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2020

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Citation of this paper:
Coles, J., and Li, Z.F. 2020. Managerial Attributes, Incentives, and Performance. **Review of Corporate Finance Studies** 9(2): 256–301

Managerial Attributes, Incentives, and Performance

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This version: April 3, 2020

Abstract

We examine the relative importance of observed and unobserved firm- and manager-specific heterogeneities in determining executive compensation incentives and firm policy, risk, and performance. First, we decompose executive incentives into time-variant and time-invariant firm and manager components. Manager fixed effects supply 73% (60%) of explained variation in delta (vega). Second, controlling for manager fixed effects alters parameter estimates and corresponding inference on observed firm and manager characteristics. Third, larger CEO delta (vega) fixed effects predict better firm performance (riskier corporate policies and higher firm risk). These results suggest that the delta (vega) fixed effect captures managerial ability (risk aversion). (*JEL* G3, G32, G34, J24, J31, J33)

Acknowledgments
We thank the editor and, in particular, the referees for their constructive suggestions and insight. We are grateful to seminar participants at ASU, CICF 2017, and CEIBS Accounting and Finance Symposium 2017 and Sreedhar Bharath, John Graham, Mike Hertzel, Si Li, Laura Lindsey, and Jiaping Qiu for helpful comments. Send correspondence to Zhichuan (Frank) Li, University of Western Ontario, Richard Ivey School of Business, Building 3322, 1255 Western Rd., London, ON N6G 0N1, Canada; telephone: 519-661-4112. E-mail: fli@ivey.uwo.ca.

Managerial Attributes, Incentives, and Performance

Introduction

The level and components of compensation of named executive officers (up to five top executives, NEOs) of listed U.S. corporations are disclosed and attract considerable attention from researchers, as well as from investors and the media. While the level of pay is likely relevant for the retention motive, the prior literature emphasizes two other properties of managerial contracts. One attribute is the extent to which managerial incentives are aligned with shareholder interests, typically measured as the sensitivity of managerial wealth to stock price, or delta (Jensen and Murphy 1990; Bizjak, Brickley, and Coles 1993). The second attribute is the extent to which contracts encourage risk taking, often measured as the sensitivity of expected managerial wealth to stock volatility, or vega (Guay 1999; Core and Guay 2002).

Per the standard agency problem (e.g., Mirrlees 1976; Holmstrom 1979), managerial compensation delta should be higher when managerial input (or a more capable manager) causes a larger rightward shift in the distribution of value or profitability and the marginal cost to the manager of input is lower. This prediction also obtains support from both "screening" and "signaling" theories, in which, assuming agent's ability is unknown to the principal, high ability agents will receive and accept high-delta compensation (e.g., Spence 1973, 1974; Pan 2017; Rothschild and Stiglitz 1976; Goel and Thakor 2008). Even if the agent's ability is known, the principal will still give high delta to high ability agents because the marginal product of delta is higher for high ability agents.

In terms of the convexity of the compensation contract, Guay (1999) argues that compensation vega can be used to offset managerial risk aversion and create value for shareholders. Imposing additional risk (i.e., higher vega) on risk averse managers, however, is costly to firms

through higher pay because managers need to be compensated for the risk they take. Goel and Thakor (2008) find that firms use risk-sensitive compensation to attract risk-tolerant managers; managers are also willing to accept such contracts to signal their risk tolerance. Furthermore, the marginal effect of vega in implementing risk incentives is higher for risk-tolerant executives, so vega is higher for such managers. The limited empirical work appears to support this view. Carter, Franco, and Gine (2017) find that, all else equal, female executives, who they assume are more risk averse, have lower vega and demand larger salary premiums for bearing compensation risk. Cain and McKeon (2016) find that risk-tolerant CEOs, as indicated by possession of a private pilot license, have higher vega. In terms of other determinants of vega, the limited empirical work (Guay 1999; Coles, Daniel, and Naveen 2006) agrees on the direction of the effect of investment opportunities (R&D intensity, market-to-book, and firm size) but disagrees on the effect of risk exposure (through delta). One potential reason for the variation and scarcity in results is endogeneity, arising from omitted variables, reverse causation, or measurement error. For example, measures of managerial risk aversion or ability are at least noisy and perhaps doubtful or even absent altogether. Furthermore, for vega the underlying theory is new and potentially less complete. For instance, the literature does not consider the choice of optimizing vega in the presence of a choice set in which there is a relation between risk and the project's net present value. In any event, when the theory is nascent, it is certain that some variables will be omitted and that one is unlikely to even know what these variables might be or represent.

We investigate these empirical difficulties by examining the nature of the determinants of executive incentives. We assess the relative importance of observable and unobservable firm- and manager-specific characteristics in determining two primary attributes of executive incentives,

delta and vega. We also consider the corresponding effects of these characteristics on firm policy, risk, and performance.

To do so, we follow the "connected groups" approach of Abowd, Karmarz, and Margolis (1999, AKM). In particular, the AKM (1999) approach allows the empiricist to identify both manager and firm fixed effects rather than relying on one or the other or a combined (unseparated) fixed effect defined by each unique firm-manager combination (a "spell" fixed effect). Graham, Li, and Qiu (2012, GLQ) use the connected groups method to decompose the relative explanatory power of different types of variables for the *level* of executive pay. Given the importance for firm performance and policy of the incentive properties of managerial compensation contracts (Morck, Shleifer, and Vishny 1988; CDN 2006), we assess and build upon the prior literature on the determinants of the delta and vega of top corporate executives by identifying and including both firm and manager fixed effects. We decompose the variation in executive incentives into observed time-variant firm and manager components, unobservable or excluded time-invariant firm and manager components, time fixed effects, and a residual component. This decomposition allows us to provide evidence on the relative importance of omitted firm and manager characteristics as determinants of delta and vega; examine the severity of the endogeneity problem as it pertains to the incentive properties of managerial compensation; measure the importance of unobserved managerial attributes for firm performance, risk, and policy; and provide circumstantial evidence on the nature of the unobserved managerial attributes.

Our analysis yields four classes of results. First, our results indicate that manager fixed effects explain a majority of the variation in executive incentives. Approximately 21% of the explained variation in executive delta arises from observable, time-varying manager and firm characteristics, whereas 73% comes from manager fixed effects and 5% from firm fixed effects.

The figures for explained variation in vega are approximately 26%, 60%, and 8%, respectively. These results are reminiscent of those in Lemmon, Roberts, and Zender (2008) on the importance of unobserved firm characteristics for capital structure. However, Lemmon, Roberts, and Zender (2008) do not include unobserved managerial attributes in their analysis.

Second, it is widely known that when unobservable manager or firm heterogeneity is correlated with observable characteristics, regression specifications that do not explicitly account for such heterogeneity can produce biased coefficient estimates (e.g., Kennedy 1997). Our analysis indicates that this is a concern for empirical models of contract design. Including one or both of unobservable firm and manager characteristics significantly alters the sign, magnitude, and precision of estimated coefficients for primary variables and, thus, modifies associated inference.

Third, we provide a rudimentary assessment of the economic content captured by the estimated manager fixed effects. Based on the classic agency theories, manager fixed effects of delta and vega, estimated by removing all the other effects (i.e., firm fixed effects, time effects, effects of all observable firm and manager attributes, and noise), should capture manager-specific innate ability and risk preference. We find that the estimated managerial fixed effects from the delta and vega regressions are associated with firm performance, investment policy, and risk. Specifically, Tobin's q and return on assets increase in the CEO delta fixed effect, holding the other components of delta constant, which is consistent with the idea that the CEO fixed effect component of delta likely captures some omitted elements of managerial ability or human capital. The volatility of stock returns and the riskiness of investment policies increase in the CEO vega fixed effects, which suggests that the vega fixed effects capture managerial risk aversion. In addition, we find that the delta and vega fixed effects are positively correlated, which suggests that

managerial ability and risk tolerance are positively associated[1] and jointly determine managerial contract incentives. At this juncture it is appropriate to note, however, that manager fixed effects can capture not only time-invariant managerial characteristics that are difficult to measure, but also observable time-invariant characteristics, which somewhat blurs the line of sight between delta and vega fixed effects and ability and risk tolerance, respectively.

To address the concern that our results on the association between managerial delta and vega fixed effects and firm performance, risk, and policy are spurious, we perform placebo tests that randomly scramble the actual manager-firm spells found in the data. This severs the firm-manager connection. We find that this procedure removes the explanatory power of the manager fixed effects, which supports the notion that the results described in the prior paragraph reflect a genuine underlying relation between manager identity and firm performance, investment policy, and risk, rather than being a spurious statistical artifact.

Finally, our results are not solely driven by firm-manager matching. Identification is a challenge because manager effects and firm effects can overlap due to endogenous matching. We use three methods to account for matching. First, as an attempt to "purify" the manager fixed effects, we regress the estimated manager fixed effects of delta and vega on all observable manager and firm characteristics and firm fixed effects. The residual is a cleaner measure of unobserved managerial characteristics. The "purification" process further removes any firm-specific information from the estimated manager fixed effects. Second, we apply a two-sided matching procedure (per Ackerberg and Botticini 2002) that controls for the situations where certain types of managers are matched to certain types of firms. Third, we explore exogenous CEO turnovers

[1] For example, Graham, Harvey, and Puri (2013) find in their survey that CEOs are much less risk averse than the general population. Cain and McKeon (2016) find that risk-tolerant CEOs who possess private pilot licenses have higher vega and are more capable of improving firm value.

and some unique endogenous turnovers. In particular, we focus on forced retirement, CEO sudden deaths or health problems, forced turnover, and outside succession. In general, we find that for a firm that experiences an exogenous turnover (e.g., a CEO's sudden death) or wants to use a turnover as an opportunity to change the direction of the firm (e.g., forced turnover), the differences in manager fixed effects of delta and vega are significant between the departing CEO and the incoming CEO. We further study whether these differences matter and find that the differences between the departing CEOs and incoming CEOs significantly affect firm outcomes and policies around these exogenous turnovers.

These findings may not be surprising because, as suggested by the classic agency theories, our results suggest that manager fixed effects of delta and vega capture managerial ability and risk aversion. It is surprising, however, that we further find some established relationships in the literature between executive incentives and firm outcomes and policies are indeed driven by the manager fixed effects portions of delta and vega *only*, but not the remainder portions. Manager fixed effects are more important than any other determinant in explaining managerial incentives, so isolating these personal heterogeneities becomes necessary. For example, when considering the incentive effect of vega, a manager with high vega implements riskier policy, not only because the firm provides vega as a risk-taking incentive (firm fixed effects) but also because he is less risk averse (manager fixed effects). If we do not control for this risk aversion, we may overestimate the real incentive effects of the vega. The endogeneity problem arises from the fact that the dependent variable (e.g., corporate policies) and independent variable vega are jointly determined by managerial risk aversion. This argument is also applicable for delta. Without controlling for managerial ability (in our case, through the manager fixed effects on delta), isolating the incentive effect of delta on firm performance is not possible.

These results contribute to four components of the literature. First, the paper enlarges the literature on contract design by providing the first comprehensive empirical examination of the role of both unobserved firm and managerial heterogeneities in determining executive incentives. Observable characteristics of firms and particularly managers at best have modest explanatory power relative to the power of our newly separated manager and firm fixed effects. Either the underlying theoretical models, such as the principal-agent problem, do not include all the important economic forces that determine the structure of executive incentives, or the empirical proxies for those forces are inadequate. While this conclusion seems pessimistic, it represents an opportunity for both empiricists to develop better proxies for primary variables in existing models and theorists to develop models that identify other economic determinants of contract design. In particular, the high relative explanatory power of unobserved managerial heterogeneity suggests that both theoretical and empirical work focusing on the attributes, role, and incentives of managers in decision making, policy selection, and performance would be relatively fruitful.

Second, our empirical exploration of the economic content of the estimated manager fixed effects indicates that omitted variables represent a significant hurdle for empirical specifications that "explain" contractual incentives. Identifying and including manager and firm fixed effects changes the sign, magnitude, and significance of several observable right-hand side variables in ways that are consistent with hypotheses arising from theory, including agency theory. For example, our results inform the contradictory empirical results on the effect of firm risk on delta. We find a negative relation, as standard agency theory predicts. Including managerial fixed effects alters the sign and magnitude of several other important parameter estimates, such as those for governance attributes. Credible coefficient estimates that are inconsistent with existing theory, including current theory pertaining to governance variables, invite new theory.

Third, we contribute to the growing literature on how unobservable versus observable managerial attributes affect corporate policy, risk, and performance. Unobserved managerial attributes, such as managerial ability and risk aversion, potentially as contained in manager delta and vega fixed effects, are strongly associated with performance, risk, and policy. Managerial ability, for which empiricists can rely on few (if any) good proxies,[2] is a likely factor. Insofar as the manager delta fixed effect is positively related to firm performance, our evidence extends prior work on the relation between managerial ownership and firm performance (e.g., Morck, Shleifer, and Vishny 1988; McConnell and Servaes 1990; Himmelberg, Hubbard, and Palia 1999; Coles, Lemmon, and Meschke 2012). Likewise, vega fixed effects are associated with riskier investment policy and higher volatility of firm stock returns. Thus, our results illuminate prior work on the relation between vega and policy choices and firm risk (Rogers 2002; Nam, Ottoo, and Thornton 2003; Coles, Daniel, and Naveen 2006).

Finally, we contribute to the identification strategy by explicitly treating the endogeneity problem and firm-manager matching. We are the first to identify manager fixed effects and their impact on firm performance and policy in the context of exogenous CEO turnovers. These events appear to be well suited for evaluating whether managerial ability and risk preference play an independent role in determining executive incentives, firm policy, and firm performance.

1. Estimation Methodology

[2] The manager's education, age, tenure, and firm performance are among the few agreed-on proxies for managerial ability (e.g., Custodio, Ferreira, and Matos 2013). Nonetheless, these proxies are either too noisy (e.g., stock performance) or measure only certain types of ability (e.g., education as a proxy for academic attainment and ability, tenure for experience-based ability, and media citations for reputation for effectiveness). In addition, the data are often available only for a small group of executives. Measures of managerial risk aversion have been even more elusive, including age, gender, tenure, and stock/option holdings (e.g., Croci and Petmezas 2015).

To quantify the amount of variation in executive incentives that is attributable to observable time-variant firm effects, observable time-variant manager effects, time-invariant firm fixed effects, time-invariant manager fixed effects, and year effects, we employ the connected groups method of AKM (1999). This approach is relatively new in finance, so we provide a brief description herein.

The simplest way to include fixed effects is to create a dummy variable for each unique combination of manager and firm (i.e., for each employment spell). In Execucomp data, each employment spell has a unique firm-executive ID: CO_PER_ROL. This approach has been used in the economics literature, for example, by Schank, Schnable, and Wagner (2007) and Munch and Skaksen (2008). The "spell method" uses the full sample and addresses possible omitted variable bias, but it can only estimate the joint firm and manager effects and does not disentangle the two.

Note that simply using firm dummies and manager dummies is insufficient for separating the effects. If a firm has no managerial turnover, the two effects are perfectly collinear. This does suggest one way forward, which is to restrict the sample to managers who have moved from one company to another. Bertrand and Schoar (2003) use this approach to examine whether unobserved managerial heterogeneity has the power to explain return on assets, investment, leverage, and cash holdings. One potential difficulty with this mover dummy variables (MDV) approach is that movers may be significantly different from the nonmovers, resulting in selection bias and limiting the generalizability of results. Furthermore, the sample that can be studied is usually quite small because of infrequent managerial turnover. Or in the case of a large sample, this method may be computationally infeasible because it requires inverting a covariate matrix with many dummy variables.

Relative to the MDV and spell approaches, the method of AKM (1999) achieves separate "identification" of the firm and manager fixed effects. First, begin with an arbitrary manager and include all the firms for which he or she has ever worked. Then include all the managers who have ever worked for these companies. Next, continue adding all other firms for which any of these managers have ever worked. Repeatedly add all the managers in these firms until no more managers or firms can be added to the current group. Repeat the above steps for the next group and continue until all data are exhausted. The final sample will contain not only all the movers but also nonmovers as long as they work in firms that have hired at least one mover. In this way, the firm fixed effect can be estimated if any executive of that firm moved, which in turn allows estimation of the manager fixed effect for any nonmoving manager at that same firm. AKM (1999) prove that such connectedness is a necessary and sufficient condition to separately identify firm and individual fixed effects in a connected group sample. This approach restricts sample *attrition* to firms that employ the same group of executives for the entire sample period. GLQ (2012) use the AKM method to good effect in their analysis of the explanatory power of firm and manager fixed effects for total pay levels for top executives.

To reduce concerns about selection bias and to increase sample size, we report results using the AKM method. In the appendix, we estimate primary specifications using the MDV and the spell methods to check the robustness of our AKM results.

2. Assembling the Sample

We begin with all executive-year observations from Execucomp for firms with fiscal years ending from 1993 to 2014. For a firm-year, this includes up to five top executives, the "named executive officers" designated in the year-end proxy statement. We exclude any observations

without matching CRSP and Compustat North America data and, consistent with prior literature, we eliminate financial services and utility firms from the sample. The full sample consists of 163,017 executive-year observations. The usable sample will be smaller for the AKM and MDV methods, and some specifications use fewer observations when one or more data values are missing.

We follow Guay (1999) and Core and Guay (2002) to calculate accumulated delta and vega for each executive on an annual basis. The variable *Delta* is defined as the change in the dollar value of the executive's accumulated holdings of stock and options net of dispositions for a one percentage point change in stock price.[3] *Vega* is the change in the dollar value of the executive's portfolio for a 0.01 change in the annualized standard deviation of stock returns. Guay (1999) shows that option vega is many times higher than stock vega; therefore, we use vega of the option portfolio to measure the total vega of the stock and option portfolio.[4] Please refer to the appendix for detailed definitions of these and other variables.

Maximal sample size varies by estimation method. After eliminating observations with one or more missing primary data items (delta, vega, and market-to-book of assets), the spell method can employ up to 158,371 observations, including 2,840 unique firms and 31,129 unique executives. Using MDV reduces the maximal sample to 14,933 executive-year observations, represented by 1,607 firms and 1,832 movers. In contrast, the AKM approach generates connected

[3] This is generally consistent with the literature, including Yermack (1995), Hall and Liebman (1998), Aggarwal and Samwick (1999), Cohen, Hall, and Viceira (2000), Datta, Iskandar-Datta, and Raman (2001), Rajgopal and Shevlin (2002), and Coles, Daniel, and Naveen (2006). Alternatively, we follow Jensen and Murphy (1990) to calculate *Delta* as the dollar change in executive wealth per $1,000 change in shareholder value. We also calculate the firm-size-scaled measure of delta, according to Edmans, Gabaix, and Landier (2009). All three measures generate similar results, likely because we always control for firm size in our regressions.

[4] Knopf, Nam, and Thornton (2002), Rajgopal and Shevlin (2002), and Coles, Daniel, and Naveen (2006), among others, adopt the same approximation.

group subsamples that aggregate to 98,754 executive-year observations arising from 1,703 firms and 19,967 managers.[5]

Table 1 presents summary statistics on the incentives of the top executives, executive characteristics, firm characteristics, and investment and financing measures. Consistent with previous literature (Guay 1999; Core and Guay 1999; Coles, Daniel, and Naveen 2006), we winsorize *Delta*, *Vega*, and *Market-to-book* at the 1st and 99th percentiles. Mean (median) *Delta* is $235,906 ($45,316) and mean (median) *Vega* is $38,125 ($7,664) in the full sample. The full (spell) sample and MDV sample differ in that movers have shorter tenure and higher incentives than the nonmovers.[6] Otherwise, the observable characteristics of the MDV and spell samples are similar. Such similarity, however, may not extend to the unobservable firm and manager features. For example, unobservable managerial talent and risk aversion, which are of central interest to this paper, may differ significantly between movers and nonmovers even if the observable characteristics of movers and nonmovers appear to be similar. This is less of a potential issue for the sample of connected groups because it includes all movers and nonmovers as long as they work in the same companies. To avoid selection bias, our primary approach is to employ the AKM method to include all listed named executives, both movers and nonmovers, in each firm.

We use the estimated manager fixed effects of *Delta* and *Vega* to examine firm performance and various other corporate outcomes. We measure performance with Tobin's q (*q*) and return on assets (*ROA*). The policy variables we consider are (1) *R&D*, defined as research

[5] Some of the secondary variables, such as *Age* and *Tenure*, are often missing. To maximize sample size, we define dummy variables that indicate whether the variable is missing (= 1, otherwise = 0) and set the variable itself equal to zero when the indicator equals 1. This procedure follows the literature, such as Himmelberg, Hubbard, and Palia (1999) and Byoun (2008).

[6] Differences in *Delta* and *Vega* are likely to arise because movers in the Execucomp data are usually higher-ranked executives, such as CEOs, in larger firms. When managers of lower-ranked or smaller firms switch companies, they are less likely to show up in the data again (i.e., the top-five executives in a new company). These managers are not identified as "movers" in the sample and thus explain some of the sample attrition in the MDV and AKM samples.

and development expenditures scaled by assets; (2) *CAPEX*, defined as net capital expenditures (capital expenditures less sales of property, plant, and equipment) scaled by assets; (3) *Leverage*, defined as total book debt divided by market value of equity assets plus book debt; and (4) *PPE* is investment in property, plant, and equipment scaled by assets. The effect of these policy variables should be captured in stock return volatility (*Firm risk*), which we define as the ranking (CDF) of the standard deviation of 1-year daily stock returns.

3. Executive Incentives and Unobservable Firm and Manager Heterogeneity

The literature on the determinants of executive incentives and pay level suffers from substantial variation in results and low explanatory power. Summarizing the literature on executive pay level, GLQ (2012) note that pay level varies widely for executives who appear equally qualified and work in similar firms. Based on this premise, GLQ (2012) assess the importance of such unobserved attributes by decomposing the variation in executive pay level into various components. They find that time-variant firm variables and especially manager fixed effects capture more than half of the explained variation in the logarithm of the level of executive pay.

For *Delta* and *Vega* as dependent variables, the estimated regression coefficients on observable characteristics of firms and managers vary in sign and significance across studies.[7,8]

[7] Among many papers on delta, Bizjak, Brickley, and Coles (1993) report a negative relation between delta and each of the following: total assets, market-to-book, and R&D intensity, but find no relation with firm risk. Gaver and Gaver (1993) find a positive relation between the incidence of stock and option grants and ln(assets). Core and Guay (1999) find a positive relation between delta and ln(assets), ln(firm-specific risk), and ln(CEO tenure) and a negative relation to book-to-market. Himmelberg, Hubbard, and Palia (1999) find that average managerial equity ownership is positively related to ln(sales) and the ratio of PP&E to sales, unrelated to R&D intensity, and negatively related to firm-specific risk. Coles, Daniel and Naveen (2006) find a positive relation between delta and ln(sales), CEO tenure, and market-to-book and a relation to firm risk that varies in the form of the regression specification.

[8] Much less literature tackles the determinants of vega. Core and Guay (1999) find a positive relation between vega and ln(market value of assets) and R&D intensity and a negative relation with book-to-market assets. Coles, Daniel, and Naveen (2006) find a positive relation between vega and ln(sales), market-to-book assets, R&D intensity, and firm risk.

Moreover, aggregate explanatory power for the right-hand-side variables tends to be poor. For contract design, given the importance of delta and vega in determining managerial incentives, we build on GLQ (2012) to compare the ability of different classes of variables to explain variation in *Delta* and *Vega*. Firm and manager fixed effects represent characteristics that are potentially observable to the contracting parties but are unobservable to the econometrician. Note that for the unobserved factor to affect the contract, one or both contracting parties must have at least some information on that attribute. Write *Delta* or Vega for manager *j* at time *t*, $y_{jt} = \delta_{jt}$ or ν_{jt}, as

$$y_{jt} = F_{it}\hat{\beta} + M_{jt}\hat{\alpha} + \hat{\mu}_i + \hat{\theta}_j + \hat{\lambda}_t + \varepsilon_{jt}, \quad (1)$$

where the right-hand side comprises observable time-variant firm characteristics ($F_{it}\hat{\beta}$), observable time-variant manager characteristics ($M_{jt}\hat{\alpha}$), firm fixed effects ($\hat{\mu}_i$), manager fixed effects ($\hat{\theta}_j$), year fixed effects ($\hat{\lambda}_t$), and residuals ($\hat{\varepsilon}_{jt}$). Hat denotes an estimate of a parameter or a vector of parameters.

3.1 Observable firm and manager characteristics as determinants of delta and vega

We follow existing literature in selecting the observable characteristics that determine managerial incentives (e.g., Bizjak, Brickley, and Coles 1993; Core and Guay 1999; Guay 1999; Aggarwal and Samwick 1999; Coles, Daniel, and Naveen 2006). Specifically, firm characteristics from these studies include market-to-book (assets), board independence, surplus cash, leverage, R&D intensity, firm risk, capital and equipment expenditures, and firm size. Manager characteristics include tenure in the company, age, gender, whether the manager is the CEO, and whether the manager is a member of the board.

3.2 Determinants of delta and vega: Estimates based on the AKM (1999) method

Our primary approach to quantifying the absolute and relative importance of different factors in determining delta and vega is to apply the AKM regression approach to the connected sample. In addition to various combinations of manager and firm fixed effects, all specifications include year fixed effects to capture systemic factors, such as regulatory changes and macro shocks, which potentially affect delta and vega of all executives. Tables 2 and 3 contain the regression results.

Consider wealth performance sensitivity first. Specification 1 in panel A is a pooled ordinary least squares (OLS) regression on the AKM (1999) connected groups sample without firm or manager fixed effects. Model 2 includes firm fixed effects; model 3 employs manager fixed effects; and model 4 includes both. The adjusted R^2 for model 1 is 0.27, which is similar to the higher adjusted R^2s found in previous studies, such as Himmelberg, Hubbard, and Palia (1999). When we include both unobservable firm-level and manager-level heterogeneities, the adjusted R^2 increases to 0.75. Firm fixed effects control for unobservable time-invariant differences across firms, such as unobserved core competencies, firm culture, or other unobserved aspects of the contracting environment. Manager fixed effects control for time-invariant differences across managers, such as unobserved talent and skill, risk aversion, and the cost to the manager of providing managerial input.[9] Much of the increase in explanatory power is due to manager fixed effects. Model 3, which does not include firm fixed effects, generates an R^2 of 0.73, so most of the improvement from 0.27 to 0.75 arises from our new manager fixed effects.

[9] Manager fixed effects capture time-invariant or slow-changing manager heterogeneity, such as latent managerial ability and risk aversion. For example, Iranzo, Schivardi, and Tosetti (2008), AKM (1999) and Abowd, Lengermann, and McKinney (2003) use person fixed effects to proxy for employee human capital. Ability may change over time. We include job tenure and age when modeling time-variant ability.

To provide further quantitative comparison of the relative economic significance of the classes of variables, we follow GLQ (2012) to decompose variation of the dependent variable (*Delta* or *Vega*) into five estimated components and the unexplained remainder. Based on equation (1), model R^2 can be decomposed as

$$R^2 = \frac{\text{cov}(\hat{y}_{jt}, y_{jt})}{\text{var}(y_{jt})} = \frac{\text{cov}(F_{it}\hat{\beta} + M_{jt}\hat{\alpha} + \hat{\mu}_i + \hat{\theta}_j + \hat{\lambda}_t, y_{jt})}{\text{var}(y_{jt})}$$

$$= \frac{\text{cov}(F_{it}\hat{\beta}, y_{jt})}{\text{var}(y_{jt})} + \frac{\text{cov}(M_{jt}\hat{\alpha}, y_{jt})}{\text{var}(y_{jt})} + \frac{\text{cov}(\hat{\mu}_i, y_{jt})}{\text{var}(y_{jt})} + \frac{\text{cov}(\hat{\theta}_j, y_{jt})}{\text{var}(y_{jt})} + \frac{\text{cov}(\hat{\lambda}_t, y_{jt})}{\text{var}(y_{jt})}$$

Panel B in Table 2 presents the covariances between delta and each of the components, normalized by the variance of the dependent variable. These percentages are the fractions of the model sum of squares attributable to particular components. For example, applying the AKM method to *Delta* with both manager and firm fixed effects (specification 4 of panel A), we find that manager fixed effects, firm fixed effects, observable manager characteristics, observable firm characteristics, and year effects account for proportions 0.59, 0.04, 0.05, 0.12, and 0.01 of total variation of *Delta*, with proportional residual unexplained variation of 0.19 (Table 2, panel B). Normalized by variation of *Delta* explained by the model (0.81 = 1.00 – 0.19), the five classes of variables contribute 72.84% [0.59/(1-0.19)], 4.94%, 6.17%, 14.81%, and 1.23% of model R^2, respectively. Unobservable managerial attributes have by far the bulk of "explanatory" power in determining managerial wealth-performance sensitivity.

In panel A of Table 3, with *Vega* as the dependent variable, the adjusted R^2 increases from 0.29 in pooled OLS (model 1) to 0.49 after including both firm and manager fixed effects (model 4). Including firm (manager) fixed effects only, in model 2 (3), yields adjusted R^2 equal to 0.42 (0.47). Based on specification 4 in panel A of Table 3, panel B indicates that the proportions of explained variation of *Vega* attributable to the five components are 59.68% [0.37/(1 – 0.38)],

8.06%, 9.68%, 16.13%, and 6.45% for managerial fixed effects, firm fixed effects, manager observables, firm observables, and time fixed effects, respectively.

Overall, of the candidate classes of explanatory variables, unobserved time-invariant manager characteristics (i.e., manager fixed effects) play by far the most important role in explaining the variation in *Delta* (72.84%) and *Vega* (59.68%).

3.3 Two-sided matching of executives and firms

Empirical designs to explain contract formation typically regress contract choice on observed principal, agent, and firm (or task) characteristics. If some of these characteristics are unobserved, then estimated coefficients on the observed characteristics may be misleading. If omitted relevant variables or unobserved factors that give rise to endogeneity concerns are time constant or slow moving, then fixed effects provide a simple solution. On the other hand, should the unobserved factors vary through time, fixed effects is not a solution for endogeneity or bias from omitted variables. Other methods to extract causation, such as instrumental variables, are required.

In our empirical context, one likely source of time variation is endogenous matching or sorting of agents to firms. Following Ackerberg and Botticini (2002), if one agent contracts with multiple firms or one firm contracts with multiple agents and unobserved characteristics are constant across these contracts, panel techniques can address the endogeneity problem. In particular, the use of firm and manager fixed effects with explicit consideration of two-sided matching can ameliorate concerns about omitted variables and various sources of endogeneity.

In terms of wealth-performance sensitivity, one selection effect would be for high-ability workers to receive high incentives (Lazear 2000). Matching high managerial talent with exceptional professional opportunity and then maximizing the value of that match with high delta

is a likely outcome.[10] Likewise, risk-tolerant managers are likely to select firms with high risk and be subjected to higher risk through high delta.

In the first stage of our procedure, we estimate firm risk as a function of proxies for risk aversion, specifically executive gender and age, and market-to-book as a function of proxies for managerial talent, specifically tenure, age, and whether the executive serves as a director of the firm. In matching firms and executives, we obtain

$$\underset{}{MTB_{it}} = \underset{(68.4)}{3.56} - \underset{(-1.26)}{0.001}\,Tenure_{jt} - \underset{(-22.7)}{0.024}\,Age_{jt} + \underset{(5.85)}{0.100}\,Director_{jt} - \underset{(-22.90)}{1.240}\,Dage_{jt} - \underset{(-18.50)}{0.290}\,Dtenure_{jt} + \varepsilon_{ijt}$$

$$\underset{}{\sigma_{it}} = \underset{(93.58)}{0.53} + \underset{(5.42)}{0.017}\text{Female}_{j} - \underset{(-31.09)}{0.003}\text{Age}_{jt} - \underset{(-34.28)}{0.198}\text{Dage}_{jt} + \varepsilon_{ijt}$$

with *t*-statistics in parentheses and $R^2 = 0.05$ in both equations.

In the second stage, we insert the fitted values in place of the actual values on the right-hand side of the equations that explain delta and vega. On the right-hand side, we continue to include firm and manager fixed effects.

Panel A in each of Tables 2 (*Delta*) and 3 (*Vega*) report the results in model 5. For both *Delta* and *Vega*, the fit is quite similar to the specifications that use fixed effects and do not control for two-sided matching (model 4 in each case). Accordingly, attribution of explained variation to the five components, though not reported here, is very similar to that for model 4, as reported in panel B of Tables 2 and 3. Once again, manager fixed effects provide much of the explained variation, with observable firm characteristics coming in a distant second.

[10] Lazear (2000) studies the impact of piece rates on the performance of workers who install windshields on automobiles. He documents that productivity rose by 35% after adopting piece rates (incentives), with wages increasing by 12%. Using turnover data documenting that less-capable workers left the plant and more talented ones replaced them, the paper concludes that one-third of the improved performance can be attributed to selection effects. Note that Lazear (2000) and similar studies, such as Ferrall and Shearer (1999) and Paarsch and Shearer (2000), essentially use the worker fixed effects methodology to isolate worker selection. Our analysis is similar in spirit to theirs.

3.4 Statistical and economic inference for observable attributes

To this point, we have used fixed effects and instruments for matching to assess whether standard empirical designs using observed firm and manager attributes do well in explaining contract design. We now assess whether inferences about the economic implications of *observable* attributes are altered when we control for unobserved firm and managerial heterogeneity and sorting effects. We find that in several prominent instances, including fixed effects and matching changes the magnitude, sign, and significance of coefficients.

In Tables 2 and 3, panel A, the column between models 3 and 4 indicates whether (=) or not ($\neq$) the sign of the coefficient in model 4 matches that in model 1 and whether the coefficient is significantly larger at $p < .05$ (<) or smaller (>) or neither (=) than the estimate in model 1. These comparisons indicate that including unobservable, time-invariant considerations frequently alter the magnitude, statistical significance, and even the sign of coefficients on observable time-varying manager and firm characteristics. By way of illustration, we discuss three examples.

Specification 1 in panel A of Table 2 yields a positive and significant estimate of the relation between *Delta* and *Firm risk*. This result is consistent with numerous previous findings, including Core and Guay (1999) and Coles, Daniel, and Naveen (2006). However, if the standard agency problem is the primary explanation for compensation structure and suitable controls are included, lower delta will impose less risk on the manager, which is particularly important in a firm with high risk, so the sign would be negative. The sign on risk does indeed become negative and significant as soon as firm and/or manager fixed effects are included. Model 4 yields a significantly negative coefficient on *Firm risk* that is also significantly different from the estimate in model 1 at $p < .01$. Note also that manager (model 3) or firm (model 2) fixed effects alone, as well as firm and manager FEs with matching, yield a negative coefficient on risk or fitted risk.

Moreover, controlling for matching and separating manager and firm fixed effects (model 5), yields a significantly negative coefficient that is almost four times the size of the coefficient in model 4. While these results are quite different from the pooled OLS result without fixed effects, they are consistent with Aggarwal and Samwick (1999, 2003) and Himmelberg, Hubbard, and Palia (1999), who report a negative coefficient on risk in some specifications.

A second example, again based on delta, is the coefficient on board independence which is viewed as an important aspect of firm governance (Shleifer and Vishny 1997). Experiments that regress structure on structure (see Coles, Lemmon, and Meschke 2012) arise naturally from the notion that the firm is an incentive system (Holmstrom and Milgrom 1991). Are two different mechanisms, managerial compensation and board independence, for example, substitutes or complements in "production" or performance? Restated, if a relatively independent board fulfills the monitoring function, is it necessary to expose the management team to high pay-performance sensitivity? Again, the empirical evidence is mixed. Denis and Sarin (1999), Shivdasani and Yermack (1999), and Coles, Daniel, and Naveen (2008) estimate a negative relation between managerial ownership and the proportion of outsiders on the board. In contrast, Ryan and Wiggins (2004) and Davila and Penalva (2006) find a positive relation. Model 1 (panel A, Table 2), which has no fixed effects, delivers a significantly negative coefficient on *Board independence*. In contrast, including both manager and firm fixed effects yields a positive but insignificant estimate that is significantly different from the OLS estimate at $p < 0.01$. Including both fixed effects and controlling for matching (model 5), or including firm fixed effects alone (model 2), gives a positive and significant estimate on *Board independence*.

A third example, based on vega, is that in model 1 of Table 3 the coefficients on two measures for growth opportunities, *R&D* and *Market-to-book*, are both positive and significant, whereas

model 4 gives estimates that are negative, significantly so for *Market-to-book*, and both significantly different from model 1 at $p < .01$. One reasonable hypothesis is that growth opportunities represent higher-risk projects, so higher vega would be appropriate to induce managers to pursue such projects. Once we address time-invariant omitted variables with manager and firm fixed effects, confirmatory evidence per model 1 apparently dissolves.

Finally, note that including manager and firm fixed effects tends to diminish the estimated economic significance of observable manager and firm attributes. For delta (vega) fixed effects, based on column 4 of Table 2 (3), the estimated coefficient on independent variables is closer to zero in 8 of 9 (6 of 9) cases. Overall, including manager and firm fixed effects and matching affects regression coefficients on primary explanatory variables. In estimating the marginal effects of observable determinants of contract design and in assessing causation it is likely to be important both to control for unobserved heterogeneity of firms and managers and perhaps to account for two-sided matching of firms and executives.

3.5 Determinants of executive pay level: The AKM (1999) method

To assess how closely our results on delta and vega relate to GLQ (2012), we apply AKM to executive pay level in our sample. These calculations also allow us to employ the estimated manager pay-level fixed effects in our analysis of firm performance and to relate the pay-level fixed effects to delta and vega fixed effects.

Table A1 in the appendix contains the results for the AKM method applied in our data to executive pay level. Moving from specifications that use no fixed effects to those that include one or both of manager and firm fixed effects, several coefficient estimates change in magnitude (panel A) and fit improves substantially (panel B). The coefficient estimates on *R&D*, *CEO* (the CEO indicator), and *Firm risk* differ across specifications. Unlike GLQ's (2012) estimates, our estimates

on log(*Net assets)* do not markedly decline. In terms of explained variation in executive pay level, as in GLQ (2012), manager fixed effects and observable firm characteristics come first and second.[11]

3.6 Estimates based on the spell and MDV methods

For completeness and to frame the AKM results in Tables 2 and 3, we perform our analysis using both the spell and MDV methods. Note that MDV is based on a small sample (N = 14,933) and may suffer from selection bias. On the other hand, using the full sample prohibits identification of both firm and manager fixed effects, so we employ spell fixed effects instead (N = 158,371). The results are contained in Tables A2 (MDV) and A3 (spell) in the appendix.

3.7 Summary and directions for future research

Using any of our three estimation approaches, we consistently find that manager fixed effects, first and foremost, and then observable firm characteristics account for the bulk of "explained" variation in executive incentives. Moreover, our analysis indicates that omitted variable bias is likely to be a concern for empirical models of managerial incentives. Our results indicate that, as expected based on agency theory, higher firm risk is associated with lower wealth-performance sensitivity. In contrast, measures of growth opportunities that are thought to proxy for the extent to which managerial input implies first-order stochastically dominated shifts in performance do not necessarily increase delta.

Our results suggest limitations to conventional empirical approaches to managerial compensation but, at the same time, evoke at least three corresponding potential opportunities. First, supposing that the standard Holmstrom (1979) agency problem is a primary determinant of

[11] The specifications in Table A1 are similar to those in GLQ (2012). The primary differences are that GLQ (2012) also include *ROA*, lagged *ROA*, and lagged *Market-to-book* as independent variables, and we include *Board independence* and *Institutional ownership*. Excluding our additional variables and including the GLQ variables in our regression model generates results that differ little from those in Table A1.

the structure of managerial compensation, it appears that our current empirical proxies for managerial risk aversion and talent and the marginal revenue product of managerial effort and skill in production are inadequate, although these are often the key inputs to the principal-agent models. Recent work towards improved measures includes Custodio, Ferreira, and Matos (2013) who collect detailed information on CEOs' past industry background and experience to construct an index of general managerial ability. Second, progress may be possible using a structural model (containing the agency problem) to provide more appropriate specifications that researchers can estimate or calibrate with data (e.g., Coles, Lemmon, and Meschke 2012; Coles, Lemmon, and Wang 2008). Third, it is likely that other forces aside from those in the agency problem are germane. Attributes of managers that are likely to be relevant include social capital, personality, other psychological traits, religion, functional experience, and genetic makeup. Developing new models of how managerial attributes affect firm policy and performance and the contractual structure of managerial compensation is likely to contribute to our understanding of the determinants and implications of organization form.

4. Association between Manager Delta and Vega Fixed Effects and Manager and Attributes

To empirically assess the economic content of the estimated manager delta and vega fixed effects, we explore the extent to which the estimated manager delta and vega fixed effects are empirically associated with manager and firm attributes.

Figures 1 and 2 present the distributions of executive delta and vega fixed effects as estimated by the AKM method in the connectedness sample (Table 2, model 4, panel A for delta and panel B for vega). Note that under the AKM method, the means of the fixed effects in each connected group are adjusted to zero, so they can be compared across groups. Figures 1 and 2

indicate that managers exhibit substantial heterogeneity in unobserved attributes that affect contract design. The manager delta fixed effect for manager delta has a standard deviation of 0.56 ($millions for a 1% change in stock price), the standard deviation of manager vega fixed effects is 0.15 ($millions per 0.01 change in standard deviation of stock return), and both are approximately normally distributed.

What are the correlates of the manager delta and vega fixed effects? In Table 4 we regress the estimated manager fixed effects of delta and vega from Tables 2 and 3 on observable firm and manager characteristics and firm fixed effects. We include firm dummies and observable firm fundamentals and corporate governance measures in the regression specifications to control for any selection effects not captured in the matching equations. We use tenure in the firm, whether the executive is CEO, serving on the board, and industry experience as indicators of ability. Presumably, increased tenure in the firm and industry experience are associated with accumulation of firm and industry-specific human capital. An executive who serves as CEO, being the winner of the succession tournament, is more likely to be highly capable. A similar notion applies to executives who serve on the board. Board service differentiates an executive from others, particularly given that most board seats are filled by nonmanagement directors.

Table 4, Column 1, indicates that the unmatched manager delta fixed effect increases in indicators of manager human capital. Comparing Column 3 with Column 1 shows that the results are similar for matched manager delta fixed effects. At first glance this seems somewhat puzzling, given that stage 1 matches managers on *Tenure*, *Age* and *Director* to firm *Market-to-book*. The likely reason is that both the left-hand-side and right-hand-side variables in the matching equations are noisy proxies. Therefore, for example, predicted *Market-to-book* does not fully capture managerial ability, so unmeasured ability is captured by the manager delta fixed effect. Finally,

manager fixed effects are associated with stronger corporate governance. Managers with higher delta fixed effects are more likely to work in firms with an independent board, a board with more financial experts, higher analyst following, higher institutional ownership, and more industry competition.

For manager fixed effects of vega, the conventional wisdom is that risk aversion increases in age, tenure, when the manager is female, and when the manager has had exposure to the Great Depression (Malmendier and Nagel 2011), and is lower if the executive is CEO or prone to switching firms (see Barsky et al. 1997; Donkers, Melenberg, and Van Soest 2001; Byrnes, Miller, and Schafer 1999, among others). For example, gender and tenure are negatively related to the time to retirement, so the corresponding variables should indicate higher risk aversion. In both the unmatched and matched manager vega fixed effect equations (specifications 2 and 4 in panel B) the coefficients on the CEO and mover indicators are significantly positive and the coefficients on age and the depression baby indicator are significantly negative.[12] Based on these estimates, it appears that the manager vega fixed effect decreases in risk aversion. The negative coefficients on *Tenure* and *Female* in equation (2) are consistent with this, but once sorting of managers by ability and risk aversion is included in the estimation of the manager vega fixed effect the signs on *Tenure* and *Female* become positive. Finally, manager vega fixed effects increase in analyst following, financial experts on the board, institutional ownership, industry competition, and proximity to firm inception.[13] The idea that more risk-tolerant CEOs could be working in such firms seems plausible.

[12] Depression babies, that is, executives born during the Great Depression, exhibit higher risk aversion, which is consistent with Malmendier and Nagel (2011).

[13] To explore potential industry heterogeneity, we use industry fixed effects based on Fama-French 48 industries (instead of firm fixed effects) and find that the computer and business services industries employ executives with the highest manager fixed effects of delta, whereas the printing and publishing industry employs those with the lowest. The pharmaceutical and telecommunication industries employ managers with the highest manager vega fixed effects, whereas the shipbuilding and oil industries employ those with the lowest.

In summary, the results in Table 4 suggest that manager delta and vega fixed effects, without and with controls for matching of executives to firms based on ability and risk aversion, are related to proxies for managerial human capital and risk aversion.[14] In general, the manager delta fixed effect increases in measures of managerial ability. While the manager vega fixed effect generally decreases in proxies for risk aversion, controlling for matching of executives to firms based on risk aversion and talent yields a positive relation between the vega fixed effect and tenure in the firm and the indicator for female gender.

If such omitted variables captured by fixed effects are important for delta and vega, then they likely would matter as well for firm performance, risk, and policy. Sections 6 and 7 assess this possibility.

5. Managerial Delta Fixed Effect and Firm Performance

The relation between firm performance and managerial ownership is a substantial, active, and controversial segment of the empirical corporate governance literature. The benefits of increased ownership include enhanced alignment of managerial incentives with shareholder interests. The costs include risk bearing that is inefficient, entrenchment and the unrestrained use of span of control and power at the top of the firm. Hundreds of studies have empirically examined the relation between performance or value and ownership (Coles, Lemmon, and Meschke 2012, p. 150, e.g., footnote 3). Some find a positive relation, others find a negative relation, some find no relation (e.g., Demsetz and Lehn 1985), and some find both with a nonlinear specification (Morck, Shleifer, and Vishny 1988; McConnell and Servaes 1990). Numerous successors examine this

[14] This also justifies the use of fixed effects. When the omitted unit effects are highly correlated with the covariates, the fixed effects model should be used. Otherwise, a random effects model is more appropriate (Wooldridge 2010; Greene 2012).

relation with results that vary widely across various samples, measures of performance and ownership, and alternative empirical methods.[15] Such variation in results suggests endogeneity problems, including that the estimated specifications omit important variables (Coles, Lemmon, and Meschke 2012).

In this context, we further examine the empirical implications and interpretation of the delta and vega fixed effects for executives. The main idea is that the manager fixed effects embody the portions of talent and risk aversion not captured by observable proxies. More generally, the delta and vega fixed effects likely reflect other attributes that are thought to be important but are unobservable; characteristics representable by observable but omitted proxies; and observable and unobservable attributes that are important but not identified by current theory. All of these, both directly and through managerial incentives engendered by delta and vega, are likely to affect firm performance. As a test we regress firm performance on the estimated managerial delta and vega fixed effects.

We employ two measures of firm performance: operating performance (ROA) and a valuation ratio (Tobin's q). We consider only CEOs because they have the most extensive decision rights and authority and are most likely among the executive team to influence firm performance. Explanatory variables include the CEO delta and vega fixed effects, lagged performance rather than firm fixed effects, and the logarithm of net assets.

Our estimated manager fixed effects potentially capture the time-invariant component of observable manager characteristics. Many measures of managerial attributes used in the literature, such as gender and age, do not change much over time. Researchers need to find better proxies for managerial characteristics; otherwise manager fixed effects alone are sufficient to control for most

[15] See Himmelberg, Hubbard, and Palia (1999), Demsetz and Villalonga (2001), who depict the wide variation in results, and Coles, Lemmon, and Meschke (2012).

observable characteristics. Furthermore, the manager and firm fixed effects can overlap because of assortative matching. To further purge the effects of observable characteristics and firm fixed effects, we use the residuals from models 1 and 2 of Table 4 as "purified" manager fixed effects of delta and vega that are arguably less likely to be driven by observable characteristics and firm fixed effects.[16] We partition each of observed delta and vega into the portion of the "purified" manager fixed effect and the remainder of delta and vega. The intent is to control for the incentive effects of the components of delta and vega that arise from aspects of the contracting problem that are not related to unobserved CEO attributes. The same procedure and logic apply to CEO vega.

In some specifications, we also control for our estimates of the GLQ (2012) manager fixed effects for pay level. GLQ (2012) find that ROA is positively correlated with the pay-level executive fixed effect and that firm performance improves after CEOs with larger compensation fixed effects are hired. GLQ view these results as consistent with the fixed effect being associated with innate managerial ability, which in turn affects firm performance. Including the CEO-pay-level fixed effect allows us to check the GLQ result in our data and to isolate which of the CEO pay-level and CEO delta and vega fixed effects have explanatory power for firm performance.

The results in Table 5 indicate that the CEO delta fixed effects are positively and significantly associated with both measures of firm performance. The coefficient on the CEO delta fixed effect is positive and highly significant for all four performance regressions. For example, based on model 1 in Table 5, for a 1-standard-deviation increase in the CEO delta fixed effect, for example, from a median of about 0 to 0.58, *q* increases from median 1.67 to 1.70 (= 1.67 + 0.052 x 0.58), and firm value increases by $38.8 million from median $1.29 billion to $1.33 billion.

[16] We acknowledge the difficulty in fully disentangling observable and unobservable characteristics. Nonetheless, no matter what manager fixed effects capture, we show that they reflect the manager-specific characteristics that relate to delta and vega and have explanatory power for future firm outcomes and policies.

Using the coefficient of 0.727 on lagged *q* and limiting the iterative valuation effect to 10 years yields an accumulated increase in value of $105 million for the 1-standard-deviation increase in the CEO delta fixed effect. Residual delta, relative to the CEO delta fixed effect, has no effect on *ROA* and a significant negative association with Tobin's *q*. This negative effect on *q* may be a manifestation of the hump-shaped relationship documented in McConnell and Servaes (1990) and Morck, Shleifer, and Vishny (1988).[17] We have no prior hypothesis on vega, but include it as a control. In three of four cases the sign on residual vega matches the sign on the vega fixed effect.

Consider now the coefficients on CEO pay-level fixed effects, estimated using specification 4 in panel A of Table A1. In relation to the results in GLQ (2012), in our specifications the CEO pay-level fixed effect has diminished power to explain *ROA*. In contrast, the estimated coefficient when *q* is the dependent variable is positive and highly significant. The economic significance of the CEO delta fixed effects for *q* appears to exceed that of the pay-level fixed effects.[18]

6. Managerial Vega Fixed Effect, Firm Risk, and Firm Policy

Whether higher sensitivity of expected managerial wealth to firm risk implements risky financial and investment policy depends on whether vega offsets concavity of the managerial utility function (Ross 2004; Guay 1999). Thus, whether vega implements higher risk is an empirical question. Among empirical studies, the one most closely related to the work herein is

[17] Note that managerial entrenchment, as suggested by this literature to cause this negative relation, is more likely firm specific (e.g., because of weak board governance) and will therefore be captured in firm fixed effects, namely in the remainder portion of delta rather than in the manager fixed effects.

[18] To further address any concerns about endogeneity, we generate the fixed effects estimates from model 4 in Table 2 using the first half of the sample (1992–2003) and then regress firm performance, policy, and risk using data in the holdout sample (2004–2014) on those prior estimates. The results are qualitatively similar to those reported in Tables 5 and 6. In some cases, the estimates are not as significant statistically, as would be expected using a smaller sample and given the possibility of nonstationarities through time.

Coles, Daniel, and Naveen (2006).[19] They find that higher CEO vega implements riskier policy choices, including relatively more investment in R&D, less investment in property, plant, and equipment, greater focus on fewer lines of business, higher leverage, and higher firm risk. We extend this line of inquiry by examining the empirical content of the manager fixed effect. We test whether the manager vega fixed effect and the portion of vega not captured in the fixed effect are translated into risky policy choices and increased overall firm risk. To the extent that a higher manager vega fixed effect represents higher manager risk tolerance, and to the extent that residual vega (determined by all firm characteristics and observable manager characteristics) provides incentives to take risks, both should be associated with riskier investment policy, debt policy, and overall firm risk.

6.1 CEO vega fixed effect and firm risk

To measure firm risk we use the ranking (CDF) of the standard deviation of 1-year daily stock returns. We only consider CEOs because they are most likely among the executive team to influence overall firm risk. Explanatory variables include the CEO vega fixed effect (calculated based on model 4, panel A, Table 3), lagged *Firm risk*, and the logarithm of *Net assets*. We also include the remainder of observed vega net of the CEO vega fixed effect so that we may allow the vega associated with CEO attributes to differ in effect from vega arising from other forces. Finally, since delta exposes the manager to risk and so may suppress risk-taking, we also include the CEO delta fixed effect and residual delta as controls.

[19] Among others, Mehran (1992, 1995), Tufano (1996), Esty (1997a, 1997b), and Rogers (2002) explore the association between managerial stock and/or option holdings and financial strategy (such as leverage, repurchase, or the extent of derivatives usage and hedging), but with differing conclusions. Ryan and Wiggins (2002) find that the value of options granted has the power to explain contemporaneous R&D. Guay (1999), using data on a 1993 sample of 278 CEOs, shows that the standard deviation of returns is associated contemporaneously with vega. Rajgopal and Shevlin (2002) find that oil exploration risk is positively related to lagged vega.

In specification 1 of Table 6, with *Firm risk* as the dependent variable, the estimated coefficients on the CEO vega fixed effect are positive and highly significant. The most likely channels giving rise to the positive relation with firm risk would be high CEO tolerance for risk and the effect of an additional preference of the CEO for risk arising from the incentive from high vega. Note that the estimated coefficient on residual vega is insignificant. The primary effect of vega on firm risk arises through the CEO vega fixed effect.

6.2 The CEO vega fixed effect and corporate policy

To examine the content of the vega fixed effect further, we test for an association between the CEO vega fixed effect and firm policy characteristics that would be associated with firm risk. The provision of vega to executives is likely to represent the deliberate intention of inducing executives to implement risky policy choices. We follow Coles, Daniel, and Naveen (2006) to consider three aspects of investment policy and one aspect of financial policy: (1) *R&D*, defined as research and development expenditures scaled by assets; (2) *CAPEX*, defined as net capital expenditures (capital expenditures less sales of property, plant, and equipment) scaled by assets; (3) *Leverage*, defined as total book debt divided by the market value of equity plus book assets; and (4) *PPE*, which is investment in property, plant, and equipment scaled by assets. Empirical research suggests that investments in intangible assets, such as research and development, are riskier than investments in tangible assets, such as property, plant, and equipment (see Kothari, Laguerre, and Leone 2002; Ryan and Wiggins 2002; Coles, Daniel, and Naveen 2006; Amir, Guan, and Livne 2007). High leverage increases firm risk and the likelihood of bankruptcy (Gilson 1989, 1990). The effect of these policy variables should be captured in firm risk. In sum, we expect that CEOs with high risk tolerance and high vega incentives will spend more on R&D, spend less on hard assets, and use more leverage, ceteris paribus.

We present the empirical evidence in models 2–5 of Table 6. In three of four cases the results are consistent with our conjecture. The estimated coefficient on the CEO vega fixed effect is positive and significant for *R&D* and negative and significant for *CAPEX* and *PPE*. A higher CEO vega fixed effect is associated with riskier investment policy. For *Leverage*, the estimated coefficient on the CEO vega fixed effect is insignificant. The coefficient on residual vega is insignificant for *CAPEX*, *Leverage*, and *PPE* but is significant and positive for *R&D*. In unreported results, we interact manager fixed effects with industries and find manager fixed effects are more pronounced in telecommunications, pharmaceuticals and automobiles, which suggests that managerial ability and risk aversion are more important in these industries. Table 6 indicates that the correlations among vega and firm risk and policies found in previous studies (e.g., Coles, Daniel, and Naveen 2006) primarily arise from the CEO vega fixed effects rather than residual vega.

In sum, firm risk and riskiness of policy choices increase in the CEO vega fixed effect. One plausible explanation is that the vega fixed effect represents the incentive arising from vega to take risks matched with a greater executive tolerance for risk.

7. Placebo Tests for the Effects of Delta and Vega FEs on Performance, Risk, and Policy

Section 6 examines the association between the CEO delta fixed effects and firm performance. Section 7 examines the relation between CEO vega fixed effects and firm risk and policy choices. The fit statistics and coefficient estimates from the analysis suggest that executive attributes associated with delta and vega fixed effects indeed have a meaningful association, causal or otherwise, with firm performance, risk, and policy. If this is true, then we should not expect to find that manager delta and vega fixed effects have comparable explanatory power in data where the assignment of managers to firms is random. On the other hand, if the results in Tables 5 and 6

are spurious, perhaps due to overfitting a large number of dummy variables to random noise, then we would expect to find results similar to those in Tables 5 and 6 using data that severs the connection of the manager to the firm.

Our procedure resembles that in Jarosiewicz and Ross (2020). We randomly scramble the actual manager-firm spells found in the data. We perform the test two ways. First, we randomize the firm-manager match in the first stage by randomly assigning managers in a firm to a different firm, and then use the estimated manager fixed effects in the second stage. Second, we randomize the firm-manager match in the second stage and use the manager fixed effects estimated from the first stage with the original firm-manager match. In both instances, we find that this randomization procedure removes the explanatory power of the manager delta and vega fixed effects. This supports the notion that the results in Tables 5 and 6 reflect a nonspurious relation between firm performance, investment policy and risk, and the managerial attributes reflected in the manager delta and vega fixed effects.

8. CEO Exogenous and Endogenous Turnovers

Manager effects and firm effects can overlap due to endogenous matching. Using firm and manager fixed effects does alleviate the endogeneity problem and firm-manager matching problem, though not perfectly. In particular, when matching is based on observable characteristics and time-variant effects but does not depend on unobserved time-invariant factors, our estimated manager fixed effects are not contaminated by matching. If managers and firms are matched on the basis of unobserved time-invariant manager characteristics, however, then neither the AKM method nor the movers-only (MDV) methods can fully address the problem without explicit treatment of matching. Therefore, in previous sections we use two methods to further reduce the bias arising

from matching. First, as an attempt to further "purify" the manager fixed effects, we regress the estimated manager fixed effects of delta and vega on all observable manager and firm characteristics and firm fixed effects, and we believe the residual is a purer measure of unobservable managerial information. The "purification" process further removes any firm-specific information from the estimated manager fixed effects. Second, we use explicit two-sided matching regressions (per Ackerberg and Botticini 2002) to control for firm-manager matching. To supplement these approaches, this section studies the subsamples of different types of CEO exogenous and endogenous departures, such as forced retirement, a CEO's sudden death or health problems, forced turnover, and outside succession.

To isolate the endogenous matching effect, several studies (e.g., Fee, Hadlock, and Pierce 2013) exploit the approach of Johnson et al. (1985) by focusing on turnovers due to CEO deaths or specified health problems. They argue that while the replacement CEO choice remains endogenous, the exit of the departing CEO and need for a replacement is exogenous in this context. Other authors identify turnover events associated with natural retirements (frequently in the age category of 63 to 71) as exogenous cases of management changes (e.g., Fracassi and Tate 2012).

In addition, we also examine some interesting and unique *endogenous* turnovers, such as forced turnover, where CEOs are fired (based on news search), and outside succession where firms hire new CEOs from outside.[20] In both cases, the incoming CEOs with characteristics different from the incumbent CEOs are more likely hired to change direction of the companies.

The idiosyncratic style hypothesis (Fee, Hadlock, and Pierce 2013) predicts that in exogenous turnovers, the difference in manager fixed effects between the departing CEO and the incoming CEO should be more significant. The selected style hypothesis implies that for some

[20] We are grateful to Dirk Jenter, Fadi Kanaan, Florian Peters, and Alexander Wagner for sharing their CEO turnover data sets with us.

specific endogenous turnovers, the difference also can be significant because the board deliberately chooses managerial ability and risk aversion to move the firm in a different direction. Note that even when turnovers are endogenous, the causality can still run from CEO characteristics to firm outcome and policy (e.g., a CEO's risk aversion does influence his policy choices for the firm), but the board anticipates it and chooses the right CEO to influence and execute policies and achieve desired outcomes. Table 7 shows that manager fixed effects have significant explanatory power, in terms of R^2, for *Delta* and *Vega* in all these turnover subsamples. The adjusted R^2 values for regressions with manager fixed effects (Column 3) are considerably higher than those with firm fixed effects (Column 2). The statistics in Table 8 suggest that for a firm that experiences an exogenous turnover or wants to use a turnover as an opportunity to change the direction of the firm, the differences in manager fixed effects of delta and vega are significant between the departing CEO and the incoming CEO.[21]

We now assess whether the significant differences between the incoming and departing CEOs matter. The results in Table 9 suggest that the differences between the departing CEOs and incoming CEOs significantly affect firm outcomes and policies around these exogenous turnovers. These events appear well suited for evaluating whether managerial ability and risk preference play an independent role in generating changes in firms. In particular, we implement a change-on-change regression, which allows us to directly address the question of whether variation in CEO fixed effects around CEO turnovers explains subsequent changes in firm performance and policy. We include changes in all control variables in our estimations. The results in Table 9 suggest that the departure of high ability CEOs for ostensibly exogenous reasons are followed by the

[21] Because the raw delta and vega are based on executives' accumulated stock and option holdings, we are not surprised to see that delta and vega are significantly smaller for new versus incumbent CEOs.

deterioration of firm performance; departures of risk-tolerant CEOs predict reduced corporate risk taking.[22]

9. Conclusion

We assess the role of unobserved versus standard observed firm and managerial characteristics as determinants of contract form. In particular, we use the AKM (1999) method to accommodate firm and managerial heterogeneity by identifying and estimating both manager and firm fixed effects. We supplement fixed effects with empirical estimation of the sorting of executives to firms. Fixed effects and matching of executives to firms reduce concerns about omitted variables, selection effects, and other sources of endogeneity that impede causal inference.

We find that manager fixed effects account for a very large portion of the variation in executive incentives. For example, of the explained variation of delta (vega) incentives, 72.8% (59.7%) arises from unobserved managerial characteristics. These figures suggest that the literature explaining contract design empirically is not very successful. Either the underlying theoretical models do not include the economic forces that determine the structure of executive incentives or the empirical proxies for these forces are inadequate.

Of the observable managerial characteristics researchers employ, few seem to be viable direct and comprehensive measures of managerial talent and risk aversion. The good news is that those firm characteristics that proxy for marginal revenue product of managerial input and for exposure to firm risk as a class appear to perform relatively well. Moreover, the manager delta and vega fixed effects (i.e., the estimated coefficients of manager dummies in the regressions

[22] The results are weakest for changes in *Leverage*, possibly because capital structure is largely determined by unobserved firm characteristics instead of manager characteristics (Lemmon, Roberts, and Zender 2008; Kopecky, Li, and Tucker 2018).

explaining delta and vega, respectively) have significant empirical content. We also find that managerial fixed effects of compensation incentives have the power to explain future firm policy, risk, and performance. For example, firm performance increases in the CEO delta fixed effect and firm risk and riskiness of investment policy increase in the CEO vega fixed effect. These results are robust to including the matching of executives to firms. Moreover, the results survive placebo tests that break the connection between the manager and firm.

This paper contributes to the managerial incentive literature by providing the first comprehensive empirical examination of the role of unobserved firm and managerial heterogeneities in determining executive incentives. An additional benefit, given the significance of latent factors such as innate ability, risk aversion, preferences, nonalgorithmic reasoning, or firm culture in shaping corporate outcomes, is that our estimated parameters on observable firm and manager characteristics are less likely to be affected by omitted variable bias. While we acknowledge the difficulties in disentangling the observable manager characteristics from unobservable ones and firm fixed effects from manager fixed effects, we contribute to the identification strategy by explicitly treating the endogeneity problem and firm-manager matching. We are the first to identify manager fixed effects and their impact on firm changes in the context of likely exogenous CEO turnovers. These events appear well suited for evaluating whether managerial ability and risk preference play an independent role in determining executive incentives and generating changes in firms. This paper also contributes to the growing literature on how unobservable managerial attributes affect corporate outcomes. Managerial talent captured through our empirical approach affects both managerial incentives (delta) and firm performance. Managerial talent and risk aversion affect risk-taking incentives (vega) along with the riskiness of investment policy and measurable firm risk. The high relative explanatory power of unobserved

managerial heterogeneity suggests that both theory and empirical work focusing on the role and attributes of top managers would be fruitful.

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Table 1. Summary statistics

This table presents summary statistics for the full sample of the cross-sectional yearly data from 1993 to 2014, depending on estimation approach and sample (spell, movers only [MDV], and connected groups [AKM]). Refer to the appendix for variable definitions. All dollar values are stated in 2014 dollars. *Delta* is in $millions for a 1% change in equity value; *Vega* is in $millions per 0.01 change in standard deviation of stock return; and total compensation and net assets are in $millions. *Vega*, *Delta*, *Total compensation*, and *Market-to-book* are winsorized at the 1st and 99th percentile levels. The number of executive-year observations with no missing data values is 158,371 for the spell sample, 14,933 for the MDV sample, and 98,754 for the AKM sample.

	Mean			Median			SD		
Variable	Spell	MDV	**AKM**	Spell	MDV	**AKM**	Spell	MDV	**AKM**
Executive characteristics									
Delta ($000,000s)	0.24	0.25	**0.25**	0.05	0.05	**0.05**	0.60	0.58	**0.60**
Vega ($000,000s)	0.04	0.06	**0.06**	0.01	0.02	**0.02**	0.08	0.10	**0.09**
Total compensation ($000,000s)	2.20	3.61	**2.55**	1.10	1.89	**1.31**	3.31	4.62	**3.70**
Tenure (years)	11	6	**11**	6	2	**6**	12	8	**11**
Tenure as CEO (years)	7	4	**7**	6	2	**5**	7	4	**7**
Age (years)	52	51	**52**	52	51	**52**	8	6	**8**
Director (yes = 1/no = 0)	0.35	0.41	**0.33**	0	0	**0**	0.48	0.49	**0.47**
Female (yes = 1/no = 0)	0.06	0.04	**0.05**	0	0	**0**	0.22	0.19	**0.21**
Firm characteristics									
Net assets ($000,000,000s)	4.92	7.70	**5.91**	0.88	1.62	**1.31**	21.05	22.51	**19.48**
log(*Net assets*)	6.90	7.51	**7.23**	6.79	7.41	**7.18**	1.89	1.90	**1.89**
Market-to-book	2.17	2.05	**2.17**	1.67	1.63	**1.67**	2.50	2.67	**2.80**
Institutional holdings (%)	60.12	60.80	**61.65**	64.07	65.08	**65.47**	21.99	21.57	**21.64**
Board size	9.30	9.65	**9.45**	9	9	**9**	2.98	3.14	**3.00**
Board independence (%)	65.66	68.26	**67.49**	66.69	71.42	**70.00**	17.18	17.87	**16.75**
Classified board (yes = 1)	0.58	0.62	**0.59**	1	1	**1**	0.49	0.49	**0.49**
G index	9.29	9.55	**9.42**	9	10	**9**	2.70	2.64	**2.67**
ROA	0.14	0.12	**0.14**	0.14	0.12	**0.14**	0.13	0.11	**0.13**
Surplus cash ($000,000s)	0.09	0.09	**0.9**	0.08	0.08	**0.08**	0.15	0.17	**0.15**
Policy measures									
R&D (to total assets)	0.03	0.03	**0.03**	0	0	**0**	0.10	0.10	**0.10**
Advertisement (to total assets)	0.04	0.04	**0.04**	0.02	0.02	**0.02**	0.06	0.06	**0.06**
Leverage	0.17	0.18	**0.17**	0.13	0.15	**0.14**	0.16	0.16	**0.15**
CAPEX (to total assets)	0.06	0.06	**0.06**	0.04	0.04	**0.04**	0.06	0.06	**0.06**
PPE (to total assets)	0.29	0.30	**0.30**	0.23	0.23	**0.24**	0.24	0.24	**0.23**
Firm risk (SD yearly stock returns)	0.42	0.43	**0.43**	0.42	0.42	**0.42**	0.28	0.29	**0.28**

Table 2. Observable and unobservable determinants of executive delta incentives, connectedness sample with the AKM method

This table presents the regression results on the observable and unobservable determinants of executive incentives. The dependent variable in Panel A is *Delta*. Specification 1 is a pooled OLS regression without firm or manager fixed effects (FEs). Specification 2 is the firm fixed effect regression. Specification 3 is the manager fixed effect regression. Specification 4 uses both firm and manager fixed effects. Specification 5 includes both firm and manager fixed effects and controls for two-sided matching between firms and executives. The column adjacent to models 3 and 4 indicates whether (=) or not (≠) the sign of the coefficient in model 4 matches that in model 1 and whether the coefficient is significantly larger at ≤ 0.05 (<) or smaller (>) or neither (=) than the estimate in (1). In this column, bold signifies a change in directional or economic significance. Year fixed effects are included in all the regressions. Panel B uses coefficient estimates in specification 4 of panel A to decompose model R^2 in order to quantify relative importance of various components in determining *Delta*. Refer to the appendix for variable definitions. All specifications include indicator variables for missing values for each independent variable. Heteroscedasticity-robust *t*-statistics, clustered at the firm level, are in parentheses. **p* < .1; ***p* < .05; ****p* < .01.

A. Dependent variable: **Delta**

	(1) Pooled OLS (no FE)	(2) Firm FE (no manager FE)	(3) Manager FE (no firm FE)	(4) vs. (1) Sign, larger or smaller (*p* < .05)	(4) Firm & manager FE	(5) Firm & manager FE with matching
Executive characteristics						
Age	0.003***	0.004***	0.011***	=, <	0.014***	0.000
	(6.15)	(9.83)	(10.79)		(9.67)	(0.23)
Tenure	0.009***	0.010***	0.007***	=, >	0.001	0.000
	(24.56)	(25.09)	(7.50)		(0.64)	(0.33)
CEO	0.253***	0.250***	0.108***	=, >	0.088***	0.092***
	(35.07)	(36.57)	(18.04)		(13.71)	(13.52)
Female	-0.036***	-0.035***	n/a	n/a	n/a	n/a
	(-3.70)	(-3.59)				
Director	0.214***	0.184***	0.076***	=, >	0.060***	0.072***
	(29.70)	(26.88)	(10.50)		(7.47)	(7.15)
Mover	-0.008***	-0.003	-0.002	=, <	-0.001	0.000
	(-4.78)	(-1.39)	(-1.13)		(-0.82)	(0.78)
Industry experience	0.002	0.008***	0.006***	=, >	0.008***	0.007***
	(1.18)	(4.32)	(4.09)		(3.12)	(3.07)
Depression baby	0.002	0.002	0.001	=, =	0.002	0.002
	(0.21)	(0.71)	(0.55)		(0.43)	(0.29)
Total compensation	0.031***	0.017***	0.011***	=, =	0.008***	0.007***
	(17.30)	(8.54)	(8.29)		(7.76)	(7.22)
Corporate governance						
Board independence	-0.213***	0.065***	0.008	≠, <	0.013	0.035**
	(-11.94)	(3.41)	(0.56)		(0.80)	(2.14)
Female board	-0.002***	0.000	0.000	=, >	0.000	0.000
	(-3.98)	(1.57)	(1.23)		(1.28)	(1.17)
Finance board	0.003***	0.002***	0.002***	=, =	0.002***	0.002***
	(4.17)	(3.65)	(3.36)		(3.19)	(3.30)
Analyst coverage	0.010***	0.004***	0.004***	=, =	0.003***	0.003***

	(9.79)	(5.37)	(3.92)		(3.72)	(3.49)
Institutional holdings	-0.001*** (-5.37)	-0.000 (-0.80)	-0.000 (-0.85)	=, =	-0.000 (-0.67)	-0.000 (-0.58)
Industry H index	-0.233*** (-5.17)	-0.121 (-1.45)	-0.072 (-0.93)	=, <	-0.115 (0.72)	-0.119 (-0.80)
Firm fundamentals						
Life stage	0.002*** (4.10)	0.000 (1.22)	0.000 (1.10)	=, =	0.000 (0.84)	0.000 (0.91)
Market-to-book	0.082*** (55.45)	0.073*** (35.92)	0.070*** (43.61)		0.070*** (39.77)	
Predicted *Market-to-book*						-0.015 (-0.24)
Firm risk	0.140*** (6.51)	-0.119*** (-4.64)	-0.077*** (-3.60)	≠, >	-0.114*** (-5.47)	
Predicted *Firm risk*						-0.372* (-1.85)
Leverage	-0.185*** (-16.47)	-0.122*** (-7.59)	-0.151*** (-10.74)	=, <	-0.155*** (-9.78)	-0.194*** (-11.99)
R&D	-0.062*** (-2.90)	-0.096*** (-3.38)	-0.066** (-2.20)	=, =	-0.054** (-2.11)	0.014 (0.50)
log(*Net assets*)	0.087*** (55.71)	0.096*** (24.42)	0.120*** (34.22)	=, <	0.143*** (35.89)	0.123*** (32.74)
Year FE	Yes	Yes	Yes		Yes	Yes
Adjusted R^2	.29	.39	.74		.75	.75
N	82,755	82,755	82,755		82,755	82,755

B. Relative importance of components in determining* Delta *(panel A, model 4)

	$\frac{\text{cov}(Delta, \text{component})}{\text{var}(Delta)}$	% of R^2 attributable to the component
Manager fixed effects	0.56	68.29
Firm fixed effects	0.04	4.88
Observable manager characteristics	0.07	8.54
Observable firm characteristics	0.14	17.07
Year fixed effects	0.01	1.22
Residual	0.18	

Table 3. Observable and unobservable determinants of executive vega incentives, connectedness sample with the AKM method

This table presents the regression results on the observable and unobservable determinants of executive incentives. The dependent variable in Panel A is *Vega*. Specification 1 is a pooled OLS regression without firm or manager fixed effects (FE). Specification 2 is the firm fixed effect regression. Specification 3 is the manager fixed effect regression. Specification 4 uses both firm and manager fixed effects. Specification 5 includes both firm and manager fixed effects and controls for two-sided matching between firms and executives. The column adjacent to models 3 and 4 indicates whether (=) or not (≠) the sign of the coefficient in model 4 matches that in model 1 and whether the coefficient is significantly larger at ≤ .05 (<) or smaller (>) or neither (=) than the estimate in specification 1. In this column, bold signifies a change in directional or economic significance. Year fixed effects are included in all the regressions. Panel B uses coefficient estimates in specification 4 of panel A to decompose model R^2 in order to quantify relative importance of various components in determining *Vega*. Refer to the appendix for variable definitions. All specifications include indicator variables for missing values for each independent variable. Heteroscedasticity-robust *t*-statistics, clustered at the firm level, are in parentheses. *p < .1; **p < .05; ***p < .01.

***A. Dependent variable:* Vega**

	(1) Pooled OLS (no FE)	(2) Firm FE (no manager FE)	(3) Manager FE (no firm FE)	(4) vs. (1) Sign, larger or smaller (p < .05)	(4) Firm & manager FE	(5) Firm & manager FE with matching
Executive characteristics						
Age	-0.001***	-0.001***	0.001***	≠, <	0.001***	0.000*
	(-7.97)	(-6.58)	(4.10)		(4.01)	(1.54)
Tenure	0.001***	0.001***	0.000***	=/ =	0.001***	0.001***
	(6.42)	(7.91)	(5.32)		(5.80)	(3.65)
CEO	0.046***	0.045***	0.026***	=, >	0.027***	0.029***
	(36.87)	(35.78)	(17.11)		(17.93)	(18.01)
Female	-0.005*	-0.007***	N/A	N/A	N/A	N/A
	(-1.60)	(-3.36)				
Director	0.024***	0.026***	0.024***	=, =	0.022***	0.025***
	(26.67)	(24.88)	(11.40)		(11.67)	(12.12)
Mover	-0.000	0.002***	0.002***	≠, >	0.002***	0.002***
	(-0.78)	(3.40)	(3.17)		(3.12)	(3.10)
Industry experience	0.001	0.002***	0.002***	=, >	0.002***	0.002***
	(1.23)	(3.45)	(3.41)		(3.36)	(3.25)
Depression baby	-0.000	0.001	0.001	≠, =	0.000	0.001
	(-0.77)	(1.03)	(0.91)		(0.81)	(0.95)
Total compensation	0.005***	0.003***	0.002***	=, =	0.002***	0.002***
	(5.99)	(5.38)	(5.20)		(4.77)	(5.01)
Corporate governance						
Board independence	0.014***	0.015***	0.014***	=, =	0.015***	0.015***
	(3.91)	(4.05)	(3.41)		(3.68)	(4.20)
Female board	-0.001***	-0.001	-0.001	=, <	-0.000	-0.000
	(-4.27)	(-1.63)	(-1.41)		(0.82)	(0.99)
Finance board	0.003***	0.002***	0.003***	=, =	0.003***	0.003***
	(5.25)	(4.19)	(4.28)		(4.07)	(3.84)
Analyst coverage	0.004***	0.002***	0.002***	=, =	0.002***	0.002***
	(4.51)	(3.80)	(3.55)		(3.46)	(3.50)
Institutional holdings	-0.000**	-0.000	-0.000	≠, =	0.000	0.000
	(-2.20)	(-1.04)	(-0.39)		(0.41)	(0.55)

Industry H index	-0.194*** (-3.58)	-0.133** (2.18)	-0.087 (1.30)	=, =	-0.082 (1.25)	-0.080 (1.17)
Firm fundamentals						
Life stage	0.008 (0.47)	-0.014*** (3.36)	-0.018*** (3.81)	≠, <	-0.018*** (3.74)	-0.016*** (3.66)
Market-to-book	0.010*** (30.77)	0.002*** (4.61)	-0.000 (0.63)	≠, >	-0.001* (-1.82)	
Predicted *Market-to-book*						-0.030 (-1.36)
Firm risk	-0.015 (1.10)	-0.058*** (-11.57)	-0.045*** (-7.32)	=, >	-0.045*** (-7.14)	
Predicted *Firm risk*						-0.114 (-0.47)
Leverage	-0.038*** (-17.47)	-0.016*** (-5.67)	-0.017*** (-5.50)	=, <	-0.015*** (-4.11)	-0.015*** (-4.49)
R&D	0.079*** (14.10)	0.007 (0.90)	-0.006 (-0.61)	≠, >	-0.009 (-1.18)	-0.008 (-1.06)
log(*Net assets*)	0.026*** (86.75)	0.026*** (40.50)	0.022*** (28.11)	=, =	0.024*** (28.48)	0.024*** (25.50)
Year FE	Yes	Yes	Yes		Yes	Yes
Adjusted R^2	.32	.44	.48		.50	.50
N	82,755	82,755	82,755		82,755	82,755

B. Relative importance of components in determining* Vega *(panel A, model 4)

	$\frac{cov(Vega, \text{component})}{\text{var}(Vega)}$	% of R^2 attributable to the component
Manager fixed effects	0.36	56.25
Firm fixed effects	0.05	7.81
Observable manager characteristics	0.08	12.50
Observable firm characteristics	0.11	17.19
Year fixed effects	0.04	6.25
Residual	0.36	

Table 4. Manager delta and vega fixed effects and observable characteristics

This table presents regression results for delta and vega on observable manager and firm characteristics. The dependent variables are manager delta and vega fixed effects: for delta estimated by the AKM method in the connectedness sample based on specification 4 of Table 2, panel A; and for vega based on specification 4 of Table 3, panel A. The manager delta fixed effects with matching are estimated based on specification 5 of Table 2, panel A. The manager vega fixed effects with matching are based on specification 5 of Table 3, panel A. Heteroscedasticity-robust *t*-statistics, clustered at the firm level, are in parentheses. *$p < .1$; **$p < .05$; ***$p < .01$.

	(1) Manager delta fixed effects	(2) Manager vega fixed effects	(3) Manager delta fixed effects with matching	(4) Manager vega fixed effects with matching
Executive characteristics				
Age	-0.012***	-0.002***	-0.015***	-0.002***
	(-41.30)	(-38.09)	(-34.18)	(-44.64)
Tenure	0.003***	0.001***	0.006***	0.001***
	(8.65)	(14.99)	(19.18)	(15.19)
CEO	0.099***	0.010***	0.097***	0.008***
	(13.32)	(10.44)	(12.99)	(9.02)
Female	-0.036***	-0.005***	0.074***	0.013***
	(-4.70)	(-5.04)	(5.21)	(6.49)
Director	0.142***	0.002**	0.173***	0.014**
	(25.09)	(2.41)	(30.66)	(2.41)
Mover	-0.021***	0.003***	-0.021***	0.003***
	(-4.35)	(5.18)	(-4.48)	(4.73)
Industry experience	0.002***	0.000	0.002***	0.000
	(3.38)	(1.05)	(4.18)	(0.97)
Depression baby	-0.012	-0.008**	-0.015	-0.008**
	(-0.76)	(-2.13)	(-0.84)	(-2.25)
Total compensation	0.020***	0.009***	0.019***	0.009***
	(22.13)	(28.97)	(20.90)	(27.08)
Corporate governance				
Board independence	0.020***	-0.006	0.019***	-0.008
	(3.13)	(-1.19)	(3.08)	(-1.44)
Female board	0.000	-0.001	0.000	-0.001
	(0.85)	(-1.03)	(1.16)	(-0.93)
Finance board	0.002***	0.002***	0.002***	0.002**
	(3.18)	(2.97)	(3.22)	(2.48)
Analyst coverage	0.006***	0.003***	0.006***	0.003***
	(4.85)	(3.26)	(4.72)	(3.22)
Institutional ownership	0.007***	0.010***	0.007***	0.010***
	(3.63)	(3.79)	(3.65)	(3.82)
Industry H index	-0.250***	-0.218***	-0.234***	-0.216***
	(-3.26)	(-4.19)	(-3.17)	(-3.80)
Firm fundamentals				
Life stage	-0.001	-0.009***	-0.001	-0.010***
	(-0.05)	(-3.91)	(-0.09)	(4.15)
Market-to-book	0.002	0.002***	0.002	0.002***
	(1.40)	(10.88)	(1.38)	(9.63)
Firm risk	-0.008	-0.041***	-0.013	-0.043***
	(-0.45)	(-19.26)	(-0.78)	(-20.23)
log(*Net assets*)	-0.048***	-0.000	-0.051***	-0.001**
	(-16.89)	(-0.01)	(-17.65)	(-2.19)
Fixed effects	Year + firm	Year + firm	Year + firm	Year + firm
Adjusted R^2	.63	.88	.61	.80

N	82,755	82,755	82,755	82,755

Table 5. CEO delta fixed effects and firm performance

This table presents the regression analysis on the impact of CEO delta fixed effects on firm performance as measured by the dependent variables (Tobin's) *q* and *ROA*. The fixed effects are estimated by the AKM method in the connectedness sample (specification 4 of Table 3, panel A) and then normalized by 1,000. Residual delta is the observed delta minus the purified CEO delta fixed effect (the residual from Table 4, Column 1). Residual vega is the observed vega minus the purified CEO vega fixed effect (the residual from Table 4, Column 2). The lagged dependent variables are the lagged *q* (i.e., *q* in the previous year) and lagged *ROA* in specifications 1 and 2, respectively. Year fixed effects are included in both regressions. Refer to the appendix for variable definitions. Heteroscedasticity-robust *t*-statistics, clustered at the firm level, are in parentheses. *$p < .1$; **$p < .05$; ***$p < .01$.

	q	*ROA*	*q*	*ROA*
CEO delta fixed effect	0.058***	0.007***	0.053***	0.008***
	(5.03)	(4.35)	(4.87)	(4.40)
Residual delta (= *Delta* – CEO delta FE)	-0.117***	-0.004	-0.112***	-0.003
	(-6.88)	(-1.30)	(-5.92)	(-1.46)
CEO pay-level fixed effect			0.012**	0.001*
			(2.15)	(1.78)
CEO vega fixed effect	0.105	-0.027**	-0.195*	-0.043***
	(1.49)	(-2.41)	(-1.84)	(-3.46)
Residual vega (= *Vega* – CEO vega FE)	0.392***	-0.012	0.395***	-0.011
	(5.49)	(-1.11)	(5.50)	(-1.10)
Lagged dependent variable	0.727***	0.541***	0.729***	0.542***
	(112.67)	(63.92)	(112.17)	(64.25)
log(*Net assets*)	-0.022***	0.010***	-0.026***	0.010***
	(-3.18)	(9.60)	(-3.19)	(9.40)
Year fixed effects	Yes	Yes	Yes	Yes
R^2	.64	.34	.63	.34
N	13,736	13,736	13,736	13,736

Table 6. CEO vega fixed effects and firm risk

This table presents regression results of the impact of CEO vega fixed effects on firm risk and risk-related corporate policies. The fixed effects, in million dollars, are estimated by the AKM method in the connectedness sample (specification 4 of Table 3, panel B). Residual vega is the observed vega minus the purified CEO vega fixed effect (the residual from Table 4, Column 2). Residual delta is the observed delta minus the purified CEO delta fixed effect (the residual from Table 4, Column 1). Refer to the appendix for variable definitions. All specifications include year fixed effects. Heteroscedasticity-robust *t*-statistics, clustered at the firm level, are in parentheses. *$p < .1$; **$p < .05$; ***$p < .01$.

	(1) *Firm risk*	(2) *R&D*	(3) *CAPEX*	(4) *Leverage*	(5) *PPE*
CEO vega fixed effect	0.030***	0.060***	-0.010***	-0.002	-0.009**
	(4.25)	(6.88)	(-3.11)	(-0.40)	(-2.19)
Residual vega (*Vega* – CEO vega FE)	-0.004	0.028***	-0.004	-0.006	-0.001
	(-0.58)	(3.50)	(-0.77)	(-1.38)	(-0.54)
CEO delta fixed effect	-0.001	-0.000	0.001***	-0.003***	0.001
	(-1.18)	(-0.73)	(3.81)	(-2.96)	(1.23)
Residual delta (= *Delta* – CEO delta FE)	0.004*	0.006**	0.001	0.005***	0.002*
	(1.88)	(2.20)	(1.49)	(3.64)	(1.77)
Lagged dependent variable	0.933***	0.411***	0.611***	0.817***	0.927***
	(13.89)	(43.31)	(68.08)	(128.05)	(280.82)
log(*Net assets*)	-0.003***	-0.010***	-0.001***	0.001**	0.001***
	(-5.03)	(-14.99)	(-3.08)	(2.25)	(3.32)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	.74	.22	.46	.75	.92
N	13,792	13,792	13,792	13,792	13,792

Table 7. Explanatory power of manager fixed effects in different subsamples
This table presents the adjusted R^2 values for regressions based on different subsamples. The dependent variables are *Delta* and *Vega* in panels A and B, respectively. The samples include observations from 3 years before a CEO turnover to 3 years after, excluding the transition year. All specifications are the same as those in Tables 2 and 3: specification 1 is a pooled OLS regression without firm or manager fixed effects (FEs); specification 2 is the firm fixed effect regression; specification 3 is the manager fixed effect regression; and specification 4 uses both firm and manager fixed effects. Year fixed effects are included in all the regressions.

A. Dependent variable: **Delta**

Adjusted R^2	(1) Pooled OLS (no FE)	(2) Firm FE (no manager FE)	(3) Manager FE (no firm FE)	(4) Firm & manager FE
CEO death/health subsample	.18	.26	.37	.43
Natural Retirement subsample	.21	.30	.52	.57
Outside Hire subsample	.24	.32	.59	.65
Forced turnover subsample	.21	.27	.53	.56

B. Dependent variable: **Vega**

Adjusted R^2	(1) Pooled OLS (no FE)	(2) Firm FE (no manager FE)	(3) Manager FE (no firm FE)	(4) Firm & manager FE
CEO death/health subsample	.16	.21	.26	.29
Natural retirement subsample	.19	.28	.28	.30
Outside hire subsample	.23	.30	.35	.38
Forced turnover subsample	.20	.25	.29	.31

Table 8. Departing CEOs and incoming CEOs in different turnover subsamples

This table presents summary statistics of departing CEOs and incoming CEOs for different CEO turnover subsamples. The manager fixed effects of delta and vega are estimated based on panel A of Tables 2 and 3, respectively. The significance of the difference between departing CEOs and incoming CEOs is based on the Wilcoxon signed-rank test. Delta and Vega are estimated 1 year before a turnover for departing CEO and 1 year after the turnover for incoming CEOs; manager fixed effects of delta and vega are estimated based on panel A of Tables 2 and 3, respectively. *$p < .1$; **$p < .05$; ***$p < .01$.

A. Summary statistics of* Delta *and manager delta fixed effects

	Delta			Manager fixed effects of delta		
	Departing CEO	Incoming CEO	Diff.	Departing CEO	Incoming CEO	Diff.
CEO death/health subsample	0.33	0.13	-0.20***	0.00	0.05	0.05*
Natural retirement subsample	0.42	0.18	-0.24***	-0.02	0.03	0.05**
Outside hire subsample	0.35	0.12	-0.23***	-0.02	0.09	0.11***
Forced turnover subsample	0.29	0.16	-0.13***	-0.08	0.04	0.12***

B. Summary statistics of* Vega *and manager vega fixed effects

	Vega			Manager fixed effects of vega		
	Departing CEO	Incoming CEO	Diff.	Departing CEO	Incoming CEO	Diff.
CEO death/health subsample	0.06	0.01	-0.05***	0.00	0.02	0.02**
Natural retirement subsample	0.09	0.03	-0.06***	-0.03	0.00	0.03***
Outside hire subsample	0.06	0.01	-0.05***	-0.01	0.02	0.03***
Forced turnover subsample	0.06	0.02	-0.04***	-0.03	0.01	0.04***

Table 9. CEO fixed effects and firm performance and policies in different turnover subsamples
This table presents the estimated coefficients of CEO fixed effects of delta and vega in panels A and B, respectively. Panel A shows the impact of change in CEO delta fixed effects on change in firm performance as measured by the dependent variables Tobin's *q* and *ROA*. Change in CEO fixed effects of delta is calculated as the incoming CEO's manager fixed effects of delta minus the departing CEO's manager fixed effects of delta. Panel B shows the impact of change in CEO vega fixed effects on change in firm policy as measured by the dependent variables firm risk, R&D, CAPEX, leverage, and PPE. The specifications are the same as those in Tables 5 and 6, except that all variables represent the change between the 3-year average before a CEO turnover and the 3-year average after. Refer to the appendix for variable definitions. Heteroscedasticity-robust *t*-statistics, clustered at the firm level, are in parentheses. *$p < .1$; **$p < .05$; ***$p < .01$.

A. Coefficients of change in CEO fixed effects of delta (incoming CEO – departing CEO)

	(1) Δ *q*	(2) Δ *ROA*
CEO death/health subsample	0.035**	0.003*
Natural retirement subsample	0.050**	0.008**
Outside hire subsample	0.058***	0.007***
Forced turnover subsample	0.071***	0.008**

B. Coefficients of change in CEO fixed effects of vega (incoming CEO – departing CEO)

	(1) Δ *Firm risk*	(2) Δ *R&D*	(3) Δ *CAPEX*	(4) Δ *Leverage*	(5) Δ *PPE*
CEO death/health subsample	0.015*	0.033**	-0.020***	0.001	-0.005
Natural retirement subsample	0.020***	0.048***	-0.013**	0.002	-0.011***
Outside hire subsample	0.032***	0.066***	-0.013***	0.004**	-0.013***
Forced turnover subsample	0.028***	0.041***	-0.010*	0.001	-0.008*

Figure 1
Distribution of the estimated manager's delta fixed effects

The figure presents a histogram and kernel density line of the distribution of the estimated manager delta fixed effects in millions of dollars for a 1% change in stock price. The fixed effects are estimated by the AKM method in the connectedness sample (specification 4 of Table 2, panel A). Following the AKM method, the means of fixed effects in each group are adjusted to zero for comparisons between groups. The standard deviation and the shape of the distribution do not depend on the normalization of the mean. Statistics that portray the shape of the distribution are as follows: 25th percentile = -0.29; median = -0.07; 75th percentile = 0.22; minimum = -2.44; maximum = 2.97; and standard deviation = 0.58.

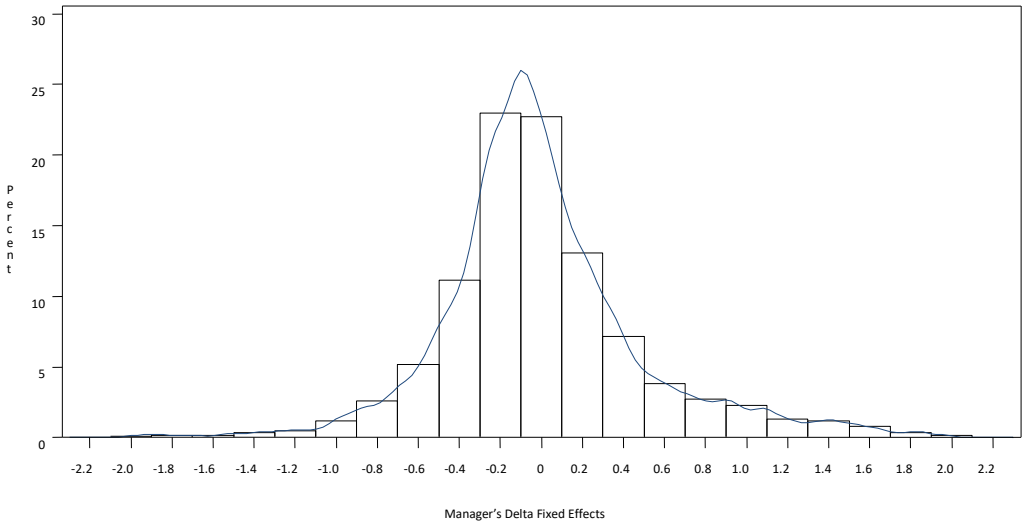
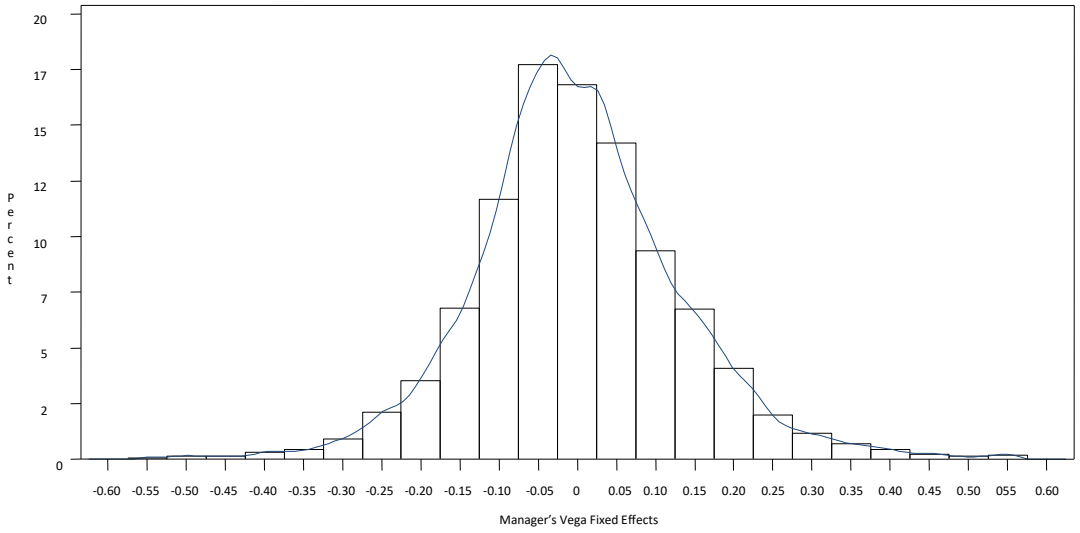


Figure 2
Distribution of the estimated manager's vega fixed effects

The figure presents a histogram and kernel density line of the distribution of the estimated manager vega fixed effects in millions of dollars per 0.01 change in the standard deviation of stock return. The fixed effects are estimated by the AKM method in the connectedness sample (specification 4 of Table 2, panel B). Following the AKM method, the means of fixed effects in each group are adjusted to zero for comparisons between groups. The standard deviation and the shape of the distribution do not depend on the normalization of the mean. Statistics that portray the shape of the distribution are as follows: 25th percentile = -0.08; median = -0.01; 75th percentile = 0.09; minimum = -0.67; maximum = 0.69; and standard deviation = 0.15.



Appendix. Variable definitions

Executive-Level Variables:

Delta is the dollar change in the executive's wealth for a 1% change in stock price.

Vega is the dollar change in the executive's wealth for a 0.01 change in standard deviation of returns.

Total compensation (TDC1 in Execucomp) includes salary, bonus, grants of restricted stock, grants of stock options, long-term incentive plan payouts, gross-ups for tax liabilities, perquisites, preferential discounts on stock purchases, contributions to benefit plans, severance payments, and all other compensation.

Age is the age in years of an executive. *Dage* is an indicator variable that takes the value of 1 when Age is missing and 0 otherwise. *Age* is set to zero when *Dage* equals 1.

Tenure is years in company. *Dtenure* is an indicator variable that takes the value of 1 when tenure is missing and 0 otherwise. *Tenure* is set to zero when *Dtenure* equals 1.

Tenure as CEO is years as CEO in a company.

Director is a dummy variable equal to 1 if the executive served as a director of the company and 0 otherwise.

Female is a dummy variable equal to 1 for female and 0 for male.

Mover is a dummy variable equal to 1 for managers who switched firm and 0 for those who did not.

Depression baby is a dummy variable equal to 1 if an executive was born between 1920 and 1929 and 0 otherwise (Malmendier and Nagel 2011).

Industry experience is the number of years the executive has worked in this industry.

Corporate Governance:

Board independence is the number of independent outside directors divided by board size.

Female board is the percentage of females on a board.

Finance board is the percentage of a firm's board members who are categorized as financial experts.

Analyst coverage is the number of analysts following a firm.

Institutional ownership is the percentage of a company's outstanding common shares held by institutions.

Industry H index is Herfindahl-Hirschman index (HHI) of industry concentration, defined as the sum of the squares of market shares of the firms operating in the industry.

Classified board is a dummy variable equal to 1 if only a fraction of the members of the board of directors is elected each time and equal to 0 instead if all directors are elected at the same time on an annual basis

G index is the 24-item governance index defined in Gompers, Ishii, and Metrick (2003).

Firm Fundamentals:

Life stage takes values between 1 and 5 according to the five firm life cycle stages (Dickinson 2011): introduction, growth, mature, shake-out, and decline, based on expected cash flow generated separately from operating, investing, and financing.

Market-to-book ratio, or *q* (Tobin's q), is the ratio of the market value of equity item minus the book value of equity plus the book value of assets to the book value of assets.

ROA is return on assets, which is calculated as net income before extraordinary items and discontinued operations divided by total assets.

Firm risk is the ranking (CDF) of standard deviation of 1-year daily stock returns.

log(*Net assets*) is used as a proxy for firm size, where *Net assets* are calculated as total assets less cash and short-term investments.

PPE is investment in property, plant, and equipment scaled by assets.

R&D is research and development expenditure scaled by assets.

CAPEX is capital expenditure net of sales of property, plant, and equipment, scaled by assets.

Leverage is defined as total book debt divided by the market value of equity plus book debt.

Surplus cash is the amount of cash available to finance new projects, scaled by assets.

Advertisement is advertising expenditure scaled by total assets.

Table A1. Comparison with GLQ (2012): Observable and unobservable determinants of executive *Pay level*, connectedness sample with the AKM method

This table presents the regression results on the observable and unobservable determinants of executive incentives. The dependent variable of the regressions is *Total compensation* (TDC1) in million dollars. Specification 1 is a pooled OLS regression without firm or manager fixed effects (FEs). Specification 2 is the firm fixed effect regression. Specification 3 is the manager fixed effect regression. Specification 4 uses both firm and manager fixed effects. Specification 5 includes both firm and manager fixed effects and controls for two-sided matching between firms and executives. Year fixed effects are included in all the specifications. Refer to the appendix for variable definitions. Heteroscedasticity-robust *t*-statistics, clustered at the firm level, are in parentheses. *$p < .1$; **$p < .05$; ***$p < .01$.

A. Dependent variable: **Total compensation**

	(1) Pooled OLS (no firm or manager FE)	(2) Firm FE (no manager FE)	(3) Manager FE (no firm FE)	(4) Firm & manager FE	(5) Firm & manager FE with matching
Tenure	0.015***	0.006***	0.012***	0.002	0.006
	(9.59)	(3.82)	(2.67)	(0.57)	(0.88)
Age	0.014***	0.010***	0.060***	0.053***	0.050
	(6.48)	(4.24)	(5.92)	(5.70)	(1.17)
Female	-0.030	-0.181***	N/A	N/A	N/A
	(-0.95)	(-3.37)			
CEO	1.904***	1.855***	1.043***	0.884***	0.891***
	(48.09)	(47.70)	(20.21)	(16.82)	(17.27)
Director	1.401***	1.412***	1.215***	1.240***	1.516***
	(37.65)	(36.61)	(21.20)	(19.10)	(19.26)
Surplus cash	0.172	-0.412***	-0.185	-0.218	-0.234
	(1.28)	(-3.80)	(-1.06)	(-1.34)	(-2.11)
Leverage	-1.096***	-1.020***	-1.015***	-1.015***	-1.217***
	(-15.32)	(-10.75)	(-9.23)	(-8.94)	(-9.43)
R&D	1.813***	-0.194	-0.283	-0.292	0.052
	(10.85)	(-1.17)	(-1.23)	(-1.16)	(0.50)
q	0.476***	0.445***	0.466***	0.469***	
	(54.28)	(35.26)	(36.24)	(37.09)	
Firm risk	3.017***	1.184***	2.005***	1.783***	
	(30.42)	(7.83)	(12.35)	(8.80)	
Board independence	0.138	0.390***	0.368***	0.477***	0.495***
	(1.40)	(3.38)	(3.16)	(3.86)	(4.09)
Institutional holdings	-0.002	-0.000	0.002	0.002***	0.003***
	(-1.18)	(-0.27)	(1.08)	(2.86)	(2.97)
Predicted *q*					-3.195***
					(-6.26)
					-8.406*

Predicted *Firm risk*					(-1.83)
log(*Net assets*)	1.071*** (122.65)	1.075*** (43.70)	0.933*** (38.19)	0.986*** (32.35)	0.781*** (24.04)
Year FE	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	.35	.45	.61	.65	.65
N	98,754	98,754	98,754	98,754	98,754

B. Relative importance of components in determining pay level

	$\frac{\text{cov}(Total\ compensation, \text{component})}{\text{var}(Total\ compensation)}$	% of R^2 attributable to the component
Manager fixed effects	0.34	47.22
Firm fixed effects	0.05	6.94
Observable manager characteristics	0.08	11.11
Observable firm characteristics	0.15	20.83
Year fixed effects	0.10	13.89
Residual	0.28	

Table A2. Robustness: Observable and unobservable determinants of executive incentives, the movers-only sample with the mover dummy variable method

This table presents the regression results on the observable and unobservable determinants of executive incentives. The dependent variables are *Delta* and *Vega* in panels A and B, respectively. Specification 1 is a pooled OLS regression without firm or manager fixed effects (FEs). Specification 2 includes firm fixed effects. Specification 3 includes manager fixed effects. Specification 4 uses both firm and manager fixed effects. Year fixed effects are included in all the regressions. Refer to the appendix for variable definitions. Heteroscedasticity-robust *t*-statistics, clustered at the firm level, are in parentheses. *$p < .1$; **$p < .05$; ***$p < .01$.

***A. Dependent variable:* Delta**

	(1) Pooled OLS (no firm or manager FE)	(2) Firm FE (no manager FE)	(3) Manager FE (no firm FE)	(4) Firm & manager FE
Tenure	0.010***	0.013***	0.007***	0.008***
	(12.18)	(12.64)	(7.40)	(2.85)
Age	0.006***	0.011***	0.009***	0.004
	(7.29)	(11.84)	(4.05)	(1.26)
Female	-0.068***	-0.031	N/A	N/A
	(-2.84)	(0.93)		
CEO	0.207***	0.169***	0.128***	0.094***
	(14.05)	(11.80)	(8.82)	(6.33)
Director	0.138***	0.118***	0.078***	0.049***
	(10.39)	(7.54)	(6.21)	(3.09)
Market-to-book	0.097***	0.076***	0.073***	0.073***
	(25.40)	(15.22)	(21.00)	(18.78)
Surplus cash	-0.177***	-0.101*	-0.159***	-0.043
	(-3.61)	(-1.86)	(-3.73)	(-1.20)
Leverage	-0.228***	-0.227***	-0.225***	-0.246***
	(-8.80)	(-7.01)	(-9.74)	(-7.33)
R&D	0.095	-0.039	-0.127	-0.279*
	(1.50)	(-0.82)	(-1.08)	(-2.01)
Firm risk	0.196***	-0.175***	-0.006	-0.069
	(4.95)	(-3.27)	(-0.71)	(-1.31)
Board independence	-0.184***	0.033	0.010	0.015
	(-4.36)	(0.69)	(0.40)	(0.38)
Institutional holdings	-0.000	0.000	-0.000	0.000
	(-0.70)	(-0.66)	(-0.50)	(0.77)
log(*Net assets*)	0.095***	0.130***	0.090***	0.145***
	(29.10)	(11.33)	(18.04)	(14.15)
Year FE	Yes	Yes	Yes	Yes
Adjusted R^2	.24	.46	.68	.74
N	14,933	14,933	14,933	14,933

***B. Dependent variable:* Vega**

	(1)	(2)	(3)	(4)

	Pooled OLS (no firm or manager FE)	Firm FE (no manager FE)	Manager FE (no firm FE)	Firm & manager FE
Tenure	0.001***	0.001***	0.000	0.001
	(2.97)	(4.84)	(1.01)	(0.83)
Age	-0.001***	0.000	0.001	0.001
	(-2.90)	(0.42)	(1.30)	(0.94)
Female	-0.002	-0.012*	N/A	N/A
	(-0.51)	(-1.70)		
CEO	0.049***	0.045***	0.029***	0.025***
	(14.52)	(13.09)	(7.29)	(5.26)
Director	0.033***	0.039***	0.026***	0.021***
	(10.77)	(11.62)	(6.79)	(4.10)
Market-to-book	0.011***	0.003	0.003***	-0.001
	(14.08)	(1.26)	(3.18)	(-0.95)
Surplus cash	0.011	0.008	0.027*	0.027
	(1.12)	(0.51)	(1.70)	(1.58)
Leverage	-0.042***	-0.025**	-0.033***	-0.028***
	(-6.94)	(-2.48)	(-4.48)	(-2.43)
R&D	0.170***	0.008	0.000	-0.070
	(8.30)	(0.22)	(0.10)	(-1.30)
Firm risk	-0.010	-0.085***	-0.045***	-0.070***
	(-0.71)	(-6.62)	(-4.26)	(-4.81)
Board independence	-0.015*	-0.007	0.002	0.002
	(-1.72)	(-0.40)	(0.15)	(0.15)
Institutional holdings	-0.000***	-0.000	-0.000	-0.000
	(-2.69)	(-0.48)	(-1.55)	(-0.21)
log(*Net assets*)	0.032***	0.034***	0.023***	0.029***
	(42.10)	(12.02)	(13.84)	(9.28)
Year FE	Yes	Yes	Yes	Yes
Adjusted R^2	.30	.40	.43	.51
N	14,933	14,933	14,933	14,933

C. Relative importance of components in determining delta

	$\frac{\text{cov}(Delta, \text{component})}{\text{var}(Delta)}$	% of R^2 attributable to the component
Manager fixed effects	0.44	54.32
Firm fixed effects	0.14	17.28
Observable manager characteristics	0.08	9.88
Observable firm characteristics	0.13	16.05
Year fixed effects	0.01	1.23
Residual	0.19	

D. Relative importance of components in determining vega

	$\frac{\text{cov}(Vega, \text{component})}{\text{var}(Vega)}$	% of R^2 attributable to the component
Manager fixed effects	0.28	44.44
Firm fixed effects	0.06	9.52
Observable manager characteristics	0.08	12.70
Observable firm characteristics	0.16	25.40
Year fixed effects	0.05	7.94
Residual	0.37	

Table A3. Robustness: Observable and unobservable determinants of executive incentives, full sample with the spell method

This table presents the regression results on the observable and unobservable determinants of executive incentives. The dependent variables are *Delta* and *Vega* in panels A and B, respectively. Specification 1 is a pooled OLS regression without firm or manager fixed effects (FEs). Specification 2 includes firm fixed effects. Specification 3 includes manager fixed effects. Specification 4 uses firm-manager spell fixed effects. Year fixed effects are included in all regressions. Refer to the appendix for variable definitions. Heteroscedasticity-robust *t*-statistics, clustered at the firm level, are in parentheses. *$p < .1$; **$p < .05$; ***$p < .01$.

***A. Dependent variable:* Delta**

	(1) Pooled OLS (no firm or manager FE)	(2) Firm FE (no manager FE)	(3) Manager FE (no firm FE)	(4) Firm-manager spell FE
Tenure	0.009***	0.012***	0.005***	0.001
	(36.71)	(42.57)	(7.18)	(0.77)
Age	0.006***	0.007***	0.011***	0.012***
	(20.31)	(26.45)	(12.11)	(11.84)
Female	-0.020**	-0.022***	N/A	N/A
	(-2.87)	(-2.94)		
CEO	0.219***	0.220***	0.080***	0.082***
	(39.72)	(41.88)	(17.42)	(17.73)
Director	0.195***	0.166***	0.070***	0.054***
	(38.08)	(33.70)	(12.02)	(9.15)
Market-to-book	0.092***	0.069***	0.069***	0.070***
	(72.81)	(41.06)	(53.48)	(54.99)
Surplus cash	-0.063***	-0.118***	-0.051***	-0.022
	(-3.60)	(-5.27)	(-2.83)	(-1.24)
Leverage	-0.141***	-0.064***	-0.070***	-0.062***
	(-18.84)	(-7.44)	(-10.08)	(-8.97)
R&D	-0.022	-0.122***	-0.055***	-0.065***
	(-1.07)	(-3.58)	(-3.10)	(-3.18)
Firm risk	0.148***	-0.130***	-0.065***	-0.092***
	(10.80)	(-5.72)	(-4.04)	(-5.97)
Board independence	-0.222***	0.098***	0.048***	0.048***
	(-14.96)	(5.75)	(3.79)	(4.00)
Institutional holdings	-0.001***	-0.000	0.000	0.000
	(-6.52)	(-0.66)	(0.93)	(0.97)
log(*Net assets*)	0.083***	0.085***	0.110***	0.130***
	(71.68)	(24.60)	(42.15)	(42.64)
Year FE	Yes	Yes	Yes	Yes
Adjusted R^2	.23	.37	.72	.74
N	158,371	158,371	158,371	158,371

B. Dependent variable: **Vega**

	(1) Pooled OLS (no firm or manager FE)	(2) Firm FE (no manager FE)	(3) Manager FE (no firm FE)	(4) Firm-manager spell FE
Tenure	0.001***	0.001***	0.000***	0.000
	(3.24)	(7.40)	(2.41)	(1.58)
Age	-0.000***	-0.000***	0.000*	0.000
	(-13.05)	(-9.12)	(1.87)	(1.39)
Female	-0.001	-0.004***	N/A	N/A
	(-1.21)	(-3.94)		
CEO	0.040***	0.035***	0.023***	0.023***
	(42.60)	(40.79)	(20.50)	(20.42)
Director	0.022***	0.023***	0.022***	0.022***
	(26.22)	(28.52)	(14.56)	(13.59)
Market-to-book	0.009***	-0.002***	0.001	-0.000
	(39.68)	(-5.80)	(1.25)	(-0.53)
Surplus cash	0.015***	-0.005	0.001	0.001
	(6.16)	(-1.34)	(0.92)	(0.44)
Leverage	-0.020***	-0.009***	-0.010***	-0.009***
	(-17.08)	(-6.16)	(-4.53)	(-3.89)
R&D	0.088***	-0.005	-0.008	-0.010***
	(25.22)	(-0.86)	(-1.12)	(-2.16)
Firm risk	-0.006	-0.055***	-0.044***	-0.045***
	(1.34)	(-15.98)	(-11.17)	(-11.41)
Board independence	0.018***	0.012***	0.013***	0.013***
	(6.91)	(5.16)	(5.22)	(4.86)
Institutional holdings	0.000	0.000**	0.000**	0.000***
	(0.73)	(2.30)	(2.65)	(2.96)
log(*Net assets*)	0.022***	0.022***	0.019***	0.020***
	(119.76)	(41.17)	(30.80)	(29.85)
Year FE	Yes	Yes	Yes	Yes
Adjusted R^2	.26	.38	.43	.45
N	158,371	158,371	158,371	158,371