CEO incentive dynamics and their effect on firm value*

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Abstract

This paper examines the trajectory of pay-performance-sensitivity (PPS) in the years immediately after chief executive officers (CEOs) assume their positions. We show that PPS "steady state equilibrium" is not achieved overnight, but instead evolves through a process whereby CEO incentives increase gradually before eventually leveling off. We discuss various factors that might contribute to these observed dynamics including liquidity constraints, career concerns, entrenchment, survivor bias, and learning of the CEOs' true abilities. We find strong support for some, but only mixed support for others. Because median CEO tenure in ExecuComp is eight years, our results suggest that this dynamics of incentive accumulations over a CEO's tenure cannot be ignored when studying executive incentive schemes. Finally, we show this gradual adjustment of PPS over a CEO's tenure to have a meaningful impact on firm valuation, as measured by Tobin's Q.

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Abstract

This paper examines the trajectory of pay-performance-sensitivity (PPS) in the years immediately after chief executive officers (CEOs) assume their positions. We show that PPS "steady state equilibrium" is not achieved overnight, but instead evolves through a process whereby CEO incentives increase gradually before eventually leveling off. We discuss various factors that might contribute to these observed dynamics including liquidity constraints, career concerns, entrenchment, survivor bias, and learning of the CEOs' true abilities. We find strong support for some, but only mixed support for others. Because median CEO tenure in ExecuComp is eight years, our results suggest that this dynamics of incentive accumulations over a CEO's tenure cannot be ignored when studying executive incentive schemes. Finally, we show this gradual adjustment of PPS over a CEO's tenure to have a meaningful impact on firm valuation, as measured by Tobin's Q.

1. Introduction

Pay-performance-sensitivity is a key element in a well-designed compensation contract that provides an agent with the appropriate level of incentives. A large body of research has documented the positive relation between CEO compensation and performance (see Jensen and Murphy, 1990; Haubrich, 1994; and Hall and Liebman, 1998, among many others). But there has been little research into how pay-performance-sensitivity changes over a CEO's tenure, and how this changing process affects firm performance.[1] To the best of our knowledge, ours is the first paper to systematically document from a dynamic perspective the evolution of CEO incentives, and impact of this evolution on firm value, over time.

Our study is important for two reasons. First and foremost, we show that the optimal CEO incentive is not realized overnight, but takes several years to achieve.[2] Our empirical evidence that incentives rise over a CEO's tenure before eventually leveling off has significant implications for empirical analyses that assume equilibrium at all times. Second, a dynamic perspective better serves the design of our test of the relation between CEO incentives and firm value. A typical panel data or cross-sectional data analysis is likely to be subject to the endogeneity problem. Particularly with respect to estimation of the cross-sectional relation between managerial ownership and firm value, this problem could potentially render the interpretation of results difficult (see, for a recent discussion, Fahlenbrach and Stulz [2009]). To the extent that firms (boards' executive compensation committees, to be precise) are believed to be optimizing on incentives to achieve the highest firm valuation at all times, any deviation from

[1] Two papers have explored the relationship between current compensation and future firm performance. Hanlon, Rajgopal, and Shevlin (2003) examine how option grants relate to firm future operating performance. Core, Holthausen, and Larcker (1999) study how excess compensation (compensation level) is related to future performance (both operating performance and stock returns).

[2] Our use of the term "optimum" implicitly assumes that incentives will settle at the level-off level. More important, we verify the optimality by empirically documenting that the firm value rises as the incentive accumulates over a CEO's tenure.

the current incentive level, whether increase or decrease, would precipitate a drop in firm value. We show here, however, that, in fact, it takes a number of years for CEO incentives to reach the optimal level, and that a meaningful increase in firm value is observed concurrently with the increase in incentives during this time.

We design our empirical study as follows. We first demonstrate that the incentives of newly appointed CEOs exhibit a time series dynamic before eventually leveling off. This pattern is robust and substantial, increasing from a median of approximately $3 per $1,000 the first year to a median of about $10 per $1,000 in year five. This documented difference in incentives over the tenure of CEOs has important implications for the design of future empirical studies of CEO incentives: clearly, the incentives of a CEO five years on the job should not be the same as the incentives of a CEO new to the job. This empirical evidence of a dynamic incentive process is the starting point for our empirical exploration of why CEO incentives change. We propose and test a number of factors that might contribute to or explain the dynamics of CEO incentives. To effectively argue that this dynamic process is the path to the optimality, we finally document the associated dynamics with respect to firm value as a CEO's incentive accumulates over her tenure.

The first possible explanation for the incentive dynamics that comes to our mind is an intuitive one: CEO liquidity constraints. Suppose that, in the steady state, the optimal CEO incentive is equivalent to a 10% stake in the firm. It might be infeasible, both economically and politically, but would also be considered outrageous under most circumstances, to grant a CEO a 10% ownership stake in the firm upon appointment. Options, being essentially leveraged positions in firms, might constitute a more "cost effective" way to load CEOs with incentives upfront, but this is possible only if they have great personal wealth, which they are willing to use

to purchase company stocks and options.[3] Nor is it practical to expect CEOs to borrow substantially from the firm in order to purchase the desired 10% stake. When this is indeed the agreed-upon target level for CEO incentives, it might take a number of years to achieve through annual grants of stocks and options. If this is a potential explanation of the observed adjustment process for CEO incentives, it should affect large and small firms differently, as it might be easier for a firm with a $100 million market cap than for a firm with a $100 billion market cap to give a newly hired CEO a 10% upfront stake. We found some empirical support for this argument and later controlled for this effect throughout our explorations of other possible explanations.

The next factor we explore is the learning of CEOs' ability over time. If, as many believe (and as we formally model in the Appendix), a CEO's true ability is unknown when hired by the board and revealed only over time, it is plausible that the CEO's incentives would also evolve according to the perceived "precision" of true ability. This could generate the observed dynamics of PPS over time. Empirically, we test this idea two ways. We first contrast inside with outside CEOs under the assumption that for the former less learning is required.[4] Consistent with this hypothesis, we found the evolution of incentives to be much more dramatic for outside than for inside CEOs. Second, focusing only on inside CEOs, we examine whether tenure with the firm before their appointment has any impact on the evolution of PPS. To the extent that pre-CEO tenure reveals more about a prospective CEO's skills, there will be less to be learned after the

[3] New CEOs are occasionally, but certainly not systematically, observed to make out-of-pocket purchases of their firms' stocks and options. For example, Albert Dunlap, upon being named CEO of Scott Paper in 1994, invested four million dollars in the company's stocks.

[4] This is based on the intuitive assumption that inside CEOs as well as their firms should be better able to assess "fit" than could possibly be the case for outside CEOs, who have no reciprocal experience with their firms. Of course, this is subject to the caveat that inside CEOs, however comfortable with the corporate culture, are still not battle-tested in their new position. But uncertainty about true ability notwithstanding, uncertainty about "fit" is less for insiders than for outsiders.

CEO's appointment and the evolution of the CEO's incentives should thus be less dramatic. Our empirical tests confirm this to be the case. Note for this learning test, we specifically control for CEOs' firm-specific wealth at the time of appointment (through pre-CEO accumulation of firm-specific wealth). We found higher initial firm-specific wealth to be associated with a less dramatic adjustment process for CEO incentives.

Because the CEO tenure variable's use in prior literature to proxy for career concerns, ability, and entrenchment could potentially affect the interpretation of our results, we conduct further analyses along these dimensions, beginning with career concerns. The milestone paper (both analytically and empirically) on career concerns being Gibbons and Murphy (1992), we first verify that their main result (the career concerns hypothesis) holds for our data, and that career concerns remain an important factor today. Controlling for career concerns using the Gibbons and Murphy "close to retirement" measure, we show the effect of our tenure variable on PPS dynamics to remain largely intact.

We next examine entrenchment. It is important to note that entrenchment alone cannot explain increased PPS over CEOs' tenure. If CEOs become more entrenched in their jobs over time, and entrenched CEOs want to reduce PPS for given pay or increase pay for given incentives, PPS should be lower for more seasoned CEOs. But, in fact, we observe the opposite. It is still possible, however, that entrenchment is relevant in explaining the observed dynamics, that it perhaps dampens the post-appointment rise in PPS precipitated by liquidity constraints and manifestation of CEO skills. In other words, entrenchment could be relevant because in its absence PPS might have risen even faster. We test for the impact of entrenchment by breaking the sample into subsamples of well-governed and poorly-governed firms. If the entrenchment effect is operative, the trajectories of CEO PPS adjustments should be different for the two

subsamples. Using as proxies for corporate governance the CPS measure and G-index, we fail to find a meaningful difference in CEO PPS adjustments for either subsample, using either proxy.

The last potential explanation we examine is survivor bias. Having good performance or being able to survive over the years on the CEO post may be the reason behind the observed accumulation of incentive process. We conduct two more tests along the line by first incorporating firm stock return performance and then using predicted CEO retention probability as a proxy for survivor. We find neither variable to have any significant effect on the PPS dynamics observed over CEOs' tenure.

In order to argue that the rise of incentive over a CEO's initial years on the job is to gradually adjust to the optimal, the ultimate test we need to conduct is to show that the firm value also rises concurrently. This will happen as the interests between the CEO and the shareholders are getting better aligned. As such, lastly, we explore how the dynamics of PPS affect firm valuation. We found that change of firm value is positively associated with the change of a CEO's incentive and this positive association diminishes as a CEO's tenure increases. This is consistent with the hypothesis that firms will benefit greatly from a rapid rise in PPS following the appointment of a new CEO, and that this effect gradually diminishes as the CEO seasons. We carefully test this effect by controlling for D&O ownership, to ensure that we are not merely picking up important effects of director and officer ownership on firms' Tobin's Q, first documented by Fahlenbrach and Stulz (2009). Note that this result is in sharp contrast to the running (or implicit) assumption in most of the extant literature that firms are already optimizing on PPS so as to maximize valuation. If this were true, then any change in PPS, whether increase or decrease, would have negative effect on firm value. Given that our PPS analyses have revealed some meaningful differences in incentive convergence based on liquidity constraints

and manifestation of CEO ability, we examine how variations in incentive convergence affect the speed of convergence on firm value. We find firm value convergence to be slower both in larger than in smaller firms (although the difference is not statistically significant) and for firms with CEOs promoted from within than for firms with CEOs hired from outside.

Our results indicate that target levels for new CEO incentives do not obtain overnight, but are the product of a process of adjustment that occurs over a period of six to eight years before tapering off. This adjustment is largely consistent with learning of CEOs' true ability and we also find some supporting evidence for liquidity constraint. Firm value increases in step with incentive increases. Our findings regarding the effect of CEO incentive dynamics on firm value suggest that any initial constraint, regardless of where it stems from, represent a substantial cost to firms.[5] To the extent that firms can overcome these constraints and rapidly increase PPS during the early years of a CEO's tenure, we will observe a meaningful increase in firm value, as measured by Tobin's Q.

Our paper makes the following contributions to the CEO compensation and firm valuation literatures. First, it documents systematic differences in PPS over the tenure of CEOs, and suggests that subsequent literature cannot simply ignore this accumulation process. Assuming a complete and frictionless world so that the CEO incentive should be at the optimal all the time, Core and Guay (1999) use panel data to examine how the flow of incentives from annual compensation is used to restore an optimal level whenever there is any deviation (either too much or too little incentive). Our paper explicitly documents the adjustment process whereby pay-performance-sensitivity reaches the steady state level to take several years. More important,

[5] For example, a smoothing CEO transition would be ideal here even when the firm prefers hiring an outsider. What the firm could do is to hire the potential CEO candidate first as president or COO for a year or two before the baton is passed to her.

by tying this dynamic process to corresponding increases in firm value, we can directly argue for optimality.

Second, this dynamic perspective, being less contaminated by the usual concern that firm value is already optimized, provides a natural comparative static analysis setting in which to test how changes in incentives affect firm value. We believe ours is the first paper to use this dynamic process to link changes in current year incentives to changes in next year firm value, and show that the process of adjusting incentives to optimal levels is accompanied by increases in firm value. This suggests that increasing CEO incentives improves alignment of the interests of CEOs and shareholders such that firm value improves as well. Our study differs from studies that use panel data to cross-sectionally examine the relation between managerial ownership and firm value. Fahlenbrach and Stulz (2009) avoid the endogeneity problem by relating (large) current changes in ownership (by both officers and directors) and Tobin's Q to the next year's change in Tobin's Q. They show an increase in managerial ownership, especially in shares held by officers, to increase Tobin's Q.[6] Because we use Fahlenbrach and Stulz's methodology to follow the same CEOs, we are able to document the dynamic process whereby changes in incentives precipitate changes in firm value and show that, eventually, the improvement in Tobin's Q saturates.

This paper broadly relates to the following separate but related literatures. The first explores the relationship between career concerns and CEO incentives. Gibbons and Murphy (1992) predict a rise in incentives (1) as retirement nears, holding tenure constant (career concerns hypothesis), and (2) with tenure, holding years remaining as CEO constant (learning

[6] The relationship between change in D&O ownership and change in Tobin's Q in Fahlenbrach and Stulz (2009) is still cross-sectional, although they document a time trend in the change in D&O ownership from 1988 to 2003.

hypothesis). Using Forbes CEO compensation data, and with a dummy indicator for each hypothesis (close to retirement for the former, early tenure for the latter), they find strong supporting evidence for their career concerns, but not for their learning hypothesis. In a related paper, Milbourn (2003) uses CEO perceived ability/reputation to explain the heterogeneity in stock-based pay sensitivity. Using four measures including CEO tenure as proxies for perceived ability/reputation, he documents a positive relation between CEO reputation and stock-based compensation.[7] The third related paper, a concurrent work by Cremers and Palia (2010) focused on the correlation between tenure and CEO compensation, documents a positive association between tenure and CEO pay level, and a positive, but weak, relation between tenure and CEO pay-performance-sensitivity. Our paper explicitly uses the CEO tenure variable as a proxy for the dynamic process (whether learning or not) beginning with a CEO's first year on the job, and provides, by documenting the process of increasing incentives over a CEO's tenure, strong, consistent empirical evidence of the learning hypothesis predicted in Gibbons and Murphy (1992). More important, we document that this process is converging, and further link it to improvements in firm value over a CEO's tenure.

The second literature to which this paper relates is the one which explores the relationship between managerial ownership and firm value. Drawing inspiration from the agency model, this considerable literature tests the positive relation between managerial ownership and Tobin's Q, and finds the two to be positively related, but in a nonlinear manner due to entrenchment when ownership becomes too large (Morck, Shleifer, and Vishny, 1988). As first noted by Demsetz (1983) and Demsetz and Lehn (1985), however, any cross-sectional relationship between

[7] CEO ability or talent is typically modeled as an unknown but fixed parameter (see both Gibbons and Murphy [1992] and Milbourn [2003]). The *manifestation* of an unknown ability is a dynamic process, but ability is not. Believing *length* of CEO tenure (not tenure itself) to be a good proxy for CEO talent, we control for it in one of our sensitivity tests (untabulated) and find our results to be unchanged. The finding will be provided upon request.

managerial ownership and Tobin's Q should not be observed in equilibrium if managerial ownership is the solution to the agency problem in a public firm. This led to subsequent studies that tried to get around the endogeneity problem by using various methods including fixed-effect (Himmelberg, Hubbard, and Palia, 1999), instrument variables (Demsetz and Villalonga, 2001; Villalonga and Amit, 2006, Coles, Lemmon, and Meschke, 2006), and change on change (Fahlenbrach and Stulz, 2009). But whereas these papers examine mainly the relationship between managerial ownership and Tobin's Q via cross-sectional variation, we explore the dynamic process whereby firm value changes over a CEO's tenure, in particular, how changes in incentives over the CEO's tenure occasion changes in firm value that eventually level off.[8]

The rest of the paper is structured as follows. Section 2 discusses our data sample and research designs. Section 3 presents the empirical analyses. Section 4 concludes. The Appendix describes a theoretical model that fully develops our intuition with respect to learning and its impact on the evolution of incentives and firm value.

2. Data and research design

2.1. Data and key variables

We use the ExecuComp data set to identify CEOs and extract their compensation, ownership, and tenure information (hand collected from firm proxy statements if missing). CEOs' prior positions, hand collected by reading articles from Factiva, were used to distinguish outside from inside CEOs. CEOs brought in from outside the firm, at the moment of assuming the position, are classified as outside CEOs. Following Parrino (1997), CEOs with a firm for less

[8] Due to data limitations, CEO ownership is rarely used in studies in this literature. Typically used instead are various definitions of managerial ownership, such as directors', top largest shareholders', and directors' and officers' ownership.

than a year before becoming CEO are also classified as outside CEOs. The remaining CEOs are coded as inside CEOs. Directors' and officers' ownership is from Compact Disclosure. All firm characteristics variables except firm risk, which is based on daily stock return data from CRSP, are from Compustat.

The key variables of interest in our empirical analyses are pay-performance-sensitivity, Tobin's Q, and CEO tenure. We use both Jensen and Murphy's (1990) and Core and Guay's (1999) PPS measures. The former measures PPS as the dollar change in executive wealth per $1,000 change in shareholder wealth, the latter as the dollar change in executive wealth per 1% change in stock price.[9] Given its less stringent data requirement, we compute the Core-Guay PPS first, using annual compensation information (for both options and stocks) from ExecuComp, then convert it to the Jensen-Murphy PPS using the following relation between the two measures: PPS_{JM} = (PPS_{CG}*100,000)/Market value (Core and Guay, 1999). Tobin's Q is a standard measure of market value of assets divided by book value of assets. The key variable in our examination of the dynamic processes for both incentive and firm value, the CEO tenure variable, is measured as the years a CEO has been in the position since taking the post.

We restrict our sample to CEOs who assumed their positions during the sample period 1992 to 2007. We do this for two reasons, (1) because the dynamic process is best examined from the year in which a CEO was hired, and (2) because compensation practice has changed so much over the past several decades (Murphy, 2000). The compensation trajectories of CEOs hired before the start of our sample period (for instance, in the 1970s or 1980s or earlier) may be

[9] The Jensen-Murphy PPS is more aligned with the ownership concept, but subject to the firm size criticism, the Core-Guay PPS free from the firm size criticism, but subject to stock price variation.

quite different from those of CEOs hired in 1990.[10] In addition, to remove interim CEOs, we delete any who held the job for less than two years.[11] Throughout the paper, standard errors are corrected by clustering at firm-CEO level. When we restrict the sample for our main test to CEOs whose last year with their firms also falls within the sample period, our results are unchanged.

2.2. Empirical design

The first part of our analysis of CEO incentives tests the relation between PPS and CEO tenure using the following specification.

$$PPS = \alpha + \beta_1 * Tenure + \beta_2 * Tenure^2 + \gamma Controls + \varepsilon \quad (1)$$

The parameter associated with *Tenure* (β_1), which captures the dynamic process of increasing the PPS variable, is expected to be positive, the parameter associated with $Tenure^2$ (β_2), which captures the convergence of the evolving PPS process, expected to be negative.

We follow Core and Guay (1999) and Jin (2002) in our selection of control variables, which include *Book-to-Market* (to proxy for growth opportunity), *Free-cash-flow problem* (to proxy for the agency problem), *Sales* and its square (to control for size effect), *Capital* and its square, *R&D* (to control for the benefits of giving incentives), *Advertising, Investment,* and *Risk.* We add two more controls, the *G-index* for corporate governance, and *Trend* and its square. The last control variable is particularly important as we want to ensure that tenure is capturing the dynamic process rather than a time trend. When we test liquidity constraints, learning of unknown ability, entrenchment, and survivor bias, we interact a new variable with *Tenure* and

[10] Using all CEOs covered by ExecuComp from 1992-2007 yields nearly the similar but little weaker results for all analyses performed in the paper.

[11] Most were appointed as interim CEOs, and some are actually turnovers; a two-year term being too brief to exhibit any dynamic pattern, we remove them from of our sample.

Tenure^2. To test the impact of firm size on the evolution of PPS, we define a dummy variable, *Large*, that takes the value of one if the market value of equity is larger, and zero if it is smaller, than the sample median in the year in which the CEO is hired. (Note that this variable is firm, not firm-year, based.) For the tests based on insider/outsider difference, we define a dummy variable, *Outsider*, that takes the value of one if the CEO is hired from outside, and zero if promoted from within, the firm. For the test of CEO entrenchment, we define a dummy variable, *Large_CPS* or *Large_G-index*, that takes the value of one if it is above the sample median, and zero otherwise. For the test of survivor bias, we define a dummy variable that takes the value of one if the probability of CEO retention is larger than the sample median, and zero otherwise. The specification becomes:

$$PPS = \alpha_1 + \alpha_2 * Dummy + \beta_1 * Tenure + \beta_2 * Tenure^2 + \beta_3 Dummy * Tenure + \beta_4 * Dummy * Tenure^2 + \gamma Controls + \varepsilon \quad (2)$$

We expect the parameters associated with the interaction term *Dummy* Tenure* (β_3) and interaction term *Dummy* Tenure*^{2} (β_4) to be significant if there is any difference in the incentives convergence process for different groups of CEOs. If there is any difference in the initial incentives level across groups of newly hired CEOs, we expect the parameter associated with the dummy (α_2) to be significant as well.

For the analysis of how firm valuation changes with incremental changes in CEO incentives, we adopt the same methodology as Fahlenbrach and Stulz (2009) to mitigate the potential endogeneity problem between ownership and Tobin's Q. Specifically, we locate change of independent variable at time *t-1* on the right hand side and change of dependent variable at

time *t* on the left hand side. This research design being particularly suited to our setting, as we document first the increasing incentives over CEOs' tenure, we use the following specification.

$$\Delta Tobin'sQ_t = \alpha + \beta_1 \Delta PPS_{t-1} + \beta_2 \Delta PPS_{t-1} * Tenure_{t-1} + \gamma Controls + \varepsilon \quad (3)$$

The two key parameters for our prediction are β_1 and β_2. The parameter associated with ΔPPS (β_1) is predicted to be positive to reflect the positive impact of incentives on firm value, the parameter associated with $\Delta PPS * Tenure$ (β_2) to be negative to reflect the diminishing positive effect of incentives as tenure increases. We select our control variables largely following Fahlenbrach and Stulz (2009), and include firm size, investment, and risk, analyst coverage, financially constrained, and NYSE and NASDAQ turnovers and stock returns. We also include the G-index for governance as well as time trend and D&O ownership. The last control variable is extremely important to us, as we want to show our results for incentives to be over and above the D&O ownership effect (their main variable of interest) documented in Fahlenbrach and Stulz (2009). For our cross sectional variation analyses, we interact the same dummy variables as defined above for Eq. (2) with the two key variables of interest in Eq. (3), which becomes:

$$\begin{aligned}\Delta Tobin'sQ_t = {} & \alpha + \beta_1 \Delta PPS_{t-1} + \beta_2 \Delta PPS_{t-1} * Tenure_{t-1} + \beta_3 Dummy * \Delta PPS_{t-1} \\ & + \beta_4 * Dummy * \Delta PPS_{t-1} * Tenure_{t-1} + \beta_5 * Dummy + \gamma Controls + \varepsilon\end{aligned} \quad (4)$$

Again, we expect the parameters associated with the interaction term $Dummy * \Delta PPS_{t-1}$ (β_3) and the interaction term $Dummy * \Delta PPS_{t-1} * Tenure_{t-1}$ (β_4) to be significant if the difference in the incentives convergence process has a differential impact on the change in firm value.

3. Empirical analyses

3.1. Dynamic process of pay-performance-sensitivity

Table 1 and Table 2 report the summary statistics for all variables used in the first and second part of our analyses separately. Because we have slightly different samples for our two sets of analyses, due to the availability of the variables used in each, sample statistics for the same variables are close but different between the two samples. For the first sample, the mean of the Jensen-Murphy PPS is about $17.57, the median $9.01 for a one thousand dollar change in shareholder wealth. The mean of the Core-Guay PPS is $684 thousands, the median $171 thousands for a one percent change in stock price. Both measures exhibit the right skewness commonly observed in CEO compensation measures. The mean (median) for CEO tenure is 4.79 (4) years. For the second sample, the mean (median) for the Jensen-Murphy PPS is a slightly larger (than for the first sample) $18.75 ($10.03), and the mean (median) for CEO tenure longer at 6.39 (6) years.[12] The average of Tobin's Q in the latter sample is 1.97 (its median 1.53). Note that the statistics for our *D&O ownership* variable are significantly lower than those reported in Fahlenbrach and Stulz (2009), the reason being that the use of the ExecuComp data set restricts our sample to the S&P 1,500 largest firms. The mean for *D&O ownership*, at 22.08%, is comparable to the mean for their sample, and for *Assets* is $3,768 million before merging with ExecuComp data. After merging, the mean for *D&O ownership* reduces to 7.13%, and for *Assets*, it rises to $11,228 million.

Our first test is on the dynamic process for CEO incentives. Table 3 reports the main results. Panel A uses the full sample; Panel B reports the results of sensitivity tests using two different subsamples, for both of which we require that both the first and last year with the firm fall into the sample period of 1993-2007. Considering the potential effect of extreme values or right

[12] Note that the statistics reported here for tenure variable is CEO-year based. The mean and median would be 9.8 and 8 years if it is CEO based (i.e. the CEO length).

skewness on PPS measures, we follow Core and Guay (1999) in using log (PPS+1) as the dependent variable. Our results are unchanged when the median regression is used for all PPS analyses. The Jensen-Murphy PPS measure is reported in the left column, the Core-Guay PPS measure in the right column. For both measures of PPS, the estimates associated with the tenure variable are significantly positively related to PPS, which suggests that CEO incentives are strengthened as tenure increases. When tenure increases by one year, for example, the log Jensen-Murphy incentive goes up by 0.22, a 46% increase in incentives in the first year for a CEO who starts with $3 per $1,000 in incentives. The speed of this incentive strengthening process decreases, however, as all the estimates associated with $Tenure^2$ are negative.

For the control variables, the strong positive effect of the time trend possibly reflects the increasing use of incentive compensation over the past two decades. That the size variable has a positive and significant effect on the Core-Guay PPS measure, but a negative, insignificant effect on the Jensen-Murphy measure, is a natural consequence of the difference between the two PPS measures. This difference also explains the opposite estimates for some of the other firm characteristic control variables such as R&D, advertising, and book-to-market. Opposite estimates of the two measures for firm risk we believe to be a result of endogeneity between firm risk and incentives, a problem emphasized in Dai, Jin, and Zhang (2010).

The dynamic process documented above depends, of course, on a CEO's life with a firm. To determine whether our sample selection might affect our results, we repeat our analyses using a full tenured CEO-years subsample, by which we mean that CEOs' first and last years with their firms fall into our sample period of 1992-2007. The results from this sample are presented in the left two columns of Panel B. We then further restrict the sample to CEO-years in which CEOs' tenure with a firm is at least six years (this is also the sample we use for the career concerns test,

the results of which are reported in Table 7). The results are similar, although the magnitude varies somewhat across the three different samples.

3.2. Possible explanations for the dynamic incentives process

We are now ready to explore possible explanations for the dynamic incentive process, beginning with simple CEO liquidity constraints. Although both the board that hires a new CEO and the CEO might agree at the outset on an optimal incentive level, say, 10% of firm ownership, it is highly unlikely that the CEO will be able to get there immediately, or even within one year, owing either to the CEO lacking sufficient liquidity to purchase the requisite shares, or the firm being unable or unwilling to make such a substantial grant of equity compensation in a single year. Boards' consequent tendency to increase incentives gradually over a CEO's tenure is termed the liquidity constraints hypothesis.

Everything else being equal, this constraint would be more severe for CEOs of large than of small firms. So we test this hypothesis with a dummy variable (one if a firm's market equity value is above the sample median, zero if below). Table 4 reports the results. We find that firm size does, indeed, reduce the magnitude of the relation between incentives and CEO tenure. For example, were the log incentives to go up each year as CEO tenure increases, say, by 0.26 for small firms, the log incentives would go up by only 0.16 the first year for large firms. Additionally, the estimates associated with size and $Tenure^2$ are positive, suggesting that the process of increasing CEO incentives is much slower in large than in small firms. This suggests that the convergence process is quite different for large and small firms. With that, we do find no results when the Core-Guay measure is used. This should not be surprising, however, given the earlier remarked definitional difference between these two PPS measures.

The second hypothesis around the dynamic process of convergence concerns the manifestation of CEOs' unknown talents. As is consistently shown in Bayesian learning models, uncertainty about a CEO's unknown talent should be reduced as that talent is revealed to the principal over time. Consequently, as CEO tenure increases, uncertainty about CEO ability should decrease and incentives increase to balance the risk-incentives trade-off. We formally derive this result and its impact on firm value over the learning process in the Appendix. We test this possibility by partitioning CEOs into those promoted from within and those hired from outside of firms using information gathered through reading news announcement. Some CEOs are dropped due to missing information for this test. Intuitively, the board is supposed to have more knowledge about CEOs' ability on those promoted from within than those hired from outside. In other words, more learning will be going on for a CEO newly arrived from outside than a CEO who has been with the firm for some time, and, correspondingly, the longer insiders have been with their firms before being promoted to CEO, the less there is to learn about their unknown ability.

Table 5 provides the results for this hypothesis. Again, results for the Jensen-Murphy measure of PPS are reported in the left, results for the Core-Guay measure in the right, column. We find the coefficients associated with *Tenure* and $Tenure^2$, and their interactions with *Outsider*, to be significant, both statistically and economically. In particular, we find the incentives increase as CEO tenure increases by one year to be much greater for outside than for inside CEOs (0.4994 vs. 0.2061 using the Jensen-Murphy measure; 0.6056 vs. 0.2219 using the Core-Guay measure). Convergence is also much more rapid for outside than for inside CEOs (-0.0316 vs. -0.0099 using the Jensen-Murphy measure; -0.0392 vs. -0.0085 using the Core-Guay

measure). The results seem to suggest that gradual manifestation of their unknown ability could explain the incentives dynamics over CEOs' tenure.

There is, however, a confounding factor associated with this test in that inside CEOs may already have accumulated certain level of incentives before being promoted, and this "initial endowment," gives rise to the incentive convergence difference documented in Table 5. In fact, we do observe the coefficient associated with O*utsider* to be significantly negative. To disentangle the learning effect from this "initial endowment" effect, we perform for inside CEOs only three analyses to determine how each factor, individually and jointly, contributes to the incentive convergence process. Results are reported in the three panels of Table 6. In Panel A, years with the firm before becoming CEO will be our second proxy for the learning effect. Panel B directly interacts inside CEOs' initial incentives with *Tenure* and $Tenure^2$ to proxy for the endowment effect. Panel C includes both the learning and endowment effects. The results from Panel A indicate that the longer a CEO has been with a firm before being promoted, the slower convergence, as the coefficient associated with *Years became CEO*Tenure* is significantly negative and the coefficient associated with $Years\ became\ CEO*Tenure^2$ significantly positive. Panel B shows the size of initial incentives to also matter for incentive convergence; the greater the initial incentives before becoming CEO, the slower convergence. Combining these effects in the same test in Panel C, we find both to have a significant effect on CEO incentive convergence. The results of the last test suggest that manifestation of CEOs' unknown ability does contribute to the incentives dynamics. Note that if the initial incentive serves as an indirect measure for the liquidity constraint, the results in Panel C provide some evidence in support of the liquidity constraints hypothesis.

As discussed in the previous section, CEO tenure has been used in prior empirical literature as a proxy for career concerns (Gibbons and Murphy [1992]). We now test whether career concerns might contribute to the observed incentive dynamics. Note that the difference between the career concerns and learning hypotheses is that the former holds length of CEO tenure constant, such that PPS will be greater for CEOs closer to, than for CEOs farther from, retirement, whereas the latter holds years remaining as CEO constant, in which case PPS will be greater for CEOs who have more than for CEOs who have fewer years on the job.[13] Gibbons and Murphy (1992) made this distinction clear in two separate hypotheses (their original hypotheses one and two). Because Gibbons and Murphy (1992) use the Forbes sample covering 1970-1988, we first replicate their test and report the results in Panel A of Table 7. Following Gibbons and Murphy (1992), we define a dummy that takes the value of one for CEOs in their last three years in the position, and zero otherwise. To define this variable, we need to know a CEO's last year with a firm, and, again following Gibbons and Murphy (1992), further require that the CEO have been with the firm, as CEO, for at least six years. These conditions dramatically reduce our sample size for this test. In Panel A of Table 7, we find the dummy variable *Close to Retirement* to be significant, confirming Gibbons and Murphy's (1992) career concerns hypothesis. We want to control for the career concerns effect in our incentive dynamics analysis, and Panel B of Table 7 does that. We find that the dynamic process persists, but the career concerns effect disappears.

We next assess the impact of the CEO tenure variable, commonly used as a proxy for CEO entrenchment even though entrenchment would not necessarily lead to the observed

[13] The example would be as follows. For career concerns, CEO A and CEO B both have 10 years' tenure, but CEO A is in year eight and CEO B in year two on the job. The career concerns hypothesis predicts a higher PPS for CEO A than for CEO B because the former is closer than the latter to retirement. For learning, CEO A and CEO B both have five years remaining as CEO, but CEO A has been CEO for five years already (10 years total tenure) and CEO B for only one year (six years total tenure). The learning hypothesis predicts that PPS will be higher for CEO A than for CEO B because the former is better known than the latter.

incentive dynamic. We explicitly measure entrenchment and its impact, if any, on incentive dynamics using two common corporate governance measures, namely, CPS (CEO pay slice), which is the CEO's fraction of the total pay of the top five executives (Bebchuk, Creamers, and Peyer, 2010), and the G-index (Gompers, Ishii, and Metrick, 2003). For both measures, we define a dummy that takes the value of one if it is above sample median, and zero otherwise, one indicating entrenchment. The results are presented in Table 8, Panel A using CPS, Panel B the G-index, for entrenchment. Note that although both measures are lagged, CPS is firm-year based and the G-index firm based (the year before the CEO was hired). Results from both panels indicate that entrenchment has no significant effect on CEO incentives dynamics. So we conclude that entrenchment probably does not play any role in the observed phenomenon of increasing incentives over CEOs' tenure.

The last test reported here is of survivor bias. That CEOs have kept their jobs over time implies that they have been successful (with good performance) such that they have survived. To test this possibility, we perform two tests, one to control for performance and interact it with the variables of interest, the other to control for CEO retention probability and interact it with the variables of interest. The results are presented in Panel A and Panel B, respectively, of Table 9. Panel A shows that the stock return, although it has positive effect on CEO incentives, does not affect the dynamic process. In Panel B, none of three, newly added variables are significant. We conclude from these tests that survivor bias does not explain the observed dynamic process.

3.3. Firm value dynamics over CEO tenure

If we believe that it takes time for compensation incentives to reach the optimal level, the ultimate test should be on firm value, as optimality has to be argued from the shareholders'

perspective. Here, we relate to firm value the earlier documented dynamic process of change (or increase) in incentives and the possible explanations (or cross-sectional variations) thereof.

Given the potential for endogeneity in the relationship between Tobin's Q and incentives when panel data is used, we follow Fahlenbrach and Stulz (2009) in using the change specification in our regression to examine how changes in current incentives affect future (following year) changes in firm value. This research design is especially relevant in our context, as we have already documented that incentives increase over a CEO's tenure. We relate year t compensation information to year t+1 firm value, assuming CEO compensation information in year t to be fully known to the market in year t+1. Because proxy statements are typically filed three months after year-end, this is a safe assumption. Under this methodology, we not only lag the independent variables, but use as well changes in both the incentives variable and firm value. We also use the changes in most of our control variables. Results are reported in the two columns in Table 10.

The difference between the two columns is that we add, à la Fahlenbrach and Stulz (2009), four more controls for the right column. The first thing we notice is that the change in current incentives is significantly and positively related to the following year's change in Tobin's Q (0.016 with p-value of 0.005), suggesting that the increase in CEO incentives is accompanied by an increase in firm value. This improvement in firm value gradually diminishes, however, as CEO tenure increases, as indicated by the negative coefficient associated with the interaction term of change in PPS and tenure (-0.001 with p-value of 0.035), which reduces the positive effect of year by year changes in incentives that suggest the convergence of firm value over CEO tenure. Re-estimating this regression including the financial market turnovers and stock returns of the past two years does not affect, economically or statistically, our results for either

coefficient of interest, and three of the four controls are statistically and significantly correlated with Tobin's Q, suggesting that it is important to control for these variables in firm value analyses.[14]

Regarding our control variables, again consistent with Fahlenbrach and Stulz (2009), we find change in directors' and officers' ownership to have a positive effect on firm value, implying that managerial ownership, in helping to relieve the agency problem, is positively correlated with firm value. We find firm size, change in investment, and past stock returns all to be significantly negatively correlated, and analyst coverage to be positively correlated, with firm value. None of the remaining controls are statistically significant, nor does the tenure variable have any impact on firm value.

Having documented (in section 3.2.) a significant impact of the liquidity constraint and manifestation of CEO ability on the incentives convergence paths, we now test their effect on firm value. Results of the test of the liquidity effect measured by firm size are reported in Table 11, results of the test of the learning effect measured by partitioning CEOs into insiders and outsiders in Table 12. When we add the size dummy *Large* to our model, we find from both columns in Table 11 that the incentive change for CEOs in large firms has little impact on Tobin's Q, and that the effect drop is less over a CEO's tenure. The coefficients of $Large * \Delta PPS_{t-1}$ and $Large * \Delta PPS_{t-1} * Tenure_{t-1}$ are not, however, statistically significant. Our results suggest that although the incentives convergence path is somewhat different for CEOs in large and small firms, the impact of the change in incentives over a CEO's tenure on the change in Tobin's Q is not significantly different between large firms and small firms. Note that, independently, the dummy *Large* has a significantly negative effect on the change in Tobin's Q.

[14] The coefficient associated with *D&O Ownership* becomes slightly weaker with these additional controls, consistent with Fahlenbrach and Stulz (2009).

We can see in Table 12 that the increase in firm value attributable to the increase in incentives is much greater for outside (0.049) than for inside (0.014) CEOs, and that, over time, the effect is more negative for outside (-0.006) than for inside (-0.002) CEOs. Adding the four controls does not affect our results. Interestingly, the effect on *D&O Ownership* is also minimal. No significant difference in firm value is observed between the two groups of CEOs in terms either of when they were hired or their length of tenure (the coefficients of *Tenure* and *Outsider* are statistically not different from zero). All this seems to suggest that any difference in firm value over the tenure of inside and outside CEOs stems from the incentive difference associated with their compensation contracts.

Traditional firm theory stresses the relation between ownership and firm value (e.g., Demsetz, 1983). Empirically, prior researchers have used company's directors' ownership (Morck, Shleifer, and Vishny, 1988), top 5 or 20 largest shareholders' ownership (Demsetz and Lehn, 1985), and directors' and officers' ownership (Fahlenbrach and Stulz, 2009) to examine how ownership affects Tobin's Q. Consistent with this practice, our last test uses ownership rather than incentives (or PPS) to test the dynamic process that generates the relation between ownership and firm value over CEOs' tenure. Table 13 presents the results. For this test, we exclude, when D&B ownership is used as a control, CEO ownership from the D&B ownership measure in columns (3) and (4).

The left two of the four columns in Table 13 use only change in CEO ownership, the right two columns change in CEO ownership while controlling for other directors' and officers' ownership. Change in CEO ownership has a positive effect on the change in Tobin's Q, which diminishes as CEO tenure increases. Directors' and officers' ownership has a marginally

significant positive effect on firm value, but little effect, when added to CEO ownership, on its decreasing positive relation with Tobin's Q.

4. Concluding remarks

This paper identifies and examines the dynamic process by which the incentives of newly hired chief executive officers change over time. We find a systematic and substantial increase in pay-performance-sensitivity to be associated with CEO tenure. Exploring factors perceived to be likely to contribute to the observed dynamics, and found the pattern to be most consistent with gradual manifestation of CEOs' true skills over time, and somewhat consistent with liquidity constraints story and career concerns. We do not find support for a story based on CEO entrenchment or for survivor bias driving our results. The observed dynamics also have a meaningful impact on firm valuation. To the extent that the loading of incentives in CEOs' early years can be expedited, firm valuation, as measured by Tobin's Q, will increase.

References

Bebchuk, L., M. Creamers, and U. Peyer, 2010, The CEO Pay Slice, Working paper, Harvard Law School.

Bushman, R., Z. Dai, and X. Wang, 2009, Risk and CEO Turnover, Journal of Financial Economics 96, 381–398.

Coles, J., M. Lemmon, and J. Meschke, 2006, Structural Models and Endogeneity in Corporate Finance: The Link between Managerial Ownership and Corporate Performance, Working paper, University of Utah.

Core, J., R. Holthausen, and D. Larcker, 1999, Corporate Governance, CEO Compensation, and Firm Performance, Journal of Financial Economics 51, 371–406.

Core, J., and W. Guay, 1999, The Use of Equity Grants to Manage Optimal Equity Incentives Levels, Journal of Accounting and Economics 28, 151–184.

Core, J., W. Guay, and D. Larcker, 2003. Executive Equity Compensation and Incentives: A Survey, Economic Policy Review 9, 27-50.

Cremers, M., and D. Palia, 2010, Tenure and CEO Pay, Working paper, Yale University and Rutgers University.

Dai, Z., L. Jin, and W. Zhang, 2010. Litigation, Corporate Governance and Executive Compensation, Working paper, Harvard University and University of Texas, Dallas.

Demsetz, H., 1983, The Structure of Ownership and the Theory of the Firm, Journal of Law and Economics 26, 375–390.

Demsetz, H., and K. Lehn, 1985, The Structure of Corporate Ownership: Causes and Consequences. Journal of Political Economy 93, 1155–1177.

Demsetz, H., and B. Villalonga, 2001, Ownership Structure and Corporate Performance. Journal of Corporate Finance 7, 209–233.

Fahlenbrach, Rudiger, and Rene Stulz, 2009, Managerial Ownership Dynamics and Firm Value, Journal of Financial Economics 92, 342–361.

Gibbons, R., and K. Murphy, 1992, Optimal Incentives Contracts in the Presence of Career Concerns: Theory and Evidence, Journal of Political Economy 100, 468–505.

Gompers, P., J. Ishii, and A. Metrick, 2003, Corporate Governance and Equity Prices, The Quarterly Journal of Economics, 107–155.

Hall, B. J., and J. B. Liebman, 1998, Are CEOs Really Paid Like Bureaucrats? The Quarterly Journal of Economics CXIII, 653–691.

Hanlon, Michelle, Shivaram Rajgopal, and Terry Shevlin, 2003, Are Executive Stock Options Associated with Future Earnings? Journal of Accounting Economics 36, 3–43.

Haubrich, J. G., 1994, Risk Aversion, Performance Pay, and the Principal-Agent Problem, The Journal of Political Economy 102, 258–276.

Hermalin, B., and M. Weisbach, 2008, Information Disclosure and Corporate Governance, Working paper, University of California at Berkeley.

Himmelberg, C., R. Hubbard, and D. Palia, 1999, Understanding the Determinants of Managerial Ownership and Performance, Journal of Financial Economics 53, 333–384.

Holmstrom, B., 1999, Managerial Incentives Problems: A Dynamic Perspective, The Review of Economic Studies 66, Special Issues, 169-182.

Jensen, M. C., and K. J. Murphy, 1990, Performance Pay and Top-Management Incentives, The Journal of Political Economy 98, 225–264.

Jin, L., 2002, CEO Compensation, Diversification, and Incentives, Journal of Financial Economics 66, 29–63.

Milbourn, T., 2003, CEO Reputation and Stock-based Compensation, Journal of Financial Economics 68, 233-262.

Morck, R., A. Shleifer, and R. Vishny, 1988, Management Ownership and Market Valuation: An Empirical Analysis, Journal of Financial Economics 20, 293–315.

Murphy, K. J., 2000, Executive Compensation, in O. Ashenfelter and D. Card (eds), Handbook of Labor Economics, Vol. 3, North-Holland, Amsterdam, Chapter 38: 2485- 2563.

Parrino, R., 1997, CEO Turnover and Outside Succession: A Cross-sectional Analysis, Journal of Financial Economics 46, 165–197.

Taylor, L., 2010, CEO Pay and CEO Power: Evidence from a Dynamic Learning Model, Working paper, University of Pennsylvania.

Villalonga, B., and R. Amit, 2006, How Do Family Ownership, Control, and Management Affect Firm Value? Journal of Financial Economics 80, 385–417.

Table 1 Descriptive Statistics for PPS Convergence Analysis

The sample period is 1993-2007 and sample size 7,512 firm-CEO-years. ***Jensen-Murphy PPS*** is the Jenson and Murphy measure of pay-performance-sensitivity (change in wealth for every $1,000 change in shareholder wealth) converted from the Core and Guay measure (change in wealth for 1% change in stock price) using the following formula: *PPS* = (Core and Guay *PPS* *100,000)/Market value (Core, Guay, and Larcker, 2003); ***Core-Guay PPS*** is computed for both options and stocks based on Core and Guay (1999); ***Tenure*** is CEO tenure; ***Capital*** is gross plant, property and equipment; ***R&D*** is equal to the research and development expenditure if R&D expenditure is not missing, otherwise zero; ***Missing R&D*** is an indicator variable that equals one if R&D expenditure is missing, otherwise zero; ***Advertising*** is the advertisement expenditure; ***Investment*** is the capital expenditure; ***G-Index*** is from Gompers, Ishii, and Metrick (2003); ***Idiosyncratic Risk*** is the standard deviation of the residual from the CAPM model using firms' daily return over the year; ***Book-to-Market*** is (book value of assets) / (book value of liabilities + market value of equity); ***Free-cash-flow problem*** is equal to zero if the book-to-market ratio is less than one, otherwise it is the three-year average of [(cash flow from operations - common and preferred stock dividends) / total assets]; ***CEO age*** is the age of the CEO.

Variables	Mean	Median	STD	Q1	Q3
Jensen-Murphy PPS	17.571	9.015	28.610	3.710	18.818
Core-Guay PPS	684.562	171.481	4474.490	59.388	479.796
Natural log of Jensen-Murphy PPS	2.295	2.304	1.087	1.550	2.987
Natural log of Core-Guay PPS	5.090	5.150	1.660	4.101	6.175
Tenure	4.793	4.000	2.862	3.000	6.000
Log Sales	7.481	7.398	1.471	6.486	8.482
Capital / Sales	0.849	0.461	1.236	0.273	0.898
R&D / Capital	0.101	0.000	0.272	0.000	0.069
Missing R&D	0.427	0.000	0.495	0.000	1.000
Advertising / Capital	0.036	0.000	0.111	0.000	0.017
Missing Advertising	0.678	1.000	0.467	0.000	1.000
Investment / Capital	0.104	0.087	0.072	0.057	0.131
G-index	9.546	9.000	2.621	8.000	11.000
Idiosyncratic Risk (%)	0.001	0.000	0.001	0.000	0.001
Book-to-Market	0.652	0.654	0.260	0.456	0.840
Free-Cash-Flow Problem (%)	0.003	0.000	0.020	0.000	0.000
CEO Age	54.234	55.000	6.378	50.000	59.000

Table 2 Descriptive Statistics of PPS Convergence on Firm Value

The sample period is 1993-2007, sample size 7,173 firm-CEO-years. ***Tobin's Q*** is the market value of asset divided by the book value of asset; ***Jensen-Murphy PPS*** is the Jenson and Murphy measure of pay-performance-sensitivity (change in wealth for every $1,000 change in shareholder wealth) converted from the Core and Guay measure (change in wealth for 1% change of stock price) using the following formula: *PPS* = (Core and Guay *PPS* *100,000)/Market value (Core, Guay, and Larcker, 2003); ***Tenure*** is CEO tenure; ***CEO ownership*** is the percentage of ownership held by the CEO; ***D&O Ownership*** is the percentage of ownership held by the directors and officers (includes CEO ownership); ***Sales*** is sales revenue; ***Capital*** is gross plant, property, and equipment; ***R&D*** is equal to the research and development expenditure if R&D expenditure is not missing, otherwise zero; ***Missing R&D*** is an indicator variable that equals one if R&D expenditure is missing, otherwise zero; ***Advertising*** is the advertisement expenditure; ***Missing Advertising*** is an indicator variable that equals one if advertisement expenditure is missing, otherwise zero; ***Investment*** is the capital expenditure; ***G-Index*** is from Gompers, Ishii, and Metrick (2003); ***Idiosyncratic Risk*** is the standard deviation of the residual from the CAPM model using firms' daily return over the year; ***Cash Flow*** is the cash flow from operations; ***Analyst Coverage*** is the average number of analysts that follow a firm during a fiscal year; ***Became Financially Constrained (Became Financially Unconstrained)*** is an indicator variable that equals one if the firm becomes financially constrained (unconstrained) according to the definition of Whited and Wu (2006); ***Turnover NYSE (NASDAQ)*** annualized average daily Nasdaq turnover if traded on Nasdaq, otherwise zero; ***Return*** is the industry adjusted annual return.

	Mean	Median	STD	Q1	Q3
Tobin's Q_t	1.969	1.529	1.501	1.194	2.197
Jensen-Murphy PPS_t	18.748	10.029	29.150	4.268	20.075
$Tenure_t$	6.387	6.000	2.865	4.000	8.000
CEO $ownership_t$ (%)	1.108	0.187	4.158	0.061	0.565
D&O $Ownership_t$ (%)	7.136	3.856	9.337	1.771	8.272
Log $Sales_t$	7.450	7.380	1.498	6.432	8.499
Log Sales $Squared_t$	57.751	54.458	22.178	41.373	72.232
$Capital/Sales_t$	0.857	0.458	1.215	0.266	0.919
Capital/Sales $Squared_t$	2.210	0.210	16.570	0.071	0.845
$R\&D/Capital_t$	0.111	0.000	0.289	0.000	0.075
$Advertising/Capital_t$	0.034	0.000	0.108	0.000	0.015
$Investment/Capital_t$	0.106	0.089	0.073	0.057	0.134
Idiosyncratic $Risk_t$ (%)	0.067	0.038	0.104	0.020	0.075
$Cash\ Flow/Sales_t$	0.080	0.103	0.734	0.055	0.173
Analyst $Coverage_t$	10.054	8.545	7.895	4.000	14.800
Missing $R\&D_t$	0.420	0.000	0.494	0.000	1.000
Missing $Advertising_t$	0.682	1.000	0.466	0.000	1.000
G-$index_t$	9.610	10.000	2.594	8.000	11.000
Became Financially $Constrained_t$	0.081	0.000	0.273	0.000	0.000
Became Financially $Unconstrained_t$	0.054	0.000	0.225	0.000	0.000
Turnover $NYSE_t$	0.496	0.572	0.335	0.000	0.771
Turnover $NASDAQ_t$	0.208	0.000	0.373	0.000	0.000
$Return_{t-1}$	-0.034	-0.059	0.515	-0.278	0.159

Table 3 PPS Convergence over Tenure

The sample period is 1993-2007. ***Jensen-Murphy PPS*** is Jenson and Murphy measure of pay-performance-sensitivity (change in wealth for every $1,000 change in shareholder wealth) converted from the Core and Guay measure (change in wealth for 1% change of stock price) using the following formula: *PPS* = (Core and Guay *PPS* *100,000)/Market value (Core, Guay, and Larcker, 2003); ***Tenure*** is CEO tenure; ***Sales*** is the firm annual sales revenue; ***Capital*** is gross plant, property, and equipment; ***R&D*** is equal to the research and development expenditure if R&D expenditure is not missing, otherwise zero; ***Missing R&D*** is an indicator variable that equals one if R&D expenditure is missing, otherwise zero; ***Advertising*** is the advertisement expenditure; ***Investment*** is the capital expenditure; ***G-Index*** is from Gompers, Ishii, and Metrick (2003); ***Idiosyncratic Risk*** is the standard deviation of the residual from the CAPM model using firms' daily return over the year; ***Book-to-Market*** is (book value of assets) / (book value of liabilities + market value of equity); ***Free-cash-flow problem*** is equal to zero if the book-to-market ratio is less than one, otherwise it is the three-year average of [(cash flow from operations - common and preferred stock dividends)/total assets]; ***CEO age*** is the age of the CEO. Industry dummies are included in all columns. The standard error of OLS regression is corrected using the Huber-White procedure with clustering by CEO. Panel A is for the full sample, Panel B two subsamples, of CEOs whose full tenure falls within the 1993-2007 period.

Panel A: full sample of full tenure CEOs

	Dependent variable is natural log of PPS			
Dependent variable =	Jensen-Murphy PPS		Core-Guay PPS	
	Coef.	p-value	Coef.	p-value
Intercept	1.9225	0.0001	0.1635	0.7956
Tenure	**0.2165**	**<.0001**	**0.2896**	**<.0001**
Tenure^2	**-0.0091**	**<.0001**	**-0.0128**	**<.0001**
Trend	0.0851	<.0001	0.2192	<.0001
Trend^2	-0.0020	0.1003	-0.0080	<.0001
Log Sales	-0.0354	0.7226	0.4626	0.0005
(Log Sales)^2	-0.0179	0.0052	0.0054	0.5243
Capital / Sales	-0.1814	<.0001	0.1762	0.0008
[Capital/Sales]^2	0.0083	<.0001	-0.0026	0.2816
R&D/Capital	-0.1234	0.1277	0.2301	0.0252
Missing R&D	-0.0279	0.6091	-0.0989	0.1418
Advertising/Capital	0.2362	0.4353	0.1864	0.6507
Missing Advertising	0.0001	0.9985	-0.0298	0.6195
Investment/Capital	0.9448	<.0001	2.0836	<.0001
G-index	0.0059	0.4261	0.0021	0.8255
Decile Rank of Idiosyncratic Risk	0.3779	<.0001	-0.0538	0.6189
Book-to-Market	0.2646	0.0022	-2.0171	<.0001
Free-Cash-Flow Problem	0.0825	0.9075	0.6533	0.5005
CEO Age	0.0000	0.9993	-0.0013	0.7749
R^2	0.4702		0.5924	
No. of firm-years	7,512		7,512	

Panel B: subsample of full tenure CEOs: the left column for CEO-years whose first year and last year fall within the sample period, the right column further restricted to CEOs with at least 6 years' tenure.

	Dependent variable is natural log of PPS							
	Jensen-Murphy PPS		Core-Guay PPS		Jensen-Murphy PPS		Core-Guay PPS	
	(1)		(2)		(3)		(4)	
	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
Intercept	1.8426	0.0003	-0.2629	0.7038	2.8739	0.0002	1.0644	0.2726
Tenure	**0.2541**	**<.0001**	**0.3270**	**<.0001**	**0.1744**	**<.0001**	**0.2091**	**<.0001**
Tenure^2	**-0.0114**	**<.0001**	**-0.0150**	**<.0001**	**-0.0068**	**0.0005**	**-0.0080**	**0.0044**
Trend	0.0704	0.0158	0.2164	<.0001	0.0784	0.0098	0.2314	<.0001
Trend^2	-0.0019	0.2056	-0.0087	<.0001	-0.0008	0.6205	-0.0076	0.0013
Logsales	-0.0009	0.9932	0.5805	<.0001	-0.0792	0.5288	0.3781	0.0407
(Logsales)^2	-0.0207	0.0020	-0.0024	0.7943	-0.0153	0.0635	0.0107	0.3710
Capital/Sales	-0.1507	0.0013	0.2370	<.0001	-0.2019	0.0062	0.1634	0.0931
[Capital/Sales] ^{2}	0.0082	<.0001	-0.0033	0.2119	0.0076	0.0043	-0.0037	0.2839
R&D /Capital	-0.1043	0.2214	0.2720	0.0125	-0.1263	0.2322	0.1455	0.2403
Missing R&D	-0.0483	0.3888	-0.1098	0.1176	0.0095	0.9043	-0.0868	0.3841
Advertising/Capital	0.3918	0.2379	0.3628	0.4195	0.4404	0.2404	0.4455	0.4611
Missing Advertising	0.0100	0.8416	-0.0035	0.9569	0.0051	0.9377	-0.0378	0.6549
Investment/Capital	0.7451	0.0010	1.8759	<.0001	0.8774	0.0015	2.0393	<.0001
G-Index	0.0128	0.1117	0.0071	0.4913	0.0025	0.8255	0.0032	0.8434
Decile Rank of Idiosyncratic Risk	0.2436	0.0016	-0.2187	0.0534	0.3488	0.0012	-0.0971	0.5430
Book-to-Market Ratio	0.2340	0.0101	-2.0371	<.0001	0.1691	0.1722	-2.0766	<.0001
Free-Cash-Flow Problem	-0.2531	0.6991	-0.1142	0.8988	-0.8032	0.4306	-0.3094	0.8424
CEO Age	-0.0035	0.3739	-0.0054	0.2725	-0.0050	0.4074	-0.0036	0.6418
R^2	0.4638		0.5990		0.4911		0.5860	
No. of firm-years	6,279		6,279		3,936		3,936	

Table 4 PPS Convergence over Tenure: Liquidity effect

The sample period is 1993-2007. ***Jensen-Murphy PPS*** is the Jenson and Murphy measure of pay-performance-sensitivity (change in wealth for every $1,000 change shareholder wealth) converted from the Core and Guay measure (change wealth for 1% change in stock price) using the following formula: *PPS* = (Core and Guay *PPS* *100,000)/Market value (Core, Guay, and Larcker, 2003); ***Tenure*** is CEO tenure; ***Large*** is a dummy variable that takes the value of one if prior year firm equity value is above the sample median, otherwise zero; ***Sales*** is the firm annual sales revenue; ***Capital*** is gross plant, property, and equipment; ***R&D*** is equal to the research and development expenditure if R&D expenditure is not missing, otherwise zero; ***Missing R&D*** is an indicator variable that equals one if R&D expenditure is missing, otherwise zero; ***Advertising*** is the advertisement expenditure; ***Investment*** is the capital expenditure; ***G-Index*** is from Gompers, Ishii, and Metrick (2003); ***Idiosyncratic Risk*** is the standard deviation of the residual from the CAPM model using firms' daily return over the year; ***Book-to-Market*** is (book value of assets) / (book value of liabilities + market value of equity); ***Free-cash-flow problem*** is equal to zero if the book-to-market ratio is less than one, otherwise it is the three-year average of [(cash flow from operations - common and preferred stock dividends)/total assets]; ***CEO age*** is the age of the CEO. Industry dummies are included in all columns. The standard error of OLS regression is corrected using the Huber-White procedure with clustering by CEO.

	Dependent variable is natural log of PPS			
Dependent variable =	Jensen-Murphy PPS		Core-Guay PPS	
	Coef.	p-value	Coef.	p-value
Intercept	1.7555	0.0005	0.4439	0.4850
Tenure	**0.2609**	**<.0001**	**0.2984**	**<.0001**
Tenure^2	**-0.0133**	**<.0001**	**-0.0144**	**<.0001**
Large*Tenure	**-0.1001**	**0.0010**	**-0.0146**	**0.7326**
Large*Tenure^2	**0.0094**	**0.0002**	**0.0034**	**0.3466**
Large	**0.0941**	**0.3155**	**0.2146**	**0.0965**
Trend	0.0878	<.0001	0.2126	<.0001
Trend^2	-0.0021	0.0699	-0.0075	<.0001
Logsales	-0.0185	0.8518	0.3941	0.0027
(Logsales)^2	-0.0175	0.0058	0.0062	0.4614
Capital/Sales	-0.1660	<.0001	0.1526	0.0040
[Capital/Sales]^2	0.0078	<.0001	-0.0022	0.3566
R&D/Capital	-0.1130	0.1596	0.2160	0.0395
Missing R&D	-0.0328	0.5484	-0.0886	0.1912
Advertising/Capital	0.2301	0.4468	0.2025	0.6196
Miss Advertising	-0.0053	0.9099	-0.0262	0.6598
Investment/Capital	0.9284	<.0001	2.1043	<.0001
G-Index	0.0066	0.3694	0.0027	0.7827
Decile Rank of Idiosyncratic Risk	0.3657	<.0001	-0.0280	0.7941
Book-to-Market Ratio	0.2366	0.0060	-1.9238	<.0001
Free–Cash-Flow Problem	0.0914	0.8968	0.6392	0.5062
CEO Age	-0.0001	0.9878	-0.0010	0.8206
R^2	0.4733		0.5958	
No. of firm-years	7,512		7,512	

Table 5 PPS Convergence over Tenure: Inside CEOs vs. outside CEOs

The sample period is 1993-2007. ***Jensen-Murphy PPS*** is the Jenson and Murphy measure of pay-performance-sensitivity (change in wealth for every $1,000 change shareholder wealth) converted from the Core and Guay measure (change in wealth for 1% change in stock price) using the following formula: *PPS* = (Core and Guay *PPS* *100,000)/Market value (Core, Guay, and Larcker, 2003); ***Tenure*** is CEO tenure; ***Outsider*** is a dummy variable that takes the value of one if the CEO comes from another firm or came to the firm within one year before becoming CEO, otherwise zero; ***Sales*** is the firm annual sales revenue; ***Capital*** is gross plant, property, and equipment; ***R&D*** is equal to the research and development expenditure if R&D expenditure is not missing, otherwise zero; ***Missing R&D*** is an indicator variable that equals one if R&D expenditure is missing, otherwise zero; ***Advertising*** is the advertisement expenditure; ***Investment*** is the capital expenditure; ***G-Index*** is from Gompers, Ishii, and Metrick (2003); ***Idiosyncratic Risk*** is the standard deviation of the residual from the CAPM model using firms' daily return over the year; ***Book-to-Market*** is (book value of assets) / (book value of liabilities + market value of equity); ***Free-cash-flow problem*** is equal to zero if the book-to-market ratio is less than one, otherwise it is the three-year average of [(cash flow from operations - common and preferred stock dividends)/total assets]; ***CEO age*** is the age of the CEO. Industry dummies are included in all columns. The standard error of OLS regression is corrected using the Huber-White procedure with clustering by CEO.

	Dependent variable is natural log of PPS			
Dependent variable =	Jensen-Murphy PPS		Core-Guay PPS	
	Coef.	p-value	Coef.	p-value
Intercept	1.7372	0.0019	-0.0734	0.9062
Tenure	**0.2061**	**<.0001**	**0.2219**	**<.0001**
Tenure^2	**-0.0099**	**0.0046**	**-0.0085**	**0.0484**
Outsider * Tenure	**0.2933**	**<.0001**	**0.3837**	**<.0001**
Outsider * Tenure^2	**-0.0217**	**<.0001**	**-0.0307**	**<.0001**
Outsider	**-0.8346**	**<.0001**	**-1.0001**	**<.0001**
Large*Tenure	-0.0532	0.1878	0.0324	0.4924
Large*Tenure^2	0.0049	0.2236	-0.0024	0.6177
Large	0.0443	0.6697	0.1959	0.1055
Trend	0.0915	0.0004	0.2423	<.0001
Trend^2	-0.0023	0.1013	-0.0089	<.0001
Log Sales	-0.0055	0.9630	0.4611	0.0008
(Log Sales)^2	-0.0191	0.0105	0.0012	0.8929
Capital / Sales	-0.1489	0.0015	0.1071	0.0232
[Capital/Sales]^2	0.0081	0.0002	0.0009	0.6931
R&D/Capital	-0.0670	0.4793	0.1906	0.0379
Missing R&D	-0.0372	0.5314	-0.1118	0.0836
Advertising/Capital	0.3700	0.3469	0.0175	0.9594
Missing Advertising	-0.0293	0.5887	0.0020	0.9731
Investment/Capital	0.6107	0.0119	1.7549	<.0001
G-index	0.0116	0.1781	0.0038	0.7053
Decile Rank of Idiosyncratic Risk	0.2530	0.0020	-0.0827	0.3596
Book-to-Market	0.2863	0.0035	-1.9164	<.0001
Free-Cash-Flow Problem	0.6976	0.3551	1.2976	0.1054
CEO Age	-0.0009	0.8399	0.0027	0.5290
R^2	0.4679		0.6121	
No. of firm-years	5,669		5,669	

Table 6 PPS Convergence over Tenure: Inside CEOs only

The sample period is 1993-2007. ***Jensen-Murphy PPS*** is the Jenson and Murphy measure of pay-performance-sensitivity (change in wealth for every $1,000 change in shareholder wealth) converted from the Core and Guay measure (change in wealth for 1% change in stock price) using the following formula: *PPS* = (Core and Guay *PPS* *100,000)/Market value (Core, Guay, and Larcker, 2003); ***Tenure*** is CEO tenure; ***Years became CEO*** is the number of years the CEO worked in the firm before being promoted to CEO; ***Initial incentives*** is the Jensen-Murphy incentives measure the year before being promoted to CEO; ***Close to Retirement*** is a dummy that takes the value of one if it is the last three years before retirement, otherwise zero; ***Sales*** is the firm annual sales revenue; ***Capital*** is gross plant, property, and equipment; ***R&D*** is equal to the research and development expenditure if R&D expenditure is not missing, otherwise zero; ***Missing R&D*** is an indicator variable that equals one if R&D expenditure is missing, otherwise zero; ***Advertising*** is the advertisement expenditure; ***Investment*** is the capital expenditure; ***G-Index*** is from Gompers, Ishii, and Metrick (2003); ***Idiosyncratic Risk*** is the standard deviation of the residual from the CAPM model using firms' daily return over the year; ***Book-to-Market*** is (book value of assets) / (book value of liabilities + market value of equity); ***Free-cash-flow problem*** is equal to zero if the book-to-market ratio is less than one, otherwise it is the three-year average of [(cash flow from operations - common and preferred stock dividends)/total assets]; ***CEO age*** is the age of the CEO. Industry dummies are included in all columns. The standard error of OLS regression is corrected using the Huber-White procedure with clustering by CEO.

Panel A: years working in the firm before becoming CEO

	Dependent variable is natural log of PPS			
Dependent variable =	Jensen-Murphy PPS		Core-Guay PPS	
	Coef.	p-value	Coef.	p-value
Intercept	1.6432	0.0714	0.8170	0.5524
Tenure	**0.2061**	**0.0001**	**0.2343**	**0.0003**
Tenure^2	**-0.0117**	**0.0227**	**-0.0128**	**0.0499**
Years became CEO*Tenure	**-0.0077**	**0.0015**	**-0.0103**	**0.0006**
Years became CEO *Tenure^2	**0.0006**	**0.0149**	**0.0009**	**0.0017**
Years became CEO	**0.0178**	**0.0053**	**0.0225**	**0.0063**
Large*Tenure	0.0673	0.3596	0.1465	0.0960
Large*Tenure^2	-0.0052	0.4727	-0.0120	0.1816
Large	-0.1988	0.2625	-0.0554	0.7931
Trend	0.1085	0.0115	0.2843	<.0001
Trend^2	-0.0026	0.2526	-0.0104	0.0013
Logsales	0.0345	0.8531	0.2651	0.3684
(Logsales)^2	-0.0223	0.0563	0.0116	0.5178
Capital/Sales	-0.2616	0.0140	0.3385	0.0121
[Capital/Sales]^2	0.0252	0.1623	-0.0494	0.0357
R&D /Capital	-0.0509	0.6587	0.0104	0.9420
Missing R&D	0.1804	0.0632	0.1321	0.2605
Advertising/Capital	-0.1012	0.8475	-0.0063	0.9929
Missing Advertising	0.0323	0.7061	0.0943	0.3521
Investment/Capital	0.4795	0.2070	1.8734	0.0003
G-Index	-0.0121	0.4120	-0.0176	0.3684
Decile Rank of Idiosyncratic Risk	0.1614	0.2149	-0.2625	0.1935
Book-to-Market Ratio	0.2690	0.0858	-2.1220	<.0001
Free-Cash-Flow Problem	-0.3887	0.6943	0.5365	0.6428
CEO Age	0.0012	0.8386	0.0018	0.8092
R^2	0.5223		0.6562	
No. of firm-years	2,055		2,055	

Panel B: initial incentives before becoming CEO

Dependent variable =	Dependent variable is natural log of PPS Jensen-Murphy PPS		Core-Guay PPS	
	Coef.	p-value	Coef.	p-value
Intercept	0.9183	0.2496	-0.1504	0.8856
Tenure	**0.3065**	**<.0001**	**0.3944**	**<.0001**
Tenure^2	**-0.0163**	**0.0011**	**-0.0206**	**0.0017**
Initial incentives*Tenure	**-0.1075**	**0.0004**	**-0.1559**	**<.0001**
Initial incentives *Tenure^2	**0.0064**	**0.0060**	**0.0099**	**0.0003**
Initial incentives	**0.6354**	**<.0001**	**0.8548**	**<.0001**
Large*Tenure	-0.0210	0.6719	0.0094	0.8847
Large*Tenure^2	0.0001	0.9784	-0.0018	0.7712
Large	-0.0416	0.7611	0.1563	0.3877
Trend	0.0299	0.4442	0.2039	0.0009
Trend^2	0.0011	0.5903	-0.0068	0.0300
Logsales	0.1223	0.4607	0.3551	0.1115
(Logsales)^2	-0.0220	0.0309	0.0138	0.3145
Capital/Sales	-0.1174	0.2180	0.5181	<.0001
[Capital/Sales]^2	0.0079	0.5984	-0.0711	0.0009
R&D/Capital	0.0468	0.6505	0.1312	0.2449
Missing R&D	0.0294	0.7375	-0.0580	0.5746
Advertising/Capital	-0.2878	0.4865	-0.2176	0.7053
Missing Advertising	-0.0171	0.8198	0.0187	0.8346
Investment/Capital	-0.3938	0.2541	0.7022	0.1002
G-Index	-0.0013	0.9164	-0.0034	0.8417
Decile Rank of Idiosyncratic Risk	0.2782	0.0119	-0.1534	0.3228
Book-to-Market Ratio	0.2340	0.0841	-2.1861	<.0001
Free-Cash-Flow Problem	-1.6045	0.0336	-1.1064	0.2167
CEO Age	-0.0056	0.2637	-0.0061	0.3299
R^2	0.6295		0.7288	
No. of firm-years	1,985		1,985	

Panel C: years became CEO and initial incentives before becoming CEO

Dependent variable =	Dependent variable is natural log of PPS			
	Jensen-Murphy PPS		Core-Guay PPS	
	Coef.	p-value	Coef.	p-value
Intercept	1.0545	0.1855	0.0109	0.9918
Tenure	**0.3442**	**<.0001**	**0.4354**	**<.0001**
Tenure^2	**-0.0194**	**0.0001**	**-0.0249**	**0.0001**
Years became CEO*Tenure	**-0.0059**	**0.0021**	**-0.0072**	**0.0028**
Years became CEO *Tenure^2	**0.0005**	**0.0158**	**0.0007**	**0.0020**
Years became CEO	**0.0068**	**0.1638**	**0.0060**	**0.3795**
Initial incentives*Tenure	**-0.1001**	**0.0008**	**-0.1455**	**<.0001**
Initial incentives *Tenure^2	**0.0059**	**0.0110**	**0.0089**	**0.0010**
Initial incentives	**0.6280**	**<.0001**	**0.8481**	**<.0001**
Large*Tenure	0.0149	0.7739	0.0595	0.3770
Large*Tenure^2	-0.0026	0.6088	-0.0068	0.2988
Large	-0.1159	0.3983	0.0684	0.7100
Trend	0.0381	0.3281	0.2066	0.0010
Trend^2	0.0006	0.7861	-0.0070	0.0257
Logsales	0.0909	0.5788	0.3304	0.1400
(Logsales) ^{2}	-0.0196	0.0522	0.0159	0.2500
Capital/Sales	-0.0859	0.3527	0.5570	<.0001
[Capital/Sales] ^{2}	0.0009	0.9489	-0.0794	0.0002
R&D /Capital	0.0211	0.8365	0.1064	0.3489
Missing R&D	0.0241	0.7832	-0.0595	0.5652
Advertising/Capital	-0.2579	0.5362	-0.1847	0.7508
Missing Advertising	-0.0071	0.9240	0.0261	0.7707
Investment/Capital	-0.4450	0.1958	0.6341	0.1404
G-Index	-0.0022	0.8603	-0.0044	0.7948
Decile Rank of Idiosyncratic Risk	0.2403	0.0313	-0.1958	0.2111
Book-to-Market Ratio	0.1830	0.1861	-2.2439	<.0001
Free-Cash-Flow Problem	-1.6634	0.0247	-1.2093	0.1792
CEO Age	-0.0034	0.4951	-0.0037	0.5642
R^2	0.6348		0.7316	
No. of firm-years	1,985		1,985	

Table 7 PPS Convergence over Tenure: Career concerns

Panel A replicates Gibbons and Murphy's (1992) career concerns results; Panel B controls for career concerns. The sample period is 1993-2007. ***Jensen-Murphy PPS*** is the Jenson and Murphy measure of pay-performance-sensitivity (change in wealth for every $1,000 change shareholder wealth) converted from the Core and Guay measure (change in wealth for 1% change in stock price) using the following formula: *PPS* = (Core and Guay *PPS* *100,000)/Market value (Core, Guay, and Larcker, 2003); ***Tenure*** is CEO tenure; ***Close to Retirement*** is a dummy that takes value of one if it is the last three years before retirement, otherwise zero; ***Sales*** is the firm annual sales revenue; ***Capital*** is gross plant, property, and equipment; ***R&D*** is equal to the research and development expenditure if R&D expenditure is not missing, otherwise zero; ***Missing R&D*** is an indicator variable that equals one if R&D expenditure is missing, otherwise zero; ***Advertising*** is the advertisement expenditure; ***Investment*** is the capital expenditure; ***G-Index*** is from Gompers, Ishii, and Metrick (2003); ***Idiosyncratic Risk*** is the standard deviation of the residual from the CAPM model using firms' daily return over the year; ***Book-to-Market*** is (book value of assets) / (book value of liabilities + market value of equity); ***Free-cash-flow problem*** is equal to zero if the book-to-market ratio is less than one, otherwise it is the three-year average of [(cash flow from operations - common and preferred stock dividends)/total assets]; ***CEO age*** is the age of the CEO. Industry dummies are included in all columns. The standard error of OLS regression is corrected using the Huber-White procedure with clustering by CEO.

Panel A: replicate Gibbons and Murphy (1992)

	Dependent variable is natural log of PPS			
Dependent variable =	Jensen-Murphy PPS		Core-Guay PPS	
	Coef.	p-value	Coef.	p-value
Intercept	2.5278	0.0008	0.6281	0.5112
Close to Retirement Dummy	**0.1214**	**0.0002**	**0.1197**	**0.0050**
Trend	0.1215	<.0001	0.2827	<.0001
$Trend^2$	-0.0011	0.4732	-0.0078	0.0006
Logsales	-0.1077	0.4171	0.3428	0.0760
$(Logsales)^2$	-0.0138	0.1162	0.0126	0.3170
Capital/Sales	-0.1763	0.0136	0.1946	0.0430
$[Capital/Sales]^2$	0.0065	0.0138	-0.0050	0.1439
R&D /Capital	-0.1044	0.3303	0.1726	0.2075
Missing R&D	0.0098	0.9056	-0.0867	0.4065
Advertising/Capital	0.4805	0.2068	0.4956	0.4155
Missing Advertising	-0.0073	0.9134	-0.0531	0.5422
Investment/Capital	1.2463	<.0001	2.4921	<.0001
G-Index	0.0017	0.8907	0.0023	0.8937
Decile Rank of Idiosyncratic Risk	0.3532	0.0017	-0.0943	0.5722
Book-to-Market Ratio	0.1339	0.2965	-2.1181	<.0001
Free-Cash-Flow Problem	-0.6753	0.5257	-0.1623	0.9204
CEO Age	0.0049	0.4204	0.0087	0.2517
R^2	0.4559		0.5625	
No. of firm-years	3,936		3,936	

Panel B: control for career concerns

Dependent variable =	Dependent variable is natural log of PPS			
	Jensen-Murphy PPS		Core-Guay PPS	
	Coef.	p-value	Coef.	p-value
Intercept	2.6698	0.0006	1.1790	0.2300
Tenure	**0.2300**	**<.0001**	**0.2457**	**<.0001**
Tenure^2	**-0.0112**	**<.0001**	**-0.0110**	**0.0003**
Close to Retirement Dummy	**-0.1314**	**0.0025**	**-0.0722**	**0.2616**
Large*Tenure	0.0109	0.0024	0.0065	0.2281
Large*Tenure^2	0.1900	0.1881	0.3875	0.0604
Large	0.0090	0.7739	-0.0176	0.6687
Trend	0.0868	0.0043	0.2256	<.0001
Trend^2	-0.0014	0.3895	-0.0070	0.0033
Logsales	-0.0638	0.6107	0.3232	0.0747
(Logsales) ^{2}	-0.0147	0.0736	0.0108	0.3616
Capital/Sales	-0.1769	0.0153	0.1371	0.1576
[Capital/Sales] ^{2}	0.0068	0.0103	-0.0030	0.3803
R&D/Capital	-0.1184	0.2603	0.1244	0.3145
Missing R&D	0.0005	0.9953	-0.0725	0.4724
Advertising/Capital	0.4394	0.2469	0.4308	0.4703
Missing Advertising	-0.0026	0.9680	-0.0260	0.7583
Investment/Capital	0.8602	0.0019	2.1359	<.0001
G-Index	0.0030	0.7919	0.0037	0.8164
Decile Rank of Idiosyncratic Risk	0.3299	0.0022	-0.0633	0.6876
Book-to-Market Ratio	0.1373	0.2630	-1.9881	<.0001
Free-Cash-Flow Problem	-0.7199	0.4784	-0.3516	0.8191
CEO Age	-0.0051	0.3929	-0.0038	0.6232
R^2	0.4951		0.5890	
No. of firm-years	3,936		3,936	

Table 8 PPS Convergence over Tenure: CEO Entrenchment

Panel A uses a lagged CPS measure, Panel B the G-index, for entrenchment. The sample period is 1993-2007. ***Jensen-Murphy PPS*** is the Jenson and Murphy measure of pay-performance-sensitivity (change in wealth for every $1,000 change in shareholder wealth) converted from the Core and Guay measure (change in wealth for 1% change in stock price) using the following formula: *PPS* = (Core and Guay *PPS* *100,000)/Market value (Core, Guay, and Larcker, 2003); ***Tenure*** is CEO tenure; ***Large_CPS*** (or ***Large_G-index)*** is a dummy variable that takes the value of one if CPS is above the sample median, otherwise zero; ***Sales*** is the firm annual sales revenue; ***Capital*** is gross plant, property, and equipment; ***R&D*** is equal to the research and development expenditure if R&D expenditure is not missing, otherwise zero; ***Missing R&D*** is an indicator variable that equals one if R&D expenditure is missing, otherwise zero; ***Advertising*** is the advertisement expenditure; ***Investment*** is the capital expenditure; ***G-Index*** is from Gompers, Ishii, and Metrick (2003); ***Idiosyncratic Risk*** is the standard deviation of the residual from the CAPM model using firms' daily return over the year; ***Book-to-Market*** is (book value of assets) / (book value of liabilities + market value of equity); ***Free-cash-flow problem*** is equal to zero if the book-to-market ratio is less than one, otherwise it is the three-year average of [(cash flow from operations - common and preferred stock dividends)/total assets]; ***CEO age*** is the age of the CEO. Industry dummies are included in all columns. The standard error of OLS regression is corrected using the Huber-White procedure with clustering by CEO.

Panel A: lagged CPS as entrenchment measure

	Dependent variable is natural log of PPS			
Dependent variable =	Jensen-Murphy PPS		Core-Guay PPS	
	Coef.	p-value	Coef.	p-value
Intercept	1.9858	0.0003	0.6938	0.3191
Tenure	**0.2373**	**<.0001**	**0.2788**	**<.0001**
Tenure^2	**-0.0110**	**<.0001**	**-0.0124**	**<.0001**
Large_CPS*Tenure	**0.0411**	**0.1443**	**0.0457**	**0.2375**
Large_CPS*Tenure^2	**-0.0040**	**0.0779**	**-0.0046**	**0.1326**
Large_CPS	**0.0366**	**0.6142**	**0.0953**	**0.3558**
Large*Tenure	-0.1113	0.0002	-0.0382	0.3318
Large*Tenure^2	0.0096	<.0001	0.0044	0.1635
Large	0.0922	0.3407	0.2150	0.1009
Trend	0.0702	0.0028	0.1996	<.0001
Trend^2	-0.0013	0.3044	-0.0070	<.0001
Logsales	-0.0469	0.6689	0.3305	0.0237
(Logsales)^2	-0.0151	0.0301	0.0114	0.2151
Capital/Sales	-0.1792	<.0001	0.1474	0.0015
[Capital/Sales] ^{2}	0.0076	0.0007	-0.0044	0.0800
R&D/Capital	-0.1959	0.0314	0.2143	0.0747
Missing R&D	-0.0332	0.5515	-0.0779	0.2625
Advertising/Capital	0.3158	0.3318	0.2828	0.5230
Missing Advertising	-0.0155	0.7346	-0.0388	0.5083
Investment/Capital	0.8221	0.0001	1.9379	<.0001
G-Index	0.0038	0.6062	-0.0004	0.9665
Decile Rank of Idiosyncratic Risk	0.3381	<.0001	-0.0520	0.6339
Book-to-Market Ratio	0.2732	0.0021	-1.8976	<.0001
Free-Cash-Flow Problem	-0.2754	0.6877	0.3368	0.7165
CEO Age	-0.0010	0.7944	-0.0010	0.8293
R^2	0.4869		0.6113	
No. of firm-years	6,858		6,858	

Panel B: G-index as entrenchment measure

	Dependent variable is natural log of PPS			
Dependent variable =	Jensen-Murphy PPS		Core-Guay PPS	
	Coef.	p-value	Coef.	p-value
Intercept	1.8656	0.0002	0.5133	0.4235
Tenure	**0.2410**	**<.0001**	**0.2861**	**<.0001**
Tenure^2	**-0.0116**	**<.0001**	**-0.0132**	**<.0001**
Large_G-index*Tenure	**0.0500**	**0.0974**	**0.0321**	**0.4398**
Large_G-index*Tenure^2	**-0.0042**	**0.0904**	**-0.0029**	**0.4021**
Large_G-index	**-0.0277**	**0.7409**	**-0.0034**	**0.9766**
Large*Tenure	-0.1039	0.0007	-0.0171	0.6916
Large*Tenure^2	0.0097	0.0002	0.0036	0.3249
Large	0.1025	0.2771	0.2191	0.0915
Trend	0.0865	<.0001	0.2114	<.0001
Trend^2	-0.0021	0.0801	-0.0075	<.0001
Logsales	-0.0302	0.7580	0.3808	0.0037
(Logsales) ^{2}	-0.0168	0.0075	0.0070	0.4066
Capital/Sales	-0.1650	0.0001	0.1537	0.0037
[Capital/Sales] ^{2}	0.0077	0.0001	-0.0023	0.3295
R&D/Capital	-0.1124	0.1565	0.2159	0.0400
Missing R&D	-0.0366	0.5026	-0.0914	0.1786
Advertising/Capital	0.2250	0.4567	0.2015	0.6222
Missing Advertising	-0.0106	0.8219	-0.0307	0.6069
Investment/Capital	0.9564	<.0001	2.1320	<.0001
Decile Rank of Idiosyncratic Risk	0.3766	<.0001	-0.0161	0.8816
Book-to-Market Ratio	0.2323	0.0067	-1.9291	<.0001
Free-Cash-Flow Problem	0.0844	0.9049	0.6357	0.5094
CEO Age	-0.0001	0.9757	-0.0011	0.8115
R^2	0.4746		0.5962	
No. of firm-years	7,512		7,512	

Table 9 PPS Convergence over Tenure: Survivor bias

The sample period is 1993-2007. ***Jensen-Murphy PPS*** is the Jenson and Murphy measure of pay-performance-sensitivity (change in wealth for every $1,000 change in shareholder wealth) converted from the Core and Guay measure (change wealth for 1% change in stock price) using the following formula: *PPS* = (Core and Guay *PPS* *100,000)/Market value (Core, Guay, and Larcker, 2003); ***Tenure*** is CEO tenure; ***Return*** is the annualized stock return; ***Large retention prob.*** is a dummy variable that takes value of one if the predicted CEO retention probability is above the sample median, otherwise zero, where retention probability is estimated using CEO turnover data from 1992-2007; ***Sales*** is the firm annual sales revenue; ***Capital*** is gross plant, property, and equipment; ***R&D*** is equal to the research and development expenditure if R&D expenditure is not missing, otherwise zero; ***Missing R&D*** is an indicator variable that equals one if R&D expenditure is missing, otherwise zero; ***Advertising*** is the advertisement expenditure; ***Investment*** is the capital expenditure; ***G-Index*** is from Gompers, Ishii, and Metrick (2003); ***Idiosyncratic Risk*** is the standard deviation of the residual from the CAPM model using firms' daily return over the year; ***Book-to-Market*** is (book value of assets) / (book value of liabilities + market value of equity); ***Free-cash-flow problem*** is equal to zero if the book-to-market ratio is less than one, otherwise it is the three-year average of [(cash flow from operations - common and preferred stock dividends)/total assets]; ***CEO age*** is the age of the CEO. Industry dummies are included in all columns. The standard error of OLS regression is corrected using the Huber-White procedure with clustering by CEO.

Panel A: control for stock return performance

	Dependent variable is natural log of PPS			
Dependent variable =	Jensen-Murphy PPS		Core-Guay PPS	
	Coef.	p-value	Coef.	p-value
Intercept	1.6704	0.0010	0.3396	0.5916
Tenure	**0.2653**	**<.0001**	**0.2993**	**<.0001**
Tenure^2	**-0.0136**	**<.0001**	**-0.0142**	**<.0001**
Return*Tenure	**-0.0475**	**0.1765**	**-0.0256**	**0.5890**
Return *Tenure^2	**0.0030**	**0.2676**	**0.0007**	**0.8404**
Return	**0.2776**	**0.0058**	**0.4056**	**0.0029**
Large*Tenure	-0.0956	0.0017	-0.0089	0.8353
Large*Tenure^2	0.0092	0.0003	0.0030	0.4006
Large	0.0932	0.3210	0.2292	0.0760
Trend	0.0934	<.0001	0.2245	<.0001
Trend^2	-0.0025	0.0350	-0.0083	<.0001
Logsales	-0.0203	0.8416	0.3743	0.0042
(Logsales)^2	-0.0176	0.0066	0.0069	0.4095
Capital/Sales	-0.1673	<.0001	0.1503	0.0046
[Capital/Sales]^2	0.0079	<.0001	-0.0021	0.3705
R&D/Capital	-0.1030	0.1977	0.2350	0.0273
Missing R&D	-0.0368	0.4996	-0.0973	0.1483
Advertising/Capital	0.2271	0.4485	0.1981	0.6228
Missing Advertising	-0.0079	0.8666	-0.0318	0.5930
Investment/Capital	1.0259	<.0001	2.3079	<.0001
G-Index	0.0062	0.4010	0.0021	0.8276
Decile Rank of Idiosyncratic Risk	0.3373	<.0001	-0.0873	0.4165
Book-to-Market Ratio	0.3348	0.0005	-1.7081	<.0001
Free-Cash-Flow Problem	0.1538	0.8268	0.7244	0.4429
CEO Age	-0.0001	0.9769	-0.0011	0.8011
R^2	0.4753		0.5954	
No. of firm-years	7,510		7,510	

Panel B: predicted CEO retention probability

	Dependent variable is natural log of PPS			
Dependent variable =	Jensen-Murphy PPS		Core-Guay PPS	
	Coef.	p-value	Coef.	p-value
Intercept	1.7461	0.0006	0.2585	0.6884
Tenure	**0.2629**	**<.0001**	**0.2990**	**<.0001**
Tenure^2	**-0.0135**	**<.0001**	**-0.0140**	**<.0001**
Large_Retention Prob.*Tenure	**0.0010**	**0.9738**	**0.0051**	**0.9059**
Large_Retention Prob.*Tenure^2	**0.0002**	**0.9282**	**-0.0010**	**0.7685**
Large_Retention Prob.	**-0.0161**	**0.8327**	**0.0245**	**0.8167**
Large*Tenure	-0.1056	0.0007	-0.0246	0.5647
Large*Tenure^2	0.0097	0.0002	0.0039	0.2715
Large	0.1208	0.2085	0.2546	0.0508
Trend	0.0894	<.0001	0.2211	<.0001
Trend^2	-0.0022	0.0745	-0.0080	<.0001
Logsales	-0.0166	0.8660	0.4115	0.0017
(Logsales) ^{2}	-0.0178	0.0050	0.0050	0.5491
Capital/Sales	-0.1713	<.0001	0.1493	0.0051
[Capital/Sales] ^{2}	0.0081	0.0001	-0.0022	0.4217
R&D/Capital	-0.1130	0.1631	0.2114	0.0432
Missing R&D	-0.0241	0.6628	-0.0746	0.2758
Advertising/Capital	0.2543	0.3625	0.2395	0.5324
Missing Advertising	-0.0044	0.9254	-0.0222	0.7081
Investment/Capital	0.8983	<.0001	2.0793	<.0001
G-Index	0.0062	0.4069	0.0015	0.8763
Decile Rank of Idiosyncratic Risk	0.3624	<.0001	-0.0220	0.8415
Book-to-Market Ratio	0.2453	0.0044	-1.9097	<.0001
Free-Cash-Flow Problem	0.1201	0.8648	0.7061	0.4605
CEO Age	-0.0001	0.9785	0.0000	0.9989
R^2	0.4756		0.5946	
No. of firm-years	7,101		7,101	

Table 10 Tobin's Q, PPS (Jensen and Murphy) and CEO Tenure

The sample period is 1993-2007. ***Tobin's Q*** is market value of asset divided by book value of asset; ***Jensen-Murphy PPS*** is the Jenson and Murphy measure of pay-performance-sensitivity (change in wealth for every $1,000 change in shareholder wealth) converted from the Core and Guay measure (change in wealth for every 1% change of stock price) using the following formula: *PPS* = (Core and Guay *PPS* *100,000)/Market value (Core, Guay, and Larcker, 2003); ***Tenure*** is CEO tenure; ***D&O Ownership*** is the percentage of ownership held by the directors and officers; ***Sales*** is the firm annual sales revenue; ***Capital*** is gross plant, property, and equipment; ***R&D*** is equal to the research and development expenditure if R&D expenditure is not missing, otherwise zero; ***Missing R&D*** is an indicator variable that equals one if R&D expenditure is missing, otherwise zero; ***Advertising*** is the advertisement expenditure; ***Missing Advertising*** is an indicator variable that equals one if the advertisement expenditure is missing, otherwise zero; ***Investment*** is the capital expenditure; ***G-Index*** is from Gompers, Ishii, and Metrick (2003); ***Idiosyncratic Risk*** is the standard deviation of the residual from the CAPM model using firms' daily return over the year; ***Cash Flow*** is the cash flow from operations; ***Analyst Coverage*** is the average number of analysts that follow a firm during a fiscal year; ***Became Financially Constrained (Became Financially Unconstrained)*** is an indicator variable that equals one if the firm becomes financially constrained (unconstrained) according to the definition of Whited and Wu (2006); ***Turnover NYSE (NASDAQ)*** is the annualized average daily Nasdaq turnover if traded on Nasdaq, otherwise zero; ***Return*** is the industry adjusted annual return. The standard error of OLS regression is corrected using the Huber-White procedure with clustering by CEO.

Dependent = Change of $Q_{t-1 \text{ to } t}$	(1)		(2)	
	Coef.	p-value	Coef.	p-value
INTERCEPT	-0.0338	0.5443	-0.0064	0.9066
Change of $PPS_{t-2 \text{ to } t-1}$	**0.0162**	**0.0052**	**0.0188**	**0.0013**
Change of $PPS_{t-2 \text{ to } t-1}$ * $Tenure_{t-1}$	**-0.0014**	**0.0350**	**-0.0017**	**0.0101**
$Tenure_{t-1}$	-0.0034	0.2984	-0.0049	0.1440
Change of $D\&O\ Ownership_{t-2 \text{ to } t-1}$	1.2169	0.0296	0.9128	0.0612
Change of Log $Sales_{t-2 \text{ to } t-1}$	-0.8547	0.0614	-0.5303	0.1756
Change of Log Sales $Squared_{t-2 \text{ to } t-1}$	0.0356	0.1945	0.0270	0.2761
Change of $Capital/Sales_{t-2 \text{ to } t-1}$	-0.0278	0.7785	0.0243	0.7922
Change of Capital/Sales $Squared_{t-2 \text{ to } t-1}$	-0.0027	0.6898	-0.0029	0.6608
Change of $R\&D/Capital_{t-2 \text{ to } t-1}$	-0.0687	0.5642	-0.0459	0.6885
Change of $Advertising/Capital_{t-2 \text{ to } t-1}$	0.5532	0.1585	0.3845	0.1964
Change of $Investment/Capital_{t-2 \text{ to } t-1}$	-1.4092	<.0001	-1.0309	<.0001
Change of Idiosyncratic $Risk_{t-2 \text{ to } t-1}$	21.6240	0.2019	-1.4873	0.9324
Change of $Cash\ Flow/Sales_{t-2 \text{ to } t-1}$	-0.0954	0.3713	-0.0882	0.3872
Change of $Analyst\ Coverage_{t-2 \text{ to } t-1}$	0.0034	0.5419	0.0119	0.0058
Missing $R\&D_{t-1}$	0.0077	0.6120	0.0025	0.8722
Missing $Advertising_{t-1}$	0.0227	0.2581	0.0245	0.2245
G-$index_{t-1}$	0.0018	0.6242	0.0010	0.7830
Became Financially Constrained	0.0213	0.6221	0.0025	0.9538
Became Financially Unconstrained	-0.1358	0.0670	-0.1043	0.1351
$Trend_{t-1}$	0.0022	0.4003	-0.0023	0.3898
Change in Turnover $NYSE_{t-2 \text{ to } t-1}$			0.1266	0.2403
Change in Turnover $NASDAQ_{t-2 \text{ to } t-1}$			-0.3001	0.2374
$Return_{t-2 \text{ to } t-1}$			-0.3209	<.0001
$Return_{t-3 \text{ to } t-2}$			-0.1989	<.0001
R^2	0.0351		0.0798	
No. of firm-years	7,173		7,173	

Table 11 Tobin's Q, PPS (Jensen and Murphy) and CEO Tenure: Interaction with firm size

The sample period is 1993-2007. ***Tobin's Q*** is market value of asset divided by book value of asset; ***Jensen-Murphy PPS*** is the Jenson and Murphy measure of pay-performance-sensitivity (change in wealth for every $1,000 change in shareholder wealth) converted from the Core and Guay measure (change in wealth for every 1% change of stock price) using the following formula: *PPS* = (Core and Guay *PPS* *100,000)/Market value (Core, Guay, and Larcker, 2003); ***Tenure*** is CEO tenure; ***Large*** is a dummy variable that takes the value of one if prior year firm equity value is above the sample median, otherwise zero; ***D&O Ownership*** is the percentage of ownership held by the directors and officers; ***Sales*** is the firm annual sales revenue; ***Capital*** is gross plant, property, and equipment; ***R&D*** is equal to the research and development expenditure if R&D expenditure is not missing, otherwise zero; ***Missing R&D*** is an indicator variable that equals one if R&D expenditure is missing, otherwise zero; ***Advertising*** is the advertisement expenditure; ***Missing Advertising*** is an indicator variable that equals one if the advertisement expenditure is missing, otherwise zero; ***Investment*** is the capital expenditure; ***G-Index*** is from Gompers, Ishii, and Metrick (2003); ***Idiosyncratic Risk*** is the standard deviation of the residual from the CAPM model using firms' daily return over the year; ***Cash Flow*** is the cash flow from operations; ***Analyst Coverage*** is the average number of analysts that follow a firm during a fiscal year; ***Became Financially Constrained (Became Financially Unconstrained)*** is an indicator variable that equals one if the firm becomes financially constrained (unconstrained) according to the definition of Whited and Wu (2006); ***Turnover NYSE (NASDAQ)*** is the annualized average daily Nasdaq turnover if traded on Nasdaq, otherwise zero; ***Return*** is the industry adjusted annual return. The standard error of OLS regression is corrected using the Huber-White procedure with clustering by CEO.

Dependent = Change of $Q_{t-1 \text{ to } t}$	(1)		(2)	
	Coef.	p-value	Coef.	p-value
INTERCEPT	0.0580	0.3513	0.0859	0.1585
Change of $PPS_{t-2 \text{ to } t-1}$	**0.0171**	**<.0001**	**0.0197**	**<.0001**
Change of $PPS_{t-2 \text{ to } t-1}$ * $Tenure_{t-1}$	**-0.0016**	**0.0055**	**-0.0019**	**0.0009**
Change of $PPS_{t-2 \text{ to } t-1}$ * $Large_{t-1}$	**-0.0098**	**0.2535**	**-0.0101**	**0.2282**
Change of $PPS_{t-2 \text{ to } t-1}$ * $Tenure_{t-1}$ * $Large_{t-1}$	**0.0012**	**0.2766**	**0.0011**	**0.3022**
$Tenure_{t-1}$ * $Large_{t-1}$	0.0138	0.0606	0.0141	0.0504
$Tenure_{t-1}$	-0.0118	0.0269	-0.0135	0.0097
$Large_{t-1}$	-0.1842	0.0005	-0.1853	0.0003
Change of $D\&O\ Ownership_{t-2 \text{ to } t-1}$	1.2198	<.0001	0.9142	0.0019
Change of $Log\ Sales_{t-2 \text{ to } t-1}$	-0.9583	<.0001	-0.6325	0.0012
Change of $Log\ Sales\ Squared_{t-2 \text{ to } t-1}$	0.0443	0.0016	0.0355	0.0098
Change of $Capital/Sales_{t-2 \text{ to } t-1}$	-0.0235	0.6130	0.0282	0.5356
Change of $Capital/Sales\ Squared_{t-2 \text{ to } t-1}$	-0.0028	0.1516	-0.0030	0.1161
Change of $R\&D/Capital_{t-2 \text{ to } t-1}$	-0.0726	0.3901	-0.0498	0.5458
Change of $Advertising/Capital_{t-2 \text{ to } t-1}$	0.5514	0.0108	0.3804	0.0724
Change of $Investment/Capital_{t-2 \text{ to } t-1}$	-1.3976	<.0001	-1.0183	<.0001
Change of $Idiosyncratic\ Risk_{t-2 \text{ to } t-1}$	21.9093	0.0434	-1.2003	0.9120
Change of $Cash\ Flow/Sales_{t-2 \text{ to } t-1}$	-0.0877	0.0037	-0.0806	0.0064
Change of $Analyst\ Coverage_{t-2 \text{ to } t-1}$	0.0035	0.3278	0.0121	0.0007
$Missing\ R\&D_{t-1}$	0.0053	0.8051	0.0002	0.9921
$Missing\ Advertising_{t-1}$	0.0193	0.4041	0.0211	0.3505
$G\text{-}index_{t-1}$	0.0037	0.3671	0.0029	0.4612
Became Financially Constrained	-0.0112	0.7755	-0.0301	0.4330
Became Financially Unconstrained	-0.1607	0.0006	-0.1289	0.0049
$Trend_{t-1}$	0.0024	0.4643	-0.0021	0.5292
Change in $Turnover\ NYSE_{t-2 \text{ to } t-1}$			0.1220	0.3339
Change in $Turnover\ NASDAQ_{t-2 \text{ to } t-1}$			-0.2937	0.1823
$Return_{t-2 \text{ to } t-1}$			-0.3215	<.0001
$Return_{t-3 \text{ to } t-2}$			-0.1988	<.0001
R^2	0.0386		0.0834	
No. of firm-year	7,173		7,173	

Table 12 Tobin's Q, PPS (Jensen and Murphy) and CEO Tenure: Interaction with outside CEO

The sample period is 1993-2007. ***Tobin's Q*** is market value of asset divided by book value of asset; ***Jensen-Murphy PPS*** is the Jenson and Murphy measure of pay-performance-sensitivity (change in wealth for every $1,000 change in shareholder wealth) converted from the Core and Guay measure (change in wealth for 1% change in stock price) using the following formula: *PPS* = (Core and Guay *PPS* *100,000)/Market value (Core, Guay, and Larcker, 2003); ***Tenure*** is CEO tenure; ***Outsider*** is an indicator variable that equals one if the CEO is hired from outside the firm, otherwise zero; ***D&O Ownership*** is the percentage of ownership held by the directors and officers; ***Sales*** is the firm annual sales revenue; ***Capital*** is gross plant, property, and equipment; ***R&D*** is equal to the research and development expenditure if R&D expenditure is not missing, otherwise zero; ***Missing R&D*** is an indicator variable that equals one if R&D expenditure is missing, otherwise zero; ***Advertising*** is the advertisement expenditure; ***Missing Advertising*** is an indicator variable that equals one if advertisement expenditure is missing, otherwise zero; ***Investment*** is the capital expenditure; ***G-Index*** is from Gompers, Ishii, and Metrick (2003); ***Idiosyncratic Risk*** is the standard deviation of the residual from the CAPM model using firms' daily return over the year; ***Cash Flow*** is the cash flow from operations; ***Analyst Coverage*** is the average number of analysts that follow a firm during a fiscal year; ***Became Financially Constrained (Became Financially Unconstrained)*** is an indicator variable that equals one if the firm becomes financially constrained (unconstrained) according to the definition of Whited and Wu (2006); ***Turnover NYSE (NASDAQ)*** annualized average daily Nasdaq turnover if traded on Nasdaq, otherwise zero; ***Return*** is the industry adjusted annual return. The standard error of OLS regression is corrected using the Huber-White procedure with clustering by CEO.

Dependent = Change of $Q_{t-1 \text{ to } t}$	(1)		(2)	
	Coef.	p-value	Coef.	p-value
INTERCEPT	-0.066	0.303	-0.045	0.479
Change of $PPS_{t-2 \text{ to } t-1}$	**0.014**	**0.012**	**0.014**	**0.014**
Change of $PPS_{t-2 \text{ to } t-1}$ * $Tenure_{t-1}$	**-0.002**	**0.038**	**-0.002**	**0.039**
Change of $PPS_{t-2 \text{ to } t-1}$ * $Outsider_{t-1}$	**0.035**	**0.000**	**0.036**	**<.0001**
Change of $PPS_{t-2 \text{ to } t-1}$ * $Tenure_{t-1}$ * $Outsider_{t-1}$	**-0.004**	**0.005**	**-0.004**	**0.006**
$Tenure_{t-1}$ * $Outsider_{t-1}$	-0.012	0.349	-0.010	0.421
$Tenure_{t-1}$	0.000	0.953	-0.001	0.906
$Outsider_{t-1}$	0.049	0.513	0.037	0.617
Change of $D\&O\ Ownership_{t-2 \text{ to } t-1}$	1.235	0.000	1.148	0.000
Change of Log $Sales_{t-2 \text{ to } t-1}$	-0.473	0.029	-0.272	0.208
Change of Log Sales Squared $_{t-2 \text{ to } t-1}$	0.018	0.224	0.012	0.436
Change of Capital/$Sales_{t-2 \text{ to } t-1}$	-0.056	0.277	-0.025	0.631
Change of Capital/Sales Squared $_{t-2 \text{ to } t-1}$	0.001	0.562	0.001	0.620
Change of R&D/$Capital_{t-2 \text{ to } t-1}$	-0.049	0.611	-0.029	0.760
Change of Advertising/$Capital_{t-2 \text{ to } t-1}$	0.553	0.084	0.503	0.112
Change of Investment/$Capital_{t-2 \text{ to } t-1}$	-1.584	<.0001	-1.338	<.0001
Change of Idiosyncratic $Risk_{t-2 \text{ to } t-1}$	49.923	0.001	28.110	0.072
Change of Cash Flow/$Sales_{t-2 \text{ to } t-1}$	0.013	0.674	0.012	0.707
Change of Analyst $Coverage_{t-2 \text{ to } t-1}$	0.012	0.003	0.016	<.0001
Missing $R\&D_{t-1}$	0.000	0.989	-0.001	0.956
Missing $Advertising_{t-1}$	0.047	0.052	0.048	0.044
G-$index_{t-1}$	-0.003	0.428	-0.004	0.388
Became Financially Constrained	0.026	0.533	0.017	0.684
Became Financially Unconstrained	-0.089	0.088	-0.066	0.202
$Trend_{t-1}$	0.006	0.127	0.003	0.403
Change in Turnover $NYSE_{t-2 \text{ to } t-1}$			-0.062	0.655
Change in Turnover $NASDAQ_{t-2 \text{ to } t-1}$			-0.656	0.006
$Return_{t-2 \text{ to } t-1}$			-0.184	<.0001
$Return_{t-3 \text{ to } t-2}$			-0.113	<.0001
R^2	0.0376		0.0572	
No. of firm-year	4,883		4,883	

Table 13 Tobin's Q, CEO Ownership and Tenure

The sample period is 1993-2007. ***Tobin's Q*** is market value of asset divided by book value of asset; ***Jensen-Murphy PPS*** is the Jenson and Murphy measure of pay-performance-sensitivity (change in wealth for every $1,000 change in shareholder wealth) converted from the Core and Guay measure (change in wealth for 1% change in stock price) using the following formula: *PPS* = (Core and Guay *PPS* *100,000)/Market value (Core, Guay, and Larcker, 2003); ***CEO ownership*** is the percentage of ownership held by the CEO; ***Tenure*** is CEO tenure; ***D&O Ownership*** is the percentage of ownership held by the directors and officers excluding CEO's ownership; ***Sales*** is the firm annual sales revenue; ***Capital*** is gross plant, property, and equipment; ***R&D*** is equal to the research and development expenditure if R&D expenditure is not missing, otherwise zero; ***Missing R&D*** is an indicator variable that equals one if R&D expenditure is missing, otherwise zero; ***Advertising*** is the advertisement expenditure; ***Missing Advertising*** is an indicator variable that equals one if advertisement expenditure is missing, otherwise zero; ***Investment*** is the capital expenditure; ***G-Index*** is from Gompers, Ishii, and Metrick (2003); ***Idiosyncratic Risk*** is the standard deviation of the residual from the CAPM model using firms' daily return over the year; ***Cash Flow*** is the cash flow from operations; ***Analyst Coverage*** is the average number of analysts that follow a firm during a fiscal year; ***Became Financially Constrained (Became Financially Unconstrained)*** is an indicator variable that equals one if the firm becomes financially constrained (unconstrained) according to the definition of Whited and Wu (2006); ***Turnover NYSE (NASDAQ)*** annualized average daily Nasdaq turnover if traded on Nasdaq, otherwise zero; ***Return*** is the industry adjusted annual return. The standard error of OLS regression is corrected using the Huber-White procedure with clustering by CEO.

Dependent = Change of $Q_{t-1 \text{ to } t}$	(1)		(2)		(3)		(4)	
	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
INTERCEPT	-0.0117	0.8635	0.0188	0.7729	-0.0085	0.9010	0.0215	0.7423
Change of CEO Ownership$_{t-2 \text{ to } t-1}$	**28.0048**	**0.0124**	**26.2250**	**0.0088**	**28.1036**	**0.0118**	**26.2938**	**0.0086**
Change of CEO Ownership$_{t-2 \text{ to } t-1}$ * Tenure$_{t-1}$	**-2.4049**	**0.0424**	**-2.3051**	**0.0321**	**-2.3936**	**0.0422**	**-2.2957**	**0.0325**
Tenure$_{t-1}$	-0.0053	0.1592	-0.0073	0.0487	-0.0057	0.1304	-0.0076	0.0410
Change of D&O Ownership$_{t-2 \text{ to } t-1}$					1.1435	0.0551	0.8790	0.1198
Change of Log Sales $_{t-2 \text{ to } t-1}$	-0.9074	0.0568	-0.5819	0.1698	-0.8783	0.0641	-0.5628	0.1849
Change of Log Sales Squared $_{t-2 \text{ to } t-1}$	0.0380	0.2295	0.0293	0.3177	0.0371	0.2379	0.0288	0.3258
Change of Capital/Sales $_{t-2 \text{ to } t-1}$	-0.0293	0.8496	0.0227	0.8804	-0.0225	0.8806	0.0276	0.8509
Change of Capital/Sales Squared $_{t-2 \text{ to } t-1}$	-0.0024	0.7704	-0.0027	0.7412	-0.0027	0.7391	-0.0029	0.7153
Change of R&D/Capital $_{t-2 \text{ to } t-1}$	-0.0738	0.5805	-0.0512	0.6938	-0.0719	0.5895	-0.0502	0.6994
Change of Advertising/Capital $_{t-2 \text{ to } t-1}$	0.4834	0.2079	0.3200	0.3037	0.5036	0.1870	0.3345	0.2801
Change of Investment/Capital $_{t-2 \text{ to } t-1}$	-1.4334	<.0001	-1.0561	0.0003	-1.4183	<.0001	-1.0465	0.0004
Change of Idiosyncratic Risk $_{t-2 \text{ to } t-1}$	21.0774	0.1970	-2.2764	0.8987	20.2210	0.2140	-2.9408	0.8704
Change of Cash Flow/Sales $_{t-2 \text{ to } t-1}$	-0.0852	0.4454	-0.0795	0.4647	-0.0889	0.4184	-0.0826	0.4411
Change of Analyst Coverage $_{t-2 \text{ to } t-1}$	0.0033	0.4574	0.0118	0.0017	0.0036	0.4197	0.0120	0.0015
Missing R&D $_{t-1}$	0.0068	0.7227	0.0018	0.9216	0.0068	0.7256	0.0017	0.9263
Missing Advertising $_{t-1}$	0.0199	0.4193	0.0213	0.3735	0.0199	0.4192	0.0213	0.3739
G-index $_{t-1}$	0.0017	0.7120	0.0010	0.8323	0.0016	0.7399	0.0008	0.8597
Became Financially Constrained	0.0291	0.4945	0.0110	0.7937	0.0285	0.5044	0.0107	0.7985
Became Financially Unconstrained	-0.1329	0.0734	-0.0993	0.1486	-0.1282	0.0841	-0.0961	0.1631
Trend $_{t-1}$	0.0021	0.4747	-0.0022	0.4462	0.0023	0.4274	-0.0020	0.4869
Change in Turnover NYSE $_{t-2 \text{ to } t-1}$			0.1147	0.2751			0.1180	0.2645
Change in Turnover NASDAQ $_{t-2 \text{ to } t-1}$			-0.3157	0.2394			-0.2795	0.3099
Return $_{t-2 \text{ to } t-1}$			-0.3200	<.0001			-0.3165	<.0001
Return $_{t-3 \text{ to } t-2}$			-0.1949	<.0001			-0.1957	<.0001
R^2	0.0336		0.0778		0.0355		0.0789	
No. of firm-years	7,173		7,173		7,173		7,173	

Appendix: Incentives dynamic and its effect on firm value using the learning model

To highlight the dynamic process of change in pay-performance-sensitivity occasioned by the manifestation of CEOs' unknown talent, we keep the model as simple as possible, largely following Bushman, Dai, and Wang (2009), save that the firm does not have a firing option. The CEO and firm have common knowledge about the distribution, but neither knows the true level, of CEO talent (see also Gibbons and Murphy, 1992; Holmstrom, 1999; Hermalin and Weisbach, 2008, and Taylor, 2010). CEOs are *ex ante* identical, all market participants holding identical prior beliefs about talent. The firm operates for two periods, t = 1, 2 for now. A contract is signed between firm and CEO at the beginning of period one with the understanding that the firm-CEO relationship will last for two periods.[15] But the firm updates its belief about the incumbent CEO's talent at the end of the first period based on the observable, period one performance, and the second period contract could depend on this updated belief.

The per-period production technology is given by:

$$y_t = \theta_t + e_t + \varepsilon_t \quad t = 1,2, \tag{1}$$

where y_t is period *t* output, θ_t represents unknown CEO talent, e_t represents CEO effort, and ε_t is a normally distributed random shock with mean zero and variance σ^2 for $t = 1,2$. We assume that θ_t is independent of ε_t. The prior distribution over talent is normal, with mean θ_0 and variance σ_0^2. Per-period CEO compensation is given as:

[15] When possibility of firing (Bushman, Dai, and Wang, 2009) or career concerns (Gibbons and Murphy, 1992) is present in the model, the difference between the two periods' pay-performance-sensitivity will be even greater. The increase in PPS over a CEO's tenure derived in this simple model is only the lower bound.

$$w_t = a_t + b_t y_t \qquad t = 1,2\,, \tag{2}$$

where w_t is the CEO's compensation for period *t*, and a_t and b_t are compensation parameters.

We assume the CEO to be risk-averse and the firm to be risk-neutral. We further assume that the period utility function for the CEO is the mean-variance with, for simplicity, γ as a risk-aversion parameter. We also assume there to be no discounting for CEO or firm. We start with the second period contract, and the principal solves the following problem.

$$\max_{a_2, b_2, e_2} : E[y_2 - w_2 \mid y_1]$$

s.t. $$e_2 = \arg\max\{E[w_2 \mid y_1] - \frac{1}{2}\gamma Var(w_2 \mid y_1) - \frac{1}{2}e_2^2\}$$

$$E[w_2 \mid y_1] - \frac{1}{2}\gamma Var(w_2 \mid y_1) - \frac{1}{2}e_2^2 \geq \bar{u}_2$$

where $\bar{u}_2$ is the period two reservation utility. When the principal faces the above problem, y_1 is realized and used by both firm and CEO to update their beliefs about CEO talent (i.e., symmetric learning). The updated mean and variance are, from the firm's perspective:

$$\theta_1 \equiv E[\theta \mid y_1] = \frac{\sigma^2\theta_0 + \sigma_0^2(y_1 - \hat{e}_1)}{\sigma_0^2 + \sigma^2}\,, \tag{3}$$

and

$$\sigma_1^2 \equiv Var(\theta \mid y_1) = \frac{\sigma^2 \sigma_0^2}{\sigma_0^2 + \sigma^2}, \quad (4)$$

where $\hat{e}_1$ is the firm's conjecture about the CEO's first period effort. Solving the principal's period two problem for an incumbent CEO, we get:[16]

$$e_2^* = b_2^* = \frac{1}{1 + \gamma(\sigma_1^2 + \sigma^2)}. \quad (5)$$ Moving to period one, the principal solves the following problem:

$$\max_{a_1, b_1, e_1} : E_1\{(y_1 - w_1) + E_2(y_2 - w_2 \mid y_1)\}$$

$$s.t.\ e_1 = \arg\max E_1\{[E_1(w_1) - \frac{1}{2}\gamma V_1(w_1) - \frac{1}{2}e_1^2] + [(E_2(w_2 \mid y_1) - \frac{1}{2}\gamma V_2(w_2 \mid y_1) - \frac{1}{2}e_2^2]\}$$

$$RHS \geq \bar{u}_1 + \overline{u_2}.$$

RHS refers to the right-hand-side of the incentives comparability constraint, ($\bar{u}_1 + \overline{u_2}$) the reservation utility for two periods. We first solve the agent maximization problem for optimal effort, then impose the equilibrium condition $\hat{e}_1 = e_1$. The solution to the above optimization problem is

$$e_1^* = b_1^* = \frac{1}{1 + \gamma(\sigma_0^2 + \sigma^2)}. \quad (6)$$

Immediately, we see that b_1^* is smaller than b_2^* as σ_0^2 is larger than σ_1^2 and this is attributed simply to learning about the CEO's unknown talent when the first period output is realized. If we extend this intuition beyond two periods for as long as the CEO stays with the firm, learning will

[16] Using the participation constraint will give us the solution for the other contract parameter a_2, similarly for a_1.

continue until the CEO's talent becomes completely known, as the following result shows: $\lim_{T\to\infty}\sigma_T^2 = 0$, and the CEO's pay-performance-sensitivity becomes a constant: $\lim_{T\to\infty} b_T^2 = \frac{1}{1+\gamma\sigma^2}$.

Regarding the firm value effect of incentive compensation, we plug the optimal solutions for both periods back into the principal's objective function and solve for the profit for each period.

$$E_1[y_1 - w_1] = \theta_0 + \frac{1}{2[1+\gamma(\sigma_0^2+\sigma^2]} - \overline{u_1}\ , \qquad (7)$$

and

$$E_2[y_2 - w_2 \mid y_1] = \theta_1 + \frac{1}{2[1+\gamma(\sigma_1^2+\sigma^2]} - \overline{u_2}\ . \qquad (8)$$

If we assume that the second period reservation utility will be adjusted accordingly and completely by the updated CEO talent, the difference between θ_1 and θ_0 will be entirely offset by the difference between $\overline{u_1}$ and $\overline{u_2}$, and the expected profit would be higher for the second than for the first period. Again, the difference is driven by the resolution of uncertainty about CEO talent. Also note that the increase in firm value, like the increase in pay-performance-sensitivity, will reach its limit as CEO tenure increases.