# The Other Side of the Trade-Off: The Impact of Risk on Executive Compensation A Comment

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#### Abstract

In contrast to studies such as Demsetz and Lehn (1985) that predict and find a strong *positive* association between firm risk and ownership incentives, Aggarwal and Samwick (A&S 1999) predict and find a strong *negative* association. A key assumption of A&S's analysis is that firm risk is the sole determinant of the pay-performance sensitivity. Neither prior research nor the data support this assumption. When we replicate the A&S model with an augmented but parsimonious model of the CEO pay-performance sensitivity that controls for firm market value, we find that the pay-performance sensitivity is significantly *positively* related to firm risk.

#### I. Introduction

In a recent article in this *Journal*, Aggarwal and Samwick (A&S 1999) state that they "demonstrate strong empirical confirmation" of a principal-agent model's "key prediction" that an executive's "pay-performance sensitivity is decreasing in the variance of the firm's performance" (p. 65). A key assumption of A&S's analysis is that the variance of a firm's performance is either the sole determinant of the pay-performance sensitivity or that other determinants of the pay-performance sensitivity are uncorrelated with variance. As we discuss below, neither prior research nor the data support this assumption. Further, we document that because this assumption is critical to A&S's empirical analysis, their results cannot be interpreted as evidence of a negative relation between risk and the pay-performance sensitivity.

The assumption that firm risk is the sole determinant of a manager's pay-performance sensitivity is not supported by related agency research such as Baker and Hall (1998) and Schaefer (1998), who emphasize the importance of controlling for an expected positive association between firm size and the CEO's marginal product. This assumption is also rejected by an extensive literature that examines the determinants of managerial ownership. Because almost all of an executive's pay-performance sensitivity is determined by his or her percentage ownership of the firm (Jensen and Murphy 1990), the determinants of executive ownership are important determinants of the total pay-performance sensitivity. The literature that examines the determinants of managerial ownership originated with Demsetz and Lehn (1985) in an earlier article in this *Journal*. Demsetz and Lehn (1985) predict and find that ownership concentration is negatively related to firm market value and positively related to firm risk. Subsequent research predicts and finds that both firm characteristics (e.g., size, risk, and other proxies for monitoring costs and managerial discretion) and manager characteristics (e.g., tenure and

education as proxies for the manager's marginal product) explain cross-sectional variation in managerial ownership.<sup>1</sup>

We argue that the exclusion of known determinants of the pay-performance sensitivity from A&S's regression models greatly alters the inference with respect to the included determinants. To show these inference problems, we replicate A&S's results by estimating the pay-performance sensitivity in a regression of the CEO's change in firm-specific wealth on dollar returns and dollar returns interacted with firm risk (as measured by the variance of dollar returns). We then add an interaction with firm size (as measured by market value) to the regression and show that it has a significantly negative relation with the pay-performance sensitivity, consistent with the findings of the managerial ownership literature. Finally, we show that market value is correlated with the variance of dollar returns in such a way that its omission from the A&S specification reverses the inference with respect to firm risk: With market value included, firm risk is significantly positively associated with the pay-performance sensitivity, consistent with the prediction and findings of the managerial ownership literature. Because the decreasing relation between isk and incentives is a comparative static prediction of A&S's version of the standard principal-agent model, this relation should hold among firms of equal size (as well as among firms that are similar along other dimensions). Our evidence documents that this is not the case. We do not argue that market value is the only important determinant omitted from the A&S regression, but simply that a parsimonious model that includes market value is sufficient to illustrate our arguments. For robustness, we show that when additional

<sup>&</sup>lt;sup>1</sup> For example, see Jensen, Solberg, and Zorn 1992; Holthausen and Larcker 1993; Loderer and Martin 1997; Cho 1998; Core and Guay 1999; Himmelberg, Hubbard, and Palia 1999; Holderness, Kroszner and Sheehan 1999; Bushman, Chen, Engel, and Smith 2000; and Palia 2001.

determinants of the pay-performance sensitivity are included in the empirical model, firm risk remains positively associated with the pay-performance sensitivity.

### **II.** Theoretical Specification

A&S test a very specific and restricted version of the principal-agent model, which is described by Holmstrom and Milgrom (1987). A&S's principal-agent framework (p. 76) assumes that: (1) firm performance is normally distributed; (2) the CEO has constant absolute risk aversion; (3) the CEO's action increases the mean of firm performance, but not its variance; (4) the CEO's contract is linear; and (5) all CEOs have the effort aversion parameter k and risk aversion parameter  $\rho$ . Holmstrom and Milgrom (p. 324) emphasize that a key restriction of the standard agency model is that the CEO has no discretion over project selection, or, equivalently, that the shareholders specify which project the CEO chooses. Given these assumptions, one firm-specific characteristic that influences the optimal pay-performance sensitivity is risk, and greater risk is predicted to lower the pay-performance sensitivity.

To test for a negative relation between risk and the pay-performance sensitivity, A&S estimate whether the slope parameter in a regression of change in firm-specific executive wealth on firm performance is negatively related to firm risk. A&S test this hypothesis using firm performance measured as dollar returns (percentage returns) and risk measured as the variance of dollar returns (percentage returns).

As emphasized by Baker and Hall (1998), Holmstrom (1992), Rosen (1992) and Schaefer (1998), how the CEO's marginal product varies with firm size also affects the pay-performance sensitivity. Although A&S do not make explicit assumptions in this regard, their dollar returns specification implicitly assumes that CEO marginal product is independent of market value, and their percentage returns specification implicitly assumes that CEO marginal product increases

one-for-one with market value. To illustrate the specific assumptions made by A&S about the relation between CEO marginal product and market value within a general framework, we use the following equation that shows a relation between CEO marginal product, beginning market value  $V_{t-1}$ , and the firm's current dollar return, which is the change in market value of equity plus dividends ( $V_t + d_t - V_{t-1}$ ):

$$V_t + d_t - V_{t-1} = (V_{t-1})^{\eta} \mathbf{x} + \varepsilon$$
 (1)

We follow the A&S notation in this equation: x is effort and  $\varepsilon$  is noise in dollar returns. The term  $(V_{t-1})^{\eta}$  is the CEO's marginal product of effort, and  $\eta \ge 0$  measures the elasticity of the CEO's marginal product to  $V_{t-1}$ . As shown in Baker and Hall (1998) and Schaefer (1998), the optimal linear contract for the specification shown in Equation (1) has slope parameter:

$$\boldsymbol{a}_{1}^{*} = \frac{V_{t-1}^{2h}}{\left(V_{t-1}^{2h} + \boldsymbol{r}k\boldsymbol{s}^{2}\right)} = \frac{V_{t-1}^{2h}}{\left(V_{t-1}^{2h} + \boldsymbol{r}k\boldsymbol{s}_{r}^{2}V_{t-1}^{2}\right)}$$
(2)

where  $\mathbf{s}^2$  is dollar return variance, and the second equality follows because dollar return variance is equal to  $V_{t-1}^2$  times percentage return variance  $\mathbf{s}_r^2$ .

When  $\eta = 0$ , Equation (1) reduces to:

$$V_t + d_t - V_{t-1} = \mathbf{x} + \mathbf{\varepsilon},\tag{3}$$

In this case, the middle expression in Equation (2) indicates that the optimal slope is independent of market value in a specification where firm risk is measured as the variance of dollar returns. Thus, when  $\eta = 0$ , the A&S empirical model using dollar return variance is well-specified without a control for  $V_{t-1}$ .

When  $\eta = 1$ , and when both sides of Equation (1) are divided by  $V_{t-1}$ , Equation (1) becomes:

$$R_{t} = (V_{t} + d_{t} - V_{t-1})/V_{t-1} = \mathbf{x} + \varepsilon/V_{t-1},$$
(4)

In this case, the right-hand side of Equation (2) indicates that the optimal slope is independent of market value in a specification where firm risk is measured as the variance of percentage returns. Thus, when  $\eta = 1$ , the A&S empirical model using percentage return variance is well-specified without a control for  $V_{t-1}$ .<sup>2</sup>

There does not appear to be a strong ex ante reason to expect that  $\eta$  equals either 0 or 1 as assumed by the A&S specifications. Baker and Hall (1998) show empirical estimates of  $\eta$  that range from 0.3 to 0.6, and show that the data strongly reject the hypothesis that  $\eta$  equals 0 or 1. This evidence, combined with Equation (2), suggests that the optimal pay-performance slope is a function of  $V_{t-1}$ . Given that  $V_{t-1}$  is correlated with A&S's measures of firm risk (e.g., A&S note on p.78 "that larger firms will tend to have larger [dollar] variances by virtue of scale"), the omission of market value from the A&S specification is expected to result in biased slope estimates. In Section III, we illustrate empirically that  $V_{t-1}$  exhibits strong correlations with both dollar return variance and percentage return variance. Thus, it seems important to include a control for market value in addition to risk in a test of the principal-agent model.

Implicit in the managerial ownership literature is a more general model of the agency relation between the shareholders and the CEO, in which shareholders cannot specify which project the CEO chooses, but must instead delegate this choice to the CEO. This model assumes that the CEO can choose from a set of projects, and that prior to making the decision, she has acquired superior information about the projects. The greater the uncertainty in the operating environment, the more difficult it is for the shareholders or board of directors to know *why* the

 $<sup>^2</sup>$  A&S note on page 78 that the percentage returns specification assumes that "the extra compensation that the executive would receive for a 1 percent increase in the value of the firm is independent of the size of the firm. In a cross-section of firms this assumption is likely to be false." This statement indicates that A&S recognize that firm size and incentives are related, and that  $\eta$  is unlikely to equal 1, on average, in a cross-section of firms. That  $\eta$  does not equal 1, however, does not imply that  $\eta$  equals 0, as is assumed in the A&S dollar returns specification.

project was selected (i.e., to maximize firm value or to maximize the CEO's private benefits), even if they know *what* project was selected (e.g., Demsetz and Lehn 1985; Smith and Watts 1992; Prendergast 2000a, 2000b). Thus, in more uncertain environments, the CEO must be given greater pay-performance sensitivity to motivate the best choice for shareholders (Smith and Watts 1992; Prendergast 2000a, 2000b). In this model, firm risk (measured empirically by the variance of *percentage* returns) proxies for both uncertainty in the operating environment and noise in the performance measure. Provided that there is sufficient uncertainty about the CEO's project choice, a positive association is predicted between risk and the pay-performance sensitivity. When there is no uncertainty, the shareholders can direct the CEO's project selection, and the model becomes a standard principal-agent model, in which the CEO has no project selection responsibilities, and an unambiguously negative relation is predicted between risk and incentives.

This more general model predicts that other firm characteristics besides risk, such as size and other proxies for monitoring costs, influence CEO incentives. For example, many studies predict and find a negative relation between CEO incentives and firm market value (e.g., Holthausen and Larcker 1993; Cho 1998; Core and Guay 1999; Holderness, Kroszner and Sheehan 1999; and Bushman, Chen, Engel, and Smith 2000; Palia 2001). One reason why the pay-performance sensitivity is expected to decrease with the market value of equity is that the cost of a given amount fractional ownership increases with firms' market value. When CEOs are risk-averse and wealth-constrained, firms with target ownership levels will find it increasingly costly to maintain the desired fractional ownership as market capitalization increases (Demsetz and Lehn 1985). It is important to remember that when CEOs are risk-averse and wealthconstrained, even a small fractional share of a large firm translates into powerful dollar incentives (Haubrich 1994; Baker and Hall 1998; Hall and Liebman 1998).

Because both the agency literature and the managerial ownership literature suggest that it is important to control for market value, we augment the A&S regression model to control for the lagged market value of equity,  $V_{t-1}$ :

Change in CEO firm-specific wealth =  $\alpha + \beta_1$  Dollar return  $+ \beta_2$ (Dollar return × CDF of \$ Variance) +  $\beta_3$  CDF of \$ Variance  $+ \beta_4$ (Dollar return × CDF of  $V_{t-1}$ ) +  $\beta_5$  CDF of  $V_{t-1}$ + year dummies +  $\epsilon$ , (5)

where \$ Variance denotes the variance of dollar returns. We follow the extensive findings in the managerial ownership literature and predict a positive coefficient on the proxy for firm risk and a negative coefficient on market value.

#### **III.** Empirical Analysis

We begin our analysis by presenting descriptive statistics for the sample and by replicating A&S's pay-performance sensitivity regressions. We then show how the apparent negative relation between pay-performance sensitivity and risk in this specification is driven by two factors: (1) market value is omitted as an economic determinant of equity incentives, and (2) A&S's measure of risk in these regressions differs from more commonly employed measures in that it has a very large *positive* correlation with firm market value and a very large *negative* correlation with stock-return volatility. In our expanded model, we document a positive and significant relation between the pay-performance sensitivity and risk that is consistent with the prediction and findings of the managerial ownership literature.

#### Sample selection and variable construction

To create our sample, we use the same data restrictions as A&S (1999), and compute

compensation variables consistent with the A&S measures. We obtain a sample of 4,812 CEOyear observations from the ExecuComp database for Compustat data years 1992 to 1996. From ExecuComp, we obtain data on CEO compensation, stock ownership, and the degree to which the CEO's options are in the money. To compute the CEO's annual flow compensation, we sum the CEO's salary, bonus, the value of grants of options and restricted stock, and other annual pay. Like A&S, we take the value of the annual option grant to be the value reported in the company's proxy statement. Consistent with A&S, we adjust all level variables to 1995 dollars using the consumer price index, and we compute real returns by subtracting growth in the CPI.

The dependent variable in the pay-performance sensitivity regressions is the change in the CEO's firm-specific wealth. This variable is the sum of annual flow compensation plus the change in the estimated value of stock and option holdings. We follow A&S and compute the change in the CEO's stock portfolio during the year by multiplying the beginning of the year portfolio value by the firm's real return for the year. We compute the change in the CEO's option portfolio as the difference between the extent to which the portfolio is in-the-money at the end of the year and the beginning of the year.<sup>3</sup>

Like A&S, we compute each firm's "dollar return" for a period as the firm's beginning of period market value of equity multiplied by the firm's real (net of inflation) percentage return for the period. We measure annual firm performance as the annual "dollar return." To compute the variance of monthly dollar returns (i.e., A&S's measure of firm risk), we use a time series of no less than 48 months and no more than 60 months of returns ending the month prior to the fiscal year in which compensation is determined. Consistent with A&S, we compute the cumulative

 $<sup>^{3}</sup>$  Like Aggarwal and Samwick, we recognize that the option portfolio's intrinsic value is a noisy measure of the change in option portfolio value, but we compute it in this way to replicate Aggarwal and Samwick as closely as possible. Our results are qualitatively the same if we calculate the change in option portfolio value using the Black-Scholes model as in Core and Guay (2001).

distribution function of the variance of monthly dollar returns (CDF of \$ Variance) by ranking the observations, and then transforming the ranks so that they lie uniformly between zero and one. We compute the CDF of  $V_{t-1}$  by using the same procedure on the market value of equity at the beginning of the year. The CDF values of zero and one correspond to the smallest and largest variances of dollar returns (and market values of equity) in our sample, and a CDF of 0.5 corresponds to the median value.

Table 1 reports descriptive statistics for 1995 CEO compensation, and shows that our sample and variables closely replicate those reported in A&S Table 1 (p. 72).<sup>4</sup> The mean (median) flow compensation (i.e., total annual pay) is \$2.2 (\$1.3) million in our sample compared to \$2.3 (\$1.4) million in the A&S sample. Similarly, the mean (median) compensation due to the change in firm-specific wealth is \$21.9 (\$3.2) million for the CEOs in our sample, compared to \$24.2 (\$3.1) million in the A&S sample. The levels of stock and option holdings for the two samples are also very similar. For example, mean and median values of stockholdings, option holdings, and current option grants for our CEOs are all within 5% of the values reported for the A&S sample. Untabulated descriptive statistics also indicate that annual returns and variance of returns for our sample are similar to those reported by A&S.

#### **Pay-performance sensitivity results**

We replicate and extend the A&S pay-performance sensitivity regressions. Following A&S, we estimate regression Equation (5) using median regressions and calculate standard errors using 20 replications of the bootstrap procedure in Gould (1992). The pay-performance sensitivity for a firm of given risk and market value is  $\beta_1 + (\beta_2 \times \text{CDF of } \text{Variance}) + (\beta_4 \times \text{CDF of } \text{Variance}) +$ 

<sup>&</sup>lt;sup>4</sup> Our sample size is slightly larger than Aggarwal and Samwick. Part of this difference occurs because we use a later version of ExecuComp that includes more firms.

CDF of  $V_{t-1}$ ). A significantly negative estimate of  $\beta_2$  is interpreted as evidence supporting the standard principal-agent model prediction of a negative relation between risk and the payperformance sensitivity. Following the prediction of the managerial ownership literature,  $\beta_4$  is expected to be negative.

Column (a) of Table 2 reports results for the regression specification where market value is omitted from Equation (5). For parsimony in Table 2, we report only the coefficients on the interactive variables. Similar to the findings of A&S, the coefficient on Dollar return ( $\beta_1$ ) is significantly positive and the coefficient on the interactive term Dollar return × CDF of \$ Variance ( $\beta_2$ ) is significantly negative. The coefficient estimates and significance levels closely correspond to A&S's Table 3, Panel A, Column 1. The negative coefficient,  $\beta_2$ , forms the basis for A&S's conclusion that the CEO's pay-performance sensitivity is negatively correlated with firm risk.

Column (b) of Table 2 reports results for the regression specification where CDF of market value is substituted for CDF of \$ Variance in the regression. The coefficient on the interactive term Dollar return × CDF of  $V_{t-1}$  is significantly negative, and the explanatory power is greater than that for the model in Column (a). This finding is consistent with the findings in much agency and managerial ownership literature that the pay-performance sensitivity is decreasing in firm market value.

Column (c) of Table 2 reports the results for the regression specification in Equation (5). When both CDF of  $V_{t-1}$  and CDF of \$ Variance and their interactive terms are included, the coefficient on CDF of  $V_{t-1}$  remains significantly negative, but the coefficient on CDF of \$ Variance changes sign and becomes significantly positive. This finding supports the prediction of Demsetz and Lehn (1985) and others that firms operating in more uncertain environments find it optimal to use greater ownership incentives and hence impose greater pay-performance sensitivity on their CEOs. That is, the results in Column (c) indicate that among firms of similar market value, there is a positive relation between risk and CEO pay-performance sensitivity. Again, the intuition for a negative coefficient on market value is that a given amount of fractional ownership is more costly to impose on a CEO of a large firm than a CEO of a small firm. In untabulated results, we also find that when CDF of  $V_{t-1}$  is included as a control variable in the A&S specification that measures firm performance as percentage returns (A&S's Table 3, Panel B), the coefficient on the CDF of % return variance changes sign and becomes significantly positive.

In the managerial ownership literature, the variance of dollar returns is not used as a proxy for firm risk. Instead, the variance of percentage returns is commonly used in this literature as a proxy for operating environment uncertainty with the prediction of a positive relation between uncertainty and incentives. In Column (d), we substitute the CDF of % return variance and the CDF of  $V_{t-1}$  for the CDF of \$ dollar variance in the specification shown in Column (a). Equation (2) shows that the variance of percentage returns and market value can be substituted for the variance of dollar returns in a test of the dollar returns specification of the agency model. The positive and significant coefficient on the CDF of % return variance in Column (d) contradicts the A&S prediction, and again indicates that among firms of similar market value, there is a positive relation between risk and CEO pay-performance sensitivity.

In Column (e) of Table 2, we augment the regression Equation (5) to control for two other variables that are frequently used to explain incentives in the managerial ownership literature. First, we include the market-to-book assets ratio as a proxy for growth opportunities (Smith and Watts, 1992). Firms with higher growth opportunities are predicted to be more difficult to monitor and to use higher incentives (Core and Guay, 1999). Second, we include CEO tenure and predict a positive association with the pay-performance slope, either because more risk can be imposed on the agent as uncertainty about his ability is resolved (Gibbons and Murphy, 1992), or because CEO wealth increases as tenure increases, and dollar incentives increase as CEO wealth increases (Core and Guay, 1999). Finally, we include the variance of percentage returns as a competing risk proxy with the variance of dollar returns.

We rank these additional explanatory variables and include both their interaction with dollar return and the variable rank in the regression. Again, for parsimony, we report only the coefficients on the interactive variables. Consistent with the predictions and findings of Core and Guay (1999) on a similar sample of ExecuComp CEOs from 1992 to 1996, Column (e) shows that the pay performance sensitivity is negatively associated with market value and positively associated with growth opportunities, CEO tenure, and the variance of percentage returns. The coefficient on variance of dollar returns is insignificant in the presence of variance of percentage returns indicates that, controlling for market value, growth opportunities, and CEO tenure, firms with riskier stock returns use more incentives. Consistent with the findings in Columns (c) and (d), we find no evidence that risk is negatively associated with the pay-performance sensitivity.

What accounts for these markedly different findings when firm market value and other controls are included in the regression? From Column (b) of Table 2, firm market value is negatively related to the pay-performance sensitivity. Therefore, econometrically, if market value is negatively correlated with the proxy for risk, the omission of market value from

<sup>&</sup>lt;sup>5</sup> If the variance of percentage returns is omitted from the regression, the coefficient on the variance of dollar returns is *positive* and significant. If CEO tenure and the market-to-book ratio are omitted, the coefficient on the variance of percentage returns remains positive and significant, and the variance of dollar returns remains insignificant.

Equation (5) results in positive bias on the implied relation between risk and pay-performance sensitivity (i.e., positive bias on  $\beta_2$ ). If market value is positively correlated with the proxy for risk, the omission of market value results in a negative bias on the implied relation between risk and pay-performance sensitivity (i.e., negative bias on  $\beta_2$ ). From Columns (a) and (c) of Table 2, the bias on  $\beta_2$  is shown to be negative. Given that a large body of asset pricing literature (e.g., Fama and French 1992) suggests a negative correlation between firm size and risk, the negative bias is at first counterintuitive.

To clarify the source of this bias, we first report correlations between market value, the variance of dollar returns, and the variance of percentage returns in Panel A of Table 3. Each variable is constructed using the cumulative distribution function for the sample firms. Consistent with intuition, firm market value has a negative correlation of -0.52 with the variance of *percentage* returns. However, the correlation between variance of *dollar* returns and size is a large and positive 0.92. This is because, by definition, holding percentage returns constant, firms with greater market value experience larger dollar changes in shareholder value. Even though larger firms do experience smaller variation in percentage returns, the cross-sectional variation in dollar returns is driven primarily by firm market value. To see this, note that even if a \$100 million biotechnology firm has 100% volatility, its volatility of dollar returns is equal to that of a \$1,000 million electric utility with 10% volatility.

In addition to this econometric specification issue, the economic driver of the misspecification is illustrated by the following derivation, which shows that the change in CEO firm-specific wealth is primarily determined by the percentage of the firm he or she owns. We obtain this expression by first setting all of the coefficients in Equation (5) equal to zero, except for the coefficients on Dollar return and the terms interacted with Dollar return, and rearranging:

Change in CEO firm-specific wealth 
$$\approx$$
  
[ $\beta_1 + \beta_2$ (CDF of \$ Variance) +  $\beta_4$ (CDF of  $V_{t-1}$ )]× Dollar return (6)

A&S note (pg. 85) that CEO pay-performance sensitivities are primarily the result of incentives provided by the executives' ownership of stock and stock options. That is, because the variance of annual flow compensation is trivial compared to that of the change in the value of the CEO's equity portfolio (see Table 1), the change in firm-specific wealth is driven primarily by the change in the CEO's equity based wealth:

Change in CEO firm-specific wealth  $\approx$  Change in CEO equity-based wealth (7) We also observe that the term in brackets in Equation (6) is the CEO's ownership share; that is, the bracketed term transforms a given change in the market value of the firm into a change in the CEO's equity-based wealth:

 $[\beta_1 + \beta_2(\text{CDF of Dollar return variance}) + \beta_4(\text{CDF of } V_{t-1})] \approx \text{CEO ownership share}$ (8)

Substituting Equations (7) and (8) into Equation (6) yields:

Change in CEO equity-based wealth  $\approx$  CEO ownership share  $\times$  Dollar Return (9) The CEO ownership share has been the focus of considerable research in the managerial ownership literature. As stated above, researchers have consistently found that the CEO's ownership share is a decreasing function of market value ( $\beta_4 < 0$ ) and have generally found it to be an increasing function of firm uncertainty ( $\beta_2 > 0$ ).<sup>6</sup> The A&S empirical framework implicitly models the CEO ownership share solely as a function of firm risk, i.e.,  $\beta_4$  is restricted to equal 0.

<sup>&</sup>lt;sup>6</sup> Counterexamples include the following: In the presence of a number of other proxies for monitoring costs and managerial discretion, Himmelberg, Hubbard, and Palia (1999) find a negative relation between percentage return volatility and percentage equity ownership. Holderness, Kroszner and Sheehan (1999) use a regression specification similar to Demsetz and Lehn (1985), and find the striking contrasts of a significant negative (positive) relation between percentage return volatility and percentage equity ownership in 1935 (1995) for managers of New York stock exchange firms.

In Panel B of Table 3, we show why these two models yield different inferences by estimating the relation between CEO ownership share and market value and risk. Our measure of the CEO ownership share includes both stock and option holdings. The ŒO's portfolio of options are converted to equivalent common shares using the option "delta" as described in Jensen and Murphy (1990) and Yermack (1995). For example, the typical executive stock option increases in value by about \$0.70 for each \$1.00 change in the stock price, so that this option provides equity incentives equivalent to 0.70 shares of stock.<sup>7</sup> As in Table 2, we estimate the relation between CEO ownership share and market value and risk with median regressions, and calculate standard errors using 20 replications of the bootstrap procedure in Gould (1992).

When CEO ownership share is regressed on either market value or the variance of dollar returns alone, the inferred relation is negative and significant. However, similar to the findings in Table 2, when size and risk are both included in the regression, the coefficient on risk changes sign and becomes significantly positive. This finding confirms the positive relation between share ownership and risk documented in previous research.

#### **IV.** Conclusion

In this paper, we reconcile contrasting empirical findings documented by managerial ownership researchers and those of A&S (1999) on the relation between firm risk and the payperformance sensitivity in CEO contracts. The principal-agent theory employed by A&S yields a comparative static prediction for a negative relation between this sensitivity and risk. However, because this theory assumes that the CEO has no private information about potential projects and no discretion over projection selection, it excludes important determinants of CEO incentives documented in the managerial ownership literature. In addition, A&S employ two very

<sup>&</sup>lt;sup>7</sup> We compute the delta of the CEO's option portfolio using the method described in Core and Guay (2001) under the assumption that the expected time-to-exercise is 70% of the each option's stated maturity.

restrictive assumptions about how CEO marginal product increases with firm market value. Prior empirical evidence does not support these restrictions and suggests that market value should be included as a control in a test of the principal-agent model. Using a parsimonious model of CEO incentives that includes market value and risk as explanatory variables, we find that the payperformance sensitivity does not vary as predicted by A&S. Instead, our results are consistent with Demsetz and Lehn's (1985) prediction that controlling for market value, there is an increasing relation between risk and ownership incentives.

We do not conclude that the principal-agent model's prediction of a decreasing relation between risk and incentives is not descriptive of CEO incentives. Rather, we suggest that more research is necessary to demonstrate this trade-off. Although most empirical research to date finds a positive relation between risk and managerial ownership, there are exceptions such as Himmelberg, Hubbard, and Palia (1999). That we have an incomplete understanding of this relation is well illustrated by Holderness, Kroszner and Sheehan (1999), who find in regression models similar to those of Demsetz and Lehn (1985), that risk was negatively (positively) associated with the ownership of executives in New York stock exchange firms in 1935 (1995). Complicating this exploration is the fact that a firm's information environment is a choice variable, and firms face a trade-off between the level of information that helps it raise capital and the level of information that is best for contracting purposes (Baiman and Verrecchia 1996; Burkart, Gromb, and Panunzi 1997). Exploring and understanding how firm characteristics interact to determine managerial incentives will enhance our understanding of how executive pay arrangements are jointly determined with other elements of corporate governance and corporate finance.

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### **TABLE 1**

	n	Mean	Median	Minimum	Maximum
Flow compensation	1,342	2,211	1,266	0	63,479
Change in firm-specific wealth	1,301	21,937	3,175	-106,815	5,691,438
Excluding existing options	1,304	19,231	2,092	-104,595	5,691,438

A. Chief Executive Officers - Measures of Executive Compensation, 1995

B. Chief Executive Officers - Ownership of Stock and Stock Options, 1995

	Percentage Who Own	Conditional Mean	Conditional Median	Maximum
Wealth in firm stock	98.00%	63,992	4,464	16,039,445
Options on firm stock	82.19%	7,067	2,204	319,600
Current option grants	68.03%	1,237	520	45,951

Sample consists of ExecuComp data for CEOs for 1995. All dollar amounts are in thousands (\$000s) and have been converted to 1995 dollars using the consumer price index at December 31, 1995. Flow compensation is the sum of salary, bonus, long-term incentive plan payouts, the value of restricted stock grants, the value of options granted during the year, and any other annual pay. Total compensation is the sum of total pay and the change in the value of the CEO's stock and option portfolio. The change in firm-specific wealth is flow compensation plus the estimated change in value of stock and optionholdings. To compute the change in the CEO's stock portfolio during the year, we multiply the beginning of the year value by the firm's real return for the year. We follow A&S (1999) and compute the change in the CEO's option portfolio as the difference between the extent to which the portfolio is in -themoney at the end of the year and the beginning of the year. Stockholdings is the value of the CEO's common stock at the end of the year, and option holdings is the extent to which the portfolio is in -the-money at the end of the year.

#### TABLE 2

	Dependent Variable: Change in Firm-specific Wealth				
	(a)	(b)	(c)	(d)	(e)
Dollar return	26.75 (34.22)	30.48 (35.22)	30.74 (30.33)	21.67 (11.87)	20.24 (5.85)
Dollar return $\times$ CDF of \$ Variance	-25.63 (-30.83)		7.37 (1.91)		-4.03 (-0.72)
Dollar return × CDF of $V_{t-1}$		-29.53 (-33.83)	-37.15 (-8.17)	-23.40 (-14.41)	-19.19 (-2.47)
Dollar return × CDF of Market-to- Book Ratio					3.53 (3.14)
Dollar return $\times$ CDF of CEO tenure					6.22 (5.71)
Dollar return $\times$ CDF of % Variance				45.27 (5.14)	50.94 (2.37)
Pseudo $R^2$	8.78%	9.28%	9.34%	9.86%	11.51%

Median Regressions of CEO Change in Firm-specific Wealth on Dollar Returns

The sample consists of 4,812 CEO-year observations from ExecuComp for 1993 to 1996. t-statistics (in parentheses) are calculated using 20 replications of the bootstrap procedure in Gould (1992). Coefficients on the intercept and three year indicator variables not shown. All dollar amounts are in \$thousands (\$000s) and have been converted to 1995 dollars using the consumer price index at December 31, 1995. The change in firm-specific wealth is flow compensation plus the estimated change in value of stock and optionholdings. To compute the change in the CEO's stock portfolio during the year, we multiply the beginning of the year value by the firm's real return for the year. We follow A&S (1999) and compute the change in the CEO's option portfolio as the difference between the extent to which the portfolio is in-the-money at the end of the year and the beginning of the year. Dollar return for the year is the firm's beginning of period market value of equity multiplied by the firm's real (net of inflation) percentage return for the year. \$ variance (% variance) refers to the variance of dollar (percent) returns. We compute these return variances with a time series of no less that 48 months and no more than 60 months of returns ending the month prior to the fiscal year in which compensation is determined.  $V_{t-1}$  refers to the market value of the firm's equity at the beginning of the year. The Market-to-Book ratio refers of the ratio of the market value of the firm's assets to the firm's book value of assets at the beginning of the year. CEO tenure is the number of years the CEO has served as CEO measured at the beginning of the year. We compute the cumulative distribution function (CDF) by ranking the observations, and then transforming the ranks so that they lie uniformly between zero and one. The CDF values of zero and one correspond to the smallest and largest variances of dollar returns (market values) in our sample.

## TABLE 3

	CDF of Dollar Return Variance	CDF of Market Value	CDF of Percentage Return Variance
CDF of \$ Variance	1.00		
CDF of Market Value	0.92	1.00	
CDF of % Variance	-0.30	-0.52	1.00

A. Correlations between Dollar Return Variance, Market Value and Percentage Return Variance

## B. Median regressions of CEO ownership share on Market Value and Dollar Return Variance

	(	CEO Ownership Shar	e
	(a)	(b)	(c)
CDF of Dollar Return Variance	-2.60 (-19.66)		2.06 (7.34)
CDF of Market Value		-2.98 (-22.71)	-5.00 (-16.52)
Pseudo R <sup>2</sup>	5.16%	6.81%	7.21%

The sample consists of 4,812 CEO-year observations from ExecuComp for 1993 to 1996. t-statistics (in parentheses) are calculated using 20 replications of the bootstrap procedure in Gould (1992). Coefficients on the intercept and three year indicator variables not shown. All dollar amounts have been converted to 1995 dollars using the consumer price index at December 31, 1995. The CDF of dollar return (percentage return) variance refers to the CDF of the variance of dollar returns (percentage returns). We compute the variance of monthly dollar returns (percentage returns) by using a time series of no less that 48 months and no more than 60 months of returns ending the month prior to the fiscal year in which compensation is determined. The CDF of market value refers to the CDF of the market value of the firm's equity at the beginning of the year. We compute the cumulative distribution function (CDF) by ranking the observations, and then transforming the ranks so that they lie uniformly between zero and one. The CDF values of zero and one correspond to the smallest and largest variances of dollar returns (market values) in our sample. CEO ownership share is equivalent shares owned by the CEO divided by total shares outstanding. CEO option holdings are converted to equivalent common shares using the option "delta" as described in Jensen and Murphy (1990) and Yermack (1995). CEO ownership value is equal to the total of the value of the CEO's common stock at the end of the year.