysis of principal-agent contracts with normally distributed errors and exponential utility, we restrict attention to linear incentive contracts of the form

$$W + \alpha X + d_F \left[1 + r_m\right] K, \tag{3}$$

where W is the manager's fixed salary, $\alpha \in [0, 1)$ is the manager's claim on firm value, and d_F is the firm's choice of RPE. The firm can reduce the manager's exposure to market risk by choosing $d_F < 0$ and can eliminate it entirely by setting $d_F = -\alpha\beta$. The above assumptions are a simplified version of a standard principal-agent model. We depart from the standard approach by allowing the manager to choose her own personal market holdings, letting d_P denote her personal portfolio adjustment. Therefore, the manager's total exposure to market risk ($\beta\sigma_m^2$) is jointly determined by d_P, d_F, and α. We do not allow the manager to short her own firm's stock, and thus she cannot adjust her exposure to her firm's idiosyncratic risk. In addition to SEC regulations on insider trading, such short-selling restrictions are commonplace. Bettis, Coles, and Lemmon (2000) document the extensive use of firm-specific bans on such trading.[4] What is important is that in practice the manager *may* be able to adjust her exposure to market risk, and thus we model this choice explicitly.

We assume that adjusting the manager's exposure to market risk is costly for both the manager and the firm. Specifically, the cost to the firm in providing RPE is given by $F \cdot H(|d_F|)$, and the cost to the manager of privately adjusting market exposure is $P \cdot H(|d_P|)$, where $F \geq 0$ and $P \geq 0$ are constants, and $H(|\cdot|)$ is a strictly convex function, with $H(|0|) = 0$, $H'(|\cdot|) > 0$ and $H''(|\cdot|) > 0$. The absolute value sign reflects the reasonable assumption that it is costly to take additional steps to either augment or offset the manager's exposure to market risk. It also incorporates the less reasonable assumption that the costs are symmetric, so that shorting the market is no more costly than buying. This is primarily for notational convenience since as we shall see the actual choices of d_F and d_P are always negative or zero in equilibrium. The parameters F and P capture the comparative advantage (disadvantage) of the manager hedging the market risk imposed by stock-based pay herself, relative to the firm doing so through RPE.[5]

When we turn to the data, we will proxy for P by executives' financial wealth and their age. The argument is that younger (or less wealthy) executives have a greater proportion of their total wealth given by human capital, rather than financial capital. Human capital is illiquid and cannot be directly used as collateral. For the firm, F includes the costs of identifying the relevant index and writing enforceable contracts, along with accounting costs. It also captures in reduced-form Himmelberg and Hubbard's (2000) and Oyer's (2001) insight that an executive's *ex post* mobility may constrain the firm's ability to index market risk *ex ante*.

A.1. Manager's Choices of Effort and Market Hedging

The optimal incentive contract must respect the fact that the manager will make optimizing choices in response. Specifically, she chooses her effort and market exposure to maximize her expected utility. Given that she has negative exponential utility, in addition to the normality assumptions, the manager's chooses her privately optimal effort (a) and hedging levels (d_P) to maximize the following certainty equivalent:

$$\max_{\langle a\in[0,\infty),d_P\in(-\infty,\infty)\rangle} U_M \equiv W+\alpha\,(X)-C(a)-P\cdot H(|d_P|)-\frac{\rho}{2}K^2\left(\alpha^2\sigma_\varepsilon^2+(\alpha\beta+d_F+d_P)^2\,\sigma_m^2\right), \quad (4)$$

where both the manager's private costs of effort ($C(a)$) and hedging ($P \cdot H(|d_P|)$) are included. Thus, the manager's two first-order conditions are given by

$$\begin{aligned} \frac{\partial U_M}{\partial a} &= \alpha - C_a = 0 \\ \Longrightarrow &\quad \alpha = C_a \end{aligned} \quad (5)$$

and

$$\begin{aligned} \frac{\partial U_M}{\partial d_P} &= -P\cdot H'(|d_P|)-\rho K^2\,(\alpha\beta+d_F+d_P)\,\sigma_m^2=0 \\ \Longrightarrow &\quad P\cdot H'(|d_P|)=-\rho K^2\,(\alpha\beta+d_F+d_P)\,\sigma_m^2. \end{aligned} \quad (6)$$

We see from (6) and the fact that $H'(|d_P|)>0$ that $d_P \le 0$, and that the manager hedges less (i.e., d_P increases), *ceteris paribus*, as it becomes more costly for her (i.e., P increases).[6] In the limiting case where $P=0$, we see immediately from (6) that $\alpha\beta+d_F+d_P=0$, thereby implying that $d_P=-(\alpha\beta+d_F)$. What this means is that if the manager can costlessly remove market risk, she will choose d_P to remove any market risk from her compensation contract, given by $\alpha\beta$, that is not removed already by the firm through its choice of d_F. We now turn to the shareholders' problem.

A.2. Shareholders' Maximization Problem

The firm's shareholders design the optimal compensation contract in light of the manager's optimal choice of effort (see (5)) and hedging (see (6)), in addition to her participation constraint, $U_M \ge 0$. Respecting these constraints, shareholders choose the optimal sharing rule, α, and the amount of RPE, d_F, to maximize

$$\max_{\langle a\in[0,\infty),\alpha\in[0,1),d_F\in(-\infty,\infty),d_P\in(-\infty,\infty)\rangle} \quad U_{SH} \equiv \begin{bmatrix} X - C(a) - F\cdot H(|d_F|) - P\cdot H(|d_P|) \\ -\frac{\rho}{2}K^2\left(\alpha^2\sigma_\varepsilon^2 + (\alpha\beta + d_F + d_P)^2\sigma_m^2\right) \end{bmatrix}$$

$$s.t. \quad \alpha = C_a$$

$$P\cdot H'(|d_P|) = -\rho K^2 (\alpha\beta + d_F + d_P)\,\sigma_m^2 \tag{7}$$

The firm's first-order conditions are:

$$\begin{aligned} \frac{\partial U_{SH}}{\partial\alpha} &= \frac{1}{C_{aa}}(1-\alpha) - \rho\alpha K^2\sigma_\varepsilon^2 - \rho K^2(\alpha\beta + d_F + d_P)\,\beta\sigma_m^2 = 0 \\ \frac{\partial U_{SH}}{\partial d_F} &= -F\cdot H'(|d_F|) - \rho K^2(\alpha\beta + d_F + d_P)\,\sigma_m^2 = 0. \end{aligned} \tag{8}$$

Using (5), we can rearrange the first condition to yield:

$$\alpha^* = \frac{1}{\left(\frac{1}{C_{aa}} + \rho K^2\sigma_\varepsilon^2\right)}\left(\frac{1}{C_{aa}} - \rho K^2(\alpha\beta + d_F + d_P)\,\beta\sigma_m^2\right). \tag{9}$$

Similar to the manager's problem, the firm's optimal choice of RPE is given by the solution to:

$$F\cdot H'(|d_F|) = -\rho K^2(\alpha\beta + d_F + d_P)\,\sigma_m^2. \tag{10}$$

Analogous to the manager's private choice of hedging, the firm's choice of RPE, $d_F \leq 0$. Moreover, if $F = 0$, then $\alpha\beta + d_F + d_P = 0$, so $d_F = -(\alpha\beta + d_P)$. That is, if providing RPE is costless to the firm, then the firm will optimally remove any market risk inherent in the incentive contract that is not removed by the manager's choice of hedging.

B. Equilibrium Characteristics of the Contracting Choices

There are three key equations, (6), (9), and (10), that provide the implicit solutions to d_P, α, and d_F, respectively. With these, we can fully characterize the relevant components of the wage contract by observing that the term $-\rho K^2(\alpha\beta + d_F + d_P)\sigma_m^2$ appears in each of these.

We turn first to the optimal sensitivity of managerial compensation to stockholder wealth, as well as the sensitivity of this sharing rule to the key components in the contracting problem. The sensitivity is given by (9), which can be rewritten using (10) and (6), respectively, as

$$\begin{aligned} \alpha &= \begin{cases} \frac{1}{\left(\frac{1}{C_{aa}} + \rho K^2\sigma_\varepsilon^2\right)}\left(\frac{1}{C_{aa}} + \beta F\cdot H'(|d_F|)\right) & \text{if } F > 0, \\ \frac{1}{1 + C_{aa}\rho K^2\sigma_\varepsilon^2} & \text{otherwise} \end{cases} \\ \alpha &= \begin{cases} \frac{1}{\left(\frac{1}{C_{aa}} + \rho K^2\sigma_\varepsilon^2\right)}\left(\frac{1}{C_{aa}} + \beta P\cdot H'(|d_P|)\right) & \text{if } P > 0, \\ \frac{1}{1 + C_{aa}\rho K^2\sigma_\varepsilon^2} & \text{otherwise.} \end{cases} \end{aligned} \tag{11}$$

An examination of this expression yields the following result.

Proposition 1 *The optimal sensitivity of managerial compensation to shareholder wealth, α^*, is decreasing in the idiosyncratic risk of the firm's stock return, σ_ε^2. If it is costly for both the firm to provide RPE and for the manager to privately hedge, the optimal pay sensitivity α^* is also decreasing in the firm's systematic risk β. However, if either the firm can provide RPE costlessly or the manager can privately hedge without cost, then the optimal pay sensitivity α^* is independent of systematic risk.*

The derivation of *Proposition 1* is straightforward given (11). As is standard in contracting solutions, the optimal sharing rule is strictly decreasing in the volatility of the performance measure, here the firm's market value. However, what is critical to our model is that *only* the idiosyncratic risk (σ_ε^2) has a universally negative effect on α, independent of the other parameters of the model. By contrast, the firm's exposure to market movements as captured by β only affects the optimal sharing rule if it is both *costly* to the firm to provide RPE *and* to the manager to privately hedge. When $F > 0$ and $P > 0$, increases in the firm's systematic risk (higher β) lead to *lower-powered incentives*. The intuition is that since RPE and hedging are costly, there is some residual market risk imposed on the manager by her contract. Therefore, the higher this risk (higher β), the lower is the optimal use of stock-based incentives.

With the sharing rule in hand, we turn now to the firm's choice of RPE and the manager's hedging choice. We know from (10) and (6) that in equilibrium, the relationship between the firm's choice of RPE and the manager's personal hedging choice is given by

$$F \cdot H'(|d_F|) = P \cdot H'(|d_P|). \tag{12}$$

This leads to our next result.

Proposition 2 *As the cost to the firm (F) increases relative to the cost to the manager (P), the firm offers less RPE (i.e., d_F increases) and the manager privately hedges more (i.e., d_P decreases). Similarly, as the manager's cost of hedging (P) increases relative to the firm's cost of providing RPE (F), the firm offers more RPE (i.e., d_F decreases) and the manager privately hedges less (i.e., d_P increases). Also, the optimal pay-performance sensitivity decreases more strongly in systematic risk β as either F or P increase.*

The proof of *Proposition 2* is straightforward given (11) and (12). *Proposition 2* speaks directly to the potentially differential costs of hedging market exposure faced by the firm and the manager herself. The direct effect of an increase in the cost of managerial hedging is to reduce the amount of such hedging. The substitution effect is that an increase in the manager's cost of hedging increases the optimal amount of RPE. Similarly, as the costs to the firm of insulating the manager from market risk increase relative to the manager's own costs, the firm will offer less RPE and the substitution effect is that the manager will carry out more of the hedging on her own account. The last statement in *Proposition 2* is a straightforward extension of *Proposition 1*'s conclusion that pay-performance is unaffected by market risk if either managerial hedging or firm RPE is costless. Market risk *does* matter if both managerial hedging and RPE are costly, and matters more as such costs increase.

C. Testable Hypotheses

Our two Propositions above provide predictions on how all of the choice variables (pay-performance sensitivity α, the firm's provision of RPE d_F, and managerial hedging d_P) vary across firms. We do not have data on managerial hedging d_P, but can estimate the other two choice variables using standard techniques. Thus, our model yields the following empirically testable hypotheses.

1. Pay-for-performance sensitivity is strictly *decreasing* in the idiosyncratic risk of the firm's stock returns (see (11), *Proposition 1*, and Aggarwal and Samwick (1999a)).

2. Pay-for-performance sensitivity is independent of the firm's *systematic* risk if either the firm can costlessly provide RPE or the manager can costlessly hedge market risk (see (11), *Proposition 1*, and also Jin (2001) and Garvey and Milbourn (2001)).

3. If providing RPE and hedging are costly, then the pay-for-performance sensitivity is *decreasing* in systematic risk (see (11) and *Proposition 1*). Pay-performance is *more strongly decreasing* in systematic risk as either the cost of hedging or RPE increases (see (11) and *Proposition 2)*

4. As it becomes more costly for the firm to provide RPE, we should observe less RPE (see (11), (12), and *Proposition 2*).

5. As the costs to privately hedging market risk fall for the manager, we should observe less RPE (see (11), (12), and *Proposition 2*).[7]

The first two hypotheses have already been confirmed. Aggarwal and Samwick (1999a) find strong confirmation of the first hypothesis. In contemporaneous work, Jin (2001) and Garvey and Milbourn (2001) find that systematic risk has a statistically insignificant effect on pay-performance.

Using our data sample, we confirm both hypotheses. The third hypothesis recognizes that while systematic risk may have little effect on pay-performance for the average firm, it may matter for some firms. The last two hypotheses take a similar approach to the provision of RPE. The optimal amount of RPE depends on the cost to firms in providing such insurance, relative to the manager's ability to do it on her own. For instance, if managers can costlessly hedge, then these managers should be able to fully offset unwanted market exposure from their incentive contracts. Therefore, we should observe no RPE in the contracts of these managers. However, if certain managers find hedging costly, then firms should be more likely to offer RPE. Thus, one possible reason why the literature to date has found little evidence of RPE is that actual RPE varies widely across firms. It should be emphasized that our results apply only to the use of broad market indices. Our model does not apply to narrower industry indices unless managers have cost-effective access to vehicles for trading in such indices. Put another way, if P is prohibitively high, our model returns the standard RPE implications so long as F is not prohibitively high. Moreover, as stressed by Aggarwal and Samwick (1999b), industry-level indices may be affected by the manager's actions, unlike the exogenous market-wide index in our model.

II. Differential Effects of Firm-Specific Risk and Market Risk on Compensation

A. Data and Descriptive Statistics

Our data come from two primary sources. Firm betas and returns are estimated from CRSP, and the compensation data come from Standard and Poors' ExecuComp. Our sample period is from 1992 to 1998, beginning in the first year of the ExecuComp data and extending two years longer than Aggarwal and Samwick (1999a). Table I.A. summarizes the basic variables of interest. Our study uses just over 1,400 large U.S. firms, resulting in 6,488 CEO-firm years. These firms pay their CEOs a salary and a bonus that both average approximately \$600,000 per year. As is well-known, stock option grants are the largest component of compensation, at least if they are valued according to Black-Scholes. Our firms granted options with an average Black-Scholes value of nearly \$1.4 million each year, but the median is far more modest at just under \$360,000. This divergence, plus the extremely large maximum grant value, indicate the presence of some extreme outliers in the data.[8] To reduce the effect of such outliers on our inferences, we winsorize our data at the one percent tails and estimate robust standard errors for our OLS regressions.[9]

Table I.A. goes here

Our betas and other risk measures are computed for each CEO-firm year using the preceding five years of monthly data. Thus, these firm-level estimates are updated each year that a firm's CEO appears in the sample. The betas reported in this paper use a simple OLS regression of log returns on the returns to the S&P 500. We use the S&P 500 index not because it is preferable from an asset-pricing standpoint, but because it is more plausible that a compensation committee would use such an index. Results are virtually identical if we compute Scholes-Williams beta values or if we use the value-weighted CRSP index. Not surprisingly, since our sample includes virtually the entire S&P 500 and other prominent firms, the average and median betas are essentially one. Betas vary widely in the sample, which is important for our purposes as we need to identify the distinct effect of the market component of total firm risk. Tobin's q is estimated as the ratio of the market value to book value of assets, where the market value of assets is given by the sum of the book value of assets and market capitalization of equity, less the sum of book equity and deferred taxes.

We propose two proxies for the manager's private cost of hedging, where both are *inversely* related to this cost P. Our first proxy for the cost to the manager of hedging/indexing market risk is her age. A younger executive will have a relatively large fraction of her wealth in the form of human capital, and this wealth cannot be freely allocated to financial assets as she sees fit. An alternative means of capturing an individual manager's ability to hedge market risk is to proxy for financial wealth. Wealthier executives should find it easier to privately hedge, and therefore wealth should be negatively related to the presence of RPE. While individual wealth data are unobservable, for a subsample of our firms we estimate the value of the identifiable portion of each executive's wealth. Our final proxy is intended to capture the costs to the firm in providing RPE. We identify the absolute number of executives leaving their firms within each two-digit SIC code. The idea is that if executive movement is more prevalent in a given firm's industry, following Himmelberg and Hubbard (2000) and Oyer (2001), this firm will face higher effective costs of providing RPE.

Table I.B. summarizes the same data as Table I.A. for the subsample of CEOs for whom we can construct our proxy for the financial wealth that each executive has accumulated by the end of 1997.[10] Given that we only have information on employment-related wealth (and not private investments or consulting), CEO wealth is estimated as the sum of cash payouts these executives received over the 1993 through 1997 period. The Sum of CEO Compensation is estimated as the sum of salary, bonus, other annual compensation, long-term incentive payouts, other cash payouts, and stock option gains over the years 1993 through 1997. As seen in the table, the average wealth is $15.23 million, with a median value of $9 million. Similar to flow compensation items, the range of accumulated financial wealth is enormous, spanning from $735,000 to $156.19 million. Naturally, executives may have accumulated wealth either in previous posts or from other outlets, but it seems reasonable to assume that our estimate here is at least positively correlated with each executive's true underlying financial wealth. This subsample is comprised of all the CEOs in 1998 who have retained the top post in their respective firms for the entire period of 1993 through 1997. The resulting subsample has 353 executives for the single year 1998. The average firm here is larger than in the full sample, and the average values of the compensation components are also commensurately larger.

Table I.B. goes here

The simple correlations reported in Table II reveal few surprises. All components of compensation are positively related to one another and are positively related to firm size. Larger firms also tend to be less risky as measured by percent stock returns, and in our sample period the small firm effect has largely disappeared. The various components of pay are all positively related to stock returns, although our interest is in how this relationship varies across the sample and we now turn to this task.

Table II goes here

B. Effects of Systematic Versus Firm-specific Risk

To verify that our extended data sample concur with the Aggarwal and Samwick (1999a) findings, we first replicate their results in Table III. The dependent variable is the same as in our theoretical model except that variables are first-differenced. The dependent variable is the change in the manager's firm-related wealth, defined as the sum of cash compensation, the Black-Scholes value of new options granted, the value of restricted stock grants, long-term incentive payments, and changes in the value of existing options and shares. Since we are interested in changes in CEO wealth, we end up with six years of compensation changes. Following Aggarwal and Samwick (1999a) and our theoretical model specification, we use dollar values for both changes in shareholder wealth and for risk measures. We also follow their convenient normalization of transforming the variance of dollar returns into its empirical cumulative distribution function (cdf), so that the estimated coefficient on the interaction of dollar returns and the cdf of dollar risk represents the effect on pay-performance of moving from the least to the most risky firm in our sample. As an additional control, we include the cdf of Tobin's q, and its interaction with dollar returns. The results of Bizjak, Brickley, and Coles (1993) suggest that we should find that higher-q firms tie their managers' pay more closely to the stock price, so the interaction of dollar returns and Tobin's q should have a positive sign. Lastly, we also include year dummies to control for changes in pay levels over time.

Table III goes here

In the first column of Table III, we control for industry fixed effects. We find that the pay-for-performance sensitivity is \$44 per \$1,000 increase in shareholder wealth (dollar return) for a CEO in a firm with the lowest total risk. The firm with median risk offers its CEO a pay-for-performance sensitivity of $\$44 - \frac{1}{2} \times \$43.38 = \$22.3$. For the firm with the highest risk, the pay sensitivity is $\$44 - 1 \times \$43.38 = \$0.6$.[11] The second column documents that controlling for executive fixed effects, in addition to industry effects, does not affect the results.

Table IV addresses the model's predictions on how idiosyncratic and market risk matter *differentially* for performance pay. Market risk is specified as the empirical cdf of the dollar variance that is due to the market, and firm risk is the cdf of the remaining dollar risk. We also test for the presence of RPE, using a CAPM benchmark equal to the beginning of year market capitalization times the sum of the risk-free rate and our estimated beta times the realized premium of the S&P 500 return over the risk-free rate. This variable will have a negative sign if the firm is removing market risks from compensation; holding constant the performance of the firm, higher underlying *market* performance reduces compensation. If executive compensation in practice is truly linear, then complete removal of market risk from the executive's compensation contract implies that the coefficient on expected returns is equal to the opposite of the coefficient on changes in shareholder wealth. In practice, executive compensation is surely nonlinear, and thus our statistical tests of whether executives are fully insulated from market movements through the firm's choice of RPE should be interpreted with some caution. We will return to this issue in Section III.

Table IV goes here

With industry fixed effects (column I), we find support for our hypothesis that market risk is insignificantly related to incentive-based pay compensation for the average executive. In fact, the estimated coefficient on market risk is insignificantly different from zero, whereas the coefficient on firm-specific risk is significant at the one percent level. When we also control for executive fixed effects (see column II), the estimated coefficient on market risk remains insignificant. We obtain mixed results on the hypothesis that the estimated coefficients on market and firm-specific risks are equal. When executive fixed effects are included, we can reject this hypothesis at the five percent level. In the specification without fixed effects, the standard error on the market component is such that we cannot reject its equality with the firm-specific component at the 10 percent level.

Overall, the results of Table IV are consistent with the idea that the *average* executive faces relatively low costs in adjusting her own market exposure, and thus the employing firms need not adjust stock-based pay sensitivities in light of increasing market risk. Further support comes from the fact that, consistent with previous research, expected returns have no significant negative effect on compensation and the sign is actually positive when executive fixed-effects are included. Put another way, we document a lack of RPE, but this is not necessarily a puzzle since the presence of market risk doesn't appear to temper the use of strong stock-based incentives.

Demsetz and Lehn (1985), Bizjak, Brickley, and Coles (1993), and Prendergast (2002) all argue that the marginal product of CEO effort may also be correlated with firm size and risk, and Core and Guay (2002) find that if Aggarwal and Samwick's (1999a) risk measure is decomposed into market capitalization and percentage volatility, market capitalization has a negative effect while volatility has a positive effect on incentives. If we similarly decompose our variables into firm size, percentage idiosyncratic risk, and percentage market risk, the results are reasonable but not overly informative. Idiosyncratic risk has the positive effect documented by Core and Guay, while market risk has no significant effect on the use of stock-based incentives. This is not surprising because the argument of Demsetz and Lehn and Prendergast is essentially that CEO discretion is more important when the environment is less stable; indeed, Demsetz and Lehn use percentage idiosyncratic risk as their measure of the importance of incentive problems. We are not aware of any theory that links systematic risk to the importance of CEO effort decisions, so it is neither surprising nor informative that the link is absent in the data.[12] Moreover, the issue of dollar versus percentage risk is unrelated to our main subject of whether RPE is important to at least some executives.

The results thus far suggest that executives can hedge their market exposure at low cost.

However, the empirical model employed in Table IV forces all executives to have the same ability to deal with market risk by estimating a single coefficient. Similarly, we are forcing all firms to offer the same degree of RPE. Our *Propositions 1* and *2* both stress the potential importance of heterogeneity by executive and by firm. In what follows, we allow for the individual manager's capacity to hedge market risk, as well as each firm's ability to provide RPE, to vary cross-sectionally. Specifically, we first introduce the age of the CEO as a proxy for each manager's ability to hedge market risk, where the idea is that older CEOs are better equipped to absorb market risk and thus face a lower P. In addition, for a subsample of our CEOs, we estimate a value for each executive's accumulated wealth in an attempt to capture the idea that greater wealth is also more highly correlated with an executive's ability to hedge market risk, and again a lower P. Lastly, as a proxy for each firm's cost to providing RPE (i.e., its F), we calculate a measure of executive mobility specific to each firm's industry. The intuition is that the greater is the mobility of each firm's executive, the more costly it is for those firms to provide RPE and thereby we should observe less of it in those firms whose industries exhibit the greatest executive mobility.

III. The Effect of Executive and Firm Attributes on RPE

A. Effects of CEO Age and Executive Mobility on Pay-Sensitivities

In Tables V.A. and V.B., we extend our original empirical specification to include our additional executive and firm attributes. Using our full sample, we first examine the effects of CEO age and executive mobility on the relationship between stock-based pay sensitivities and both idiosyncratic and market risks, respectively. Table V.A. relies on CAPM-based expected returns as the benchmark in determining RPE, and Table V.B. relies on the simpler benchmark for RPE of the S&P 500's performance.[13]

Tables V.A. and V.B. go here

Turning to Table V.A., the first column allows for the firm's use of RPE to vary with executive and firm characteristics, while the third column fixes the estimate of RPE across all executive and firm attributes. The second and fourth columns mirror the estimations of columns one and three, respectively, but also control for executive fixed effects. We first focus on the cross-sectional variation in age (as estimated in the second column of Table V.A.), and how it affects total stock-based sensitivities, the sensitivity to market risk, and the incidence of RPE. The summary panel at the bottom of Table V.A. summarizes these key findings, setting all non-age related coefficient estimates to their median values for convenience.

Consistent with Gibbons and Murphy's (1992) results on career concerns, pay-performance ($\widehat{\alpha}$) is stronger for older executives. Also broadly consistent with the importance of career concerns, pay-performance is weaker in industries where there is more executive mobility.[14] The remaining results in Table V.A. (as delineated in the summary panel) correspond quite well with our theoretical predictions. Consistent with the argument that older executives are better able to adjust their personal exposure to the market, we find that (i) systematic risk has a negative effect on pay-performance only for the younger executives in the sample CEOs (see $\frac{\partial\widehat{\alpha}}{\partial\beta\sigma_m^2}$), and (ii) RPE is present for young executives but absent for older ones ($\widehat{d}_F$).

The last two columns of the summary panel characterize the manager's exposure to the market component of firm returns based on the entire *compensation* package. This is a realistic portrayal of the manager's actual exposure if her cost of hedging is sufficiently high such that d_P is near zero. Our regressions in Table V.A. estimate the change in total compensation with a CAPM-based benchmark, which can be written in the model's notation as:

$$\begin{aligned} \Delta TotalCompensation &= \alpha K(\beta r_m + \varepsilon) + d_F K \beta r_m \\ &= K\left(\beta r_m\left(\alpha + d_F\right) + \alpha\varepsilon\right). \end{aligned} \tag{13}$$

Note that the manager is relieved of all market risk by her compensation contract if our estimate of d_F is equal to $-\alpha$, and her exposure to market risk increases in the sum $\alpha + d_F$ for all β. As seen in the summary panel, this sum is decreasing in the CEO's age. That is, firms tend to leave younger CEOs *less* exposed to market risk than their older counterparts.

Since our firms differ widely in size and in β, it is also instructive to summarize the *percentage* of market risk that is removed by the firm's choice of RPE, $\frac{-\widehat{d}_F}{\widehat{\alpha}}$. We see that for the youngest CEO, just over eight percent of market risk is removed, and this value decreases as CEO age increases.[15] Again, to the extent that older CEOs are better able to privately hedge market risk — that is, these executives have lower costs of hedging (lower P) — the firm removes less market risk for older CEOs.

Oyer's (2001) model shows that turnover concerns impede RPE, so the interaction of expected returns and mobility should have a positive coefficient. We do not find this effect in our data, nor do we find that market risk matters more for the use of stock-based pay when the executive is more mobile. We obtain a positive and marginally significant coefficient if we do not control for industry effects, but the effect disappears when we include them. To some extent, this reflects the fact that our mobility measure is also at the industry level, but it should be noted that the controls only remove the direct effect of industry classification on pay growth, rather than any potential interaction effect. A more precise measure of the relationship between the market and the CEO's outside opportunities may uncover support for the theory, but our data do not. We do not find any significant results if we use the CEO's tenure with the firm as an alternative proxy for the cost of moving.

The interaction terms of age and mobility with firm-specific risk are primarily included as controls, but the results are reasonable. We find that firm-specific risk matters less to the pay-performance of more mobile executives, and more for older executives. The latter result makes sense if, as we have assumed in our model, executives cannot directly hedge firm-specific risks (i.e., they cannot nullify their incentive contracts by taking offsetting short positions in their firms). Older executives are nearer retirement and thus may be more averse to the associated risks (see, e.g., Poterba and Samwick (1997)). Our findings on mobility effects are consistent with the idea that the human capital of a mobile executive is less exposed to firm-specific shocks so that firm-specific risk matters less for the pay of more mobile executives.

A more striking picture of the prevalence of RPE in practice emerges if we replace the CAPM-based expected return with simply the S&P 500 return as the RPE benchmark. These estimation results are contained in Table V.B., and summarized in the panel at the bottom of the table. We see that firms provide greater, yet still not complete, RPE when the benchmark is the S&P 500 return. For the youngest CEO, almost a third of the market risk is removed from his compensation contract, and for the median-aged CEO this figure is just over 12 percent.[16] The results of the above table are directly comparable to the work of Gibbons and Murphy (1990), who use the S&P 500 as the benchmark, but lack data on executive stock options. They find that 82.59 percent of the market risk is removed from the salary and bonus component of executive compensation, and 72.36 percent of the market risk is removed from total compensation (excluding stock options).

There are two alternative explanations for why the results are stronger with the simpler benchmark. One is that firms use a correct beta and our estimates of beta on the whole add noise relative to the simple expedient of setting beta equal to one for each firm. The second alternative is that firms effectively use a beta of one as a simple benchmark even though a fine-tuned, firm-specific beta would be more appropriate. Our results using Scholes-Williams betas are almost identical to those reported here, but we cannot distinguish between these two explanations using actual compensation practice as the dependent variable. Rather, we would need information on which firms are using suboptimal incentive schemes, which is well beyond the scope of this paper.

The overall message from Tables V.A. and V.B., in contrast to the analysis contained in Table IV, is that we significantly understate the amount of RPE in executive compensation packages by forcing all firms and executives to have the same demand for employer-provided insurance from market risks. Market risks *do* matter for younger and more mobile executives, and firms make some effort to provide RPE to such executives. We have, however, uncovered only partial evidence of RPE even in cases where our theory suggests that there is a demand for it. One explanation is that actual incentive contracts are optimal, but F is prohibitively high and therefore RPE is costly for the average firm. Another explanation is that our measures of individual executive and firm attributes are noisy. Age captures many attributes of an executive beyond her ability to adjust her exposure to market risks, and mobility is measured only at the industry level. While an individual-level measure of mobility would be desirable, it is important to recognize that the turnover of an individual executive could also reflect considerations such as her performance. A superior measure of mobility thus requires data beyond that used in our study. We are, however, able to use our data to construct an additional proxy for the executive's cost of adjusting market exposure on her own behalf (P), given by her *accumulated*, firm-related wealth. The results with the restricted subsample of executives in 1998 for whom we can cumulate total compensation over 1993 to 1997 are reported in the next section.

B. Effects of CEO Wealth

We begin our analysis of CEO wealth effects by first replicating the results of *Table IV* on this smaller sample of CEOs. *Table VI* highlights that our results are confirmed in this sample as well. Only firm-specific risk significantly affects stock-based pay sensitivities, whereas market risk is again insignificant. The estimate of RPE is insignificantly different from zero, and we can reject the hypothesis that it is equal to the opposite of the coefficient on raw returns (i.e., full RPE) at the one percent level. These conclusions hold regardless of whether the index is defined as the CAPM-based expected return or the return on the S&P 500 index.

Table VI goes here

In *Table VII*, we include our proxy for the manager's private cost of hedging (P) using our estimates of accumulated CEO wealth. The summary panel at the bottom of the table conveniently summarizes our results, setting all non-wealth variables at their median values.

Table VII goes here

Looking first at the CAPM-based benchmark, we find that as with executive age, financial wealth is inversely related to the manager's cost of privately hedging market risk and its interaction with RPE is our most striking result in this subsample. As seen in our estimates of $\widehat{d}_F$, we document *strong* evidence of RPE in CEO compensation contracts. The point estimates used in Table VII indicate that 76.73 percent of the market risk is removed from the compensation of the CEOs with the least financial wealth, and we cannot reject the hypothesis of full RPE for such an executive at even the 10 percent level. This finding is consistent with the idea that these CEOs are unable to privately arrange sufficient insurance from market movements owing to wealth constraints. Firms thereby are better equipped to offer such insurance through RPE, and apparently do so in the data. On the other hand, the wealthiest CEOs can arguably arrange such insurance on their own account. At the margin, such CEOs have a comparative advantage in doing so, relative to the firms that employ them. Thus, the firms that employ them can feasibly ignore RPE and in the data, it seems that this is what they do ($\widehat{d}_F$ is essentially zero for the richest CEO). These findings are confirmed when the RPE benchmark is given by the S&P 500 dollar return, as seen in the second summary panel.

The estimated effect of the market benchmark is strongly negative for the least wealthy executive. Not only is it statistically different from zero, it is large enough that it is statistically indistinguishable from the opposite of the effect of returns. Thus, we cannot reject the hypothesis that the least wealthy executive is fully insulated from market effects. There are two related caveats to this result, and our earlier results involving the full sample. The first is that the coefficients are estimated with substantial error, reducing our power to reject the hypothesis of equal and opposite effects. Second, we have assumed linear incentive contracts while actual contracts are surely nonlinear. Most obviously, nearly all executives receive stock options which are convex in stock value. Equally important, board decisions to grant new options, increase bonuses, and so forth, need not be linearly related to stock performance. In more general principal-agent settings (e.g., Holmstrom (1979)), optimal compensation will not be linear. Further research that captures both the nonlinearity in actual compensation practices and a more complete specification of executives' ability to manage risk on their own account would increase our confidence in our conclusions.

IV. Concluding Remarks

Market-indexed incentive pay is only valuable if executives rely on their employers to provide insurance from systematic risk. Our empirical results suggest that the average executive has little demand for such insurance, but also that there is significant cross-sectional heterogeneity in such demand. Specifically, we find that younger and less wealthy executives do rely on their firms to provide insulation from market risks inherent in stock-based incentive compensation. We find little evidence that mobility undermines the ability of the firm to remove market risks.

Overall, the practice of relative performance evaluation seems to reflect the firm's comparative advantage in providing insurance from market risks, relative to the executive doing it for herself. We find significant evidence of relative performance evaluation for executives who face relatively high costs of removing excessive market exposure on their own account. Whether our results would be strengthened by the use of additional data on executives' wealth and private investment holdings, we leave this to future research.

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Notes

[1]One explanation for the weak evidence of relative performance evaluation is that some indices are in fact informative of the agent's action. Aggarwal and Samwick (1999b) and Kedia (1999) show that using industry performance as a benchmark can have undesirable strategic consequences for the firm operating in imperfectly competitive markets. Consistent with this idea, Aggarwal and Samwick find that such performance benchmarking is less prevalent in more concentrated industries. The theory, however, is less than satisfactory as an explanation for the lack of relative performance evaluation. First, the theory cannot be fully refuted by the data because strategic considerations could either increase or decrease the attractiveness of benchmarking, depending on whether competition is in quantities or prices. Second, and more importantly, it does not explain why broad *market* indices are infrequently used, as no single manager's output or pricing decision could have a large effect on an index such as the S&P 500. Our paper focuses on this second point.

[2]Stock-based pay also exposes the manager to firm-specific risk, but as Holmstrom (1982) shows, this is an unavoidable cost of providing incentives unless the executive's effort can be directly observed.

[3]Core and Guay (2002) decompose total dollar variance into market capitalization and percentage variance, and find that the size component has a negative effect on stock-based incentives while percentage risk has a positive effect. As we discuss below, adopting their approach has little effect on the conclusions of this paper.

[4]If managers were able to costlessly short the stock of their own firms, Garvey (1997) shows that firms must generally turn to alternative control mechanisms, such as increased firm leverage, to elicit the desired managerial choices.

[5]Using cross-sectional Italian household survey data, Guiso, Jappelli, and Terlizzese (1996) find that individuals reduce their share of risky assets when their income risk rises. This is what we would expect if P is not prohibitively large.

[6]For example, if $H(|d_P|)$ took the form $\frac{1}{2}d_P^2$, then our model would imply an optimal hedging choice for the manager of $d_P = \frac{-\rho K^2}{P}\left(\alpha\beta + d_F + d_P\right)\sigma_m^2 < 0$, for $P > 0$.

[7]Our theory provides an analogous prediction for private hedging as well. That is, (11), (12), and *Proposition 2* imply that as the costs to providing RPE rise for the firm, we should observe more private hedging. However, without data on private managerial holdings, such a prediction is untestable.

[8]As another example, consider the fact that the youngest CEO in our sample was the 24-year old CEO of Carson Pierie Scott in 1995, who lasted only one year. Michael Dell was the second-youngest CEO at 29 in 1993. Our oldest CEO is Norman E. Alexander of the Sequa Corporation who was 84 years old in 1998.

[9]The inferences are identical if we follow Aggarwal and Samwick's (1999a) approach of using median regressions rather than OLS.

[10]Thanks to an anonymous referee for suggesting this approach to proxying for an executive's financial wealth.

[11]These estimates additionally assume that the firm has the lowest value of Tobin's q. As seen in the table, Tobin's q explains \$1.58 of the stock-based pay sensitivity. To assume instead that the firm had a median value of Tobin's q, one can simply add $\frac{1}{2} \times \$1.58 = \$0.79$ to each of the three estimates.

[12]Garen (1994) finds that CEO incentives are positively related to beta, but as stressed by Aggarwal and Samwick (1999a), he fails to distinguish between the raw volatility and the market-correlation components, and furthermore uses no separate measure of idiosyncratic risk.

[13]This simpler benchmark sets each firm's beta to one, as in Gibbons and Murphy (1990).

[14]Results on mobility can be similarly characterized from Table V.A.

[15]While the data strongly support the conclusion that younger CEOs receive a positive amount of RPE, they also reject the conclusion that *all* market risk is removed from their compensation (i.e., that the percentage of risk removed is 100 percent) at the one percent level.

[16]Note, however, that we still reject full RPE at the one percent level.

Table I.A.
Descriptive Statistics (Full Sample)

Salary and Bonus represent the CEO's yearly salary and bonus values. Option Grants represents the Black-Scholes value of the options granted to the CEO in the year. Age of CEO is the CEO's age in the data year. Stock return is the percentage return for the firm over its fiscal year. Market Cap of Equity is the firm's market capitalization at the end of the firm's fiscal year. Our beta and standard deviation values are computed using the five years of monthly data preceding the data year. The betas reported in this paper use a simple OLS regression of log returns on the log returns to the S&P 500 index. Compensation data and market value are in millions of yearly dollars. SIC Moves is the annual number of job changes across the industry within each firm's two-digit SIC code. Tobin' q is estimated as the ratio of the market value to book value of assets. The Sum of CEO Compensation is the sum of salary, bonus, other annual compensation, long-term incentive payouts, other cash payouts, and stock option gains over the years 1993 through 1997 for the subsample of CEOs in 1998 who have retained their posts over 1993 through 1997.

Variable	**Obs**	**Mean**	**Median**	**SD**	**Min**	**Max**
Salary	6,488	0.577	0.525	0.306	0	3.65
Bonus	6,488	0.584	0.308	1.798	0	10.2
Option Grants (Black-Scholes)	6,461	1.39	0.353	4.917	0	193.5
Age of CEO (years)	6,488	51.7	56	17.0	24	84
Stock return (%)	6,483	19.70	13.25	100.4	-97.2	7150
Market Cap of Equity	6,488	4,030	1,054	10,413	1.51	334,000
Beta	5,961	1.106	1.051	0.577	-1.96	5.50
Standard deviation of % returns	5,961	33.93	30.51	15.4	7.59	177
Tobin's q	5,851	3.623	1.678	8.357	0.138	186.6
SIC Moves	6,488	0.419	0	1.18	0	10

Table I.B.
Descriptive Statistics (Subsample with CEO Wealth Proxy)

Variable	Obs	Mean	Median	SD	Min	Max
Salary	353	0.724	0.687	0.345	0	2.80
Bonus	353	0.821	0.446	1.204	0	7.80
Option Grants (Black-Scholes)	353	2.75	0.596	3.95	0	152.3
Age of CEO (years)	353	59.1	59	7.19	34	84
Stock return (%)	353	6.03	2.94	46.74	-84.7	302.3
Market Value of Equity	344	10,900	2,035	30,100	10.53	334,000
Beta	344	0.977	0.965	0.457	-0.152	2.41
Standard deviation of % returns	344	33.67	30.53	12.9	12.6	81.3
Tobin's q	337	2.879	1.491	4.415	0.561	37.74
Sum of CEO Compensation	353	15.23	9.01	17.9	0.735	156.19

Table II
Simple Correlations

S&B represents the CEO's yearly salary plus bonus. Option Grants represent the Black-Scholes value of the options granted to the CEO in the year. Age is the CEO's age in the data year. Return is the percentage return for the firm's stock over its fiscal year. Market Cap is the market value of the firm's equity at the end of the firm's fiscal year. Beta and SD returns are computed using five years of monthly data preceding the data year. The betas reported in this paper use a simple OLS regression of log returns on the returns to the S&P 500 index over the preceding 60 months. Tobin' q is estimated as the ratio of the market value to book value of assets. SIC Moves is the annual number of job changes across the industry within each firm's two-digit SIC code.

	S&B	Option Grants	Age	Return	Market Cap	Beta	SD Returns	Tobin's q	SIC Moves
S&B	1								
Option Grants	0.218	1							
Age	0.079	-0.048	1						
Return	0.030	0.101	-0.058	1					
Market Cap	0.219	0.198	0.066	0.101	1				
Beta	0.050	0.063	-0.117	0.067	-0.039	1			
SD Returns	-0.093	0.042	-0.211	0.011	-0.207	0.541	1		
Tobin's q	-0.006	0.123	-0.150	0.281	0.137	0.159	0.155	1	
SIC Moves	0.072	0.017	-0.004	-0.029	0.025	0.014	0.045	-0.041	1

Table III
Changes in CEO Wealth – Total Firm Risk

This table contains OLS regressions of changes in CEO wealth on changes in shareholder wealth (Δ SH Wealth), the interaction of Δ SH Wealth and the cdf of the variance of changes in shareholder wealth over the preceding 60 months, and year dummies. The first regression also controls for industry fixed effects and the second controls for both executive and industry fixed effects. Changes in CEO wealth is defined as cash compensation plus the Black-Scholes value of new options granted plus the value of restricted stock plus long-term incentive payments, plus changes in the value of existing options and shares. The data are winsorized at the one percent tails and robust standard errors allowing for correlated errors within two-digit SIC codes are reported in parentheses. Estimated coefficients for the year effects are suppressed. The symbols * and ** indicate difference from zero at the one and five percent levels, respectively. Sample includes 5,739 observations.

Variable	I	II
Intercept	−3,620*	−6,293
	(814.3)	(6,313)
Δ SH Wealth	44.00*	49.56*
	(4.58)	(7.47)
Δ SH Wealth × cdf of variance	−43.38*	−45.24*
	(4.60)	(7.50)
Δ SH Wealth × cdf of Tobin's q	1.575**	1.598
	(0.869)	(1.401)
cdf of variance	8,463*	26,177*
	(1,741)	(8,154)
cdf of Tobin's q	7,695*	−5,470
	(2,204)	(3,869)
Inclusion of Industry Fixed Effects	yes	yes
Inclusion of Executive Fixed Effects	no	yes
adj. R^2	0.281	0.410

Table IV
Changes in CEO Wealth – Firm and Market Risk

This table contains OLS regressions of changes in CEO wealth on changes in shareholder wealth (Δ SH Wealth); the interactions of Δ SH Wealth and the cdfs of firm-specific variance, systematic variance and Tobin's q; the CAPM Benchmark of expected changes in shareholder wealth; the cdfs of firm-specific variance, systematic variance, and Tobin's q; and year dummies. The first regression also controls for industry fixed effects and the second controls for executive as well as industry fixed effects. Changes in CEO wealth is defined as cash compensation plus the Black-Scholes value of new options granted plus the value of restricted stock plus long-term incentive payments, plus changes in the value of existing options and shares. The data are winsorized at the one percent tails and robust standard errors allowing for correlated errors within two-digit SIC codes are reported in parentheses. Estimated coefficients for the year effects are suppressed. The symbols * and ** indicate difference from zero at the one and five percent levels, respectively. Sample includes 5,739 observations.

Variable	I	II
Intercept	−3,508*	−8,027**
	(810.9)	(3,915)
Δ SH Wealth	43.52*	49.25*
	(5.95)	(7.39)
Δ SH Wealth × cdf of firm-specific variance	−31.85*	−41.12*
	(6.77)	(7.39)
Δ SH Wealth × cdf of systematic variance	−9.241	−7.865
	(6.35)	(6.774)
Δ SH Wealth x cdf of Tobin's q	1.661**	2.024**
	(0.846)	(0.972)
CAPM Benchmark	0.109	0.930*
	(0.407)	(0.283)
cdf of firm-specific variance	7,437*	18.122*
	(2,734)	(5,408)
cdf of systematic variance	785.7	6,182
	(2,614)	(4,443)
cdf of Tobin's q	7,665*	−4,862
	(1,630)	(3,775)
adj. R^2	0.281	0.411

Table V.A.
Changes in CEO Wealth Controlling for Age and Mobility Effects
CAPM Benchmark as Expected Return

This table contains OLS regressions of changes in CEO wealth on changes in shareholder wealth (Δ SH Wealth); the interactions of Δ SH Wealth and the cdfs of firm-specific variance, systematic variance; these two interactions are further interacted with the cdfs of CEO age and mobility; the interactions of Δ SH Wealth and the cdfs of CEO age and mobility and Tobin's q; the CAPM benchmark of expected changes in shareholder wealth; the interaction of this CAPM benchmark with the cdfs of CEO age, mobility, and Tobin's q (included only in first two columns); the cdfs of firm-specific variance, systematic variance, CEO age, mobility, and Tobin's q; and year dummies. The first regression in each set controls for industry fixed effects and the second controls for executive as well as industry fixed effects. Changes in CEO wealth is defined as cash compensation plus the Black-Scholes value of new options granted plus the value of restricted stock plus long-term incentive payments, plus changes in the value of existing options and shares. The data are winsorized at the one percent tails and robust standard errors allowing for correlated errors within two-digit SIC codes are reported in parentheses. Estimated coefficients for the year and industry effects, and all cdfs not interacted with Δ SH Wealth are suppressed. The symbols *, **, and *** indicate difference from zero at the one, five, and ten percent levels, respectively. Sample includes 5,651 observations.

Variable	RPE Controls		No RPE Controls	
Intercept	−2,877*** (1,696)	−21,591* (7,884)	−3,414** (1,654)	−21,403* (7,894)
Δ SH Wealth	42.22* (5.36)	35.86* (6.12)	44.00* (5.45)	36.53* (6.10)
Δ SH Wealth × cdf of firm-specific variance	−1.76 (13.18)	−8.38 (15.04)	−1.04 (13.19)	−6.35 (12.40)
Δ SH Wealth × cdf of systematic variance	−39.27 (22.28)	−25.07 (15.62)	−42.38 (28.67)	−28.27 (13.51)
Δ SH Wealth × cdf of firm-specific var × cdf(age)	−70.29* (16.08)	−71.59* (17.90)	−73.37* (16.06)	−74.73* (17.88)
Δ SH Wealth × cdf of systematic var × cdf(age)	56.44* (14.55)	41.34** (16.01)	63.77* (14.44)	47.07** (15.89)
Δ SH Wealth× cdf of firm-specific var × cdf(mobility)	12.41 (15.02)	14.68 (16.47)	14.39 (13.10)	15.68 (16.46)
Δ SH Wealth × cdf of systematic var × cdf(mobility)	0.883 (13.41)	−5.32 (14.61)	−1.06 (13.32)	−5.97 (14.49)
Δ SH Wealth × cdf(age)	10.53 (6.73)	25.74* (7.52)	8.11 (6.70)	24.21* (7.50)
Δ SH Wealth × cdf(mobility)	−11.98** (6.61)	−9.14 (7.21)	−12.11** (6.56)	−9.46 (7.17)
Δ SH Wealth × cdf (Tobin's q)	2.61* (0.667)	2.88* (0.750)	2.04* (0.514)	2.71* (0.642)
CAPM Benchmark	−1.55** (0.833)	−1.33 (1.09)	0.101 (0.239)	1.09* (0.289)
CAPM Benchmark× cdf(age)	3.90* (1.07)	3.77* (1.37)		
CAPM Benchmark × cdf(mobility)	−0.337 (0.825)	−0.157 (0.924)		
CAPM Benchmark × cdf (Tobin's q)	−1.04 (0.933)	−0.137 (1.23)		
adj. R^2	0.289	0.427	0.288	0.427

Table V.A. (continued)
Summary Panel (CAPM-based Benchmark)

Rank by CEO Age	$\widehat{\alpha}$	$\frac{\partial\widehat{\alpha}}{\partial\beta\sigma_m^2}$	$\widehat{d}_F$	$\widehat{\alpha}+\widehat{d}_F$	% Market Risk Removed ($\frac{-\widehat{d}_F}{\widehat{\alpha}}$)
Youngest CEO	\$18.35	−\$27.73	−\$1.48	\$16.87	8.05%
Median CEO	\$23.65	−\$7.06	\$0.37	\$24.03	−1.58%
Oldest CEO	\$28.96	\$13.61	\$2.22	\$31.18	−7.68%

Table V.B.
Changes in CEO Wealth Controlling for Age and Mobility Effects
S&P as Expected Return

This table contains OLS regressions of changes in CEO wealth on changes in shareholder wealth (Δ SH Wealth); the interactions of Δ SH Wealth and the cdfs of firm-specific variance, systematic variance; these two interactions are further interacted with the cdfs of CEO age and mobility; the interactions of Δ SH Wealth and the cdfs of CEO age and mobility and Tobin's q; the S&P 500 benchmark of expected changes in shareholder wealth; the interaction of this S&P 500 benchmark with the cdfs of CEO age, mobility, and Tobin's q (included only in first two columns); the cdfs of firm-specific variance, systematic variance, CEO age, mobility, and Tobin's q; and year dummies. The first regression in each set controls for industry fixed effects and the second controls for executive as well as industry fixed effects. Changes in CEO wealth is defined as cash compensation plus the Black-Scholes value of new options granted plus the value of restricted stock plus long-term incentive payments, plus changes in the value of existing options and shares. The data are winsorized at the one percent tails and robust standard errors allowing for correlated errors within two-digit SIC codes are reported in parentheses. Estimated coefficients for the year and industry effects, and all cdfs not interacted with Δ SH Wealth are suppressed. The symbols *, **, and *** indicate difference from zero at the one, five, and ten percent levels, respectively. Sample includes 5,651 observations.

Variable	RPE Controls		No RPE Controls	
Intercept	2,498 (1,703)	−21,804* (7,916)	−3641** (1,656)	−20,997* (8,323)
Δ SH Wealth	41.61* (6.07)	35.28* (6.14)	43.82* (5.32)	36.48* (6.10)
Δ SH Wealth × cdf of firm-specific variance	−2.48 (13.21)	−6.20 (15.01)	−1.15 (13.18)	−7.53 (15.00)
Δ SH Wealth × cdf of systematic variance	−31.49 (19.87)	−25.70 (19.47)	−31.51 (18.99)	−27.08 (19.48)
Δ SH Wealth × cdf of firm-specific var × cdf(age)	−76.04* (16.06)	−77.52* (17.89)	−72.95* (16.05)	−75.63* (17.89)
Δ SH Wealth × cdf of systematic var × cdf(age)	61.54* (14.42)	45.67* (15.88)	63.70* (14.43)	47.76* (15.89)
Δ SH Wealth × cdf of firm-specific var × cdf(mobility)	11.67 (15.05)	14.04 (16.50)	14.73 (15.03)	15.81 (16.47)
Δ SH Wealth × cdf of systematic var × cdf(mobility)	0.821 (13.31)	−5.81 (14.48)	−1.21 (13.31)	−6.25 (14.50)
Δ SH Wealth × cdf(age)	10.70 (6.72)	27.80* (7.50)	7.83 (6.69)	24.39* (7.51)
Δ SH Wealth × cdf(mobility)	−11.56*** (6.62)	−8.45 (7.23)	−12.29** (6.57)	−9.26 (7.17)
Δ SH Wealth × cdf(Tobin's q)	2.11* (0.685)	2.32* (0.785)	1.91* (0.518)	2.75* (0.649)
S&P 500 Benchmark	−3.63* (1.15)	−4.33* (1.70)	−0.287 (0.264)	1.08* (0.337)
S&P 500 Benchmark × cdf(age)	5.52* (1.17)	5.28* (1.58)		
S&P 500 Benchmark × cdf(mobility)	0.363 (0.887)	1.26 (1.04)		
S&P 500 Benchmark × cdf(Tobin's q)	−0.350 (1.04)	1.73 (1.42)		
adj. R^2	0.291	0.428	0.288	0.426

Table V.B. (continued)
Summary Panel (S&P 500 Benchmark)

Rank by CEO Age	$\widehat{\alpha}$	$\frac{\partial\widehat{\alpha}}{\partial\beta\sigma_m^2}$	$\widehat{d}_F$	$\widehat{\alpha}+\widehat{d}_F$	% Market Risk Removed ($\frac{-\widehat{d}_F}{\widehat{\alpha}}$)
Youngest CEO	\$18.32	−\$28.61	−\$5.83	\$12.50	31.79%
Median CEO	\$24.26	−\$5.77	−\$3.19	\$21.08	13.13%
Oldest CEO	\$30.20	\$17.07	−\$0.55	\$29.62	1.80%

Table VI
Changes in CEO Wealth: Firm and Market Risk for the Subsample with CEO Wealth Data

This table contains OLS regressions of changes in CEO wealth on changes in shareholder wealth (Δ SH Wealth); the interactions of Δ SH Wealth and the cdfs of firm-specific variance, systematic variance, and Tobin's q; a benchmark of expected changes in shareholder wealth; the cdfs of firm-specific variance, systematic variance, and Tobin's q; industry effects and year dummies. The first column uses the CAPM as the market benchmark, whereas the second column uses the S&P 500 return. Changes in CEO wealth is defined as cash compensation plus the Black-Scholes value of new options granted plus the value of restricted stock plus long-term incentive payments, plus changes in the value of existing options and shares. The data are winsorized at the one percent tails and robust standard errors allowing for correlated errors within two-digit SIC codes are reported in parentheses. Estimated coefficients for the industry and year effects are suppressed. The symbols *, **, and *** indicate difference from zero at the one, five, and ten percent levels, respectively. Sample includes 318 observations.

Variable	CAPM Benchmark	S&P 500 Benchmark
Intercept	−12,131**	−13,534**
	(6,682)	(6,686)
Δ Shareholder Wealth	40.54*	38.27*
	(7.00)	(6.98)
Δ Shareholder Wealth × cdf of firm-specific variance	−35.71*	−35.86*
	(17.81)	(16.37)
Δ Shareholder Wealth × cdf of systematic variance	−1.97	1.67
	(16.64)	(16.22)
Δ Shareholder Wealth × cdf of Tobin's q	−1.63	−2.40
	(2.12)	(2.15)
Benchmark return	0.311	−1.06
	(1.34)	(1.39)
cdf of firm-specific variance	−12,893	−7,647
	(28,586)	(28,746)
cdf of systematic variance	34,000	33,706
	(28,472)	(28,448)
cdf of Tobin's q	30,860*	31,594*
	(10,929)	(10,918)
adj. R^2	0.412	0.414

Table VII
Changes in CEO Wealth: The Effect of Total Wealth

This table contains OLS regressions of changes in CEO wealth on changes in shareholder wealth (Δ SH Wealth); the interactions of Δ SH Wealth and the cdfs of firm-specific variance, systematic variance; these two interactions are further interacted with the cdfs of CEO wealth; the interactions of Δ SH Wealth and the cdfs of CEO wealth and Tobin's q; a benchmark of expected changes in shareholder wealth; the interaction of this benchmark with the cdfs of CEO wealth and Tobin's q; the cdfs of firm-specific variance, systematic variance, CEO wealth, and Tobin's q; industry effects and year dummies. The first column uses the CAPM as the market benchmark, whereas the second column uses the S&P 500 return. Changes in CEO wealth is defined as cash compensation plus the Black-Scholes value of new options granted plus the value of restricted stock plus long-term incentive payments, plus changes in the value of existing options and shares. The data are winsorized at the one percent tails and robust standard errors allowing for correlated errors within 2-digit SIC codes are reported in parentheses. Estimated coefficients for the industry and year effects are suppressed. The symbols *, **, and *** indicate difference from zero at the one, five, and ten percent levels, respectively. Sample includes 318 observations.

Variable	CAPM Benchmark	S&P 500 Benchmark
Intercept	−11,059 (6,991)	−9,967 (7,034)
Δ SH Wealth	57.94* (18.35)	62.16* (18.17)
Δ SH Wealth × cdf of firm-specific variance	−59.15*** (28.22)	−43.10*** (27.32)
Δ SH Wealth × cdf of systematic variance	5.66 (30.22)	−12.33 (30.53)
Δ SH Wealth × cdf of firm-specific var × cdf(Wealth)	33.06 (69.61)	18.10 (69.08)
Δ SH Wealth × cdf of systematic var × cdf(Wealth)	−8.68 (58.60)	12.15 (56.87)
Δ SH Wealth × cdf(Wealth)	−24.99 (25.41)	−31.13 (25.17)
Δ SH Wealth × cdf(Tobin's q)	−2.38 (2.47)	−4.43 (2.70)
Benchmark return	−22.76** (10.40)	−29.17* (9.82)
Benchmark return × cdf(wealth)	23.67** (12.69)	26.02** (11.57)
Benchmark return × cdf(Tobin's q)	−0.527 (4.49)	3.63 (4.70)
cdf of firm-specific variance	−1,597 (29,380)	18,383 (30,102)
cdf of systematic variance	53,252 (33,161)	44,443 (28,453)
cdf(Wealth)	−19,598 (13,513)	−20,337 (13,127)
cdf(Tobin's q)	26,615** (11,802)	21,284*** (11,872)
adj. R^2	0.425	0.439

Table VII (continued)

Summary Panel (CAPM-based Benchmark)

Rank by Financial Wealth Proxy	$\widehat{\alpha}$	$\widehat{d}_F$	$\widehat{\alpha} + \widehat{d}_F$	% Market Risk Removed ($\frac{-\widehat{d}_F}{\widehat{\alpha}}$)
Poorest CEO	\$30.01	−\$23.02	\$6.98	76.73%
Median CEO	\$23.61	−\$11.19	\$12.42	47.40%
Wealthiest CEO	\$17.21	\$0.65	\$17.85	−3.76%

Summary Panel (S&P 500 Benchmark)

Rank by Financial Wealth Proxy	$\widehat{\alpha}$	$\widehat{d}_F$	$\widehat{\alpha} + \widehat{d}_F$	% Market Risk Removed ($\frac{-\widehat{d}_F}{\widehat{\alpha}}$)
Poorest CEO	\$32.23	−\$27.36	\$4.88	84.87%
Median CEO	\$24.23	−\$14.35	\$9.88	59.21%
Wealthiest CEO	\$16.23	−\$1.34	\$14.89	8.23%