An Empirical Analysis of the Role of Risk Aversion

in Executive Compensation Contracts

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Abstract. This paper empirically tests the principal-agent model prediction that the use of performance measures for incentive purposes is affected by the agent's risk aversion. We find that the use of both accounting and market performance measures in executive compensation contracts decreases as the level of risk aversions increases. We further find that agent-specific characteristics, i.e., risk aversion, become more important in designing executive compensation contracts when performance measures are less useful due to measure-specific characteristics.

Key Words: *Risk aversion, agency theory, executive compensation.*

The use of accounting and market performance measures in executive compensation contracts has received considerable attention in the accounting literature. Agency theory predicts that in order to provide incentives, management compensation should be linked to measures of performance that are informative about the effort provided by managers (Holmström, 1979). Analytical studies in accounting indicate that both accounting and market performance measures are informative and should therefore be used for incentive purposes (e.g., Bushman and Indjejikian, 1993; Feltham and Xie, 1994). These studies further show that the incentive weight of a performance measure depends on measure-specific characteristics and agent-specific characteristics (e.g., Banker and Datar, 1989; Bushman and Indjejikian, 1993)

The empirical accounting literature has tried to examine to what extent the agency theory predictions can explain observed practices. This research shows that CEO compensation is on average related to both accounting performance and stock performance (e.g., Lambert and Larcker, 1987; Sloan, 1993; Baber et al., 1999). Furthermore, studies that aim to explain the cross-sectional differences in the use of performance measures, find that the use of accounting performance measures decreases relative to the use of market performance measures when its relative noise increases (e.g., Lambert and Larcker, 1987) and when the firm's growth opportunities increase (e.g., Lambert and Larcker, 1987; Baber et al., 1996). In general, these studies focus on firm characteristics (measure-specific characteristics) of which agency theory predicts that these affect the use of performance measures in compensation contracts. However, agency theory also predicts that the use of performance measures depends on agent-specific characteristics, i.e. the risk aversion of the agent. However, no attempt has been made so far to empirically examine the effect of risk aversion on the use of performance measures for incentive purposes.

The relationship between risk aversion and the use of performance measures in compensation contracts is especially relevant at the CEO level where contracts are more

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tailor-made. Discussions in the economics literature indicate that the assumed lack of pay-for-performance at the CEO level, as described by Jensen and Murphy (1990), is more illusory than real taking into account the effect of risk aversion (e.g., Haubrich, 1994). The central message from these discussions is that, although the pay-performance sensitivity might be small due to the risk aversion of the agent, it still can provide significant incentives. This indicates that risk aversion can have a significant effect on the use of performance measures for incentive purposes. In order to get a better understanding of the use of (accounting) performance measures in CEO compensation contracts, it is therefore important to empirically examine the effect of risk aversion.

Building on the linear principal-agent model of Holmström and Milgrom (1987), this study identifies proxies for managerial risk aversion that can be measured using publicly available executive compensation data. The theoretical analysis indicates that two proxies are worthy of attention, i.e., (1) the variance of compensation and (2) mean compensation divided by variance of compensation. The first proxy is based on the assumption that risk averse managers prefer less risk to more risk. Therefore, if the principal-agent model is descriptive of observed practices, the variance of compensation should be lower for more risk averse managers. The assumption underlying the second proxy is that risk averse managers demand a risk premium. Therefore, the ratio of the mean compensation to the variance of compensation should be higher for more risk averse managers.

We empirically examine the effect of the two risk aversion proxies on the sensitivity of compensation to performance after controlling for other economic determinants. The empirical results provide strong support for the principal-agent model predictions. First, consistent with previous research, we find that the use of accounting performance measures for incentive purposes decreases with its relative noise and the existence of growth opportunities. The use of market performance measures also decreases with its relative noise

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but is not affected by growth opportunities. Additional tests indicate that this latter finding can be explained by an increased use of stock-based compensation rather than cash compensation when growth opportunities increase.

Second, the empirical results show that the use of both accounting and market performance measures decreases as the level of risk aversion increases. Further, the impact of risk aversion on the use of accounting performance measures increases as the relative noise increases and/or the growth opportunities increase. This implies that as accounting performance measures become less useful due to measure-specific characteristics, the impact of agent-specific characteristics, i.e., risk aversion, on the use of these performance measures increases. Overall, the results suggest that risk aversion plays an important role in the design of executive compensation contracts.

The remainder of this paper is organized as follows. In section 1, we describe the theoretical model that underlies our theoretical and empirical analysis. In section 2, we develop two risk aversion proxies based on our theoretical model. In section 3, we present the empirical results using the risk aversion proxies and perform several sensitivity analyses and additional tests. Section 4 concludes this paper with some additional comments and directions for further research.

1. Theoretical Model

To facilitate our analysis, we use a simple linear principal-agent model (Holmström and Milgrom, 1987). The model contains the following assumptions. There is a risk neutral principal who hires a risk and work averse agent to 'run the firm'. The principal is interested in maximizing the gross-payoff to the firm x, characterized by

$$x = e + \varepsilon \tag{1}$$

where e is managerial effort and ε is the random shock affecting the gross-payoff. This gross-payoff is assumed to be noncontractible (cf. Feltham and Xie, 1994). The agent has a negative

exponential utility function over wealth. The effort aversion of the agent is reflected by his personal cost of effort, characterized by

$$C(e) = \frac{1}{2}e^2 \tag{2}$$

The principal designs a linear incentive contract based on performance measure y, i.e.,

$$s(y) = \alpha + \beta y \tag{3}$$

where α is a fixed salary and β is the incentive weight. Performance measure y is characterized by

$$y = fe + \theta \tag{4}$$

where $0 < f \leq 1$ is the marginal contribution of managerial effort to performance measure y and θ is the random shock that affects y, with $\theta \sim N(0, \sigma^2)$. The principal's problem can be formulated as follows

$$\max \quad e - \frac{1}{2}e^2 - \frac{r}{2}(\beta^2\sigma^2) \tag{5}$$

$$s.t. \quad e^* = \beta f \tag{6}$$

Solving the principal's problem leads to the following incentive weight

$$\beta = \frac{f}{f^2 + r\sigma^2} \tag{7}$$

This equation shows that the incentive weight is a function of the sensitivity of the performance measure to managerial effort, the noise of the performance measure, and the level of managerial risk aversion. Differentiating the incentive weight with respect to each of the above parameters leads to proposition 1.

Proposition 1: *differentiating the incentive weight (β) with respect to the sensitivity of the performance measure to managerial effort (f), performance measure noise (σ^2), and risk aversion (r) leads to*

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$$\frac{\partial \beta}{\partial f} > 0 \qquad \text{if } f^2 < r\sigma^2$$

$$\frac{\partial \beta}{\partial \sigma^2} < 0$$

$$\frac{\partial \beta}{\partial r} < 0$$

Proposition 1 states that the incentive weight is a decreasing function of performance measure noise and managerial risk aversion. Furthermore, the incentive weight is an increasing function of the sensitivity of the performance measure to managerial effort if $f^2<\sigma^2$. That is, the incentive weight increases with sensitivity if the following assumptions apply:

1. the agent is risk averse to some extent (see e.g., Lambert et al. (1991) for empirical evidence); and

2. the incentive weight is less than 0.5. That is, the performance measure is not 'owned' by the agent and most of the output accrues to the principal (see e.g., Jensen and Murphy (1990) for empirical evidence).

Under these assumptions, $f^2<\sigma^2$ and the incentive weight increases with the degree to which the performance measure is sensitive to the level of effort.

2. Risk Aversion Proxies

The principal-agent model and the predictions it makes can be used to indicate how empirically observable variables can proxy for the level of risk aversion of the agent. The empirical researcher is able to observe the average level of compensation and the variance of compensation. The following analysis shows how these empirically observable measures can be used to approximate the level of managerial risk aversion.

Assume that there exist two types of agents, extremely risk averse ($r\rightarrow\infty$) and close to risk neutral ($r\rightarrow0$). The extremely risk averse agent has the following incentive weight

$$\lim_{r\to\infty} \beta = 0 \tag{8}$$

That is, the incentive weight is zero, which means that he receives a fixed salary and the variance of compensation is zero. For the close to risk neutral agent, on the other hand, the incentive weight is as follows

$$\lim_{r \to 0} \beta \geq 1 \tag{9}$$

That is, the incentive weight is at least 1, which implies that the variance of compensation at least equals the variance of the performance measure. As a result, given the predictions of the principal-agent model, we can gain information about the risk aversion of agents by empirically observing the variance of compensation.

To explain this result more formally, we calculate comparative static predictions about the effect of risk aversion on the variance of compensation. The variance of compensation is defined by $\beta^2\sigma^2$. Therefore, given the optimal incentive weight, the variance of compensation equals

$$Var[C] = [\frac{f}{f^2 + r\sigma^2}]^2 \sigma^2 , \tag{10}$$

which can be rewritten into

$$Var[C] = \frac{f^2\sigma^2}{(f^2 + r\sigma^2)^2} \tag{11}$$

The effect of risk aversion on the variance of compensation can be determined by differentiating Var[C] with respect to r, which leads to Observation 1.

Observation 1: *the partial derivative of **Var[C]** to **r** is characterized by*

$$\frac{\partial Var[C]}{\partial r} < 0 \tag{12}$$

Observation 1 shows that the variance of compensation decreases as the level of risk aversion increases.

Further, the linear principal-agent model indicates that the certainty equivalent of the agent (CEA) equals the agent's expected compensation minus the risk premium, i.e.,

$$CEA = E[C] - \frac{r}{2} Var[C] \qquad (13)$$

Without loss of generality, we can assume that the agent's reservation utility equals zero, which means that CEA equals zero. As a result, the CEA can be rewritten into

$$r = 2 \frac{E[C]}{Var[C]} \qquad (14)$$

Note, however, that the expected compensation E[C] includes the agent's personal cost of effort, which is empirically unobservable. The only component of E[C] that can be empirically observed is the expected value of the linear incentive contract E[s(y)]. Given the optimal solution to the principal-agent model, the expected value of the incentive contract can be written as (see appendix)

$$E[s(y)] = \frac{f^2}{2(f^2 + r\sigma^2)} \qquad (15)$$

Therefore, the ratio of E[s(y)] to Var[C] is characterized by

$$\frac{E[s(y)]}{Var[C]} = \frac{f^2 + r\sigma^2}{2\sigma^2} \qquad (16)$$

Observation 2: *the partial derivative of (E[s(y)] / Var[C]) to **r** is characterized by*

$$\frac{\partial(E[s(y)]/Var[C])}{\partial r} > 0 \qquad (17)$$

Observation 2 indicates that the ratio of E[s(y)] to Var[C] increases as the level of risk aversion increases.

In sum, the previous analysis indicates that measures of the variance of compensation and the mean over variance of compensation can be used as proxies for the level of managerial risk aversion.

3. Empirical Analysis

In this section, we empirically investigate whether risk aversion has an effect on the compensation-performance relation, as predicted by the principal-agent model. More

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specifically, Proposition 1 states that the higher the level of risk aversion the lower will be the incentive weight. Applying this to the use of both accounting measures of performance and market measures of performance leads to the following hypotheses.

Hypothesis 1: The sensitivity of compensation to accounting performance is negatively affected by the level of managerial risk aversion.

Hypothesis 2: The sensitivity of compensation to market performance is negatively affected by the level of managerial risk aversion.

In testing the above hypotheses, we control for two other economic determinants of the compensation-performance relationship used in previous research (e.g., Lambert and Larcker, 1987; Baber et al., 1996). More specifically, we control for the impact of sensitivity and noise on the incentive weight. First, we control for the growth opportunities of the firm by using the market-to-book ratio. We expect that the use of accounting (market) performance measures decreases (increases) with the market-to-book ratio because the relative sensitivity of accounting (market) performance measures decreases (increases) as the growth opportunities increase (cf. Lambert and Larcker, 1987; Baber et al., 1996). Second, we control for the noise in accounting and market performance measures by adding the variable relative noise of the performance measures. We expect that the use of performance measures decreases with its relative noise (cf. Lambert and Larcker, 1987).

3.1   Data and Sample Selection

We obtain CEO compensation and firm performance data from the ExecuComp database for the years 1992-1999. CEO compensation data and data on accounting performance and stock returns for five consecutive years within the period 1992-1999 are available for 955 CEOs.[1] We remove the years in which the executive became CEO or, if the exact date is not available, the first year for which ExecuComp reports the CEO's compensation data. In order to reduce the influence of outlier observations, we also remove

observations with |ΔROE| ≥ 100%. These large changes in Return on Equity are generally caused by low values of stockholders' equity due to extreme losses in the previous fiscal years. Deletion of partial-year CEOs and observations with |ΔROE| ≥ 100% yields a total sample of 862 CEOs and 3,448 firm-year observations.

Panel A of table 1 summarizes the descriptive statistics for the firm-year observations of CEO compensation and firm performance. The average total cash compensation of the CEOs is $1,382,000, which consists of an average salary of $654,000 and an average bonus of $729,000. The average firm performance in terms of ΔROE (RET) is -0.3% (19.3%). Panel B of table 1 provides the descriptive statistics with respect to the firm-specific observations of the risk aversion, noise, and growth opportunities proxies. The two risk aversion proxies have the following definitions. First, we measure the variance proxy (COMPVAR) by calculating the five-year variance of total cash compensation. Second, we measure the mean-over-variance proxy (MEANVAR) as the ratio of the five-year mean of total cash compensation to the five-year variance of total cash compensation. The mean of COMPVAR (MEANVAR) equals $410 million (0.425).

The volatility of accounting performance (ROEVOL) and market performance (RETVOL) is measured by the five-year standard deviation of ΔROE and the five-year standard deviation of annual stock returns, respectively. The mean of ROEVOL (RETVOL) equals 6.9% (38.2%). In conformity with Lambert and Larcker (1987), we measure the relative noise of accounting performance measures (RELNOISE) by the ratio of ROEVOL to RETVOL, which averages 0.232. Finally, we use the average market-to-book ratio (MTB) over five consecutive years as a proxy for the firm's growth opportunities. The average MTB equals 3.036.

Insert table 1 about here

As can be inferred from table 1, the empirical distributions of the risk aversion, noise and growth opportunities proxies are skewed. Therefore, we transform these variables into ranks between 0 and 1. This ranking procedure has several advantages other than eliminating the skewness in the distribution. First, the information content of the rank-transformed variables is similar to that of the original variables. Second, because the ranks represent the cumulative distribution function (CDF) of the variables, we can compute the pay-performance sensitivity for any point on the distribution of the variables (cf. Aggarwal and Samwick 1999), which allows an interpretation of the incentive weights for different combinations of the economic determinants.

The rank-transformation for both risk aversion proxies is such that a higher rank implies *higher* risk aversion. Table 2 presents the Pearson correlation coefficients between the economic determinants.

Insert table 2 about here

3.2   *Specification of Empirical Model*

To test the principal-agent model predictions, we examine the following three regression models.

$$\Delta\ln(Comp_{it}) = \alpha_0 + \alpha_1\Delta ROE_{it} + \alpha_2 RET_{it} + \alpha_3 RELNOISE_i + \alpha_4 MTB_i$$

$$+ \alpha_5(\Delta ROE_{it}*RELNOISE_i) + \alpha_6(RET_{it}*RELNOISE_i)$$

$$+ \alpha_7(\Delta ROE_{it}*MTB_i) + \alpha_8(RET_{it}*MTB_i) + e_{it} \quad\quad (M1)$$

$$\Delta\ln(Comp_{it}) = \alpha_0 + \alpha_1\Delta ROE_{it} + \alpha_2 RET_{it} + \alpha_3 RELNOISE_i + \alpha_4 MTB_i + \alpha_5 COMPVAR_i$$

$$+ \ \alpha_6(\Delta ROE_{it}*RELNOISE_i) \ + \ \alpha_7(RET_{it}*RELNOISE_i)$$

$$+ \ \alpha_8(\Delta ROE_{it}*MTB_i) + \alpha_9(RET_{it}*MTB_i) +$$

$$+ \ \alpha_{10}(\Delta ROE_{it}*COMPVAR_i) + \alpha_{11}(RET_{it}*COMPVAR_i) + e_{it} \qquad (M2)$$

$$\Delta ln(Comp_{it}) = \alpha_0 + \alpha_1 \Delta ROE_{it} + \alpha_2 RET_{it} + \alpha_3 RELNOISE_i + \alpha_4 MTB_i + \alpha_5 MEANVAR_i$$

$$+ \ \alpha_6(\Delta ROE_{it}*RELNOISE_i) \ + \ \alpha_7(RET_{it}*RELNOISE_i)$$

$$+ \ \alpha_8(\Delta ROE_{it}*MTB_i) + \alpha_9(RET_{it}*MTB_i) +$$

$$+ \ \alpha_{10}(\Delta ROE_{it}*MEANVAR_i) + \alpha_{11}(RET_{it}*MEANVAR_i) + e_{it} \qquad (M3)$$

where

$\Delta ln(Comp_{it})$ = year t-1 to year t change in the natural log of CEOs' total cash compensation;

ΔROE_{it} = year t-1 to year t change in net income before extraordinary items scaled by common equity;

RET_{it} = year t-1 to year t change in stock price plus dividends scaled by year t-1 stock price;

$RELNOISE_i$ = ROEVOL scaled by RETVOL (rank-transformed);

MTB_i = the mean ratio of the market value of common equity to the book value of common equity measured over five consecutive years (rank-transformed);

$COMPVAR_i$ = the variance of CEO cash compensation measured over five consecutive years (inverted and then rank-transformed);

$MEANVAR_i$ = the mean of CEO cash compensation over five consecutive years scaled by the variance of CEO cash compensation over the same period (rank-transformed).

We perform a pooled cross-sectional analysis over the time period 1992-1999. To accept hypotheses 1 and 2, the regression coefficients α_{10} and α_{11} in model 2 (M2) and model 3 (M3)

should be significantly negative. Negative values for α_{10} and α_{11} imply that the relationship between compensation and performance decreases as risk aversion increases.

3.3   *Empirical Results*

Table 2 summarizes the results of the regression analysis for all three models. The results for model 1 (M1) indicate that the relationship between changes in cash compensation and ΔROE decreases with RELNOISE and MTB. This suggests that the use of accounting performance measures for determining CEO's cash compensation decreases as its relative noise increases and the growth opportunities increase. These results are consistent with previous research (e.g., Lambert and Larcker, 1987) and provide further empirical evidence of the relevance of these economic determinants. Furthermore, the interaction between RET and RELNOISE is significantly positive, while the interaction between RET and MTB is not significant. Therefore, the use of stock returns for determining CEO's cash compensation increases as the relative noise in accounting earnings increases but is not affected by growth opportunities. A plausible explanation for this latter finding is that as growth opportunities increase, the use of stock-based compensation increases rather than the use of stock returns in CEO's cash compensation. We examine this possibility in section 3.5.

The results for model 2 (M2) show that the relationship between changes in cash compensation and both ΔROE and RET decreases as COMPVAR increases, which implies that the use of both accounting performance measures and market performance measures decreases as risk aversion increases. The last column of table 2 shows the results of the regression analysis using MEANVAR as a proxy for risk aversion (model 3 (M3)). These results indicate that the relationship between changes in cash compensation and both ΔROE and RET decreases as MEANVAR increases. Similar to COMPVAR, these results suggest that the use of performance measures decreases as risk aversion increases. Although MEANVAR seems to slightly outperform COMPVAR, the results suggest that the variance in

compensation predominately determines the ranking in risk aversion, while the mean of compensation makes some minor adjustments to this ranking. Finally, in both model 2 and 3, the results with respect to the interactions between ΔROE (RET) and RELNOISE and MTB are identical to those in model 1.

In sum, the empirical results suggest that the use of both accounting and market performance measures for determining CEO's cash compensation decreases as the level of managerial risk aversion increases. Therefore, the results provide strong support for hypotheses 1 and 2. Furthermore, the use of accounting performance measures decreases with its relative noise and the existence of growth opportunities, while the use of market performance measures increases as the relative noise in accounting earnings increases.

Insert table 3 about here

3.4 *Economic Determinants and the Use of Accounting Performance Measures*

In order to get a better understanding of how the economic determinants simultaneously affect the use of accounting performance measures, we compute the incentive weight of ΔROE for different combinations of RELNOISE, MTB, and MEANVAR.[2] Using the empirical results of model 3, we compute the different incentive weights by filling in three different values, i.e., 0, 0.5, and 1, for all three economic determinants. The three different values represent respectively the lowest, median, and highest observed values of the economic determinants. This procedure yields 27 coefficients (incentive weights), which are presented in table 4.

A number of inferences can be drawn from table 4. First, the results show that, consistent with agency theory, the incentive weights are highest when both RELNOISE and MTB are low. In these circumstances, accounting performance measures are highly sensitive and relatively precise and are therefore most useful for incentive purposes. The results suggest

that, for the median level of risk aversion, a one percentage-point increase in ROE leads to a 2.3% increase in cash compensation. In contrast, when both RELNOISE and MTB are high, the results indicate that accounting performance measures are not used for incentive purposes.

Second, the characterization of the incentive weight in section 1 (equation 7) implies that the same incentive weight can be found for different combinations of the performance measure properties and the level of risk aversion. Table 4 indicates that for the median level of RELNOISE, MTB and MEANVAR, the incentive weight is approximately one, which implies that a one percentage-point increase in ROE leads to a 1% increase in cash compensation. Approximately the same incentive weight applies to the situation where RELNOISE is high (low), MTB is low (high), and MEANVAR is low (high). Although these last two situations are each other's opposites with respect to sensitivity, noise, and the level of risk aversion, the use of accounting performance measures for incentive purposes is identical. These results stress the importance of examining multiple determinants and their interactions.

Finally, the relative impact of MEANVAR on the use of accounting performance measure increases with increases in RELNOISE and/or MTB up to the point where accounting performance are not used anymore, i.e., when both RELNOISE and MTB are high. This suggests that when accounting performance measures become less sensitive and/or noisier, the relative impact of risk aversion on the incentive weight increases. For example, when both RELNOISE and MTB are low, the incentive weight for low MEANVAR is 37% higher than the incentive weight for high MEANVAR. In contrast, when RELNOISE is high and MTB is low, the incentive weight for low MEANVAR is almost three times the incentive weight for high MEANVAR. Similarly, at the median RELNOISE and high MTB, the incentive weight for low MEANVAR is almost four times the incentive weight for high MEANVAR. Our theoretical interpretation of this finding is the following. When accounting performance measures are relatively precise, the role of risk aversion is relatively low since

the performance measure imposes few risks on the manager. However, when the performance measure becomes noisier, the risk imposed on the manager increases and, as a result, the level of risk aversion determines to what extent the manager can cope with these risks, which affects the incentive weight. With respect to the effect of MTB, our interpretation is the following. When growth opportunities increase, managers need to make riskier investments and more long-term oriented decisions. In general, managers who are risk averse are reluctant to make these investments and decisions. These managers should therefore not be compensated based on accounting performance measures, since this would make them even more reluctant. Although this effect might also apply to managers who are characterized by low levels of risk aversion, the impact is likely to be much smaller, which makes the use of accounting performance measures in these circumstances less problematic. On the other hand, when growth opportunities are low, the above tradeoff becomes less relevant and therefore the impact of risk aversion decreases.

Insert table 4 about here

3.5   *Sensitivity Analysis*

In the previous analyses, we used the variance in cash compensation to determine the level of risk aversion. We interpret the result that a lower variance is related to a lower pay-for-performance as evidence of the prediction that increased risk aversion decreases the incentive weight. However, if substitution effects between different components of compensation are present, then a lower variance in cash compensation might not be due to increased risk aversion but due to a substitution of cash compensation by, for example, stock-based compensation. Although the presence of a substitution effect will not affect the empirical results, it will result in a different interpretation of the results.

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In order to examine whether there are substitution effects, we correlate the risk aversion proxies with the CEO's stake in the firm (STAKE) and the variance in the value of stock options granted to the CEO (OPTIONS).[3] If the examined companies substitute options or shares for cash compensation, the correlation between the risk aversion proxies and both STAKE and OPTIONS should be significantly positive. Table 5 presents the Pearson correlation coefficients between the different variables. The results indicate that the correlation between the risk aversion proxies and OPTIONS is significantly negative, while the correlation between the proxies and STAKE is not significant. This suggests that the different components of compensation are not used as substitutes and therefore substitution effects cannot explain our results.

Insert table 5 about here

The results in table 3 further showed that the interaction between MTB and RET is insignificant, which implies that, contrary to our expectations, the use of stock returns in determining CEO's cash compensation is not affected by the existence of growth opportunities. This insignificant interaction might be due to an increased use of stock-based compensation when growth opportunities increase. To examine this possibility, we correlate MTB with STAKE. The results show that the correlation between MTB and STAKE is 0.466 (p<0.01). This significant positive correlation provides some evidence that if growth opportunities increase, there is a stronger link between CEO's compensation and stock performance through an increased use of stock-based compensation (cf. Smith and Watts, 1992).[4]

Our theoretical model predicts that increased risk aversion decreases the incentive weight, which consequently decreases the variance of compensation. The question arises of

whether the relationship between the incentive weight and variance of compensation will exist even if the incentive weight is not determined by risk aversion. That is, if our theoretical model is not empirically valid and factors that are not taken into account in our model determine the incentive weight, does the variance of compensation still increase with increases in the incentive weight? If so, then our empirical results could be an artifact based on a deterministic relationship. To test whether our results can be artificially determined, we use the following procedure. We estimate the following basic compensation-performance regression

$$\Delta\ln(\text{Comp}_{it}) = \alpha_0 + \alpha_1\Delta\text{ROE}_{it} + \alpha_2\text{RET}_{it} + e_{it} \quad\quad\quad (18)$$

Subsequently, we determine a normal distribution for the incentive weights based on the mean regression coefficients and their standard error. We then randomly assign incentive weights from this normal distribution to the 862 managers, randomly allocate the 3,448 empirically obtained residuals and calculate 3,448 changes in cash compensation based on actual observations of ΔROE and RET. Taking the actual compensation in the first of the five years (that was not included in the regression analysis due to differencing), we predict for each manager the level of cash compensation in the following four years using the calculated changes in cash compensation. Finally, we calculate the risk aversion proxy COMPVAR based on the predicted compensation data and estimate equation (18) adding two interaction terms, i.e., $\Delta\text{ROE}_{it}*\text{COMPVAR}_i$ and $\text{RET}_{it}*\text{COMPVAR}_i$. In estimating the equation, we use the predicted changes in compensation, actual accounting performance and stock performance, and the risk aversion proxy based on predicted compensation. The results based on 500 iterations show that the regression coefficients for the interaction between the risk aversion proxy and respectively ΔROE and RET are not significant. These insignificant interactions lead us to reject the possibility that our empirical results are artificially determined.

3.6 Alternative Explanation

In the empirical analysis we tested the theoretical prediction that incentive weights increase with decreases in risk aversion. The significant interactions that we find in the empirical analysis are consistent with this explanation. However, an alternative explanation for the significant interactions might be that incentive contracts are nonlinear and more convex for less risk averse managers. This increase in convexity with decreases in risk aversion will statistically also lead to significant interactions. To test whether increased convexity rather than increased incentive weights can explain our results, we perform the following test. We split the sample based on deciles of MEANVAR and estimate for each of the ten subsamples the following compensation-performance relationship using Box-Cox transformation (cf. Lambert and Larcker, 1987)

$$B(c_t, \lambda) - B(c_{t-1}, \lambda) = \beta_0 + \beta_1 \Delta ROE_t + \beta_2 RET_t + v_t \qquad (19)$$

where $B(c_t, \lambda)$ is the Box-Cox transformation of c_t, which denotes the level of cash compensation in year t divided by the company-specific five-year average of cash compensation, with λ indicating the level of convexity. We apply the following Box-Cox transformation:

$$B(c_t, \lambda) = [c_t^\lambda - 1] / \lambda \qquad \text{when } \lambda \neq 0 \qquad (20)$$

$$B(c_t, \lambda) = \log(c_t) \qquad \text{when } \lambda = 0 \qquad (21)$$

In the estimation procedure, we let λ vary from -1.0 to 3.0 with increments of 0.05. If the convexity of incentive contracts drives our results, the parameter λ should increase with increases in MEANVAR, i.e., risk aversion.

Figure 1 graphically shows the different λs for the ten subgroups of risk aversion. The results indicate that λ does not gradually increase with increases in risk aversion. Further, for seven out of ten subgroups, the confidence interval includes $\lambda=1$, which implies linearity. However, we do find that the compensation-performance relationship is convex for the lowest

two deciles of risk aversion, while it is concave for the highest decile. Although it is unlikely that this finding drives our original results, we re-estimate model 2 and 3 using the data of the seven deciles for which $\lambda=1$ is in the confidence interval. The results (not reported) are quantitatively similar to those presented in table 3. Overall, the results suggest that, although we observe non-linearities in the extremes of risk aversion, these non-linearities do not drive our results and we therefore conclude that our empirical findings cannot be explained by changes in the convexity of incentive contracts.

Insert figure 1 about here

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4. Concluding Remarks

In this paper, we examine the role of risk aversion in executive compensation contracts. The empirical results provide strong support for the principal-agent model prediction that the use of performance measures for incentive purposes decreases as risk aversion increases. The results further show that, consistent with the principal-agent model prediction, measure-specific characteristics and agent-specific characteristics simultaneously determine the incentive weight. Finally, the empirical results indicate that the impact of risk aversion on the incentive weight increases as the performance measure becomes less sensitive and/or noisier.

The contribution of this paper is twofold. First, we provide strong evidence of the relevance of incorporating risk aversion in executive compensation research. The results indicate that risk aversion has a significant effect on the use of performance measures, which suggests that future executive compensation research should therefore take the level of risk aversion into account. Second, the risk aversion proxies that we test are robust, simple, and can easily be measured using publicly available data. As a result, these proxies can be used in future accounting research other than in the executive compensation area. Areas in which the

risk aversion measures can be applied are, for example, earnings management, CEOs' financing and investment decisions, and voluntary disclosure issues.

Appendix: Proofs

The expected value of the incentive contracts can be determined as follows. The certainty equivalent of the agent (CEA) is characterized by

$$CEA = \alpha + \beta y - \frac{1}{2}e^2 - \frac{r}{2}(\beta^2\sigma^2)$$

Replacing y by fe leads to

$$CEA = \alpha + \beta fe - \frac{1}{2}e^2 - \frac{r}{2}(\beta^2\sigma^2)$$

Filling in the optimal effort level, i.e., $e^* = \beta f$, results in

$$CEA = \alpha + \beta^2 f^2 - \frac{1}{2}\beta^2 f^2 - \frac{r}{2}(\beta^2\sigma^2)$$

Replacing β by the characterization of the optimal incentive weight, i.e., equation 7, leads to

$$CEA = \alpha + [\frac{f}{f^2 + r\sigma^2}]^2 f^2 - \frac{1}{2}[\frac{f}{f^2 + r\sigma^2}]^2 f^2 - \frac{r}{2}([\frac{f}{f^2 + r\sigma^2}]^2 \sigma^2)$$

By setting the CEA equal to zero, we can solve for α

$$\alpha = -\frac{f^2(f^2 - r\sigma^2)}{2(f^2 + r\sigma^2)^2}$$

Given this characterization of the fixed wage, the expected value of the incentive contract equals

$$E[s(y)] = -\frac{f^2(f^2 - r\sigma^2)}{2(f^2 + r\sigma^2)^2} + [\frac{f}{f^2 + r\sigma^2}]^2 f^2,$$

which can be rewritten into

$$E[s(y)] = \frac{f^2}{2(f^2 + r\sigma^2)}$$

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Table 1. Descriptive statistics

Variable	Mean	Standard Deviation	Median	Lower Quartile	Upper Quartile
Panel A: Firm-year observations (N=3,448)					
Cash salary	654	337	600	429	819
Cash bonus	729	1,134	415	134	853
Total compensation	1,382	1,320	1,024	650	1,635
ΔROE	-0.003	0.122	0.001	-0.034	0.029
RET	0.193	0.501	0.137	-0.088	0.386
Panel B: Firm-specific observations (N=862)					
COMPVAR (millions)	410	2,203	52	15	173
MEANVAR	0.425	9.588	0.018	0.008	0.051
ROEVOL	0.069	0.069	0.047	0.023	0.088
RETVOL	0.382	0.297	0.314	0.218	0.439
RELNOISE	0.232	0.329	0.144	0.071	0.277
MTB	3.036	2.378	2.325	1.660	3.522

Variable definition:

ΔROE = the change in net income before extraordinary items scaled by common equity.

RET = the annual change in stock price plus dividends scaled by the stock price at the beginning of the year.

COMPVAR = the variance in CEO cash compensation measured over five consecutive years.

MEANVAR = the mean of CEO cash compensation over five consecutive years scaled by the variance of CEO cash compensation over the same period.

ROEVOL = the standard deviation of Return on Equity (net income before extraordinary items scaled by common equity) measured over five consecutive years.

RETVOL = the standard deviation of annual stock returns measured over five consecutive years.

RELNOISE = ROEVOL scaled by RETVOL.

MTB = the mean of the market value of common equity scaled by the book value of common equity measured over five consecutive years.

Table 2. Pearson correlation coefficients among rank-transformed variables (p-values are in parentheses).

	COMPVAR	MEANVAR	RELNOISE
MEANVAR	0.961 (<0.01)		
RELNOISE	-0.097 (<0.01)	-0.097 (<0.01)	
MTB	-0.169 (<0.01)	-0.121 (<0.01)	0.047 (0.17)

Notes:

The variables are defined in Table 1.

Table 3. OLS regression analysis of the effect of risk aversion proxies on the relationship

between performance measures and compensation (White-adjusted t-statistics are in

parentheses)

		Risk aversion proxy	
	Model 1	Model 2	Model 3
Independent variables	Basic regression equation	COMPVAR	MEANVAR
Intercept	0.058 (3.30)***	0.071 (2.98)***	0.081 (3.38)***
ΔROE	2.466 (7.02)***	2.702 (6.32)***	2.608 (6.54)***
RET	0.160 (1.82)*	0.282 (3.72)***	0.265 (3.24)***
ΔROE * RELNOISE	-1.748 (-4.00)***	-1.608 (-3.69)***	-1.538 (-3.63)***
RET * RELNOISE	0.182 (2.27)**	0.154 (2.04)**	0.165 (2.03)**
ΔROE * MTB	-0.927 (-4.07)***	-0.948 (-4.27)***	-0.892 (-3.90)***
RET * MTB	-0.114 (-1.08)	-0.154 (-1.63)	-0.145 (-1.43)
ΔROE * Risk aversion		-0.686 (-2.40)**	-0.706 (-2.53)**
RET * Risk aversion		-0.192 (-1.84)**	-0.197 (-1.85)**
F-value	88.44***	73.89***	74.37***
Adjusted R^2	0.169	0.189	0.190

(Continued on next page)

(Table 3 continued)

Notes:

***, **, * is statistically significant at respectively the 1%, 5%, and 10% level (two-tailed). Coefficients on the risk

aversion proxies, RELNOISE and MTB are included in the regression but not separately reported. The

independent variables (except ΔROE and RET) are rank-transformed variables.

Table 4. The use of accounting performance measures for different combinations of RELNOISE, MTB, and MEANVAR.

MTB		RELNOISE		
		Low	Median	High
Low	Low MEANVAR	2.608	1.839	1.070
	Median MEANVAR	2.255	1.486	0.717
	High MEANVAR	1.902	1.133	0.364
Median	Low MEANVAR	2.162	1.393	0.624
	Median MEANVAR	1.809	1.040	0.271
	High MEANVAR	1.456	0.687	-0.082
High	Low MEANVAR	1.716	0.947	0.178
	Median MEANVAR	1.363	0.594	-0.175
	High MEANVAR	1.010	0.241	-0.528

Notes:

The variables are defined in Table 1.

*Table 5.* Pearson correlation coefficients among rank-transformed variables (p-values are in parentheses).

	COMPVAR	MEANVAR	OPTIONS
OPTIONS	-0.572	-0.491	
	(<0.01)	(<0.01)	
STAKE	-0.049	-0.035	0.245
	(0.15)	(0.31)	(<0.01)

Notes:

OPTIONS = the five-year variance in the value of stock options granted to the CEO. Options are valued using the Black & Scholes method (as reported by ExecuComp).

STAKE = the five-year mean of the end-of-the-year market value of the company's common shares owned by the CEO plus the end-of-the-year value of exercisable and non-exercisable in-the-money options scaled by the CEO's annual cash compensation.

The remaining variables are defined in Table 1. The reported variables are rank-transformed variables.
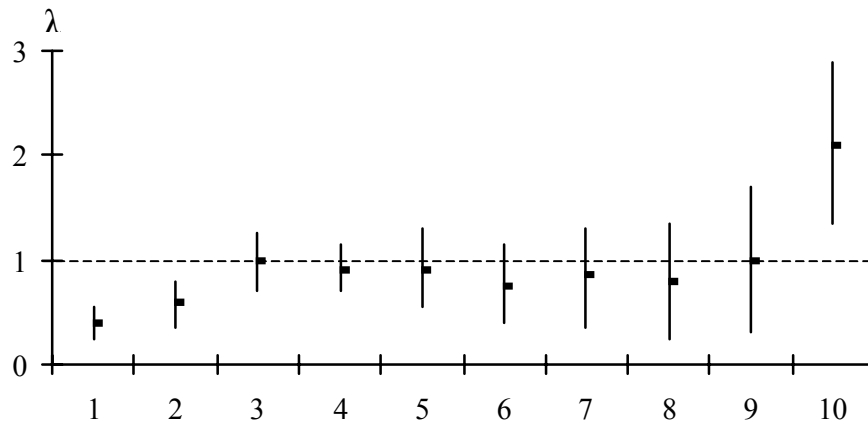
	1	2	3	4	5	6	7	8	9	10
λ_{HIGH}	0.55	0.80	1.25	1.15	1.30	1.15	1.30	1.35	1.70	2.90
λ^{*}	0.40	0.60	1.00	0.90	0.90	0.75	0.85	0.80	1.00	2.10
λ_{LOW}	0.25	0.35	0.70	0.70	0.55	0.40	0.35	0.25	0.30	1.35

Figure 1. The optimal level of λ and confidence intervals for deciles of risk aversion. Lower values of λ imply greater convexity and $\lambda=1$ implies linearity. Decile 1 (10) is the lowest (highest) risk aversion group. λ^{*}, λ_{HIGH}, and λ_{LOW} denote the optimal level of λ, the upper 95 percent confidence limit, and the lower 95 percent confidence limit, respectively.

Endnotes

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[1] If more than five years of data are available, we use the data for the last five years.

[2] The results are identical when COMPVAR is used.

[3] STAKE is measured as the five-year mean of the end-of-the-year market value of the company's common shares owned by the CEO plus the end-of-the-year value of exercisable and non-exercisable in-the-money options scaled by the CEO's annual cash compensation. OPTIONS is measured as the five-year variance in the value of stock options granted to the CEO, where the options are valued using the Black & Scholes method (as reported by ExecuComp). Both STAKE and OPTIONS are rank-transformed.

[4] Note that this result does not indicate a substitution effect between different components of compensation. Since the use of stock returns in determining CEO's cash compensation is not affected by MTB, it can be concluded that CEOs receive additional incentives when growth opportunities increase. As a result, the use of stock-based compensation is complementary to the use of cash compensation.