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Abstract

We examine, both theoretically and empirically, the determinants and performance impact of three measures of CEO incentives: pay-performance elasticity (PPE), semi-elasticity (PPSE), and sensitivity (PPS). Larger, more R&D intensive, and low-idiosyncratic risk firms have higher PPE and PPSE, resolving puzzling prior empirical findings based on PPS. Performance is generally hump-shaped in PPE and PPSE; shortfalls relative to predicted levels appear particularly detrimental to firm performance, suggesting that the average firm's incentives are at the low end of the optimal range. Overall, the results obtained with the PPE and PPSE measures accord better with economic intuition than those obtained using PPS.

JEL Classification: G32, G34

Keywords: Executive compensation, pay-for-performance elasticity

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CEO Incentives:
Measurement, Determinants, and Impact on Performance[1]

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Introduction

Since the late 1990s, the design of CEO compensation, and in particular, the use of equity based incentives, has attracted widespread attention from the general public, the media, and policy makers. Misaligned incentives are regarded as a central cause of the spate of corporate scandals that erupted around the turn of the century, exemplified by WorldCom and Enron, as well as of the exponential increase in accounting restatements reported by the General Accounting Office (GAO 2002, 2007). More recently, inappropriate compensation has been singled out as one of the main contributors to the 2007-2009 financial crisis. The Dodd-Frank Act, the most sweeping financial regulation enacted since the great depression, includes an important component focusing on executive compensation, calling for features such as clawback provisions and deferral of bonuses in the financial industry. There have also been calls to give shareholders more influence on executive pay: "say on pay", whereby shareholders are given the right to vote on executive compensation at the annual shareholder meeting, was first required by UK in 2003, and has subsequently been adopted by countries such as the Netherlands, Australia, Sweden, Norway, and the USA.

If corporate boards are to draft the right compensation contract and policy makers are to propose and implement appropriate compensation regulation, it is important to understand how the strength of managerial incentives embedded in a compensation contract can be assessed, how the incentives should depend on firm and managerial characteristics, and finally, how effective incentives are in shaping firm performance.

How best to measure CEO incentives remains an unresolved issue. A good measure should map directly into the amount of CEO effort elicited. It's not clear that the most commonly used measure, the $-for-$ sensitivity of pay to firm value, is the best metric. In this paper, we provide a comprehensive evaluation of the three incentive measures of stock-based incentives that have been examined in the literature: pay-for-performance sensitivity, pay-for-performance semi-elasticity, and the more recently proposed pay-for-performance elasticity. We discuss the firm-CEO environment under which each measure

is appropriate. We then empirically examine the determinants of these competing incentive measures and their link to firm valuation and performance.

The most popular measure of incentives, the pay-performance sensitivity (PPS) used by Jensen and Murphy (1990) is defined as the dollar change in CEO wealth per dollar change in firm value; it is essentially the ownership percentage of the CEO.[2] Hall and Liebman (1998) advocate the use of the pay-for-performance semi-elasticity (PPSE): the change in CEO wealth per 1% change in the value of the firm. Baker and Hall (2004) show that PPS is the appropriate measure when the marginal product of CEO effort is constant across firm size, while PPSE is appropriate when the marginal product of CEO effort scales with firm size.

A third measure, advocated recently by Peng and Röell (2008, 2014) and Edmans, Gabaix, and Landier (2009), is the pay-performance elasticity (PPE) - the percentage change in CEO wealth per percentage change in firm value. PPE captures incentives in settings where CEO effort has a multiplicative (rather than additive) effect on firm value and risk and when CEO utility is Cobb-Douglas in wealth and leisure so that there is some complementarity between leisure and wealth (as in Peng and Röell, 2008, 2014). Despite the theoretical attractions of this measure, it remains underexplored in empirical studies, to some extent due to the limited availability of data on CEO wealth.

This paper starts off by reviewing the theoretical settings that determine which of the three measures (PPS, PPSE and PPE) best captures the strength of incentives. The theoretical framework provides a set of predictions on the determinants of the different incentive measures. While PPS has been employed extensively in the existing literature, some of the patterns found are hard to reconcile with agency theory. For instance, if PPS is the right incentive measure, then the negative relation between PPS and firm size observed in the data by Jensen and Murphy (1990), Schaefer (1998), and others, is puzzling because it would suggest that CEOs of larger firms are given weaker incentives for effort. This led Rosen (1992) and

[2] The extensive literature on PPS is surveyed by Murphy (2013).

subsequent researchers to question whether PPS is the appropriate specification of incentives. Another example is a central prediction of classical agency theory, namely, the negative tradeoff between risk and incentives: the empirical evidence on risk and incentives as measured by PPS is mixed, as shown in Prendergast's (2002) review. These findings beg the question of whether PPS is the right measure of incentives for real world firms. Indeed, a PPS value of 0.03 % as documented by Jensen and Murphy (1990) may seem to indicate weak incentives at first glance, but for a $10 billion firm, it means a pay rise of $ 3 million for every 1% change in firm value, hardly a minor reward. Thus the empirical sections of the paper focus on analyzing PPSE and particularly PPE, which have not been as well explored.

The first main objective of the paper is to analyze the determinants of PPE, PPS and PPSE, and to investigate whether the empirical evidence is consistent with the predictions of agency theory in the three stylized settings presented in the theory section. The empirical relationship between the three incentive measures and firm size has been analyzed by Edmans *et al.* (2009), who predict and find that PPE is size-invariant. In contrast, the model of Peng and Röell (2008, 2014) predicts an increasing relation between size and PPE. Whether small firms should give their CEOs the same level of PPE as large firms is of interest in the design of compensation packages. Consistent with the prediction of Peng and Röell (2008, 2014), we find that PPE is not size-invariant and increases significantly with firm size. This result confirms that larger firms' CEOs indeed are given stronger incentives.

But aside from firm size, other determinants of incentives should not be neglected, and in particular the impact of risk. In line with classical agency theory, Peng and Röell (2008, 2014) show that more risk-averse CEOs should have lower PPE and that riskier firms should grant lower PPE to their executives. We test these predictions empirically for all ExecuComp firms. We find that PPE and PPSE decrease with firms' idiosyncratic risk in particular, and that older CEOs have lower PPE. These findings are consistent with the key insight from traditional agency theory that optimal incentives should decrease with CEO risk aversion and business risk, and in particular, the idiosyncratic risk that executives cannot easily hedge by adjusting the riskiness of their personal portfolio. In contrast, PPS is positively related to risk, reproducing

the puzzling relation between PPS and risk discussed by Prendergast (2002). Thus our findings based on PPE or PPSE help resolve the puzzle without having to resort to additional modelling features such as an association between risk and the complexity of the manager's tasks. Other empirical results based on PPE also make sense intuitively: for example, there is a positive relation with R&D and capital expenditure.

The second main objective of the paper is to investigate the effectiveness of incentive contracts by looking at the relation between different incentive measures and firm valuation and performance. The empirical evidence is again mixed. Some find that the relation between incentives (measured by PPS or ownership) and performance is positive when incentives are low (Mehran, 1995, and Core and Larcker, 2002), but the relationship turns negative when the level of ownership is high.[3] Another set of papers argues that, taking into account endogeneity of incentives, there is no evidence of a relationship between incentives, again measured by PPS, and firm performance, consistent with observed contracts being optimal.[4] In the light of recent theoretical developments in incentive measures, it would be useful to compare and contrast the relation between different *ex ante* incentive measures and *ex post* firm performance.

To assess the economic impact of incentives on firm performance, we examine the relation between CEO incentives and subsequent ROA and Tobin's Q. We find that PPE and PPSE are generally positively associated with both ROA and Tobin's Q, except for very high values of incentives, consistent with the notion that there is an optimal level of compensation, but that not all firms are at the optimum. In contrast, the relation of PPS with performance is insignificant, which could either mean that PPS does not capture incentives, or that all firms optimize their incentives (as measured by PPS) and any differences in

[3] Morck *et al*., 1988; McConnell and Servaes 1990, 1995; Hermalin and Weisbach, 1991; Hubbard and Palia, 1995; Holderness *et al*., 1999; Anderson and Reeb, 2003; Tian, 2004; Davies *et al*., 2005; Adams and Santos, 2006; Pukthuanthong *et al*., 2007; McConnell *et al*., 2008; Tong, 2008.
[4] Demsetz and Lehn (1985), Agrawal and Knoeber (1996), Loderer and Martin (1997), Cho (1998), Demsetz and Villalonga (2001), Himmelberg *et al*. (1999), Palia (2001), Coles *et al*. (2003), Brick *et al*. (2005), and Cheung and Wei (2006).

performance are noise. We conduct robustness checks by accounting for endogeneity through various methods: controlling for firm fixed effects and using instrumental variable analysis.

We further refine our investigation of whether firms are providing the optimal level of incentives by considering how deviations from predicted levels of incentives affect performance. Specifically, we use a two stage procedure to first estimate the predicted level of PPE and PPSE using a set of firm and CEO characteristics, and we then examine the role of deviations from the predicted value. We find that a CEO compensation contract that employs lower than the predicted level of PPE and PPSE is detrimental to firm performance. In contrast, for PPS, both upward and downward deviations from the predicted level of incentives enhance performance; a result that is hard to make sense of and which suggests that PPS does not capture incentives properly. The results based on PPSE and PPE suggest that getting the right level of incentives is of crucial importance for firm performance and shareholder value.

Overall, we find that PPE and PPSE are superior to PPS as measures of incentives, in the sense that they are related to firm/CEO characteristics in a way that is grounded in basic agency theory, and that their impact on firm performance can be substantiated. Our results show that the optimal strength of incentives is firm, industry, and CEO specific, and that the average firm does not over-incentivize. The analysis suggests that public policy directed at reining in excessive pay should be careful not to compromise firms' ability to provide appropriate incentives.

1. Theory

How incentives are best measured depends very much on the model of managerial behavior that underlies the analysis. In this section we will illustrate this point by sketching out three competing baseline models of CEO preferences and productivity, and deriving the appropriate measure of incentives that corresponds to each one. We then consider the comparative statics of the determinants of optimal incentives for each setting.

Consider a standard two-period agency model. At date 0, the manager and the firm's shareholders sign a pay contract which relates managerial pay (w) to firm performance, as measured by the gross-of-pay market value of the firm (V) at time 1. Shareholders are risk neutral and seek to maximize expected net-of-pay firm value. At time 0, after signing the contract the manager, who is risk averse, chooses his unobservable productive effort (E) to maximize his expected utility. The final payoffs, which depend both on the CEO's effort (E) and a random shock (ε), are realized at date 1, when firm value is revealed and the manager is paid. Following the approach pioneered by Baker and Hall (2004), we will explore the implications of different ways in which effort can interact with firm scale and random shocks.

The formal general structure of the models is the following. The manager's utility depends positively on his wealth ($W = W_0 + w$, where W_0 is the manager's initial wealth and w is his pay). Pay is a non-decreasing function of firm value, $w(V)$ where V is firm value gross of pay. Firm value depends on effort, the initial scale of the firm (X) and the random shock ε: $V = V(X, E, \varepsilon)$. The manager's utility depends on both wealth and effort, $U = U(W,E)$, and is decreasing in effort. This classic principal agent model was introduced by Mirrlees (1974, 1975), Spence and Zeckhauser (1971), Ross (1973) and Holmström (1979), and has been extensively studied since.

We consider three specific settings. [5]

I. The standard additive quasi-linear model. In this setting, the manager's utility is linear in wealth and the cost of effort,[6] and the impact of both effort and random shocks on firm value is additive, so that the manager's choice of effort (E) is described by:

$$\max_{\{E\}} \mathbf{E}\left[U(\widetilde{W} - E)\right] \qquad \text{where} \quad \widetilde{W} = W_0 + w\left(\tilde{V}\right) \quad \text{and} \quad \tilde{V} = X + P(E) + \tilde{\varepsilon} \qquad (1)$$

[5] All proofs for this section are collected in Appendix C.

[6] We define effort in money-metric utility terms; a more commonly used equivalent formulation defines effort as output $\hat{E} \equiv P(E)$, in which case the utility function incorporates a cost of effort function $C(\hat{E}) \equiv P^{-1}(\hat{E})$, the inverse of the productivity-of-effort function in our formulation; $C(\cdot)$ is thus increasing and convex.

where the productivity-of-effort function is assumed to be increasing and concave. Tilde superscripts denote random variates.

II. Money and effort are complements and the impact of effort is multiplicative. We next assume that preferences are Cobb-Douglas in leisure and wealth, and that managerial effort and risk both affect firm value proportionally, in a variant of the multiplicative models proposed by Peng and Röell (2008, 2014) and Edmans, Gabaix and Landier (2009):

$$\max_{\{E\}} \mathbf{E}\left[U(\widetilde{W} \cdot (E_0 - E))\right] \quad \text{where} \quad \widetilde{W} = W_0 + w\left(\tilde{V}\right) \quad \text{and} \quad \tilde{V} = X \cdot P(E) \cdot \tilde{\varepsilon} \qquad (2)$$

where E_0 is an endowment of leisure, and effort E can be interpreted as time spent working.

III. Quasilinear preferences with multiplicative effort impact. We lastly consider a model with standard quasilinear utility and multiplicative impact of effort on firm value. That is, the manager chooses effort to:

$$\max_{\{E\}} \mathbf{E}\left[U(\widetilde{W} - E)\right] \qquad \text{where} \quad \widetilde{W} = W_0 + w\left(\tilde{V}\right) \quad \text{and} \quad \tilde{V} = X \cdot P(E) \cdot \tilde{\varepsilon} \ . \qquad (3)$$

The first question to be addressed is how the compensation contract determines effort in each of these three settings. In empirical work, a suitable measure of the "strength" of incentives should map directly into managerial effort.

PROPOSITION 1. *Effort is determined as follows in the three settings:*

I. If the manager's utility is quasilinear in effort, and effort affects firm value additively, effort is increasing in pay-for-performance sensitivity (PPS) and increasing (decreasing) in the marginal product (cost) of effort:

$$1/_{P'(E)} = \mathbf{E}\left[\left(\frac{\tilde{U}'}{\mathbf{E}[\tilde{U}']}\right) \cdot \widetilde{w}'\right]. \qquad (4)$$

II. If the manager's utility is Cobb-Douglas in wealth and leisure and effort and random shocks affect firm value multiplicatively, effort is increasing in the elasticity of executive wealth to firm value (PPE) and in the effort elasticity of firm value:

$$\mathbf{E}\left[\left(\frac{\tilde{U}'\cdot\tilde{W}}{\mathbf{E}[\tilde{U}'\cdot\tilde{W}]}\right)\cdot\frac{\tilde{w}'\cdot\tilde{V}}{\tilde{W}}\right]=\frac{P}{(E_0-E)P'} \quad . \tag{5}$$

III. If the manager's utility is quasilinear in effort, and effort and random shocks affect firm value proportionately, effort is increasing in the semi-elasticity of pay to firm value (PPSE) and in the semi-elasticity of firm value to effort:

$$\mathbf{E}\left[\frac{\tilde{U}'}{\mathbf{E}[\tilde{U}']}\cdot\tilde{w}'\cdot\tilde{V}\right]=P/P' \, . \tag{6}$$

Note that in this proposition the pay contract *w(·)* is taken to be differentiable but not otherwise constrained. For models I and III, equations (4) and (6) show that a marginal-utility-weighted average of the relevant incentive measure (*PPS* and *PPSE* respectively) determines effort. This means that punishing failure is a more powerful driver of effort than rewarding success (as risk aversion means that *U'* is a decreasing function of its argument). For model II, the weighting factor in equation (5), $U'\cdot w$, is decreasing in wealth iff the coefficient of relative risk aversion ($-U''\cdot w/U'$) is greater than 1, as generally found in empirical work.[7] Thus again the value of the incentive measure (*PPE*) is most heavily weighted at the lower end of the range of possible outcomes. The three models and the corresponding determinants of effort are summarized in Table 1 to facilitate comparison.

We turn now to the comparative statics of the optimal incentive contract, that is, the nature of the pay contract *W(·)* which maximizes shareholder value:

$$\max_{\{w(\cdot)\}}\mathbf{E}[V-w(V)] \quad \text{where} \quad V=V(X,E,\varepsilon) \quad \text{subject to:} \tag{7}$$

Incentive constraint: $E=\operatorname{argmax}\mathbf{E}[U(W,E)]$ where $W=W_0+w(V)$

[7] For example, Szpiro (1986) estimates the coefficient of relative risk aversion to be between 1.2 and 1.8.

Participation constraint: $\mathbf{E}[U(W,E)] \geq \underline{U} = U(\underline{W},0)$

where $\underline{W} \equiv W_0 + \underline{w}$ is the manager's reservation wealth level, and $\underline{w}$ is the reservation wage.

Closed-form solutions can be obtained for each of the three settings by adopting suitably functional forms for the utility and productivity-of-effort functions and the distribution of the output shock, as well as restricting the functional form of the compensation function. These assumptions are collected in Table 2.

PROPOSITION 2. *The second-best optimal compensation contract has the following properties:*

I. If the manager has a CARA utility and effort affects firm value additively, the strength of incentives, as measured by the \$-\$ sensitivity of pay to firm value (m), is decreasing in the firm's fundamental risk (Σ) and the manager's CARA risk aversion (ρ), increasing in the manager's productivity of effort (p) (or equivalently, decreasing in the cost of effort), and independent of firm size (X)[8] *and the manager's wealth and reservation wage.*

II. If the manager's utility is CRRA and Cobb-Douglas in wealth and leisure and effort and random shocks affect firm value multiplicatively, the strength of incentives, as measured by the elasticity of the manager's wealth[9] *to firm value (μ), is increasing in the scale of the firm (X) and the manager's productivity of effort (p), and decreasing in the firm's fundamental risk (σ^2), the manager's CRRA risk aversion (θ), his reservation wage ($\underline{w}$) and his personal wealth (W_0).*

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[8] The independence from firm size only applies if risk is fully controlled for. The measure of risk Σ corresponding to the additive model is the absolute variance of firm value, that is, the volatility of the stock return σ^2 scaled by X^2, *viz.* $\Sigma \equiv X^2 \cdot \sigma^2$. Thus it is reasonable to assume that Σ, the absolute variance of firm value, will increase as the scale of the firm expands. If so, \$-for-\$ incentives will decrease as the scale of the firm X grows, in step with the absolute variance of the firm's total value.

[9] It should be noted that the theory is framed in terms of the executive's total wealth, not just his pay from the firm. The elasticity of wealth and the elasticity of pay are not the same thing unless the manager has zero outside wealth W_0:

$$\underbrace{w'/\tfrac{w}{V}}_{\substack{\text{pay}\\ \text{elasticity}}} = \frac{W}{w} \cdot w'/\frac{W}{V} = \frac{W}{w} \cdot W'/\frac{W}{V} = \frac{W_0+w}{w} \cdot \underbrace{W'/\tfrac{W}{V}}_{\substack{\text{wealth}\\ \text{elasticity}}} \tag{8}$$

This means that the impact of the manager's outside wealth on the elasticity of pay is ambiguous: an increase in the manager's wealth W_0, by equation (20) of Appendix C, reduces the optimal wealth-elasticity incentive μ , but at the same time by equation (8) the pay elasticity must increase in order to achieve any given wealth elasticity μ.

III. If the manager has a CARA utility and effort and random shocks affect firm value proportionately, the strength of incentives, as measured by the semi-elasticity of pay to firm value (δ), and the corresponding managerial effort, is increasing in the scale of the firm (X) and the manager's productivity of effort (p), and decreasing in risk and in risk aversion (σ^2 and ρ), and independent of the manager's initial wealth and reservation wage.

The predictions for the three settings are summarized in Table 3.

We will now turn to the empirical determination of incentives for effort as captured by the three measures presented in this section.

2. Data

Our data are primarily taken from the ExecuComp and Compustat databases. In our main sample, we include all CEOs with required variables available during 1992-2010. We obtain consumer price index (CPI) information from the Bureau of Labor Statistics so that all dollar amounts can be converted into 2010 dollars. In addition, the corporate governance index is obtained from the RiskMetrics database, and the marginal tax rate from www.taxfoundation.org. Detailed definitions of all variables constructed in the paper are given in Appendix A.

3.1 CEO incentive measures

We define CEO pay-performance elasticity (PPE) as the percentage change in CEO wealth per one percent change in shareholders' wealth. To calculate changes in CEO wealth, we include both the shares owned by and the stock options granted to a CEO. In particular, we use detailed award information from ExecuComp to estimate the delta of stocks and options from year 2006 onward. For the early years, we estimate the delta following the method of Core and Guay (2002). Because CEO wealth is not directly available from ExecuComp, we adopt the method of Dittmann and Maug (2007) to estimate total CEO

wealth from his/her entire compensation history in the ExecuComp database. In particular, we first estimate the net cash inflows based on the compensation and equity transactions of each year. We then accumulate an executive's cash wealth over years, assuming that the executive invests all her surplus cash at the risk-free rate of interest. For any year, an executive's total wealth is calculated as the sum of his/her cash wealth, market value of shares owned, and value of unexercised exercisable options. Following Dittmann and Maug (2007), we require an executive to be in the ExecuComp for at least 5 years before she can be included in our sample (see Appendix B for a detailed description of this method). To check robustness we also construct measures requiring at least three or seven years instead (PPE_3Y+ and PPE_7Y+).

Following Jensen and Murphy (1990), we also examine the traditional pay-performance sensitivity (PPS) as the dollar change in CEO wealth per ten-dollar change in shareholder wealth. The third measure is the pay-performance semi-elasticity (PPSE), calculated as the CEO wealth change (in millions of 2010 dollars) per 1% change in stock price.

For comparison purposes and to check robustness, we also consider several elasticity measures as alternatives to PPE. Following Edmans, Gabaix and Landier (2009), we construct PPE_EGL: the change in CEO wealth (W) scaled by annual compensation (w) per unit of relative change in shareholder value. This definition implicitly assumes that annual compensation adequately captures CEO wealth insofar as it affects CEO utility. Indeed, by definition

$$PPE\_EGL = PPE \cdot W / w \tag{16}$$

Our PPE measure is based on the accumulated CEO wealth using information in the ExecuComp database, which covers executive compensation starting in the year 1992. This measure is preferable to PPE_EGL in theory, as it attempts to approximate CEO's wealth by using information about all available historic compensation contracts rather than only relying on the current pay contract. Nevertheless, the wealth estimate in PPE is likely to be noisy and subject to bias. Any CEO wealth accumulated prior to 1992 is not accounted for so that the imputed wealth of old CEOs is likely to be biased downward relative to that

of young CEOs. To partially address this concern, we also construct a measure, PPE_LH, based on a long-history estimate of CEO's total wealth that incorporates additional information from Frydman & Saks (2010).[10] Since Frydman and Saks' data cover a much smaller sample of firms during 1936-1991, if an executive is a CEO in the ExecuComp database in 1992 with an age older than 38, we estimate his outside wealth using the following assumptions: (1) A CEO starts to work as a CEO from 38 years old (based on bottom 1% of CEO age in the ExecuComp database from 1992-2010); (2) A CEO earns median CEO cash compensation based on (Salary + Annual Bonus + Payout of Long-Term Bonus + Options Exercised) in Frydman and Saks' dataset; (3) A CEO pays tax based on the marginal tax rate given by www.taxfoundation.org. As for a CEO's outside wealth, it is assumed to earn the 1-year Treasury rate when the Treasury rate is available.[11] From year 1992 on, we accumulate an executive's wealth using the method in Dittmann and Maug (2007). After estimating this long-history total wealth, we then calculate the pay-performance elasticity as the dollar change in CEO wealth for 1% change in stock price over the CEO's long-history total wealth. As shown in Table 4, both average and median PPE_LH are less than those of PPE as expected. The two measures are highly correlated with a correlation of 0.95.[12]

One might argue that the strength of an incentive contract depends on its impact on the present value of a CEO's lifetime expected pay. We create an incentive measure, PPE_life, following the method used by Eckbo, Thorburn and Wang (2015), to estimate the present value of lifetime expected pay. Specifically, the wealth measure equals CEO cumulated wealth up to the current year plus the present value of future compensation until age 65, assuming that the future annual compensation and tax rate will be the same as those of current year, and using a discount rate of 10%.[13]

[10] We are grateful to Professors Frydman and Saks for making their data publicly available online.
[11] Before year 1962, due to the unavailability of Treasury rate, we assume that CEO outside wealth increases at the inflation rate.
[12] Due to the much higher marginal tax rates and the lower compensation levels before mid 1980's than after 1992, the missing data in the early history is less of a concern.
[13] In unreported analysis, we also tried different assumptions, such as a discount rate of 6% and a future annual compensation equal to the average annual compensation of the past three years; the results are consistent.

3.2 Definition of other variables

Our main measure of firm size is sales, as this measure is not directly used to construct the incentive or performance measures. As robustness check, we also use alternative firm size measures such as the market value of total assets, the book value of total assets, and market capitalization. The market value of total assets is estimated as book value of total assets less book value of equity and plus the product of share price and shares outstanding (Compustat items: *at - ceq* + *prcc_f* × *csho*). Following previous literature, we take the natural logarithm of these firm size measures to decrease the skewness of the original data.

Other potential determinants of incentives and performance include firm risk, CEO age and tenure. Firm risk is measured as the standard deviation of monthly returns during the past 60 months. As market risk can readily be hedged away by the CEO, it is idiosyncratic risk that should impact incentives. A firm's idiosyncratic risk is calculated as the square root of the difference between total return variance and systematic return variance during past 60 months, and denoted as a percentage. CEOs with longer tenure could be more productive or less so, depending on whether long tenure is a sign of competence or of entrenchment. In addition, CEOs with longer tenure are likely to accumulate more shares.

Firm characteristics such as R&D intensity, proportion of hard assets as opposed to intangibles, and capital expenditure (as a fraction of net fixed assets), may also be associated with incentives and performance.[14] Following standard practice, we control for year fixed effects as well as for industry fixed effects, using the Fama-French 48-industry classification.

As measures of performance we consider both Tobin's Q and return on assets (ROA). Tobin's Q is calculated as the book value of assets less book value of equity plus the product of stock price and shares outstanding, and then scaled by book value of assets (Compustat items: *(at - ceq* + *prcc_f*csho)/at*). Return

[14] The inclusion of these control variables follows previous literature, such as Himmelberg, Hubbard, and Palia (1999) and Benson and Davidson (2009).

on assets is calculated as net income over the book value of assets denoted in percent (100*ni/at). Detailed definitions of the variables are collected in Appendix A.

3.3 Summary Statistics

Table 4 reports the summary statistics for CEO incentive measures, firm characteristics, and other variables. To ease concerns about outliers, we winsorize PPE, PPSE and PPS measures at top 2% and winsorize all other variables at 1%. Since we compare across different incentive measures, we restrict Table 4 to the observations for which all three incentive measures and all control variables are available. As the PPE measure is not available until the year 1996, the sample period for this table is 1996-2010.[15]

The average PPE for our sample is 1.02, showing that, on average, a CEO's wealth increases by about 1.02% as the stock price increases by 1%, so that CEO interests seem to be aligned with shareholder value. However, there is substantial cross-sectional variation: PPE ranges from 0.00 to 2.89 (at the 98th percentile), and it has a standard deviation of 0.61. We will explore how this variation in PPE is related to firm and CEO characteristics in the next sections.

The pay-performance semi-elasticity (PPSE) measures the change in CEO wealth for every 1% change in stock price. On average, CEO wealth increases by 0.86 million in 2010 dollars when the stock price increases by 1%; the median is 0.28 million dollars.

Pay-performance sensitivity (PPS), the dollar change in CEO pay per (ten-) dollar increase in firm market capitalization is also reported in Table 4. Table 4 shows that when shareholder value increases by $1,000, the median CEO's wealth increases by $13 in the ExecuComp sample. Murphy (2013) observes

[15] Later, among the robustness checks, we extend the sample period by constructing a less demanding measure of PPE.

that for CEOs of S&P500 firms, this number ranges from $3.5 to $6.9 in the period 1992-2011, reflecting the well-documented empirical fact that PPS tends to decrease with firm size.[16]

Turning to the summary statistics for the competing pay-performance elasticity measure PPE_EGL: it averages 28.83, that is, for every 1% increase in the stock price, CEO wealth increases by 28.83% of annual total compensation. PPE_EGL is on average much larger than PPE because PPE is scaled by CEO wealth, while PPE_EGL is scaled by CEO's annual compensation, as per equation (16), and the difference is consistent with average CEO wealth ($ 112.7 million) of about 23 times average CEO annual compensation ($ 4.9 million). PPE_EGL varies considerably, with a standard deviation of 73.6 and a range of [0, 434]. Furthermore, PPE_EGL is highly skewed: its skewness is 4.4, and the median of 7.3 is much smaller than the mean of 28.85. The kurtosis is 22.78, much higher than 3, showing a leptokurtic distribution, *i.e.* a higher density of observations around the mean than the corresponding normal distribution with the same mean and standard deviation. In contrast, the distribution of PPE is better behaved, with a skewness of 0.95 and a kurtosis of 3.98, which makes the analysis less susceptible to outliers. After taking a natural logarithm of PPE_EGL, the skewness and kurtosis decreases dramatically.[17] For this reason, we carry out a set of robustness checks using the log measure of the incentives. To avoid missing observations due to zero incentives, we add one to all incentives before we take the natural logarithm.

The original firm size measures are highly skewed: the mean (median) sales, market value of total assets, book value of total assets, market capitalization, and are $5.6 ($1.6), $15.0 ($3.1), $9.4 ($1.8), and $7.6 ($1.7) billion respectively. They are also highly leptokurtic. After taking a natural logarithm, the skewness is close to zero and the kurtosis is close to three. For these reasons, and following the previous literature, we take a log of these variables to proxy for firm size.

[16] When we restrict our sample to S&P500 firms, we get numbers similar to Murphy (2013).
[17] We use Ln(1+PPE_EGL) for the log transformation unless noted explicitly otherwise.

The return on assets (ROA) has a mean (median) of 3.4% (4.5%). The market to book of total assets (also referred to as Tobin's Q) has a mean (median) 1.89 (1.5) respectively. The average CEO age is 56 and average CEO tenure is 9 years.

Table 5 shows the correlations among various variables. PPE is positively correlated with firm size, registering a correlation of 0.17 and 0.12 with Ln(sales) and Sales respectively. Consistent with our prediction, this correlation shows that CEOs of larger firms have higher pay-for-performance elasticity. On the other hand, there is a negative correlation between PPE and Ln(CEO age) and Ln(CEO tenure), -0.16 and -0.25 respectively, showing that older CEOs and CEOs with longer tenure have lower pay-for-performance elasticity. PPE is positively correlated with firm performance measures, such as ROA in the subsequent year (a correlation of 0.10) and year-end Tobin's Q (correlation 0.15). Surprisingly, PPE is not highly correlated with PPSE (correlation 0.06) or with PPS (- 0.10); the correlation between PPSE and PPS is somewhat higher at 0.48. These correlations remain similar if we take a log of PPE.

3. The determinants of CEO incentives

In this section, we analyze the firm-CEO characteristics that affect CEOs' equity based incentives: PPE, PPS, and PPSE.

4.1 The determinants of PPE

We first focus on the PPE measure of incentives. To test the models' predictions, we include firm size, risk and the logs of CEO age, tenure and wealth. Following the existing literature (see, for example, Himmelberg, Hubbard and Palia (1999), Palia (2001) and Benson and Davidson (2009)), we include a set of control variables, such as hard assets, R&D, advertising and capital expenditures as potential determinants. We also control for year-fixed and industry-fixed effects using the Fama and French (1997)

48 industry classification. To ease concerns about endogeneity, all independent variables are lagged one year, except for CEO age and tenure.[18]

Table 6 reports the regression results with robust standard errors clustered at both the firm and the year level. In Panel A, we use Ln(sales) as a measure of firm size. As shown in Column (1), Ln(sales) is positive and highly significant, suggesting that CEOs of large firms have stronger pay-for-performance elasticity. This effect is also economically important: when firm size moves from the 25th to the 75th percentile, PPE increases by 0.26 [=0.127 × (ln(4778)-ln(610)], that is, for every 1% increase in firm value, all else equal, the impact on the wealth of a CEO of a firm with $4.778 billion in sales is 26 basis points higher than that for a firm with $610 million in sales. Using the median PPE of 0.94, this increase in PPE is about 28% [0.26/0.94=28%]. This positive relationship between firm size and incentives agrees with the predictions of the Cobb-Douglas utility - multiplicative impact model of Section 2 as described in Proposition 2. In contrast, Edmans *et al.* (2009) find that the pay-for-performance elasticity is size invariant. We explore the reasons for this difference in findings in more detail in Section 6.1.

Consistent with Proposition 2, the coefficient on the total risk of the firm is negative and significant, with a value of -0.013, that is, a one standard deviation increase in volatility (5.75) reduces PPE by 0.075. This result confirms one of the central intuitions of classical principal-agent theory, namely that incentives should decrease with risk. This finding stands in marked contrast to previous findings where incentives are measured by the pay-for-performance sensitivity (PPS). As reviewed by Prendergast (2002), the empirical evidence on firm risk and executive incentives is mixed.[19] Prendergast argues that a positive relation is plausible in a model that considers the effect of uncertainty on incentives through the allocation of more responsibility to employees in high-risk firms. Cao and Wang (2013) provide a job search based explanation: an increase in idiosyncratic risk is associated with greater dispersion in firm-CEO match value,

[18] Lagged independent variables are also used by Hermalin and Weisbach(1991).
[19] Lambert and Larcker (1987), Aggarwal and Samwick (1999), and Jin (2000) find negative relation between risk and incentives. Garen (1994), Yermack (1995), Bushman et al (1996), Ittner et al. (1997), and Conyon and Murphy (1999) find the relation to be insignificant. Core and Guay (1999) and Oyer and Shaefer (2001) find the relation to be positive.

thus increasing the market equilibrium value of CEOs' outside job options and obliging firms to increase PPS in order to retain their CEOs. He *et al.* (2014) show that a positive relation between uncertainty and incentives can be generated if the model incorporates learning, as stronger incentives can induce more learning and thus greater uncertainty reduction. Alternative explanations include the need to incentivize the otherwise risk averse managers to take on more risk (e.g., Core and Guay, 1999; Edmans and Gabaix, 2011a), or the view that risk does not reduce incentives when the effect of risk is second order and outweighed by the benefits of effort (e.g., Edmans, Gabaix, and Landier, 2009; Edmans and Gabaix, 2011b). But our PPE-based evidence strongly supports the negative risk-incentive tradeoff predicted by the basic agency models presented in Section 2, without any need for additional theorizing. Our results suggest that the choice of an appropriate measure of incentives can resolve the volatility-incentives puzzle.

CEOs may be able to hedge market risk at a relatively low cost, as shown by Jin (2002) and Garvey and Milbourn (2003). To see which component of risk contributes to the risk-incentive tradeoff, we decompose total risk into systematic risk and idiosyncratic risk, and include both as independent variables in column (2). PPE is negatively associated with firm-specific risk but is not affected by market risk, supporting the existing findings in the literature.

A wealthier CEO should be given lower PPE as his marginal utility of leisure is relatively high, as shown in Proposition 2. Consistent with this prediction, we find a negative coefficient of PPE on lagged CEO wealth: the PPE for a CEO in the 75th wealth percentile is 0.22 lower than for a CEO in the 25th wealth percentile.

There is a significantly negative coefficient on CEO age, suggesting that older CEOs have lower pay-for-performance elasticities. As shown in Morin and Suarez (1983), risk aversion tends to increase with age. Standard principal-agent theory predicts that the optimal incentive should be lower for agents who are

more risk averse, because a more risk averse CEO is less willing to accept a high PPE, making equity based incentives costly for the firm.[20]

The coefficient of CEO tenure is also negative and significant. This is consistent with the prediction of Peng and Röell (2014): CEOs who have an established track record are associated with less manipulation cost uncertainty, and this makes prices more sensitive to disclosures about performance indicators, so that optimal contracts can have a reduced price elasticity of pay. Competing theories are that longer-tenure CEOs are more entrenched, though it is not clear whether that means weaker or stronger optimal incentives, given that pay incentives are a substitute for career concerns, and that longer-tenure CEOs are more competent, which should result in higher optimal incentives.

The coefficient of R&D is positive, which implies that managers of R&D intensive companies are given stronger pay-for-performance elasticities. This result is consistent with the results of standard agency models: as the marginal contribution of CEO effort is likely to be higher in R&D intensive companies, it is optimal to give the CEO stronger incentives.

In Panel B, we use Ln(market value of assets) as an alternative measure for firm size. The results are very similar.

In summary, the results from the multivariate analysis of PPE are generally consistent with the predictions of the Cobb-Douglas – multiplicative model presented in Proposition 2 part II.

4.2 Determinants of other CEO incentive measures

In the rest of Table 6, we examine two other measures of incentives: the dollar-to-percentage pay-performance semi-elasticity (PPSE) and the dollar-to-dollar pay-performance sensitivity (PPS) commonly

[20] Note that CEO age could be mechanically related to PPE through its correlation with CEO wealth, as described in Section 6.2, therefore the age coefficient can be sensitive to the wealth measure used and should be interpreted with caution.

used in previous papers. To enhance the comparability of the results across the different incentive measures, we use a common sample for all three.

Columns (3) and (4) of Table 6 display the determinants of the pay-for-performance semi-elasticity (PPSE). Firm size is positively associated with PPSE, which is consistent with our theoretical prediction and with the findings of Edmans, Gabaix and Landier (2009). Per one percent stock price increase, the dollar gain in CEO wealth is greater in larger firms. As firm size moves from the 25th to the 75th percentile, PPSE increases by 0.11 [=0.054 × (ln(4778)-ln(610))]. This positive sign is consistent with the multiplicative models II and III presented in Section 2; the standard additive model, I, predicts no relationship.

The coefficient of total risk is negative and significant, as predicted by theory. When we separate systematic risk from idiosyncratic risk, it is again the latter that is significant, as shown in column (4).

There is a significantly positive coefficient on lagged CEO wealth, showing that richer CEOs are granted much more PPSE than CEOs with less wealth. In the quasi-linear multiplicative model that motivates the use of PPSE (model III), optimal incentives are independent of CEO wealth. Two possible explanations for the positive coefficient that we find are: absolute risk aversion is not constant (as in model III) but decreasing in wealth, or unobserved ability is positively associated with wealth. PPSE is negatively associated with CEO tenure, and the coefficient of CEO age is also negative (though insignificant), as for PPE.

Turning to the pay-for-performance sensitivity (PPS), its determinants are reported in columns (5) and (6) of Table 6. Consistent with findings from previous literature, firm size is negatively associated with PPS, suggesting that the proportion of shares (including stock-equivalent options) held by top executives decreases as the firm becomes larger. As firm size moves from the 25th to the 75th percentile, PPS decreases by 0.34 [= 0.167 × (ln(4778)-ln(610))]. As shown by Lemma 2, however, that does not mean that the economic incentives are weaker for large firms. Instead, a low PPS for a large firm may actually imply strong incentives as the ratio of CEO wealth to firm size is typically lower for large firms, and thus even a

low PPS can translate into a large percentage change in CEO wealth. This is confirmed by the positive size-incentive relationship shown in columns (1) and (2) using elasticity as a measure of incentives. This also implies that PPS may not be a good measure of incentives, especially when it comes to cross-sectional comparisons.

Counterintuitively, and in contrast to our findings for PPE and PPSE, firm risk is positively associated with PPS, as found in previous studies (Prendergast, 2002). In particular, PPS is increasing in idiosyncratic risk and decreasing in systematic risk. There is no significant coefficient on CEO age. PPS increases with CEO tenure, showing CEOs accumulate more shares and/or options as they work longer. On the whole, many of the results for PPS do not conform to the intuition from basic agency theory.

4. Relation between incentive measures and firm performance

A debate that has generated intense interest in the literature is the role of managerial incentives in determining firm performance. Much of the empirical research uses PPS as a measure of incentives, or in some cases, the proportion of shares owned by the CEO, which is equal to the part of PPS arising from stockholding. The evidence is mixed. Studies either find a positive relation between managerial ownership and firm performance (Mehran, 1995; Core and Larcker, 2002), or an initially increasing but eventually flat or decreasing relation between managerial ownership and firm performance (Morck et al., 1988; McConnell and Servaes, 1990, 1995; Hermalin and Weisbach, 1991; Hubbard and Palia, 1995; Holderness *et al.*, 1999; Anderson and Reeb, 2003; Tian,2004; Davies *et al.*, 2005; Adams and Santos, 2006; Pukthuanthong *et al.*, 2007; McConnell *et al.*, 2008; Tong, 2008). These papers argue that some degree of managerial ownership aligns incentives, but that an excessively high level of managerial ownership can reduce performance for reasons such as managerial risk aversion and entrenchment. Implicitly, this approach presumes that there is a common optimal level of ownership and that deviations from this value reduce performance.

In contrast, other studies find no evidence of a connection between incentive and performance after accounting for the endogeneity of the compensation package (Demsetz and Lehn, 1985, Agrawal and

Knoeber, 1996, Loderer and Martin, 1997, Cho, 1998, Himmelberg *et al.*, 1999, Demsetz and Villalonga, 2001, Palia, 2001, Coles *et al.*, 2012, Brick *et al*., 2006, and Cheung and Wei, 2006). As Himmelberg *et al.* (1999) argue, unobserved firm heterogeneity explains cross sectional variation in managerial ownership. This implies that the optimal level of incentives is firm-specific and that all firms may be at or close to their optimum. If so, cross-sectional deviations from the "common optimum" may not be associated with poor performance, unless the optimal strength of incentives is systematically associated with the maximized performance across firms.[21] If there is an optimal incentive level for each firm-year observation, then a deviation from this optimum will be detrimental to the performance. This test can shed more light on the relation between incentives and performance.[22] A second explanation of no relation between incentives and performance is that the incentives are not measured accurately, rendering their impact insignificant. In other words, if we do not see any relation between an incentive measure and firm performance, it can simply be due to measurement error.

We investigate how the choice of incentive measures affects the empirical findings relating incentives and performance, measured by ROA and Tobin's Q. As before, we compare three measures, PPS, PPE and PPSE. Following the literature, in section 5.1 we first fit a common, quadratic, impact of incentives on performance. Next, in section 5.2, we allow for firm-specific optimal incentives by estimating the predicted value of incentives based on firm-CEO characteristics and consider how deviations from the predicted incentives affect performance.

5.1 Incentives and firm performance: overall effect

[21] For example, if the optimal incentive is higher for firms with higher maximized performance, then even each firm has optimized its incentive contract, we can still see a positive coefficient on the incentive in across firm performance regressions. Within a firm, at optimum, the marginal benefit of incentive equals the marginal cost, so the overall marginal impact of incentive on firm performance is zero. This is the first order condition. The second order condition predicts that the coefficient on the square term should be negative. However, this within firm optimal argument is not easily testable without further strong assumptions, because we can only have one observation for a firm at a certain time and the optimal incentive level is likely to change over time.

[22] A challenge here is how to find the optimal incentive level for each firm-year observation. To address this challenge, we use our determinant regressions to predict a proxy of the optimal level of incentive based on firm-CEO characteristics.

Table 7 presents the results for ROA one year ahead, and Table 8 presents the results for Tobin's Q measured at the end of the year. To incorporate potential non-monotonicities in the relation between incentives and performance, we follow McConnell and Servaes (1990) and others by including a squared term in incentives. We also control for firm size, leverage, R&D, advertising, capital expenditure, hard assets, non-discretionary accruals[23], year fixed effects, and industry or firm fixed effects.[24]

Turning to the determinants of ROA in Table 7, the coefficients of PPE and PPSE are all positive and the coefficients of the squared incentives are all negative, as shown in columns (1) and (3). Thus ROA first increases and then decreases as PPE and PPSE increase, displaying an inverted U shape. As shown in column (1), the coefficient on PPE is 6.149 and on PPE^2 is -1.631, which gives a maximum ROA performance at a PPE of 1.9 [=½×6.149/1.631]. This 1.9 corresponds to 91th percentile cutoff in the distribution of PPE. In terms of the economic significance of these numbers, as we move from a PPE of 0 to the turning point, all else being equal, ROA is expected to increase by 5.8%-points [$=6.149 \times 1.885 - 1.631 \times 1.885^2$].[25]

The inverted U shape relating ROA to PPE and PPSE suggests that there is a tradeoff between the benefits and costs of granting PPE to a CEO at the margin. The initial increase of ROA with PPE is consistent with the interest alignment interpretation that a higher PPE provides better alignment between the CEO and shareholders of a firm. The eventual decrease of ROA with PPE could be driven by three possibilities. First, standard agency theory predicts that excessive PPE imposes a net loss on the firm because the risk averse manager needs to be compensated for the extra effort and for bearing the associated risk, which is sub-optimal. Second, too high a PPE can lead to excessive risk-seeking behavior that is

[23]Accruals have been shown to be highly associated with firm performance (Guay, Kothari, and Watts, 1996, Dechow, Kothari, and Watts, 1998, and Kothari, Leone, Wasley, 2005). In addition, some accruals are subject to managers' discretion and consequently endogenous to the CEO incentives. Consequently we only include the non-discretionary accrual as predicted by Jones (1991) model as a control variable, because it is more subject to the business nature of the firm and less likely affected by CEO incentives.

[24] These control variables are similar to the ones used in previous literature, such as Himmelberg, Hubbard, and Palia (1999), Palia (2001), as well as Benson and Davidson (2009).

[25] Note that although the regression results show a turning point at PPE of 1.9, this is not to say that this 1.9 would be the optimal PPE for all firms. The choice of PPE level is firm- and CEO-specific, as we have seen in examining the determinants PPE in Table 6, and we will explore this issue further below.

undesirable. Last, excessive PPE could be a sign of rent seeking via excessive compensation, to the detriment of shareholders, as Bebchuk and Fried (2004) have argued.

When incentives are measured using pay for performance sensitivity (PPS) instead, as shown in column (5) of Table 7, neither the coefficient on PPS nor the one on its squared term is statistically significant. This result confirms findings by previous studies, such as Himmelberg, Hubbard, and Palia (1999). The lack of significance can be interpreted two ways: either each firm is compensating its CEO at the optimal PPS level and there is no correlation between PPS and firm performance as argued by Demsetz and Lehn (1985) and subsequent papers; or, PPS is not an appropriate measure of CEO incentives thus a priori it is not expected to capture the effect of incentives on firm performance. This is especially true if the assumption that CEOs' effort affects firm value additively is far from realistic. This second interpretation seems to be supported by the significant coefficients obtained with the other two incentive measures, the pay for performance elasticity, PPE, and the semi-elasticity, PPSE.

In columns (2), (4), and (6), we control for CEO-firm fixed effects rather than industry fixed effects to better address potential endogeneity issues arising from time invariant unobservable factors at the CEO-firm level. Consistent with columns (1), (3), and (5), there is significant evidence of an inverted U shape between pay for performance elasticity (PPE) and semi-elasticity (PPSE) and ROA. When incentives are measured with PPS, ROA also first increases and then decreases with PPS, but not significantly so. Overall, the results in Table 7 show that there is generally a positive and significant relation between managerial incentives, as measured by the pay-performance elasticity and semi-elasticity, and subsequent firm performance, consistent with the incentive alignment effect. However, excessive incentives can be undesirable as indicated by the inverted U-shape relationship between incentives and performance. The result based on PPE and PPSE contrasts with Himmelberg *et al* (1999) in that the U-shaped pattern remains robust when firm fixed effects are accounted for.

We perform a similar analysis of incentives and firm performance using end-of-year Tobin's Q as an alternative performance measure. Like the ROA, Tobin's Q first increases and then decreases in PPE

and PPSE after controlling for the set of control variables, year fixed effects, and either industry or CEO-firm fixed effects. As shown in column (1) of Table 8, the coefficients on PPE and its squared term are 0.493 and -0.125 respectively, giving a maximum at a PPE of 1.97 (at the 92nd percentile of PPE). As PPE increases from 0 to 1.97, all else being equal, Tobin's Q increases by 0.49 (=0.493 × 1.97 - 0.125 ×1.97^2)]. As shown in column (3), the coefficients on PPSE and its squared term are 0.621 and -0.0499 respectively, yielding an inflection point at $6.2 million per percent change in firm value (at the 97th percentile of PPSE). As shown in column (5), the coefficients on PPS and its squared term are not significant. These findings are consistent with those in Table 7. Just as for ROA, when we control for CEO-firm fixed effects rather than industry fixed effects, as shown in columns (2), (4), and (6), the inverted U shape relation between CEO incentive and Tobin's Q remain robust for PPE and PPSE, but not for PPS.

Overall, the results in Tables 7 and 8 show that firm performance first increases and then decreases with CEO incentives as measured using PPE and PPSE. To illustrate the explanatory power of incentives for firm performance, we plot the median actual performance and the performance component predicted by incentives and their squared terms as shown in columns (1), (3), and (5) of Tables 7 and 8 respectively over incentive deciles. In Figure 1, the solid curve depicts the performance predicted by incentives and the dotted curve depicts actual performance. Performance as predicted by PPE and PPSE captures actual performance reasonably well; but performance as predicted by PPS does a poor job in explaining actual performance. The findings for PPE and PPSE are consistent with the interpretation that there is a common optimal level of incentives, and that deviations from this level are detrimental to firm performance. Or, at least, the optimal levels of incentives for different firms are close enough so that the observed variation in incentives is partly due to the deviations from the optimum. Alternatively, one might argue that all firms may be at their optimal incentives, and this optimum level of incentives is systematically associated with firm performance. This second interpretation does not justify a non-monotonic relation between incentive and performance.

Our evidence, based on PPE and PPSE, confirms the conclusion obtained by the earlier literature on managerial ownership that there is an optimal strength of incentives and that at least some of the variation in incentives can be interpreted as a deviation from the optimum that is detrimental to performance.

5.2 Deviations from predicted incentives

We next allow for firm-specific optimal incentives by estimating the predicted value of incentives based on firm-CEO attributes and consider how deviations from the predicted incentives affect performance. The optimal level of incentives is likely to vary as a function of these attributes. If the predicted CEO incentives are optimal, then we would expect an excess or a shortfall to be detrimental to firm performance.

The set of two-stage regressions presented in Table 9 follow the approach taken in the literature by Hartzell, Ofek, and Yermack (2004) and Cai, Garner, and Walking (2009). The first stage, in which the various incentive measures are regressed on the set of firm and CEO characteristics, year fixed effects and industry fixed effects is described in Table 6, Panel A.[26] Using these regression estimates, we construct the shortfall in PPE as the absolute value of the regression residual when it is negative and 0 otherwise; and the excess PPE as the regression residual when it is positive and 0 otherwise. In the second stage, we regress firm performance measures on the shortfall in PPE and the excess PPE. As shown in column (1) of Table 9, consistent with our conjecture, the shortfall in PPE is negatively associated with ROA, showing that insufficient PPE results in poor future performance. Economically, when PPE is 0.1 unit less than the predicted value, the ROA falls by 52 basis points. The coefficient on the excess PPE residual is insignificant. As shown in column (2), replacing industry fixed effects with CEO-firm fixed effects gives qualitatively similar results.

[26] We use sales instead of market value of total assets to measure firm size in the first stage regression to avoid the potential correlation between market value of assets and Tobin's Q. Our results remain robust if we use market value of assets instead to measure firm size.

Columns (3) and (4) repeat the analysis when incentives are measured with pay for performance semi-elasticity, PPSE. The results show that insufficient incentives lead to significantly lower ROA. On the other hand, an excessive amount of PPSE is not statistically significant with industry fixed effects as shown in column (3), but is positively related to ROA with CEO-firm fixed effects as shown in column (4). There are two possible explanations for the puzzling positive relation between excess PPSE and Tobin's Q. Either the average firm in our sample may under-incentivize its CEO; or, PPSE may not capture the true incentives and thus gives rise to misleading coefficients.

For PPS, in column (5) the shortfall is positively related to performance, which is puzzling; but it is not significant after controlling for CEO-firm fixed effects in column (6). Excess PPS is insignificant throughout. The result thus suggests that either PPS is not a good specification for measuring incentives, or that the average firm in our sample over-incentivizes its management. In contrast, as we have seen, the elasticity and the semi-elasticity based incentive measures do find that shortfall in incentives negatively impact firm performance.

The results from the Tobin's Q regressions in Table 10 are generally consistent with those for ROA, confirming that a shortfall in PPE and PPSE is detrimental to firm value. The coefficient on the shortfall in PPE is around 0.6, showing that each 0.1-unit of shortfall in PPE will decrease firm market value by 6% of its book value. The coefficient on excess PPE is insignificant, while that on excess PPSE is positive and significant. Overall, the results in Table 10 are consistent with the interpretation that the PPE level predicted by our determinants model is close to optimal, but the PPSE level is below the optimum. The results using PPS are inconsistent with the notion that firms are optimizing their incentives.

To illustrate the relation between insufficient/excess incentives and firm performance, we plot firm performance in independently double-sorted predicted and actual incentive quintile portfolio in Figure 2.[27]

[27] In particular, in each year, we sort all the firms into five quintiles based on the predicted incentive (from the regressions in Table 6 Panel A, columns (2), (4) and (6)) and on the actual incentive independently to get 25 double-sorted portfolios. We then calculate the mean ROA/Tobin's Q in each double-sorted portfolio. Lastly, we take a time-series average over the sample years to get the average ROA/Tobin's Q for each of the 25 portfolios.

If the predicted PPE is optimal, then ROA/Tobin's Q is expected to be higher along the diagonal in the plane of PPE quintiles and predicted PPE quintiles. In other words, if the predicted PPE is in the first (second) quintile, ROA should be higher if the actual PPE also lies in the first (second) quintile than in other quintiles, and so on. From Figure 2, there is some evidence that ROA is higher along the diagonal for the third, fourth, and fifth predicted PPE quintiles. In addition, the decrease in ROA is more obvious when there is a shortfall than when there is an excess. For example, in the third predicted PPE quintile, when the actual PPE lies in the first quintile, there is a larger decrease in ROA than when the actual PPE lies in the fifth quintile. The plot for Tobin's Q and PPE is generally consistent with the plot for ROA and PPE. These observations confirm our findings in Tables 9 and 10 that insufficient PPE is detrimental to firm performance.

Regarding PPSE, as for PPE, Tobin's Q and ROA are lower when the actual PPSE quintile is below the predicted one. However, the performance level is higher to the right of the diagonal line, suggesting that there is no penalty for excess PPSE. Lastly, the PPS plots do not show a clear pattern that is consistent with the existence of an optimal level of incentives.

5.3 Incentives and performance: instrumental variables analysis

We find that Tobin's Q and ROA first increase and then decrease as PPE and PPSE increase. However, a firm's performance and CEO incentives are both endogenous, and there could be reverse causality between the two variables, or they could both be driven by other unobservable determinants. So far we have tried to account for endogeneity by including CEO-firm and time fixed effects and by lagging the independent variables when explaining ROA, and using year end Tobin's Q. To further address the concern that CEO incentives are endogenous, we conduct instrumental variable analysis.

We use two variables, lagged CEO wealth and idiosyncratic risk, as instruments for incentives. These variables are related to CEO incentives but are less likely to be directly related to firm performance

other than through the CEO's contract.[28] As found in Table 6, CEO wealth affects the incentives incorporated into CEO contracts. CEO wealth is likely to affect the contract because, as argued in Section 2.2, wealthier CEOs should be less strongly incentivized as their marginal utility of leisure is relatively high. Given the contract, CEO wealth is unlikely to have a direct impact on firm performance. Consistent with Palia (2001), we use risk as an instrument since agency theory predicts that optimal incentives should decline with risk; but unlike Palia, we use idiosyncratic rather than total risk so as to capture the risk that the CEO cannot easily hedge away. Moreover, systematic risk commands a return premium that may be reflected in the performance measures, while idiosyncratic risk is not priced according to the CAPM.

The validity of the instruments is examined in Table 11 using the Cragg-Donald Wald F tests for weak instruments and the Durbin-Wu-Hausman chi-squared test for endogeneity. For all specifications, the Cragg-Donald Wald F-statistic is satisfactory (above the Stock-Yogo critical value at the 10% level), rejecting the weak instrument null hypothesis. The first stage regressions shown in Panel B also confirm that both instruments are not weak: their coefficients are highly significant and the F-statistics for their exclusion are sufficiently high. Concerning endogeneity, the p-value from the Durbin-Wu-Hausman test is 0, confirming that endogeneity is indeed an issue.

As shown in column (1) of Panel A in Table 11, consistent with our findings in Table 7, ROA first increases and then decreases with the instrumented PPE. Note that the coefficients of both PPE and its square are larger in magnitude than the counterparts in the OLS regressions in Table 7. For example, in Table 7 column (1), the coefficients on PPE and its square are 6.149 and -1.631, respectively, while the IV estimates in column (1) of Table 11 Panel A are 124.4 and -46.6, respectively. For a quadratic function, $ROA=aPPE+bPPE^2$, the marginal effect of PPE on ROA is $a+2bPPE$. Evaluated at the sample median of PPE (0.94), this translates into an OLS slope of 3.08 [=6.149-2×0.94×1.631] and an IV slope of 36.8 [=124.4-2×0.94×46.6], a twelve-fold increase. The higher IV slope suggests that the marginal effect of PPE

[28] We acknowledge that these variables are not perfect instruments. As mentioned in Himmelberg *et al.* (1999), it is difficult to find instrumental variables for managerial incentive. For any determinant of the optimal level of managerial incentive, it is possible to argue that the same variable might affect firm performance.

on ROA could be substantially higher than what the OLS slope suggests, namely, an impact of a 0.1 increase of PPE on ROA of 3.68% rather than 0.3%. A possible explanation for the substantially larger coefficients in the IV regression could be that an unobserved variable has opposite effects on incentives and performance. For example, managerial entrenchment has a positive impact on incentives and a negative impact on performance, which would depress the OLS coefficients.

The maximum ROA, reached at a PPE level of $-a/2b$, is 1.33 for the IV estimates, compared to 1.89 for the OLS estimates. Thus the IV estimates suggest that the incentives at the 75th percentile of the sample PPE are optimal, while the OLS estimates suggest an optimum at the 91st percentile, implying that almost all firms in the sample under-incentivize.

When PPSE is instrumented, column (2) of Panel A shows that ROA initially increases and then decreases. The coefficients on the PPSE and its squared term are larger than the counterparts in Table 7 as in the case of PPE. For PPS, column (3) shows that ROA actually initially decreases and then increases with PPS, which is counterintuitive.

The results for Tobin's Q are consistent with those for ROA, as shown in columns (4) – (6). The coefficients are qualitatively similar to those in Table 8 for PPE and PPSE, displaying an inverted U-shaped pattern, but again the effects are much larger. For example, the marginal effect of PPE on Tobin's Q, evaluated at the sample median of PPE (0.94), translates into an OLS slope of 0.258 [=0.49-2×0.94×0.125] and an IV slope of 1.52 [=8.57-2×0.94×3.75], a six-fold increase. The maximum Tobin's Q, is reached at the PPE of 1.14 for the IV estimates, compared to 1.97 for the OLS estimates. Thus again the IV estimates suggest that a larger proportion of the sample is close to the optimum, compare to the OLS estimates. For PPS, the OLS results in Table 8 are insignificant, while the IV estimates in Table 11 yield a convex relationship which is inconsistent with the existence of an optimal level of incentives.

5. Robustness checks

6.1 A closer look at the relation between firm size and pay-performance elasticity measures

As previously mentioned, Edmans *et al.* (2009) find that their measure of the pay-performance elasticity is size invariant, while our results in Table 6 show a positive relationship. To explore this difference, we first replicate their results.[29] In column (1) of appendix Table A1 Panel A, we follow their analysis, by focusing on the largest 500 firms (based on total market value, including debt and equity) in the years 1992-2006 and using the same incentive measure, Ln(PPE_EGL). Consistently with the results of Edmans *et al.* (2009), the coefficient of firm size is insignificant. When we extend the sample period to the end of 2010, Ln(PPE_EGL) is still size invariant for the sample of the 500 largest firms, as shown in column (2).

However, the size invariance result does not survive for a broader sample that also includes smaller firms. Rosen (1992), Holmstrom (1992), and Baker and Hall (2004) argue that the key question is how to compare the incentives faced by the CEOs of companies of dramatically different sizes. By expanding the sample to all ExecuComp firms during the Edmans *et al.* (2009) sample period (1992-2006), the impact of firm size becomes highly positive and significant, with a coefficient of 0.095 in column (3). When the analysis of all the ExecuComp firms is extended to the full 1992-2010 sample period, the coefficient increases to 0.112 and becomes even more statistically significant, as shown in column (4). This contrast suggests that the insignificant relation between pay-performance elasticity and firm size documented by Edmans *et al.* (2009) is limited to the upper end of the firm size distribution.

In contrast, our main measure of pay-performance elasticity, PPE, is significantly increasing with firm size. As shown in Table A1 Panel B, this relationship is robust: it survives even if the sample is limited to the largest 500 firms (column 2). Columns 3 and 4, based on a common sample for which both PPE and PPE_EGL are available, again confirm that the positive relationship between the incentives and firm size is robustly positive when the full cross-section of firm sizes is considered.

[29] To facilitate the comparison, we match the specification of Edmans *et al.* (2009) by only including size and year and industry fixed effects in the regression.

To complement Table A1, the relation of size and PPE is plotted in in Figure 3. From Panel A, it is clear that PPE is positively associated with firm size over entire sample. From Panel B, the positive association between size and PPE_EGL is generally apparent in the full cross-section, but not as unambiguous for the largest firms.

6.2 PPE measures based on alternative estimates of CEO wealth

In this section, we use different definitions of CEO wealth in computing the pay-performance elasticity PPE and consider the impact of the definition of wealth on the key results concerning the determinants of PPE and its relation to performance. In our main analysis, we follow Dittmann and Maug (2007) to calculate a CEO's wealth when she is in the ExecuComp for at least five years. The alternative measures of the pay-performance elasticity, defined in Section 3.1, are: PPE_3Y+, PPE_7Y+, PPE_LH, PPE_life, and PPE_EGL. As PPE_EGL is highly skewed, we use Ln(1 + PPE_EGL).

In Table A2, we examine the determinants of the five alternative measures. All alternative PPE measures are positively and significantly related to firm size, except for Ln(1+PPE_EGL), which is negatively related.[30] The alternative PPE measures are also significantly negatively related to idiosyncratic risk and, with the exception of PPE_EGL, not significantly related to systematic risk. Similarly, R&D and Capital expenditure are associated with stronger incentives for all measures except PPE_EGL. Thus key determinants such as firm size, risk, R&D and Capital expenditure generally have the same intuitively plausible effect on the alternative incentive measures as on PPE in Table 6.

As for PPE in Table 6, CEO age is significantly negatively related to all alternative incentive measures except PPE_life, consistent with the evidence of Morin and Suarez (1983) that older CEOs are more risk averse, and therefore should be given weaker incentives. However, the results may be affected by errors in imputing wealth, which appears in the denominator of the incentive measure. If lifetime wealth

[30] In unreported results, PPE_EGL is positively associated with firm size if lagged CEO wealth is not controlled for.

is the right indicator of wealth, then the incentive measures that do not include anticipated future wealth may overestimate old CEOs' wealth relative to that of young CEOs, creating a mechanical negative association between measured incentives and age (the effect is exacerbated if there is a rising pay profile over the life time). PPE_life addresses this issue of accounting for future pay, but it may underestimate older CEO's wealth to the extent that their entire earning history may not be captured by ExecuComp. This creates the opposite bias, explaining why PPE_life is positively associated with age.

CEO tenure is negatively associated with PPE_LH, PPE_3Y+, and PPE_7Y+. The negative coefficient may be due partly to the fact that long tenure is associated with a longer history in the ExecuComp database, and our assumptions about wealth accumulation prior to entry into the database may be overly conservative. However, PPE_LH is designed to overcome this issue so that the negative sign on that measure cannot be dismissed on these grounds.

In general, the construction of the measures is strongly affected by age and tenure because accumulated wealth is based on the earnings history, and furthermore age and tenure are multicollinear. Thus caution is required in interpreting the coefficients of CEO age and tenure.

In Table A3, we examine the relation between these alternative measures and firm performance. All five measures of pay for performance elasticity show a consistent inverted U shaped effect on ROA. For Tobin's Q, the pattern is similar, except for Ln(1+PPE_EGL), where the quadratic term is insignificant. These results confirm that our main findings on the determinants of PPE and its relation to firm performance are generally robust for alternative proxies of CEO wealth.

6.3 Outlier concerns

To address concerns about outliers, we have up to now winsorized the incentive measures at 98% throughout the analysis. To further verify that our results are not driven by outliers, we perform a set of median regressions as well as a set of regressions using logarithms for the incentive variables.

As shown in Table A4, the results from median regressions are generally consistent with those from the least-squares regressions in Table 6. As shown in columns (1) and (2), firm size and R&D are positively associated with PPE, while CEO age, tenure, idiosyncratic risk, and CEO wealth are negatively related to PPE. As shown in columns (3) and (4), firm size, R&D, advertising, and CEO wealth are positively related to PPSE. As shown in columns (5) and (6), the coefficients for PPS median regressions have similar signs to the least square regressions. In summary, the results from median regressions in Table A4 confirm our previous findings.

In Table A5, we carry out a set of median regressions examining the relation between incentives and firm performance, measured by ROA in columns (1)-(3) and Tobin's Q in columns (4)-(6). The results are generally consistent with our previous findings: firm performance first improves and then deteriorates as CEO incentive increases, as measured using PPE and PPSE, and the relation between PPS and firm performance is not statistically significant.

In Table A6, we use median regressions to examine the relation between excess incentives and firm performance. The PPE results are consistent with our previous findings: shortage in PPE is detrimental to ROA and Tobin's Q, as shown in columns (1) and (4), respectively; excess PPE is positively associated with Tobin's Q and ROA, although not statistically significant for ROA. As shown in columns (2) and (5), Excess PPSE is positively related to firm performance, while shortage in PPSE is negatively associated, although the negative coefficient is not statistically significant. As shown in columns (3) and (6), shortage in PPS is positively related to firm performance, which again is not intuitive.

Another way to address the problem of large outliers on the right tail is to take logarithms for the variable of interest. In Appendix Table A7, we replicate the incentive determinants analysis in Table 6 using Ln(1+incentives) as dependent variables. The results are generally consistent with those in Table 6. In Appendix Table A8, we examine the relation between log CEO incentives and ROA & Tobin's Q in Panels

A and B respectively. In Appendix Table A9, we examine the relation between excess log CEO incentives and firm performance. The results are also consistent.[31]

6.4 Alternative measures of firm size

Our analysis of incentive determinants uses the lagged log sales and lagged log market value of assets to measure firm size. In Table A10, we use alternative firm size measures based on lagged log book value of assets in Panel A, and lagged log market capitalization in Panel B. The results are generally consistent with what we obtain in Table 6 showing a positive association between firm size and PPE.

6.5 Sampling

Our main results are based on a common sample with all key incentive measures and control variables available to facilitate comparison across the models. In Tables A11 and A12, we use the largest sample for each regression model during the sample period of 1992-2010. The results are robust to the choice of the sample.

6.6 Controlling for vega and governance

As the vega of CEO stock option holdings provides risk taking incentives, it may also affect firm performance. We did not include vega in our performance regressions because it is highly correlated with our incentive measures. For example, the correlation between the Ln(1 + Vega) and PPE is 0.48. To check the robustness of our performance findings, we include the Ln(1 + Vega) as a control variable in Table A13. As shown in the table, the coefficients on the incentives and their squared terms are consistent with our previous results.

[31] In unreported analysis, we also examine the determinants of PPE in each of Fama-French five industries, the results are consistent. We also split the sample into two subsamples based on the corporate governance index, the results are consistent in each subsample. The inclusion of corporate governance index significantly decreases our sample size and consequently, we didn't include it in our main results.

Similarly, controlling for corporate governance using the Gompers, Ishii, and Metrick (2003) G-index does not materially affect the results while it significantly reduces the sample size.

6. Conclusion

This paper investigates three CEO incentive measures: pay for performance elasticity (PPE), pay for performance semi-elasticity (PPSE) and pay for performance sensitivity (PPS). We first describe the theoretical framework under which each measure directly captures the incentive for effort. When CEO effort affects firm value proportionally and the CEO has a Cobb-Douglas utility function, the %-to-% pay for performance elasticity (PPE) best captures CEO incentives. On the other hand, when CEO effort has an additive effect on firm value and that he has a quasi-linear utility function, the $-to-$ pay for performance sensitivity (PPS) is more appropriate. For the intermediate case in which effort affect firm value multiplicatively and the CEO has a quasi-linear utility function, the $-to-% pay for performance semi-elasticity (PPSE) is appropriate.

The empirical results obtained using PPE and PPSE are sensible and consistent with basic agency theory, while those obtained using PPS are counterintuitive, as documented in the prior literature.

Considering the determinants of incentives, we find that the PPE and the PPSE measures increase with firm size, suggesting that CEOs of larger firms are more strongly incentivized, consistent with the predictions of the multiplicative models. We also confirm that PPS counterintuitively decreases with firm size, in line with prior research. Concerning the impact of risk, we find that CEOs of firms with higher idiosyncratic risk and older CEOs have lower PPE and PPSE, supporting the key intuition from the standard principal agent framework that risk, and in particular idiosyncratic risk, should have a negative effect on the optimal strength of incentives. In contrast, the prior empirical literature focusing on PPS finds a positive relation between risk and incentives, spawning a theory literature that attempts to explain this anomaly. Furthermore, as theory would predict, both PPE and PPSE are increasing in R&D, and PPE is also

increasing in capital expenditure, suggesting that growth and technological innovation call for stronger incentives.

Concerning the economic impact of incentives, we find that Tobin's Q and ROA first increase and then decrease as PPE and PPSE increase. This inverted U-shape suggests that at low to medium levels of incentives, there is an incentive alignment effect provided by the CEO compensation contract, however, excessively strong incentives can be value decreasing. In contrast, PPS has no significant relationship to performance. We also estimate the predicted incentives at the firm level and examine the effect of deviations. Using PPE and PPSE, we find that lower-than-predicted incentives appear to harm firm performance: on average firms provide incentives in the optimal range, albeit at its low end. In contrast, the results based on PPS cannot be reconciled with the existence of an optimal level of incentives.

Overall, PPE and PPSE give sensible results that resolve some of the puzzles regarding the determinants of incentives that arose in earlier work using PPS exclusively. We also find a strong relationship between incentives and performance, even after accounting for endogeneity of incentives. For future work, a first priority is better data regarding the characteristics of the CEOs. In particular, the use of more accurate measures of and instruments for CEO wealth, as well as proxies for risk aversion and ability could yield new insights into the design of optimal compensation.

Our analysis has important implications for the policy debate concerning executive compensation. The attention of the general public has mainly been captured by two aspects of compensation: the very high level of some pay packages and the incentives for excessive risk-taking in the financial sector. An equally important but less salient issue is whether top management is receiving adequate incentives. Getting this right is crucial for shareholder value maximization, and regulatory efforts to reduce average pay that at the same time impose constraints on incentive pay can be counterproductive. Our results show that the optimal strength of incentives is firm, industry, and CEO specific, and that on average firms do not over-incentivize. Blanket regulations would not be able to take account of differences between firms and thus might be counterproductive.

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Appendix A: Variable definitions

Variables	Definition
Advertising/TA	Also referred to as Ad./AT, i.e. Advertising expenses over total assets = xad /at and 0 if xad is missing.
Annual comp	Total annual compensation (item tdc1) from ExecuComp database.
BV_total assets	Book value of total assets in million dollars directly from Compustat (*at*)
Capital expenditure	Capital expenditure is scaled by net property plant and equipment = *capx/ppent*
CEO age	Age of the CEO from ExecuComp.
CEO tenure	Number of years from the first year when CEO became the CEO of current company
CEO total wealth	CEO total wealth calculated based on Dittman and Maug (2007) procedure, in thousand dollars. In particular, a CEO's wealth is calculated using her net cash inflow accumulated over the history when she appears in the ExecuComp dataset, together with the market value of equity holdings at the end of each year. For a CEO to have this total wealth measure, we require her to be in ExecuComp for at least 5 years. See Appendix C for detailed assumptions and procedure.
Fama-French 5/48 industry	Fama-French 5/48 industry classification (FF5/48) downloaded from Kenneth R. French's website in March of 2013.
Firm Age	Firm age from the IPO year given by Compustat and the IPO year is replaced by first CRSP year when missing = *year* - year(*ipodate*)
Hard assets	Net total Property, Plant and Equipment over total assets = (*ppent/at*)
Idiosyncratic risk	A firm's idiosyncratic risk is calculated as the square root of the difference between total return variance and systematic return variance during past 60 months. This risk is denoted in percentage term.
Lagged variable	The same variable in the previous year.
Leverage	Book value leverage of long-term debt = *dltt*/*at*
Ln(1+variable)	Natural logarithm of the sum of one and the value of variable.
Ln(variable)	Natural logarithm of the variable.
Market capitalization	Market value of outstanding shares at fiscal year end (in millions of 2010 dollars) = *prcc_f*csho*.
Missing Advertising	Indicator = 1 if *xad* is missing and 0 otherwise.
Missing R&D	Indicator = 1 if *xrd* is missing and 0 otherwise.
MV of total assets	Also referred to as MV assets. Market value of total assets = *at* - *ceq* + *prcc_f*csho*
Nondiscretionary accrual	The nondiscretionary accrual as predicted by the Jones (1991) model. To estimate the Jones model, we use all compustat firms with relevant variables available and winsorize both dependent and independent variables at 1% level.

PPE_3Y+	Pay-performance elasticity is the percentage change in CEO wealth for 1% change in stock price, where CEO wealth is estimated similar to the method in Dittmann and Maug (2007). We require the CEO to be in the ExecuComp Dataset for at least 3 years to be able to calculate this variable.
PPE_7Y+	Pay-performance elasticity is the percentage change in CEO wealth for 1% change in stock price, where CEO wealth is estimated similar to the method in Dittmann and Maug (2007). We require the CEO to be in the ExecuComp Dataset for at least 7 years to be able to calculate this variable.
PPE_EGL	Pay-performance elasticity, created following the definition of Edmans, Gabaix, and Landier (2009), equals the CEO wealth change as a percentage of annual compensation for 1% change in stock price. In this definition, the annual compensation is used to proxy for CEO wealth. To avoid missing observations due to zero annual compensation, we winsorize the annual compensation at 2% before calculating the percentage.
PPE_LH	Pay-performance elasticity equals the percentage change in CEO wealth for 1% change in stock price, where CEO wealth is estimated using the long-history data of Frydman & Saks (2010) and the data from ExecuComp.
PPE_life	Pay-performance elasticity equals the percentage change in CEO wealth for 1% change in stock price, where CEO wealth is estimated using the method in Dittmann and Maug (2007) for the wealth up to current year and the present value of future compensations up to age 65. In particular, we assume the future compensation per year will be the same as that of current year until 65 (less tax) and a discount rate of 10% per year.
PPE	Pay-performance elasticity is the percentage change in CEO wealth for 1% change in stock price, where CEO wealth is estimated using the method in Dittmann and Maug (2007).
PPS	Pay-performance sensitivity is the dollar change in CEO wealth for every ten-dollar change in shareholder wealth.
PPSE	Pay-performance semi-elasticity is the CEO wealth change (in millions of 2010 dollars) for every 1% change in stock price.
R&D/TA	R&D expenditure (replaced by 0 when missing) over total assets = *xrd/at*
ROA	Return on assets = 100**ni/at,* denoted in percent
Sales	Sales in million dollars (*sale*)
Systematic risk	A firm's systematic risk is calculated as the product of its beta and the standard deviation of stock market returns during the past 60 months when the data are available. A firm's beta is estimated using the single index market model during the same time period. This risk is denoted in percentage term.
Tobin's Q	Also referred to as market to book ratio or market value over book value of total assets = (at - ceq + prcc_f*csho)/at.
Total risk	Standard deviation of the monthly dividend inclusive returns during the past five years.
Vega	The value change in CEO stock option holdings (in thousand 2010 dollars) for every change of 100 basis points in stock return volatility.

Appendix B: CEO wealth estimation procedure

We estimate CEO wealth following the Dittmann and Maug (2007) approach. In particular, all executives are assumed to have no wealth before they appear in the ExecuComp database. For each year in ExecuComp, an executive's net cash inflow from a company is calculated using the following equation:

Annual inflow to executive cash wealth

= Fixed salary (after tax)

+ Dividend income from shares held in own company (after tax)

+ Value of restricted stock granted

- Personal taxes on restricted stock that vest during the year

+ Net value realized from exercising options (after tax)

- Cash paid for purchasing additional stock

= tdc2(1-tax_rate)*

+ (shrown_excl_opts[_n-1](adjex_f[_n-1]/adjex_f))*dvpsx_f*(1-tax_rate)*

-(shrown_excl_opts-shrown_excl_opts[_n-1](adjex_f[_n-1]/adjex_f))* prcc_f;*

where, following Hall and Liebman (1998), as well as Dittmann and Maug (2007), we use the personal tax rates of 31% for 1992, 39.6% for 1993, and 42% from 1994 onward. To increase the number of observations, when the shareholding of current year or previous year is not available, we calculate annual cash inflow as *(tdc2 - rstkgrnt - opt_exer_val)*(1-tax_rate)* under the old data format and as *(tdc2 - stock_awards_fv - opt_exer_val)*(1-tax_rate)* under the new data format. We also code the value of option exercise as 0 when it is missing. If an executive served in more than one company in the ExecuComp database, we sum the cash inflows across all companies for the year.

To accumulate an executive's cash wealth over multiple years, the procedure assumes that the executive invests all her surplus cash at the risk-free rate of interest and does not consume. It is assumed

that all cash inflows are realized at the end of the fiscal year and invested at the 1-year constant maturity treasury rate (from Federal Reserve) during the next fiscal year. To avoid negative cash wealth, we use the lower bound of 0 for outside cash wealth. In particular, whenever the calculated cash wealth is negative, we replace it by 0 and update the executive's cash wealth in future years based on this 0.

If an executive changes her employer during her history in the database, we assume that she sells all unrestricted stock in the old company and exercises all exercisable options. Restricted stock and unexercisable options are assumed to be lost.

For any year, an executive's total wealth is calculated as the summation of her cash wealth, market value of shares owned, and value of unexercised exercisable options. Following Dittmann and Maug (2007), we require an executive to be in the ExecuComp for at least 5 years before she can be included in our sample.

Appendix C: Proofs of Lemmas and Propositions in Section 2

Proof of Proposition 1. The first order condition for the manager's effort choice, as given by maximization problems (1), (2) and (3), immediately yields equations (4), (5) and (6) respectively.

Proof of Proposition 2. The restrictions on the functional form of compensation displayed in Table 2 mean that the relevant determinant of incentives is constant throughout ($w'=m$, $w'V/W=\mu$ and $w'V=\delta$ respectively), and in particular, independent of the realization of the random shock to firm value. Thus equations (4), (5) and (6) simplify to:

I. $P'(E) = {}^{1}/_{m}$, that is, $E = p^2m^2$ when $\kappa = ½$ (9)

II. $\frac{P}{(E_0-E)\cdot P'} = \mu$ (10)

III. $\delta \cdot \frac{P'}{P} = 1$, or in terms of the effort elasticity of production κ, $E = \delta\kappa$ (11)

and for constant-elastic productivity of effort $P(E) = pE^{\kappa}/\kappa$ these expressions further simplify to:

I. $E = (pm)^{1/1-\kappa} = p^2m^2$ when $\kappa = ½$ (12)

II. $E = \frac{\kappa\mu}{1+\kappa\mu}E_0$ (13)

III. $E = \delta\kappa$ (14)

These expressions can be used to substitute out for effort E the incentive constraint in the firm's maximization problem (7). Completing the proof for each model in turn:

Model I. The firm seeks to maximize, by setting the compensation parameters m and S:

$$\max_{\{m,S\}} \mathbf{E}[V - W] = \max_{\{m,S\}} \mathbf{E}[(1-m)V - S] \tag{15}$$

subject to the incentive compatibility and participation constraints. Substituting in for E from equation (12):

$$V = X + 2p^2m + \varepsilon \quad \text{and} \quad \mathbf{E}[S + mV] - \frac{\rho}{2}m^2\Sigma - p^2m^2 \geq \underline{w} \tag{16}$$

Observing that $\mathbf{E}[\varepsilon] \equiv 0$, substituting out for V, and substituting out for S by presuming the participation constraint binds, we have:

$$\max_{\{m\}} \; X + 2p^2 m - \; \underline{w} - \frac{\rho}{2} m^2 \Sigma - p^2 m^2 \tag{17}$$

The first order condition of this maximization problem gives:

$$m = \frac{2p^2}{2p^2 + \rho\Sigma} \tag{18}$$

Model II. The firm seeks to maximize the expected firm value net of the manager's compensation, subject to (*i*) the manager's incentive constraint determining effort E, as per equation (13), and (*ii*) the manager's participation constraint. Define the manager's reservation wage $\underline{w}$ as his alternative pay in an occupation that does not require effort, that is his reservation utility is $U(W_0 + \underline{w}, E_0)$. The firm's optimal contracting problem is then:

$$\max_{\{m,\mu\}} \mathbf{E}[V - w] \quad \text{subject to} \tag{19}$$

$$V = p\left(\frac{\kappa\mu}{1+\kappa\mu} E_0\right)^{\kappa} \cdot X \cdot \varepsilon$$

$$w + W_0 = W = mV^{\mu}$$

$$\text{and } \mathbf{E}\left[\frac{1}{1-\theta}\{(E_0 - E)\cdot W\}^{1-\theta}\right] \geq \frac{1}{1-\theta}\left(E_0 \cdot (W_0 + \underline{w})\right)^{1-\theta}$$

Referring to Peng and Röell (2014) for details, the first order condition for this maximization problem yields:

$$\frac{pXE_0{}^{\kappa}}{W_0 + \underline{w}} = (1+\kappa\mu)^{1+\kappa}\,(\kappa\mu)^{1-\kappa}[1 + \frac{1+\kappa\mu}{\kappa\mu}\theta\mu^2\sigma^2]\exp(\frac{1}{2}\theta\mu^2\sigma^2) \tag{20}$$

Since $\kappa \leq 1$, it is clear that the RHS of equation (9) is a monotonic increasing function of μ. In other words, as firm scale, X, increases, the optimal strength of incentives, μ, also increases. And the RHS of equation (20) is also a monotonic increasing function of the firm's fundamental risk, σ, and the manager's

degree of risk aversion, θ. Thus, holding all other parameters constant, as σ or θ increases, the strength of incentives, μ, should decrease.

Model III. The optimal pay scheme parametrized by $\{S,\delta\}$ solves the optimization problem:

$$\max_{\{S,\delta\}} \mathbf{E}[V - w] \qquad \text{subject to:} \tag{21}$$

$$V = \frac{p}{\kappa} E^{\kappa} \cdot X \cdot \varepsilon$$

$$w = S + \delta lnV$$

$$E = \delta\kappa$$

$$\text{and } \mathbf{E}\,[w] - E - ½\rho\text{var}[w] \geq 0$$

Simplifying, this yields:

$$\max_{\{\delta\}} \frac{p}{\kappa}(\delta\kappa)^{\kappa} \cdot X - \delta\kappa - ½\rho\delta^2\sigma^2 \tag{22}$$

With the first order condition:

$$p\kappa^{\kappa}\delta^{\kappa-1} \cdot X - \kappa - \rho\sigma^2\delta = 0 \tag{23}$$

Note that the LHS of the equation is decreasing in the optimal incentive (δ).

In the special case of constant returns to effort (κ=1), the optimal semi-elasticity of pay is given explicitly by:

$$\delta = \frac{pX-1}{\rho\sigma^2} \tag{24}$$

Table 1: Summary of models and corresponding determinants of effort

Model	Preferences as a function of wealth (W) and effort (E)	Impact of effort (E) on firm value (V)	Effort incentive measure
I	Quasilinear: $U(W,E) = U(W - E)$	Additive: $V = X + P(E) + \varepsilon$	Sensitivity PPS $\equiv w'$
II	Cobb-Douglas: $U(W,E) = U(W \cdot (E_0 - E))$	Multiplicative: $V = X \cdot P(E) \cdot \varepsilon$	Elasticity PPE $\equiv w' \cdot V/w$
III	Quasilinear: $U(W,E) = U(W - E)$	Multiplicative: $V = X \cdot P(E) \cdot \varepsilon$	Semi-elasticity PPSE $\equiv w' \cdot V$

Table 2: Additional assumptions for characterization of optimal contract

Model	Utility function $U(W)$	Productivity of effort $P(E) = p\,E^{\kappa} / \kappa$	Distribution of shock	Functional form for wealth ($W = W_0 + w$) or wage (w)
I	Quasilinear and CARA: $-exp\,\{-\rho(W - E)\}$	$\kappa \in (0,1]$; $\kappa = ½$	Normal, mean zero: $\varepsilon \sim N(0,\Sigma)$	Linear: $W = W_0 + S + mV$ [32]
II	Cobb-Douglas and CRRA: $\{W \cdot (E_0 - E)\}^{1-\theta} / (1-\theta)$	$\kappa \in (0,1]$	Lognormal, mean 1: $ln\,\varepsilon \sim N(-½\sigma^2, \sigma^2)$	Constant elastic: $W = mV^{\mu}$, $w = W - W_0$
III	Quasilinear and CARA: $-exp\,\{-\rho(W - E)\}$	$\kappa \in (0,1]$; $\kappa = 1$	Lognormal, mean 1: $ln\,\varepsilon \sim N(-½\sigma^2, \sigma^2)$	Log linear: $W = W_0 + S + \delta\, ln\, V$

Table 3: Comparative statics of the optimal contract

Model	Incentive measure	Firm size	Productivity	Risk	Risk aversion	CEO wealth	Reservation wage
I	PPS	0	+	-	-	0	0
II	PPE	+	+	-	-	-	-
III	PPSE	+	+	-	-	0	0

[32] The slope coefficient m can be thought of in terms of fractional share ownership: as the net-of-pay equity capital is worth $V - w = (1-m)V - S$, a contract that gives the manager a fraction $\frac{m}{1-m}$ of the company's equity plus a base salary of $\frac{S}{1-m}$ will generate the assumed linear pay contract.

Table 4: Summary Statistics

The summary statistics are based on all ExecuComp firms with all three incentive measures and control variables available during 1996-2010. All raw (non-logged) incentive measures are top coded at 2% and all other continuous variables are winsorized at 1%. The summary statistics are based on the winsorized sample. See Appendix A for variable definitions.

	Mean	Std. Dev.	Median	Num. Obs.	p25	p75	Skewness	Kurtosis
Incentive measures								
PPE	1.02	0.61	0.94	16014	0.59	1.32	0.95	3.98
PPSE ($mil/1%)	0.86	1.57	0.28	16014	0.10	0.80	3.33	14.51
PPS ($/$10)	0.32	0.53	0.13	16014	0.05	0.30	3.07	12.76
PPE_EGL	28.83	73.63	7.30	15954	3.62	16.36	4.41	22.78
PPE_LH	0.97	0.66	0.87	16014	0.51	1.24	1.43	6.13
PPE_life	0.68	0.37	0.66	15960	0.40	0.91	0.41	2.91
Firm performance								
ROA (subsequent)	3.40	10.57	4.46	15341	1.16	8.31	-2.46	12.89
Tobin's Q	1.89	1.18	1.50	16014	1.16	2.14	2.43	9.87
Firm size measures								
Sales ($mil)	5570	11805	1560	16012	610	4778	4	24
MV_Assets ($mil)	14982	37797	3122	16014	1100	10448	5	29
BV_Assets ($mil)	9358	24930	1825	16014	657	6417	5	34
Market Cap ($mil)	7609	18740	1748	16014	626	5527	5	28
Other firm and CEO characteristics								
Hard assets	0.29	0.23	0.23	16003	0.10	0.44	0.80	2.62
R&D/TA	0.03	0.05	0.00	16014	0.00	0.03	2.51	9.65
Missing R&D	0.45	0.50	0.00	16014	0.00	1.00	0.20	1.04
Capital expenditure	0.22	0.14	0.19	15971	0.12	0.29	1.22	4.47
Systematic risk	4.54	3.28	3.76	16014	2.28	5.83	1.46	5.36
Idiosyncratic risk	10.67	5.15	9.47	16014	6.95	13.01	1.28	4.74
Total risk	11.80	5.75	10.44	16014	7.72	14.36	1.33	4.83
Advertising/TA	0.01	0.03	0.00	16014	0.00	0.01	3.33	14.82
Missing Advertising	0.65	0.48	1.00	16014	0.00	1.00	-0.65	1.42
Leverage	0.19	0.16	0.18	15968	0.05	0.30	0.70	3.06
Nondiscretionary accrual	0.42	2.43	0.21	14536	-0.87	1.37	0.79	6.14
Firm age	26.95	19.33	21.00	16014	12.00	36.00	1.21	3.78
CEO tenure	9.13	7.24	7.00	16014	4.00	12.00	1.60	5.68
CEO age	55.99	7.05	56.00	16014	51.00	61.00	0.10	2.90
CEO total wealth ($mil)	112.74	321.77	26.64	16014	10.70	73.35	5.82	40.05
Annual Compensation ($mil)	4.91	5.93	2.84	15954	1.34	5.94	2.72	11.78

Table 5: Correlations

This table shows the correlation between each pair of variables based on all ExecuComp firms with all three incentives and control variables available during 1996-2010. All raw incentive measures are top coded at 2% and all other continuous variables are winsorized at 1%. The correlations are based on the winsorized sample. See Appendix A for variable definitions.

Variable	Label	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)
PPE	(1)	1.00																										
PPSE ($mil/1%)	(2)	0.06	1.00																									
PPS ($/$10)	(3)	-0.10	0.48	1.00																								
PPE_EGL	(4)	-0.06	0.66	0.65	1.00																							
PPE_LH	(5)	0.95	0.09	-0.08	-0.04	1.00																						
PPE_life	(6)	0.76	0.29	0.13	0.15	0.69	1.00																					
ROA (subsequent)	(7)	0.10	0.15	0.01	0.11	0.11	0.18	1.00																				
Tobin's Q	(8)	0.15	0.30	0.07	0.23	0.16	0.24	0.32	1.00																			
Sales ($mil)	(9)	0.12	0.26	-0.14	0.02	0.13	0.11	0.06	-0.03	1.00																		
MV_Assets ($mil)	(10)	0.11	0.33	-0.11	0.06	0.12	0.14	0.06	0.05	0.77	1.00																	
BV_Assets ($mil)	(11)	0.07	0.24	-0.11	0.02	0.08	0.08	0.00	-0.11	0.71	0.93	1.00																
Market Cap ($mil)	(12)	0.16	0.39	-0.10	0.10	0.17	0.19	0.13	0.21	0.75	0.85	0.65	1.00															
Hard assets	(13)	0.01	-0.08	-0.06	-0.03	-0.02	0.00	0.04	-0.13	0.01	-0.07	-0.08	-0.02	1.00														
R&D/TA	(14)	0.07	0.00	0.01	0.01	0.07	0.04	-0.17	0.34	-0.09	-0.04	-0.10	0.03	-0.27	1.00													
Missing R&D	(15)	-0.08	0.01	0.01	0.01	-0.09	-0.07	0.00	-0.22	-0.04	0.04	0.11	-0.06	0.20	-0.48	1.00												
Capital expenditure	(16)	0.03	0.10	0.08	0.08	0.03	0.05	0.00	0.32	-0.08	-0.05	-0.09	-0.02	-0.33	0.27	-0.12	1.00											
Systematic risk	(17)	-0.06	0.01	0.05	0.02	-0.01	-0.09	-0.16	0.10	-0.10	-0.06	-0.07	-0.07	-0.24	0.38	-0.23	0.18	1.00										
Idiosyncratic risk	(18)	-0.06	-0.08	0.17	0.01	-0.03	-0.10	-0.24	0.13	-0.24	-0.22	-0.22	-0.21	-0.19	0.37	-0.21	0.26	0.64	1.00									
Total risk	(19)	-0.06	-0.06	0.15	0.01	-0.03	-0.10	-0.23	0.13	-0.22	-0.20	-0.19	-0.19	-0.21	0.40	-0.23	0.26	0.77	0.98	1.00								
Advertising/TA	(20)	0.02	0.09	0.09	0.07	0.03	0.02	0.08	0.14	0.03	0.00	-0.05	0.06	-0.03	-0.04	-0.06	0.06	-0.03	0.01	0.00	1.00							
Missing Advertising	(21)	0.01	-0.08	-0.07	-0.07	-0.02	0.01	-0.05	-0.09	-0.08	-0.08	-0.05	-0.10	0.15	-0.04	0.12	-0.08	-0.07	-0.05	-0.05	-0.56	1.00						
Leverage	(22)	0.02	-0.09	-0.09	-0.13	0.00	-0.01	-0.13	-0.22	0.01	-0.03	-0.01	-0.06	0.32	-0.20	0.17	-0.25	-0.13	-0.09	-0.10	-0.05	0.08	1.00					
Nondiscretionary accrual	(23)	0.05	0.15	0.07	0.10	0.06	0.11	0.17	0.27	0.07	0.01	-0.04	0.03	-0.28	0.01	-0.08	0.28	0.02	0.07	0.07	0.02	-0.04	-0.14	1.00				
CEO tenure	(24)	-0.24	0.30	0.44	0.30	-0.28	0.04	0.02	0.04	-0.06	-0.03	-0.02	-0.03	-0.04	0.02	0.02	0.04	0.03	0.06	0.06	0.00	-0.03	-0.06	0.05	1.00			
CEO age	(25)	-0.16	0.12	0.14	0.09	-0.20	0.16	0.04	-0.07	0.05	0.06	0.08	0.05	0.06	-0.10	0.04	-0.13	-0.13	-0.16	-0.16	-0.04	0.08	0.04	-0.05	0.44	1.00		
Firm age	(26)	0.10	-0.01	-0.21	-0.11	0.09	0.06	0.07	-0.12	0.33	0.25	0.22	0.27	0.17	-0.15	0.04	-0.25	-0.24	-0.38	-0.37	0.01	0.05	0.12	-0.15	-0.12	0.13	1.00	
Ln(CEO total wealth)	(27)	-0.16	0.741	0.448	0.54	-0.11	0.178	0.22	0.3	0.28	0.31	0.26	0.35	-0.14	-0.02	-0.02	0.12	0.05	-0.08	-0.06	0.09	-0.13	-0.11	0.19	0.42	0.21	-0.02	1.00
Ln(Annual Compensation)	(28)	0.226	0.246	-0.24	-0.26	0.255	0.118	0.14	0.11	0.42	0.41	0.37	0.41	-0.09	-0.03	-0.05	0.02	0.01	-0.19	-0.16	0.04	-0.08	0.05	0.08	-0.09	0.01	0.24	0.40

Table 6: Multivariate analysis of the determinants of incentive measures

This table examines the determinants of CEO incentives for all ExecuComp firms with all three incentive measures and control variables available. All independent variables are lagged, except for Ln(CEO age) and Ln(CEO tenure). All incentive measures are top coded at 2% and all other continuous variables are winsorized at 1%. See Appendix A for variable definitions. All standard errors are double clustered at firm & year level and shown in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Panel A: Firm size measured as Ln(sales)

Dependent variable	PPE		PPSE		PPS	
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(sales)	0.127***	0.124***	0.054***	0.052***	-0.167***	-0.161***
	(0.014)	(0.014)	(0.020)	(0.020)	(0.011)	(0.010)
Total risk	-0.013***		-0.009**		0.003**	
	(0.002)		(0.004)		(0.002)	
Idiosyncratic risk		-0.017***		-0.011***		0.012***
		(0.003)		(0.004)		(0.002)
Systematic risk		0.005		0.003		-0.015***
		(0.004)		(0.007)		(0.004)
Ln(CEO age)	-0.383***	-0.378***	-0.313	-0.310	0.026	0.019
	(0.067)	(0.067)	(0.213)	(0.213)	(0.074)	(0.075)
Ln(CEO wealth) (Lagged)	-0.115***	-0.117***	0.773***	0.772***	0.222***	0.224***
	(0.014)	(0.015)	(0.042)	(0.042)	(0.013)	(0.013)
R&D/TA	1.006***	0.951***	1.505***	1.473***	-0.409*	-0.319
	(0.236)	(0.231)	(0.517)	(0.519)	(0.215)	(0.220)
Ln(CEO tenure)	-0.066***	-0.065***	-0.084**	-0.084**	0.046***	0.045***
	(0.016)	(0.016)	(0.037)	(0.037)	(0.017)	(0.017)
Missing R&D	-0.057**	-0.058**	0.061	0.060	0.052**	0.054**
	(0.023)	(0.023)	(0.060)	(0.060)	(0.025)	(0.025)
Hard assets	0.020	0.022	-0.212	-0.210	-0.028	-0.030
	(0.053)	(0.053)	(0.145)	(0.145)	(0.056)	(0.056)
Advertising/TA	0.430	0.470	2.556**	2.581**	0.468	0.408
	(0.343)	(0.341)	(1.083)	(1.084)	(0.444)	(0.439)
Missing Advertising	-0.005	-0.003	0.038	0.040	-0.022	-0.025
	(0.021)	(0.020)	(0.065)	(0.065)	(0.025)	(0.025)
Capital expenditure	0.182***	0.194***	-0.151	-0.143	-0.282***	-0.300***
	(0.048)	(0.045)	(0.133)	(0.134)	(0.049)	(0.049)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
FF48 fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,710	14,710	14,710	14,710	14,710	14,710
R-squared	0.292	0.293	0.547	0.547	0.460	0.465

Panel B: Firm size measured as Ln(Market Value of Assets)

Dependent variable	PPE		PPSE		PPS	
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(Market Value of Assets)	0.160***	0.159***	0.058**	0.056**	-0.203***	-0.200***
	(0.014)	(0.014)	(0.023)	(0.023)	(0.013)	(0.012)
Total risk	-0.010***		-0.009*		0.000	
	(0.002)		(0.005)		(0.002)	
Idiosyncratic risk		-0.011***		-0.010**		0.004**
		(0.002)		(0.005)		(0.002)

Systematic risk		-0.001		0.001		-0.008***
		(0.004)		(0.007)		(0.003)
Ln(CEO age)	-0.356***	-0.354***	-0.300	-0.299	-0.010	-0.014
	(0.066)	(0.065)	(0.213)	(0.214)	(0.070)	(0.070)
Ln(CEO tenure)	-0.029*	-0.029*	-0.076**	-0.076**	0.003	0.003
	(0.016)	(0.016)	(0.038)	(0.038)	(0.015)	(0.015)
Hard assets	0.001	0.002	-0.219	-0.218	-0.003	-0.004
	(0.049)	(0.049)	(0.144)	(0.144)	(0.053)	(0.053)
R&D/TA	0.725***	0.710***	1.384***	1.365***	-0.032	0.006
	(0.218)	(0.213)	(0.515)	(0.516)	(0.193)	(0.195)
Missing R&D	-0.039*	-0.040*	0.065	0.065	0.032	0.033
	(0.021)	(0.021)	(0.060)	(0.060)	(0.023)	(0.023)
Advertising/TA	0.702**	0.713**	2.655**	2.670**	0.121	0.098
	(0.323)	(0.323)	(1.081)	(1.081)	(0.419)	(0.417)
Missing Advertising	0.008	0.009	0.042	0.043	-0.038	-0.039*
	(0.020)	(0.020)	(0.066)	(0.066)	(0.023)	(0.023)
Capital expenditure	0.179***	0.182***	-0.163	-0.157	-0.272***	-0.280***
	(0.043)	(0.043)	(0.135)	(0.136)	(0.045)	(0.046)
Ln(CEO wealth) (Lagged)	-0.154***	-0.154***	0.763***	0.763***	0.268***	0.268***
	(0.017)	(0.017)	(0.042)	(0.042)	(0.015)	(0.015)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
FF48 fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,705	14,705	14,705	14,705	14,705	14,705
R-squared	0.324	0.324	0.547	0.547	0.515	0.516

Table 7: CEO incentives and ROA

This table compares across CEO incentives in their relation to the Return on Assets (ROA) for all firm-year observations with all relevant variables during 1996-2010. The dependent variable is ROA, which equals net income over total assets, both measured in the subsequent year. All incentive measures are top coded at 2% and all other continuous variables are bottom and top coded at 1%. See Appendix A for variable definitions. Standard errors are in parentheses. For regressions with Fama-French 48 industry and year fixed effects, the standard errors are double clustered at year and firm levels; and for regressions with CEO-firm pair and year fixed effects, the standard errors are clustered at CEO-firm pair level; *** p<0.01, ** p<0.05, * p<0.1.

	Dependent Variable = ROA in subsequent year					
	(1)	(2)	(3)	(4)	(5)	(6)
PPE	6.149***	4.017***				
	(0.946)	(0.910)				
PPE^2	-1.631***	-0.930***				
	(0.270)	(0.281)				
PPSE			3.295***	2.274***		
			(0.329)	(0.429)		
PPSE^2			-0.335***	-0.154***		
			(0.0429)	(0.0523)		
PPS					0.780	2.139
					(0.994)	(1.807)
PPS^2					0.00883	-0.452
					(0.359)	(0.638)
Ln(CEO tenure)	0.349**	0.372	-0.641***	0.140	-0.0494	0.289
	(0.170)	(0.437)	(0.170)	(0.431)	(0.174)	(0.439)
Leverage	-12.27***	-2.622*	-11.02***	-2.032	-12.20***	-2.913**
	(1.420)	(1.480)	(1.381)	(1.503)	(1.386)	(1.478)
R&D/TA	-32.72***	16.73	-32.92***	18.09	-31.19***	15.80
	(8.372)	(11.94)	(7.973)	(12.09)	(8.266)	(12.04)
Advertising/TA	10.94	27.17	7.778	26.60	9.191	24.58
	(8.582)	(19.08)	(8.557)	(19.24)	(8.784)	(19.21)
Ln(sales)	11.75***	2.104	11.64***	2.692	12.24***	2.523
	(1.130)	(3.442)	(1.115)	(3.490)	(1.133)	(3.492)
[Ln(sales)]^2	-0.706***	-0.190	-0.724***	-0.255	-0.720***	-0.202
	(0.0735)	(0.209)	(0.0728)	(0.211)	(0.0735)	(0.211)
Missing R&D	-0.335	1.288	-0.365	1.138	-0.449	1.304
	(0.410)	(0.909)	(0.418)	(0.907)	(0.424)	(0.940)
Missing advertising	-0.845**	0.292	-0.901**	0.249	-0.850**	0.236
	(0.405)	(0.780)	(0.393)	(0.778)	(0.412)	(0.785)
Capital expenditure	0.393	-1.051	0.0207	-1.386	0.992	-0.867
	(1.470)	(1.540)	(1.636)	(1.540)	(1.503)	(1.546)
Hard assets	4.238***	0.967	3.961***	0.610	4.386***	0.580
	(1.043)	(2.612)	(1.033)	(2.606)	(1.091)	(2.633)
Nondiscretionary Accrual	0.650***	0.426***	0.629***	0.426***	0.686***	0.443***
	(0.0732)	(0.0675)	(0.0777)	(0.0677)	(0.0747)	(0.0686)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	No	Yes	No	Yes	No
CEO-Firm fixed effect	No	Yes	No	Yes	No	Yes
Observations	14,519	14,519	14,519	14,519	14,519	14,519
R-squared	0.218	0.628	0.223	0.629	0.206	0.626

Table 8: CEO incentives and Tobin's Q

This table compares across various CEO incentives in their relation to firm valuation for all firm-year observations with all relevant variables available during 1996-2010. The dependent variable is Tobin's Q, which is measured in the same year as incentives. All incentive measures are top coded at 2% and all other continuous variables are bottom and top coded at 1%. See Appendix A for variable definitions. Standard errors are in parentheses. For regressions with Fama-French 48 industry and year fixed effects, the standard errors are double clustered at year and firm levels; and for regressions with CEO-firm pair and year fixed effects, the standard errors are clustered at CEO-firm pair level;*** p<0.01, ** p<0.05, * p<0.1.

	Dependent Variable = Tobin's Q					
	(1)	(2)	(3)	(4)	(5)	(6)
PPE	0.493***	0.674***				
	(0.0868)	(0.0735)				
PPE^2	-0.125***	-0.151***				
	(0.0265)	(0.0249)				
PPSE			0.621***	0.758***		
			(0.0654)	(0.0649)		
PPSE^2			-0.0499***	-0.0518***		
			(0.00728)	(0.00875)		
PPS					-0.0442	0.220
					(0.119)	(0.139)
PPS^2					0.0379	-0.0708
					(0.0442)	(0.0527)
Ln(CEO tenure)	0.0260	-0.000530	-0.174***	-0.0807*	-0.000607	-0.0117
	(0.0212)	(0.0458)	(0.0222)	(0.0432)	(0.0222)	(0.0463)
Leverage	-0.873***	-0.950***	-0.573***	-0.723***	-0.867***	-0.987***
	(0.174)	(0.148)	(0.158)	(0.139)	(0.170)	(0.148)
R&D/TA	4.848***	2.116**	4.610***	2.765***	4.963***	1.961**
	(0.750)	(0.974)	(0.682)	(0.921)	(0.743)	(0.988)
Advertising/TA	4.080***	4.418***	3.293***	4.775***	3.949***	3.849**
	(1.142)	(1.590)	(1.028)	(1.534)	(1.154)	(1.591)
Ln(sales)	0.138	-0.00169	0.0860	0.155	0.174	0.0511
	(0.110)	(0.197)	(0.105)	(0.184)	(0.108)	(0.198)
[Ln(sales)]^2	-0.00728	-0.0181	-0.0117*	-0.0384***	-0.00837	-0.0192
	(0.00722)	(0.0132)	(0.00686)	(0.0123)	(0.00719)	(0.0132)
Missing R&D	-0.0513	-0.0119	-0.0532	-0.0717	-0.0604	-0.00731
	(0.0471)	(0.0722)	(0.0454)	(0.0706)	(0.0472)	(0.0769)
Missing advertising	0.0199	0.184*	0.0152	0.180*	0.0184	0.176*
	(0.0521)	(0.101)	(0.0477)	(0.0934)	(0.0527)	(0.103)
Capital expenditure	1.690***	1.041***	1.523***	0.894***	1.742***	1.073***
	(0.181)	(0.142)	(0.151)	(0.134)	(0.178)	(0.147)
Hard assets	0.549***	0.192	0.502***	0.137	0.561***	0.129
	(0.140)	(0.227)	(0.135)	(0.212)	(0.143)	(0.226)
Nondiscretionary Accrual	0.0957***	0.0594***	0.0842***	0.0560***	0.0993***	0.0631***
	(0.0102)	(0.00531)	(0.00876)	(0.00502)	(0.0101)	(0.00547)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	No	Yes	No	Yes	No
CEO-Firm fixed effect	No	Yes	No	Yes	No	Yes
Observations	15,171	15,171	15,171	15,171	15,171	15,171
R-squared	0.324	0.801	0.404	0.826	0.316	0.795

Table 9: Excess CEO incentives and ROA

This table shows the relation between excess CEO incentives and the Return on Assets (ROA). The dependent variable is ROA, which equals net income over total assets, both measured in the subsequent year. The predicted CEO incentive is based on the CEO incentive determinant regression as shown in Columns (2), (4), and (6) of Panel A in Table 6 respectively. The excess CEO incentive equals the residual from the determinant regression when it is greater than 0 and equals 0 otherwise. The shortage in CEO incentive equals (-1) times the residual when it is less than 0 and equals 0 otherwise. All other continuous variables are winsorized at 1%. See Appendix A for variable definitions. Standard errors are in parentheses. For regressions with Fama-French 48 industry and year fixed effects, the standard errors are double clustered at year and firm levels; and for regressions with CEO-firm pair and year fixed effects, the standard errors are clustered at CEO-firm pair level;*** p<0.01, ** p<0.05, * p<0.1.

Dependent variable	ROA in subsequent year					
	(1)	(2)	(3)	(4)	(5)	(6)
Excess PPE	-0.260	0.714				
	(0.310)	(0.492)				
Shortage in PPE	-5.157***	-2.293***				
	(0.840)	(0.730)				
Excess PPSE			0.275	0.831***		
			(0.183)	(0.205)		
Shortage in PPSE			-0.854**	-1.924***		
			(0.337)	(0.391)		
Excess PPS					0.736	1.094
					(0.528)	(0.938)
Shortage in PPS					3.683***	-0.0877
					(0.991)	(1.230)
Nondiscretionary accru	0.608***	0.405***	0.657***	0.399***	0.644***	0.441***
	(0.0749)	(0.0706)	(0.0723)	(0.0697)	(0.0693)	(0.0705)
Ln(sales)	10.53***	1.357	10.87***	1.985	10.60***	1.605
	(1.080)	(3.408)	(1.095)	(3.396)	(1.085)	(3.435)
[Ln(sales)]^2	-0.616***	-0.133	-0.637***	-0.177	-0.620***	-0.154
	(0.0706)	(0.207)	(0.0714)	(0.205)	(0.0707)	(0.209)
Leverage	-13.13***	-4.479***	-13.32***	-4.349***	-13.34***	-4.751***
	(1.421)	(1.438)	(1.398)	(1.438)	(1.420)	(1.435)
R&D/TA	-28.88***	10.97	-29.17***	11.46	-29.78***	9.340
	(8.491)	(12.32)	(8.493)	(12.39)	(8.547)	(12.49)
Advertising/TA	8.760	23.18	8.351	26.07	7.113	21.83
	(7.807)	(20.14)	(7.973)	(20.24)	(8.060)	(20.29)
Missing R&D	-0.565	0.897	-0.537	0.763	-0.573	0.918
	(0.436)	(0.895)	(0.440)	(0.877)	(0.436)	(0.928)
Missing advertising	-0.921**	-0.0618	-0.896**	0.0632	-0.868**	-0.0592
	(0.388)	(0.785)	(0.399)	(0.783)	(0.396)	(0.789)
Capital expenditure	0.197	-1.362	0.899	-0.783	0.632	-1.117
	(1.650)	(1.574)	(1.647)	(1.573)	(1.682)	(1.579)
Hard assets	4.349***	0.178	4.423***	-0.139	4.500***	-0.315
	(1.029)	(2.815)	(1.045)	(2.796)	(1.060)	(2.823)
Ln(CEO tenure)	-0.0638	0.311	0.240	0.583	-0.0933	0.282
	(0.181)	(0.678)	(0.202)	(0.672)	(0.215)	(0.673)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Fama-French 48 fixed	Yes	No	Yes	No	Yes	No
CEO-Firm fixed effect	No	Yes	No	Yes	No	Yes
Observations	12,739	12,739	12,739	12,739	12,739	12,739
R-squared	0.214	0.629	0.201	0.631	0.201	0.627

Table 10: Excess CEO incentives and Tobin's Q

This table shows the relation between excess CEO incentives and Tobin's Q. The dependent variable is Tobin's Q, which is measured in the concurrent year. The predicted CEO incentive is based on the CEO incentive determinant regression as shown in Columns (2), (4), and (6) of Panel A in Table 6 respectively. The excess CEO incentive equals the residual from the determinant regression when it is greater than 0 and equals 0 otherwise. The shortage in CEO incentive equals (-1) times the residual when it is less than 0 and equals 0 otherwise. All other continuous variables are winsorized at 1%. See Appendix A for variable definitions. Standard errors are in parentheses. For regressions with Fama-French 48 industry and year fixed effects, the standard errors are double clustered at year and firm levels; and for regressions with CEO-firm pair and year fixed effects, the standard errors are clustered at CEO-firm pair level;*** p<0.01, ** p<0.05, * p<0.1.

Dependent variable	Tobin's Q					
	(1)	(2)	(3)	(4)	(5)	(6)
Excess PPE	0.0432	0.0587				
	(0.0586)	(0.0511)				
Shortage in PPE	-0.602***	-0.609***				
	(0.0656)	(0.0533)				
Excess PPSE			0.223***	0.219***		
			(0.0421)	(0.0362)		
Shortage in PPSE			-0.0738	-0.427***		
			(0.0487)	(0.0454)		
Excess PPS					0.176***	-0.0592
					(0.0683)	(0.0767)
Shortage in PPS					1.591***	0.296**
					(0.171)	(0.134)
Nondiscretionary accrual	0.0892***	0.0535***	0.0912***	0.0524***	0.0847***	0.0592***
	(0.0102)	(0.00531)	(0.00922)	(0.00532)	(0.0102)	(0.00553)
Ln(sales)	0.224*	0.0359	0.302***	0.198	0.188*	0.0807
	(0.114)	(0.209)	(0.115)	(0.209)	(0.109)	(0.205)
[Ln(sales)]^2	-0.0115	-0.0159	-0.0169**	-0.0271**	-0.00876	-0.0195
	(0.00750)	(0.0135)	(0.00743)	(0.0135)	(0.00707)	(0.0134)
Leverage	-1.036***	-1.118***	-1.002***	-1.091***	-1.035***	-1.148***
	(0.177)	(0.140)	(0.168)	(0.141)	(0.169)	(0.141)
R&D/TA	4.821***	2.146**	4.754***	2.268**	4.540***	1.829*
	(0.748)	(1.029)	(0.737)	(0.982)	(0.748)	(1.036)
Advertising/TA	4.332***	4.099***	4.086***	4.732***	3.886***	3.403**
	(1.142)	(1.545)	(1.106)	(1.550)	(1.112)	(1.582)
Missing R&D	-0.0790*	0.0144	-0.0841*	-0.0229	-0.0906**	0.0127
	(0.0470)	(0.0827)	(0.0484)	(0.0762)	(0.0450)	(0.0869)
Missing advertising	0.0417	0.114	0.0468	0.145	0.0538	0.119
	(0.0521)	(0.0974)	(0.0537)	(0.0969)	(0.0524)	(0.0981)
Capital expenditure	1.604***	0.946***	1.686***	1.083***	1.585***	0.976***
	(0.176)	(0.146)	(0.169)	(0.145)	(0.169)	(0.150)
Hard assets	0.535***	0.0544	0.545***	-0.0269	0.530***	-0.0199
	(0.148)	(0.219)	(0.149)	(0.214)	(0.148)	(0.217)
Ln(CEO tenure)	-0.0123	0.0417	0.00305	0.116*	-0.0918***	0.0180
	(0.0255)	(0.0703)	(0.0251)	(0.0701)	(0.0256)	(0.0718)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Fama-French 48 fixed effect	Yes	No	Yes	No	Yes	No
CEO-Firm fixed effect	No	Yes	No	Yes	No	Yes
Observations	13,294	13,294	13,294	13,294	13,294	13,294
R-squared	0.342	0.812	0.348	0.825	0.361	0.806

Table 11: Instrumental variable analysis of CEO incentives and firm performance

This table uses two-stage least squares instrumental variable analysis to compare across various CEO incentives in their relation to firm performance for all firm-year observations with all relevant variables available during 1996-2010. In Panel A, we report the results from the second stage regressions. In this panel, the dependent variable is ROA in the subsequent year for columns (1)-(3) and is Tobin's Q for columns (4)-(6). In Panel B, we report the first stage results for Tobin's Q regressions. All incentive measures are top coded at 2% and all other continuous variables are winsorized at 1%. See Appendix A for variable definitions. Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Panel A: Results from the second stage regressions

Dependent variable	ROA in subsequent year			Tobin's Q		
	(1)	(2)	(3)	(4)	(5)	(6)
PPE	124.4***			8.571***		
	(15.05)			(1.252)		
PPE^2	-46.66***			-3.751***		
	(5.498)			(0.459)		
PPSE		73.92***			3.074***	
		(18.41)			(0.692)	
PPSE^2		-11.98***			-0.450***	
		(3.038)			(0.114)	
PPS			-127.1***			-5.551***
			(20.13)			(1.232)
PPS^2			64.33***			3.286***
			(9.899)			(0.607)
Ln(CEO tenure)	-0.965**	-4.990***	1.445**	-0.385***	-0.371***	-0.178***
	(0.470)	(1.301)	(0.600)	(0.0411)	(0.0492)	(0.0378)
Leverage	-10.27***	-4.019	-3.577	-0.787***	-0.403***	-0.367**
	(1.626)	(3.620)	(2.370)	(0.140)	(0.135)	(0.145)
R&D/TA	-17.76***	-9.721	-39.06***	7.244***	4.955***	4.909***
	(6.653)	(13.22)	(7.811)	(0.583)	(0.492)	(0.499)
Advertising/TA	41.22***	111.1***	-25.67*	7.119***	6.775***	1.879**
	(12.01)	(34.83)	(14.32)	(1.045)	(1.268)	(0.906)
Ln(sales)	8.182***	2.519	7.559***	0.113	-0.173	0.164*
	(1.246)	(3.071)	(1.555)	(0.108)	(0.118)	(0.0990)
[Ln(sales)]^2	-0.516***	-0.370**	-0.637***	9.73e-05	-0.00387	-0.0140**
	(0.0788)	(0.163)	(0.0919)	(0.00683)	(0.00627)	(0.00587)
Missing R&D	-0.133	2.504*	-2.114**	-0.0778	0.0377	-0.165***
	(0.676)	(1.467)	(0.835)	(0.0588)	(0.0562)	(0.0524)
Missing Advertising	-1.021	-0.691	-0.161	0.0183	0.0568	0.104**
	(0.644)	(1.191)	(0.778)	(0.0560)	(0.0449)	(0.0494)
Capital expenditure	-7.386***	-3.177	9.879***	1.191***	1.386***	2.313***
	(2.286)	(3.881)	(2.798)	(0.199)	(0.147)	(0.177)
Hard assets	3.840**	-9.002*	2.252	0.525***	0.0672	0.452***
	(1.713)	(4.672)	(2.079)	(0.149)	(0.170)	(0.132)
Nondiscretionary accrual	-0.134	0.499**	1.165***	0.0324***	0.0792***	0.114***
	(0.143)	(0.199)	(0.150)	(0.0123)	(0.00744)	(0.00935)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,772	12,772	12,772	13,328	13,328	13,328
Cragg-Donald Wald F statistic	39.821	7.663	24.668	45.152	8.126	27.921
Stock-Yogo weak ID test critical values: 10% maximal IV size	7.03	7.03	7.03	7.03	7.03	7.03
Durbin-Wu-Hausman chi-sq test	490.448	325.771	468.357	1281.686	68.761	1481.863
p_Durbin	0	0	0	0	0	0
Excluded instrumental variable list	Idiosyncratic risk, Lagged Ln(CEO total wealth)	Idiosyncratic risk, Lagged Ln(CEO total wealth)	Idiosyncratic risk, Lagged Ln(CEO total wealth)	Idiosyncratic risk, Lagged Ln(CEO total wealth)	Idiosyncratic risk, Lagged Ln(CEO total wealth)	Idiosyncratic risk, Lagged Ln(CEO total wealth)

Panel B: Results from the first stage regressions for Tobin's Q

Dependent Variable	PPE	PPE^2	PPSE	PPSE^2	PPS	PPS^2
	(1)	(2)	(3)	(4)	(5)	(6)
Idiosyncratic risk	-0.0131***	-0.0245***	-0.0108***	-0.0272	0.00432***	0.000969
	(0.00121)	(0.00343)	(0.00251)	(0.0219)	(0.000949)	(0.00263)
Lagged Ln(CEO total wealth)	-0.131***	-0.367***	0.737***	4.453***	0.228***	0.464***
	(0.00408)	(0.0115)	(0.00845)	(0.0738)	(0.00320)	(0.00886)
Ln(CEO tenure)	-0.0877***	-0.238***	-0.113***	-1.051***	0.0458***	0.0571***
	(0.00764)	(0.0216)	(0.0158)	(0.138)	(0.00599)	(0.0166)
Leverage	-0.0348	-0.0888	-0.301***	-1.279**	-0.0408*	-0.186***
	(0.0312)	(0.0882)	(0.0646)	(0.565)	(0.0244)	(0.0678)
R&D/TA	1.257***	3.507***	1.294***	9.034***	-0.889***	-1.515***
	(0.126)	(0.356)	(0.261)	(2.278)	(0.0986)	(0.274)
Advertising/TA	0.349	1.658***	2.510***	23.54***	0.341**	1.188**
	(0.221)	(0.624)	(0.457)	(3.994)	(0.173)	(0.480)
Ln(sales)	0.139***	0.350***	-0.308***	-2.474***	-0.279***	-0.524***
	(0.0231)	(0.0654)	(0.0479)	(0.418)	(0.0181)	(0.0502)
[Ln(sales)]^2	-9.55e-05	0.00139	0.0241***	0.169***	0.00710***	0.0145***
	(0.00150)	(0.00424)	(0.00310)	(0.0271)	(0.00117)	(0.00326)
Missing R&D	-0.0453***	-0.108***	0.0797***	0.765***	0.0434***	0.105***
	(0.0131)	(0.0370)	(0.0271)	(0.237)	(0.0102)	(0.0284)
Missing Advertising	-0.0151	-0.0417	0.00803	0.0801	-0.0255***	-0.0609**
	(0.0125)	(0.0354)	(0.0260)	(0.227)	(0.00982)	(0.0272)
Capital expenditure	0.291***	0.575***	-0.125	-1.165	-0.376***	-0.875***
	(0.0403)	(0.114)	(0.0835)	(0.730)	(0.0316)	(0.0876)
Hard assets	0.0255	0.0637	-0.0729	-1.469**	-0.0425	-0.0558
	(0.0333)	(0.0941)	(0.0689)	(0.602)	(0.0261)	(0.0723)
Nondiscretionary accrual	0.00596***	-0.00239	0.0267***	0.153***	0.00208	-0.00292
	(0.00206)	(0.00584)	(0.00428)	(0.0374)	(0.00162)	(0.00449)
Year fixed effect	0.0576**	0.181***	0.0285	-0.0222	-0.0118	-0.0382
Industry fixed effect	-0.0186	0.108	-0.104	0.114	-0.209***	-0.611***
Observations	13,328	13,328	13,328	13,328	13,328	13,328
R-squared	0.300	0.255	0.538	0.338	0.473	0.307
F-Excluded Instruments	578.6	537.8	3808	1820	2566	1374

Table A1: Relation between firm size and PPE measures

Panel A: Relation between firm size and PPE_EGL in various samples

This panel shows the relation between PPE_EGL and firm size for various samples: the largest 500 firms during 1992-2006 (columns (1)) and 1992-2010 (columns (2)), as well as all ExecuComp firms during 1992-2006 (columns (3)) and 1992-2010 (columns (4)). For this table, the firm size is measured in the same year as the PPEs. For each regression models in columns (1)-(2), the largest 500 firms are ranked by the firm size measure in each year used in the regression. All continuous variables are winsorized at 1% level for each regression sample. See Appendix A for variable definitions. Standard errors with firm level clustering in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

	Dependent variable = Ln(PPE_EGL)			
Sample	Largest 500 firms	Largest 500 firms	All firms 92-06	All firms 92-10
	(1)	(2)	(3)	(4)
Ln(MV of total assets)	-0.037	0.008	0.095***	0.112***
	(0.044)	(0.043)	(0.016)	(0.015)
Year fixed effect	Yes	Yes	Yes	Yes
FF48 fixed effect	Yes	Yes	Yes	Yes
Observations	7,500	9,500	23,739	31,131
R-squared	0.155	0.151	0.100	0.114

Panel B: Comparison between PPE and PPE_EGL in a common sample

This panel shows the comparison between PPE and PPE_EGL with regard to the relation between PPE and firm size for various samples: the largest 500 firms with both PPE measures available during 1996-2006 (columns (1)-(2)) and all firms with both PPE measures available during1996-2010 (columns (3)-(4)). The samples in this Panel are different from those in Panel A.

Sample	Largest 500 firms 96-06		All firms 96-10	
Dependent variable	Ln(PPE_EGL)	Ln(PPE)	Ln(PPE_EGL)	Ln(PPE)
	(1)	(2)	(3)	(4)
Ln(MV of total assets)	0.027	0.062***	0.140***	0.140***
	(0.044)	(0.012)	(0.018)	(0.008)
Year fixed effect	Yes	Yes	Yes	Yes
FF48 fixed effect	Yes	Yes	Yes	Yes
Observations	5,500	5,500	18,457	18,457
R-squared	0.146	0.102	0.128	0.195

Table A2: Multivariate analysis of the determinants of alternative measures of PPE

This table examines the determinants of alternative CEO pay-performance elasticity measures: PPE scaled by CEO total wealth for sample with at least three years of compensation history (PPE_3Y+), PPE scaled by CEO total wealth for sample with at least seven years of compensation history in the ExecuComp dataset (PPE_7Y+), PPE scaled using the long-history wealth measure (PPE_LH), and PPE scaled by CEO total wealth including the present value of future compensation until age 65 (PPE_life), and PPE scaled using annual compensation (PPE_EGL). To be comparable to previous tables, we include all ExecuComp firms with all relevant variables available during 1996-2010 for columns (3)-(5). Firm size is measured as the lagged Ln(sales). All independent variables are lagged, except for Ln(CEO age) and Ln(CEO tenure). All PPE measures are top coded at 2%. All log-PPEs and other continuous variables are winsorized at 1%. See Appendix A for variable definitions. All least-square-regression standard errors are double clustered at firm & year levels and shown in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Panel A: Firm size measured as Ln(sales)

Dependent variable	PPE_3Y+	PPE_7Y+	PPE_LH	PPE_life	Ln(1+PPE_EGL)
	(1)	(2)	(3)	(4)	(5)
Ln(sales)	0.119***	0.128***	0.119***	0.042***	-0.238***
	(0.012)	(0.016)	(0.016)	(0.007)	(0.016)
Idiosyncratic risk	-0.012***	-0.018***	-0.016***	-0.012***	-0.020***
	(0.003)	(0.002)	(0.003)	(0.001)	(0.004)
Systematic risk	0.005	0.004	0.006	0.000	-0.015***
	(0.004)	(0.004)	(0.005)	(0.002)	(0.005)
Ln(CEO age)	-0.352***	-0.382***	-0.455***	0.390***	-0.305**
	(0.070)	(0.071)	(0.070)	(0.054)	(0.125)
Ln(CEO tenure)	-0.090***	-0.043**	-0.150***	-0.004	0.031
	(0.017)	(0.017)	(0.030)	(0.009)	(0.029)
Hard assets	-0.013	0.003	0.024	0.032	0.256**
	(0.053)	(0.058)	(0.057)	(0.036)	(0.100)
R&D/TA	0.944***	1.014***	0.820***	0.366**	-0.325
	(0.225)	(0.274)	(0.264)	(0.159)	(0.356)
Missing R&D	-0.064***	-0.046*	-0.057**	-0.032**	0.032
	(0.022)	(0.025)	(0.025)	(0.014)	(0.041)
Advertising/TA	0.174	0.194	0.482	0.053	0.048
	(0.317)	(0.319)	(0.352)	(0.216)	(0.679)
Missing Advertising	-0.020	-0.007	0.007	0.008	-0.019
	(0.018)	(0.021)	(0.021)	(0.015)	(0.043)
Capital expenditure	0.197***	0.198***	0.194***	0.148***	-0.113
	(0.044)	(0.055)	(0.052)	(0.030)	(0.085)
Ln(CEO wealth) (Lagged)	-0.132***	-0.108***	-0.085***	0.003	0.654***
	(0.013)	(0.017)	(0.023)	(0.009)	(0.023)
Year fixed effect	Yes	Yes	Yes	Yes	Yes
FF48 fixed effect	Yes	Yes	Yes	Yes	Yes
Observations	18,732	10,883	14,710	14,663	14,657
R-squared	0.278	0.310	0.274	0.240	0.568

Panel B: Firm size measured as Ln(market value of total assets)

Dependent variable	PPE_3Y+	PPE_7Y+	PPE_LH	PPE_life	Ln(1+PPE_EGL)
	(1)	(2)	(3)	(4)	(5)
Ln(MV assets)	0.160***	0.157***	0.153***	0.061***	-0.246***
	(0.014)	(0.016)	(0.017)	(0.007)	(0.018)
Idiosyncratic risk	-0.006**	-0.012***	-0.010***	-0.009***	-0.023***

	(0.002)	(0.002)	(0.002)	(0.001)	(0.004)
Systematic risk	-0.001	-0.001	0.001	-0.002	-0.008
	(0.004)	(0.004)	(0.005)	(0.002)	(0.005)
Ln(CEO age)	-0.330***	-0.365***	-0.432***	0.396***	-0.366***
	(0.067)	(0.068)	(0.070)	(0.053)	(0.123)
Ln(CEO tenure)	-0.053***	-0.007	-0.115***	0.013	0.005
	(0.017)	(0.017)	(0.032)	(0.009)	(0.030)
Hard assets	-0.034	-0.023	0.005	0.024	0.284***
	(0.049)	(0.055)	(0.054)	(0.035)	(0.100)
R&D/TA	0.684***	0.676***	0.588**	0.285*	0.170
	(0.206)	(0.250)	(0.241)	(0.152)	(0.366)
Missing R&D	-0.044**	-0.029	-0.039*	-0.025*	0.015
	(0.020)	(0.023)	(0.023)	(0.013)	(0.039)
Advertising/TA	0.435	0.412	0.717**	0.146	-0.345
	(0.299)	(0.313)	(0.336)	(0.206)	(0.678)
Missing Advertising	-0.006	0.001	0.018	0.013	-0.032
	(0.018)	(0.021)	(0.021)	(0.015)	(0.042)
Capital expenditure	0.194***	0.188***	0.183***	0.149***	-0.048
	(0.043)	(0.052)	(0.048)	(0.030)	(0.080)
Ln(CEO wealth) (Lagged)	-0.169***	-0.143***	-0.120***	-0.014	0.690***
	(0.016)	(0.018)	(0.026)	(0.010)	(0.025)
Year fixed effect	Yes	Yes	Yes	Yes	Yes
FF48 fixed effect	Yes	Yes	Yes	Yes	Yes
Observations	18,731	10,880	14,705	14,658	14,652
R-squared	0.308	0.341	0.300	0.256	0.570

Table A3: Alternative PPE and firm performance

This table examines the association between firm performance and alternative CEO PPE measures: PPE scaled using annual compensation (PPE_EGL), PPE scaled using the long-history wealth measure (PPE_LH), PPE scaled by CEO total wealth for sample with at least three years of compensation history (PPE_3Y+), and PPE scaled by CEO total wealth for sample with at least seven years of compensation history in the ExecuComp dataset (PPE_7Y+), and PPE scaled by CEO total wealth including the present value of future compensation until age 65 (PPE_life). For Panel A, the dependent variable is the Return on Assets (ROA), which equals net income over total assets, both measured in the subsequent year. For Panel B, the dependent variable is Tobin's Q. To be comparable to previous tables, we include all ExecuComp firms with all relevant variables available during 1996-2010. All PPE measures are top coded at 2%. All log-PPEs and other continuous variables are winsorized at 1%. See Appendix A for variable definitions. Standard errors are in parentheses. For regressions with Fama-French 48 industry and year fixed effects, the standard errors are double clustered at year and firm levels; and for regressions with CEO-firm pair and year fixed effects, the standard errors are clustered at CEO-firm pair levels;*** p<0.01, ** p<0.05, * p<0.1.

Panel A: Alternative CEO incentives and ROA

	Dependent Variable = ROA in subsequent year									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ln(1+PPE_EGL)	4.145***	1.847***								
	(0.569)	(0.540)								
[Ln(1+PPE_EGL)]^2	-0.395***	-0.153*								
	(0.0747)	(0.0862)								
PPE_LH			5.123***	3.719***						
			(0.728)	(0.801)						
PPE_LH^2			-1.163***	-0.773***						
			(0.183)	(0.215)						
PPE_3Y+					5.520***	4.735***				
					(0.802)	(0.783)				
(PPE_3Y+)^2					-1.359***	-1.025***				
					(0.209)	(0.216)				
PPE_7Y+							7.051***	3.432***		
							(1.139)	(1.039)		
(PPE_7Y+)^2							-2.059***	-0.930***		
							(0.343)	(0.343)		
PPE_life									13.83***	7.448***
									(1.955)	(1.507)
PPE_life^2									-5.961***	-2.858***
									(0.962)	(0.813)
Ln(CEO tenure)	-0.912***	0.119	0.525***	0.452	0.557***	-0.0363	0.185	0.282	-0.220	-0.000611
	(0.193)	(0.438)	(0.179)	(0.437)	(0.173)	(0.370)	(0.167)	(0.487)	(0.161)	(0.432)
Leverage	-11.11***	-2.664*	-12.16***	-2.558*	-13.38***	-4.041***	-11.10***	-1.701	-11.93***	-2.698*
	(1.434)	(1.481)	(1.397)	(1.483)	(1.378)	(1.355)	(1.399)	(1.552)	(1.404)	(1.437)
R&D/TA	-30.13***	15.59	-32.96***	16.43	-40.42***	5.806	-23.43**	42.54***	-31.05***	15.72
	(7.794)	(12.06)	(8.343)	(11.97)	(6.847)	(9.601)	(9.379)	(12.73)	(8.097)	(11.84)
Advertising/TA	10.29	26.95	10.28	26.88	7.923	18.04	13.70*	18.25	11.40	27.58
	(8.442)	(19.10)	(8.591)	(19.10)	(7.761)	(18.64)	(7.881)	(22.36)	(8.300)	(18.58)
Ln(sales)	11.37***	2.287	11.67***	2.054	11.06***	0.978	10.95***	2.272	10.75***	1.775
	(1.075)	(3.482)	(1.115)	(3.448)	(1.025)	(2.578)	(1.262)	(3.156)	(1.031)	(3.268)
[Ln(sales)]^2	-0.680***	-0.196	-0.702***	-0.185	-0.669***	-0.120	-0.656***	-0.203	-0.647***	-0.166
	(0.0695)	(0.211)	(0.0727)	(0.209)	(0.0671)	(0.163)	(0.0791)	(0.193)	(0.0669)	(0.198)
Missing R&D	-0.383	1.367	-0.341	1.254	-0.466	1.089	-0.617	0.673	-0.366	1.302
	(0.410)	(0.922)	(0.410)	(0.904)	(0.392)	(0.752)	(0.409)	(0.952)	(0.403)	(0.898)
Missing advertising	-0.778**	0.305	-0.856**	0.275	-0.648	0.801	-0.990**	-0.0881	-0.860**	0.275
	(0.388)	(0.784)	(0.405)	(0.778)	(0.398)	(0.716)	(0.411)	(0.842)	(0.380)	(0.768)
Capital expenditure	-0.246	-1.074	0.372	-1.053	-0.419	-2.453*	1.519	-0.904	-0.172	-1.191
	(1.544)	(1.542)	(1.484)	(1.541)	(1.787)	(1.421)	(1.467)	(1.593)	(1.475)	(1.493)
Hard assets	3.496***	0.588	4.250***	0.976	4.687***	0.416	4.146***	0.165	3.702***	0.644
	(1.023)	(2.623)	(1.050)	(2.615)	(1.030)	(2.320)	(1.021)	(2.851)	(0.958)	(2.556)
Nondiscretionary Accrual	0.589***	0.439***	0.649***	0.425***	0.514***	0.423***	0.657***	0.429***	0.609***	0.415***
	(0.0759)	(0.0675)	(0.0756)	(0.0674)	(0.0976)	(0.0559)	(0.0620)	(0.0744)	(0.0791)	(0.0662)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
CEO-Firm fixed effect	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	14,464	14,464	14,519	14,519	19,274	19,274	10,570	10,570	14,443	14,443
R-squared	0.234	0.626	0.217	0.628	0.207	0.617	0.210	0.647	0.228	0.624

Panel B: Alternative CEO incentives and Tobin's Q

	Dependent Variable = Tobin's Q									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ln(1+PPE_EGL)	0.225***	0.174***								
	(0.0515)	(0.0532)								

[Ln(1+PPE_EGL)]^2	0.00617	0.00968								
	(0.00838)	(0.0110)								
PPE_LH			0.505***	0.660***						
			(0.0744)	(0.0657)						
PPE_LH^2			-0.110***	-0.124***						
			(0.0178)	(0.0181)						
PPE_3Y+					0.426***	0.658***				
					(0.0753)	(0.0671)				
(PPE_3Y+)^2					-0.104***	-0.138***				
					(0.0204)	(0.0201)				
PPE_7Y+							0.543***	0.690***		
							(0.0955)	(0.0886)		
(PPE_7Y+)^2							-0.157***	-0.172***		
							(0.0325)	(0.0325)		
PPE_life									0.975***	1.154***
									(0.152)	(0.116)
PPE_life^2									-0.258***	-0.366***
									(0.0793)	(0.0662)
Ln(CEO tenure)	-0.142***	-0.0575	0.0478*	0.0227	0.0289	-0.0171	0.0168	0.0254	-0.0272	-0.0712
	(0.0220)	(0.0459)	(0.0244)	(0.0457)	(0.0195)	(0.0389)	(0.0213)	(0.0572)	(0.0206)	(0.0455)
Leverage	-0.641***	-0.916***	-0.862***	-0.936***	-0.886***	-0.998***	-0.778***	-0.800***	-0.874***	-0.935***
	(0.167)	(0.147)	(0.172)	(0.148)	(0.173)	(0.139)	(0.183)	(0.172)	(0.175)	(0.142)
R&D/TA	5.097***	2.109**	4.807***	2.072**	4.484***	1.376	5.507***	2.743**	4.862***	2.050**
	(0.699)	(0.993)	(0.751)	(0.967)	(0.626)	(0.966)	(0.788)	(1.179)	(0.728)	(0.978)
Advertising/TA	3.873***	4.594***	4.037***	4.398***	4.021***	4.285***	3.789***	4.103**	4.142***	4.511***
	(1.094)	(1.587)	(1.138)	(1.580)	(1.087)	(1.405)	(1.228)	(1.812)	(1.132)	(1.572)
Ln(sales)	0.0902	0.0256	0.123	-0.0193	-0.200	-0.535***	0.271**	0.280	0.113	-0.00807
	(0.103)	(0.201)	(0.112)	(0.196)	(0.130)	(0.197)	(0.114)	(0.246)	(0.107)	(0.193)
[Ln(sales)]^2	-0.00439	-0.0195	-0.00669	-0.0167	0.0133	0.0198	-0.0152**	-0.0384**	-0.00697	-0.0169
	(0.00682)	(0.0135)	(0.00733)	(0.0131)	(0.00861)	(0.0131)	(0.00732)	(0.0165)	(0.00697)	(0.0128)
Missing R&D	-0.0617	-0.0334	-0.0497	-0.0170	-0.0473	-0.0176	-0.0702	0.00719	-0.0425	-0.0101
	(0.0448)	(0.0704)	(0.0472)	(0.0718)	(0.0501)	(0.0628)	(0.0478)	(0.0776)	(0.0457)	(0.0713)
Missing advertising	0.0330	0.193*	0.0194	0.182*	0.0266	0.197**	-0.0161	0.182	0.0123	0.182*
	(0.0487)	(0.100)	(0.0520)	(0.101)	(0.0501)	(0.0843)	(0.0566)	(0.128)	(0.0498)	(0.0987)
Capital expenditure	1.620***	1.049***	1.679***	1.040***	1.695***	1.213***	1.573***	1.005***	1.607***	1.003***
	(0.166)	(0.145)	(0.181)	(0.142)	(0.188)	(0.122)	(0.212)	(0.173)	(0.173)	(0.136)
Hard assets	0.451***	0.141	0.547***	0.193	0.663***	0.258	0.529***	0.0205	0.511***	0.191
	(0.134)	(0.221)	(0.140)	(0.227)	(0.131)	(0.215)	(0.164)	(0.269)	(0.133)	(0.221)
Nondiscretionary Accrual	0.0857***	0.0615***	0.0947***	0.0588***	0.102***	0.0691***	0.0866***	0.0513***	0.0922***	0.0570***
	(0.00913)	(0.00541)	(0.0100)	(0.00528)	(0.00893)	(0.00543)	(0.0112)	(0.00583)	(0.00969)	(0.00509)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
CEO-Firm fixed effect	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	15,111	15,111	15,171	15,171	20,124	20,124	11,014	11,014	15,086	15,086
R-squared	0.370	0.804	0.327	0.802	0.331	0.770	0.330	0.815	0.344	0.807

Table A4: Median regression analysis of the determinants of incentive measures

This table uses median regressions to examine the determinants of CEO incentives for all ExecuComp firms with relevant variables available. All independent variables are lagged, except for Ln(CEO age) and Ln(CEO tenure). All incentive measures are top coded at 2% and all other continuous variables are winsorized at 1%. See Appendix A for variable definitions. Standard errors are shown in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Panel A: Firm size measured by Ln(sales)

Dependent variable	PPE		PPSE		PPS	
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(sales)	0.106***	0.104***	0.043***	0.041***	-0.079***	-0.078***
	(0.008)	(0.008)	(0.007)	(0.007)	(0.004)	(0.004)
Total risk	-0.013***		-0.007***		0.004***	
	(0.002)		(0.002)		(0.001)	
Idiosyncratic risk		-0.016***		-0.008***		0.007***
		(0.003)		(0.002)		(0.001)
Systematic risk		0.002		0.001		-0.005***
		(0.003)		(0.003)		(0.001)
Ln(CEO age)	-0.313***	-0.316***	-0.266***	-0.265***	-0.031	-0.030
	(0.071)	(0.070)	(0.069)	(0.069)	(0.027)	(0.029)
Ln(CEO tenure)	-0.055***	-0.054***	-0.041***	-0.041***	0.023***	0.022***
	(0.013)	(0.013)	(0.012)	(0.012)	(0.005)	(0.006)
Hard assets	0.003	-0.003	-0.012	-0.016	-0.036*	-0.030
	(0.064)	(0.062)	(0.049)	(0.047)	(0.021)	(0.022)
R&D/TA	0.929***	0.881***	0.589***	0.532**	-0.315***	-0.279***
	(0.283)	(0.285)	(0.203)	(0.212)	(0.087)	(0.078)
Missing R&D	-0.056**	-0.052**	0.019	0.016	0.012	0.013
	(0.025)	(0.025)	(0.020)	(0.020)	(0.009)	(0.009)
Advertising/TA	0.406	0.413	0.820*	0.904**	-0.094	-0.054
	(0.374)	(0.397)	(0.439)	(0.424)	(0.214)	(0.226)
Missing Advertising	-0.005	-0.005	0.009	0.014	-0.015*	-0.014*
	(0.022)	(0.023)	(0.021)	(0.021)	(0.008)	(0.008)
Capital expenditure	0.107*	0.135**	-0.099**	-0.085*	-0.047**	-0.062***
	(0.055)	(0.053)	(0.047)	(0.046)	(0.022)	(0.020)
Ln(CEO wealth) (Lagged)	-0.090***	-0.091***	0.342***	0.343***	0.089***	0.090***
	(0.007)	(0.007)	(0.017)	(0.017)	(0.007)	(0.006)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
FF48 fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,710	14,710	14,710	14,710	14,710	14,710
R-squared	0.284	0.285	0.535	0.535	0.425	0.429

Panel B: Firm size measured by Ln(market value of assets)

Dependent variable	PPE		PPSE		PPS	
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(MV_assets)	0.136***	0.135***	0.049***	0.047***	-0.104***	-0.103***
	(0.008)	(0.008)	(0.007)	(0.007)	(0.005)	(0.005)
Total risk	-0.011***		-0.006***		0.002***	
	(0.002)		(0.002)		(0.001)	
Idiosyncratic risk		-0.010***		-0.007***		0.004***
		(0.003)		(0.002)		(0.001)
Systematic risk		-0.004		-0.000		-0.002*

		(0.003)		(0.003)		(0.001)
Ln(CEO age)	-0.291***	-0.288***	-0.269***	-0.267***	-0.045*	-0.051**
	(0.074)	(0.075)	(0.067)	(0.070)	(0.024)	(0.025)
Ln(CEO tenure)	-0.027*	-0.027*	-0.030**	-0.030**	0.001	0.002
	(0.014)	(0.014)	(0.013)	(0.013)	(0.005)	(0.005)
Hard assets	-0.022	-0.018	-0.030	-0.036	-0.006	-0.004
	(0.066)	(0.067)	(0.046)	(0.046)	(0.020)	(0.020)
R&D/TA	0.600***	0.599**	0.408**	0.393**	-0.143*	-0.140**
	(0.229)	(0.235)	(0.182)	(0.200)	(0.074)	(0.067)
Missing R&D	-0.034	-0.034	0.018	0.018	0.004	0.004
	(0.024)	(0.024)	(0.019)	(0.019)	(0.008)	(0.008)
Advertising/TA	0.640*	0.641*	0.901**	0.909**	-0.048	-0.064
	(0.380)	(0.386)	(0.364)	(0.363)	(0.194)	(0.190)
Missing Advertising	0.002	0.003	0.014	0.015	-0.018**	-0.019**
	(0.023)	(0.023)	(0.020)	(0.020)	(0.007)	(0.007)
Capital expenditure	0.118**	0.121**	-0.078*	-0.081*	-0.085***	-0.088***
	(0.054)	(0.054)	(0.043)	(0.045)	(0.019)	(0.019)
Ln(CEO wealth) (Lagged)	-0.125***	-0.124***	0.331***	0.331***	0.121***	0.121***
	(0.008)	(0.009)	(0.017)	(0.018)	(0.008)	(0.008)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
FF48 fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,705	14,705	14,705	14,705	14,705	14,705
R-squared	0.317	0.317	0.534	0.534	0.492	0.492

TableA5: Median regression analysis of CEO incentives and firm performance

This table uses median regressions to compare across various CEO incentives in their relation to Return on Assets (ROA) and Tobin's Q for all firm-year observations with all relevant variables available during 1996-2010. The dependent variable is ROA, which is measured in the subsequent year, for columns (1)-(3), and Tobin's Q, which is measured in the concurrent year, for columns (4)-(6). All incentive measures are top coded at 2% and all other continuous variables are winsorized at 1%. See Appendix A for variable definitions. Standard errors are shown in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Dependent Variable	ROA in subsequent year			Tobin's Q		
	(1)	(2)	(3)	(4)	(5)	(6)
PPE	2.802***			0.278***		
	(0.387)			(0.0436)		
PPE^2	-0.728***			-0.0566***		
	(0.129)			(0.0175)		
PPSE		2.144***			0.521***	
		(0.236)			(0.0484)	
PPSE^2		-0.216***			-0.0460***	
		(0.0301)			(0.00662)	
PPS			0.329			-0.0500
			(0.532)			(0.0758)
PPS^2			-0.0230			0.0354
			(0.220)			(0.0314)
Ln(CEO tenure)	0.106	-0.443***	-0.0410	0.0117	-0.103***	-0.00506
	(0.0955)	(0.0947)	(0.0987)	(0.0121)	(0.0117)	(0.0121)
Leverage	-10.41***	-9.568***	-10.48***	-0.708***	-0.486***	-0.685***
	(0.714)	(0.692)	(0.733)	(0.0819)	(0.0686)	(0.0738)
R&D/TA	-16.41***	-17.19***	-15.16***	3.835***	3.665***	4.077***
	(5.144)	(5.093)	(5.029)	(0.607)	(0.493)	(0.523)
Advertising/TA	15.12***	14.42***	15.01***	3.494***	2.871***	3.371***
	(5.858)	(4.707)	(4.936)	(0.870)	(0.797)	(0.966)
Ln(Sales)	5.451***	5.589***	5.716***	0.172**	0.154**	0.220***
	(0.655)	(0.673)	(0.682)	(0.0730)	(0.0657)	(0.0681)
[Ln(sales)]^2	-0.324***	-0.351***	-0.333***	-0.00981**	-0.0128***	-0.0119***
	(0.0411)	(0.0424)	(0.0425)	(0.00466)	(0.00414)	(0.00428)
Missing R&D	-0.326	-0.360	-0.398	-0.0335	-0.0663***	-0.0460
	(0.253)	(0.237)	(0.261)	(0.0302)	(0.0257)	(0.0295)
Missing Advertising	-0.282	-0.320	-0.236	-0.0125	-0.0223	-0.00851
	(0.268)	(0.249)	(0.258)	(0.0396)	(0.0313)	(0.0394)
Capital expenditure	3.039***	3.032***	3.232***	1.153***	1.040***	1.199***
	(0.761)	(0.697)	(0.761)	(0.116)	(0.105)	(0.111)
Hard assets	2.632***	2.207***	2.581***	0.372***	0.312***	0.376***
	(0.592)	(0.562)	(0.616)	(0.0652)	(0.0656)	(0.0645)
Nondiscretionary accrual	0.397***	0.359***	0.405***	0.0505***	0.0419***	0.0532***
	(0.0368)	(0.0327)	(0.0380)	(0.00482)	(0.00420)	(0.00490)
Year fixed	Yes	Yes	Yes	Yes	Yes	Yes
FF48 fixed	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,519	14,519	14,519	15,171	15,171	15,171
R-squared	0.181	0.187	0.169	0.304	0.386	0.298

Table A6: Median regression analysis of excess CEO incentives and performance

This table uses median regressions to analyze the relation between excess CEO incentives and the Return on Assets (ROA)/Tobin's Q. The dependent variable is ROA, which is measured in the subsequent year, for columns (1)-(3), and Tobin's Q, which is measured in the concurrent year, for columns (4)-(6). The predicted CEO incentive is based on the CEO incentive determinant regression as shown in Columns (2), (4), and (6) of Panel A in Table 6 respectively. The excess CEO incentive equals the residual from the determinant regression when it is greater than 0 and equals 0 otherwise. The shortage in CEO incentive equals (-1) times the residual when it is less than 0 and equals 0 otherwise. All incentive measures are top coded at 2% and all other continuous variables are winsorized at 1%. See Appendix A for variable definitions. Standard errors are shown in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Dependent variable	ROA in subsequent year			Tobin's Q		
	(1)	(2)	(3)	(4)	(5)	(6)
Excess PPE	0.0352			0.0771**		
	(0.219)			(0.0319)		
Shortage in PPE	-2.593***			-0.364***		
	(0.309)			(0.0356)		
Excess PPSE		0.275**			0.120***	
		(0.130)			(0.0299)	
Shortage in PPSE		-0.206			-0.0304	
		(0.164)			(0.0222)	
Excess PPS			0.169			0.0908*
			(0.343)			(0.0496)
Shortage in PPS			3.206***			1.186***
			(0.701)			(0.123)
Nondiscretionary accrual	0.386***	0.393***	0.387***	0.0459***	0.0478***	0.0407***
	(0.0399)	(0.0412)	(0.0431)	(0.00538)	(0.00485)	(0.00430)
Ln(sales)	5.319***	5.537***	5.411***	0.235***	0.284***	0.234***
	(0.699)	(0.776)	(0.696)	(0.0758)	(0.0722)	(0.0668)
[Ln(sales)]^2	-0.309***	-0.323***	-0.313***	-0.0126***	-0.0153***	-0.0118***
	(0.0435)	(0.0482)	(0.0435)	(0.00474)	(0.00452)	(0.00423)
Leverage	-10.83***	-10.94***	-10.76***	-0.816***	-0.806***	-0.829***
	(0.729)	(0.749)	(0.757)	(0.0855)	(0.0880)	(0.0855)
R&D/TA	-13.60**	-13.81**	-13.47***	4.089***	4.192***	3.844***
	(5.312)	(5.394)	(4.929)	(0.633)	(0.544)	(0.545)
Advertising/TA	15.54**	15.45***	15.68***	3.503***	3.400***	2.711**
	(6.468)	(5.537)	(5.515)	(1.073)	(0.957)	(1.111)
Missing R&D	-0.317	-0.271	-0.268	-0.0375	-0.0603*	-0.0781***
	(0.276)	(0.277)	(0.268)	(0.0319)	(0.0326)	(0.0302)
Missing advertising	-0.302	-0.251	-0.206	-0.0172	0.00582	0.00981
	(0.288)	(0.287)	(0.269)	(0.0422)	(0.0404)	(0.0384)
Capital expenditure	2.750***	3.223***	3.016***	1.105***	1.180***	1.134***
	(0.743)	(0.856)	(0.846)	(0.124)	(0.115)	(0.120)
Hard assets	2.621***	2.450***	2.374***	0.372***	0.360***	0.346***
	(0.602)	(0.666)	(0.649)	(0.0722)	(0.0755)	(0.0736)
Ln(CEO tenure)	-0.106	0.0156	-0.179	-0.0158	0.00272	-0.0776***
	(0.114)	(0.117)	(0.115)	(0.0162)	(0.0159)	(0.0150)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Fama-French 48 fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,739	12,739	12,739	13,294	13,294	13,294
R-squared	0.179	0.167	0.166	0.322	0.327	0.344

Table A7: Multivariate analysis of the determinants of log incentive measures

This table examines the determinants of log CEO incentive measures. To avoid missing observations, we use Ln(1+incentive measures) as dependent variables. Firm size is measured as the lagged Ln(sales) in Panel A and Ln(MV_assets) in Panel B. All independent variables are lagged, except for Ln(CEO age) and Ln(CEO tenure). All variables are winsorized at 1%. See Appendix A for variable definitions. All least-square-regression standard errors are double clustered at firm & year levels and shown in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Panel A: Firm size measured by Ln(sales)

Dependent variable	Ln(1+PPE)		Ln(1+PPSE)		Ln(1+PPS)	
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(sales)	0.059***	0.057***	0.035***	0.034***	-0.102***	-0.099***
	(0.006)	(0.006)	(0.006)	(0.007)	(0.005)	(0.005)
Total risk	-0.007***		-0.005***		0.003***	
	(0.001)		(0.001)		(0.001)	
Idiosyncratic risk		-0.009***		-0.006***		0.007***
		(0.001)		(0.001)		(0.001)
Systematic risk		0.001		0.001		-0.008***
		(0.002)		(0.002)		(0.002)
Ln(CEO age)	-0.188***	-0.186***	-0.174***	-0.173***	0.004	0.000
	(0.036)	(0.036)	(0.064)	(0.064)	(0.037)	(0.037)
Ln(CEO tenure)	-0.029***	-0.029***	-0.023**	-0.023**	0.032***	0.032***
	(0.008)	(0.008)	(0.011)	(0.011)	(0.009)	(0.008)
Hard assets	0.006	0.007	-0.054	-0.054	-0.024	-0.025
	(0.026)	(0.026)	(0.043)	(0.043)	(0.028)	(0.028)
R&D/TA	0.427***	0.402***	0.499***	0.485***	-0.279**	-0.227**
	(0.118)	(0.115)	(0.157)	(0.157)	(0.111)	(0.114)
Missing R&D	-0.029***	-0.029***	0.009	0.008	0.028**	0.029**
	(0.011)	(0.011)	(0.017)	(0.017)	(0.013)	(0.013)
Advertising/TA	0.116	0.134	0.682**	0.692**	0.204	0.169
	(0.165)	(0.164)	(0.330)	(0.330)	(0.212)	(0.209)
Missing Advertising	-0.002	-0.001	0.008	0.008	-0.011	-0.012
	(0.010)	(0.010)	(0.019)	(0.019)	(0.012)	(0.012)
Capital expenditure	0.103***	0.108***	-0.031	-0.028	-0.141***	-0.152***
	(0.024)	(0.023)	(0.041)	(0.041)	(0.025)	(0.025)
Ln(CEO wealth) (Lagged)	-0.051***	-0.052***	0.300***	0.299***	0.126***	0.127***
	(0.007)	(0.007)	(0.013)	(0.013)	(0.006)	(0.006)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
FF48 fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,710	14,710	14,710	14,710	14,710	14,710
R-squared	0.289	0.290	0.674	0.674	0.535	0.540

Panel B: Firm size measured by Ln(MV_assets)

Dependent variable	Ln(1+PPE)		Ln(1+PPSE)		Ln(1+PPS)	
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(sales)	0.075***	0.074***	0.040***	0.040***	-0.123***	-0.121***
	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.006)
Total risk	-0.006***		-0.004***		0.001	
	(0.001)		(0.002)		(0.001)	
Idiosyncratic risk		-0.006***		-0.005***		0.003***
		(0.001)		(0.002)		(0.001)
Systematic risk		-0.001		-0.001		-0.004***

		(0.002)		(0.002)		(0.001)
Ln(CEO age)	-0.176***	-0.175***	-0.166***	-0.166***	-0.018	-0.020
	(0.035)	(0.035)	(0.064)	(0.064)	(0.034)	(0.034)
Ln(CEO tenure)	-0.012	-0.012	-0.016	-0.016	0.007	0.007
	(0.008)	(0.008)	(0.011)	(0.011)	(0.007)	(0.007)
Hard assets	-0.003	-0.002	-0.059	-0.059	-0.009	-0.010
	(0.024)	(0.024)	(0.043)	(0.043)	(0.025)	(0.025)
R&D/TA	0.297***	0.291***	0.420***	0.416***	-0.050	-0.028
	(0.111)	(0.108)	(0.153)	(0.153)	(0.096)	(0.097)
Missing R&D	-0.020**	-0.020**	0.012	0.012	0.016	0.017
	(0.010)	(0.010)	(0.017)	(0.017)	(0.011)	(0.011)
Advertising/TA	0.243	0.248	0.751**	0.755**	-0.007	-0.020
	(0.154)	(0.155)	(0.326)	(0.326)	(0.193)	(0.192)
Missing Advertising	0.004	0.004	0.011	0.011	-0.020*	-0.021*
	(0.010)	(0.010)	(0.019)	(0.019)	(0.011)	(0.011)
Capital expenditure	0.102***	0.104***	-0.036	-0.034	-0.134***	-0.139***
	(0.022)	(0.022)	(0.042)	(0.042)	(0.022)	(0.022)
Ln(CEO wealth) (Lagged)	-0.069***	-0.069***	0.291***	0.291***	0.153***	0.154***
	(0.008)	(0.008)	(0.012)	(0.012)	(0.007)	(0.007)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
FF48 fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,705	14,705	14,705	14,705	14,705	14,705
R-squared	0.320	0.319	0.675	0.675	0.601	0.602

Table A8: Log CEO incentives and firm performance

This table examines the relation between log CEO incentive measures and firm performance. The dependent variable is the ROA in subsequent year and Tobin's Q of concurrent year in panels A and B respectively. To avoid missing observations, we use Ln(1+incentive measures). This table includes all firm-year observations with all relevant variables available during 1996-2010. All continuous variables are winsorized at 1%. See Appendix A for variable definitions. Robust standard errors are in parentheses. For regressions with Fama-French 48 industry and year fixed effects, the standard errors are double clustered at year and firm levels; and for regressions with CEO-firm pair and year fixed effects, the standard errors are clustered at CEO-firm pair levels;*** p<0.01, ** p<0.05, * p<0.1.

Panel A: The relation between Log incentives and ROA

	Dependent Variable = ROA in subsequent year					
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(1+PPE)	13.19***	7.150***				
	(1.905)	(2.035)				
[Ln(1+PPE)]^2	-6.364***	-2.689**				
	(1.005)	(1.266)				
Ln(1+PPSE)			9.658***	7.091***		
			(0.944)	(1.244)		
[Ln(1+PPSE)]^2			-2.624***	-1.223**		
			(0.372)	(0.479)		
Ln(1+PPS)					0.574	3.025
					(1.820)	(3.114)
[Ln(1+PPS)]^2					0.738	-0.838
					(1.273)	(2.449)
Ln(CEO tenure)	0.296*	0.373	-0.882***	-0.0604	-0.0445	0.279
	(0.170)	(0.436)	(0.181)	(0.431)	(0.179)	(0.441)
Leverage	-12.21***	-2.627*	-10.71***	-1.619	-12.21***	-2.932**
	(1.425)	(1.480)	(1.395)	(1.510)	(1.390)	(1.478)
R&D/TA	-32.40***	16.90	-33.26***	18.72	-31.18***	15.78
	(8.373)	(11.96)	(7.889)	(12.04)	(8.261)	(12.04)
Advertising/TA	11.26	27.45	8.319	27.61	9.155	24.66
	(8.535)	(18.99)	(8.569)	(19.12)	(8.774)	(19.23)
Ln(sales)	11.72***	2.075	11.23***	2.384	12.24***	2.532
	(1.127)	(3.444)	(1.109)	(3.462)	(1.134)	(3.486)
[Ln(sales)]^2	-0.703***	-0.189	-0.713***	-0.244	-0.721***	-0.202
	(0.0733)	(0.209)	(0.0722)	(0.210)	(0.0737)	(0.211)
Missing R&D	-0.339	1.303	-0.293	1.143	-0.449	1.310
	(0.407)	(0.907)	(0.412)	(0.900)	(0.423)	(0.941)
Missing advertising	-0.838**	0.296	-0.882**	0.217	-0.851**	0.241
	(0.403)	(0.780)	(0.389)	(0.774)	(0.412)	(0.786)
Capital expenditure	0.329	-1.069	-0.417	-1.618	0.996	-0.864
	(1.466)	(1.539)	(1.649)	(1.538)	(1.504)	(1.547)
Hard assets	4.176***	1.001	3.902***	0.879	4.384***	0.568
	(1.038)	(2.609)	(1.028)	(2.598)	(1.096)	(2.629)
Nondiscretionary Accrual	0.639***	0.425***	0.606***	0.410***	0.686***	0.443***
	(0.0727)	(0.0675)	(0.0784)	(0.0677)	(0.0741)	(0.0684)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	No	Yes	No	Yes	No
CEO-Firm fixed effect	No	Yes	No	Yes	No	Yes
Observations	14,519	14,519	14,519	14,519	14,519	14,519

R-squared	0.220	0.628	0.232	0.630	0.206	0.626

Panel B: The relation between Log incentives and Tobin's Q

	Dependent Variable = Tobin's Q					
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(1+PPE)	0.891***	1.093***				
	(0.166)	(0.155)				
[Ln(1+PPE)]^2	-0.373***	-0.357***				
	(0.108)	(0.107)				
Ln(1+PPSE)			1.510***	1.875***		
			(0.134)	(0.160)		
[Ln(1+PPSE)]^2			-0.266***	-0.224***		
			(0.0498)	(0.0772)		
Ln(1+PPS)					-0.264	0.431
					(0.216)	(0.263)
[Ln(1+PPS)]^2					0.265*	-0.282
					(0.158)	(0.205)
Ln(CEO tenure)	0.0239	0.00301	-0.206***	-0.124***	0.00548	-0.0139
	(0.0211)	(0.0457)	(0.0222)	(0.0429)	(0.0228)	(0.0462)
Leverage	-0.870***	-0.954***	-0.536***	-0.636***	-0.863***	-0.989***
	(0.175)	(0.149)	(0.159)	(0.138)	(0.170)	(0.148)
R&D/TA	4.858***	2.127**	4.564***	2.934***	4.955***	1.959**
	(0.749)	(0.975)	(0.673)	(0.915)	(0.743)	(0.987)
Advertising/TA	4.088***	4.448***	3.349***	5.000***	3.939***	3.859**
	(1.142)	(1.589)	(1.020)	(1.479)	(1.152)	(1.596)
Ln(sales)	0.136	-0.00706	0.0360	0.105	0.171	0.0508
	(0.109)	(0.197)	(0.102)	(0.182)	(0.108)	(0.198)
[Ln(sales)]^2	-0.00715	-0.0178	-0.0107	-0.0372***	-0.00848	-0.0191
	(0.00720)	(0.0132)	(0.00669)	(0.0121)	(0.00722)	(0.0132)
Missing R&D	-0.0517	-0.00962	-0.0422	-0.0788	-0.0607	-0.00617
	(0.0470)	(0.0721)	(0.0450)	(0.0677)	(0.0472)	(0.0769)
Missing advertising	0.0204	0.185*	0.0199	0.171*	0.0181	0.177*
	(0.0520)	(0.101)	(0.0469)	(0.0914)	(0.0527)	(0.103)
Capital expenditure	1.688***	1.041***	1.454***	0.838***	1.745***	1.074***
	(0.181)	(0.142)	(0.149)	(0.129)	(0.178)	(0.147)
Hard assets	0.546***	0.195	0.497***	0.193	0.556***	0.128
	(0.140)	(0.226)	(0.134)	(0.208)	(0.143)	(0.226)
Nondiscretionary Accrual	0.0953***	0.0594***	0.0810***	0.0524***	0.0998***	0.0631***
	(0.0102)	(0.00532)	(0.00884)	(0.00483)	(0.0102)	(0.00549)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	No	Yes	No	Yes	No
CEO-Firm fixed effect	No	Yes	No	Yes	No	Yes
Observations	15,171	15,171	15,171	15,171	15,171	15,171
R-squared	0.324	0.800	0.419	0.833	0.316	0.795

Table A9: Excess log CEO incentives and ROA

This table examines the relation between excess log CEO incentive measures and firm performance. The dependent variable is the ROA in subsequent year for columns (1)-(3) and Tobin's Q of concurrent year for columns (4)-(6). To avoid missing observations, we use Ln(1+incentive measures). The predicted log CEO incentive is based on the log CEO incentive determinant regressions as shown in Columns (2), (4), and (6) of Panel A in Table A7 respectively. The excess log CEO incentive equals the residual from the determinant regression when it is greater than 0 and equals 0 otherwise. The shortage in log CEO incentive equals (-1) times the residual when it is less than 0 and equals 0 otherwise. This table includes all firm-year observations with all relevant variables available during 1996-2010. All continuous variables are winsorized at 1%. See Appendix A for variable definitions. Robust standard errors are in parentheses. For regressions with Fama-French 48 industry and year fixed effects, the standard errors are double clustered at year and firm levels; *** p<0.01, ** p<0.05, * p<0.1.

Dependent variable	ROA in subsequent year			Tobin's Q		
	(1)	(2)	(3)	(4)	(5)	(6)
Excess Ln(1+PPE)	-0.123			0.288**		
	(0.732)			(0.139)		
Shortage in Ln(1+PPE)	-9.080***			-0.895***		
	(1.452)			(0.106)		
Excess Ln(1+PPSE)		0.824			0.881***	
		(0.645)			(0.173)	
Shortage in Ln(1+PPSE)		-5.679***			-0.526***	
		(1.055)			(0.126)	
Excess Ln(1+PPS)			0.704			0.153
			(1.117)			(0.136)
Shortage in Ln(1+PPS)			5.009***			2.570***
			(1.757)			(0.290)
Nondiscretionary accrual	0.611***	0.636***	0.651***	0.0901***	0.0871***	0.0861***
	(0.0746)	(0.0735)	(0.0694)	(0.0102)	(0.00880)	(0.0103)
Ln(sales)	10.50***	10.99***	10.61***	0.225**	0.336***	0.189*
	(1.081)	(1.093)	(1.084)	(0.114)	(0.115)	(0.109)
[Ln(sales)]^2	-0.617***	-0.643***	-0.621***	-0.0118	-0.0191**	-0.00885
	(0.0706)	(0.0714)	(0.0707)	(0.00750)	(0.00747)	(0.00709)
Leverage	-13.15***	-13.11***	-13.36***	-1.045***	-0.977***	-1.035***
	(1.434)	(1.387)	(1.417)	(0.178)	(0.166)	(0.168)
R&D/TA	-29.35***	-28.99***	-29.80***	4.742***	4.735***	4.501***
	(8.526)	(8.473)	(8.544)	(0.750)	(0.720)	(0.754)
Advertising/TA	8.788	8.885	7.298	4.308***	4.158***	3.909***
	(7.785)	(7.889)	(8.072)	(1.145)	(1.085)	(1.119)
Missing R&D	-0.558	-0.545	-0.572	-0.0787*	-0.0846*	-0.0926**
	(0.436)	(0.442)	(0.434)	(0.0471)	(0.0492)	(0.0451)
Missing advertising	-0.905**	-0.916**	-0.886**	0.0433	0.0475	0.0470
	(0.388)	(0.395)	(0.398)	(0.0524)	(0.0525)	(0.0533)
Capital expenditure	0.238	0.925	0.640	1.617***	1.680***	1.577***
	(1.647)	(1.655)	(1.672)	(0.177)	(0.164)	(0.168)
Hard assets	4.328***	4.274***	4.491***	0.536***	0.524***	0.522***
	(1.030)	(1.029)	(1.062)	(0.149)	(0.148)	(0.147)
Ln(CEO tenure)	0.0378	0.309	0.00723	0.00374	0.0109	-0.0638**
	(0.185)	(0.199)	(0.210)	(0.0257)	(0.0259)	(0.0252)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Fama-French 48 fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,739	12,739	12,739	13,294	13,294	13,294
R-squared	0.214	0.207	0.200	0.340	0.363	0.358

Table A10: Multivariate analysis of the determinants of incentive measures using alternative firm size measures

This table examines the determinants of CEO incentives for all ExecuComp firms with all three incentive measures and control variables available. All independent variables are lagged, except for Ln(CEO age) and Ln(CEO tenure). All incentive measures are top coded at 2% and all other continuous variables are winsorized at 1%. See Appendix A for variable definitions. All standard errors are double clustered at firm & year level and shown in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Panel A: Firm size measured as Ln(Book value of assets)

Dependent variable	PPE		PPSE		PPS	
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(Book value of assets)	0.131***	0.129***	0.044**	0.041**	-0.173***	-0.168***
	(0.013)	(0.013)	(0.021)	(0.021)	(0.011)	(0.010)
Total risk	-0.014***		-0.010**		0.004**	
	(0.002)		(0.004)		(0.002)	
Idiosyncratic risk		-0.015***		-0.012***		0.009***
		(0.002)		(0.005)		(0.002)
Systematic risk		-0.000		0.002		-0.009***
		(0.004)		(0.007)		(0.003)
Ln(CEO age)	-0.384***	-0.381***	-0.307	-0.305	0.028	0.023
	(0.067)	(0.066)	(0.214)	(0.214)	(0.073)	(0.072)
Ln(CEO tenure)	-0.060***	-0.060***	-0.090**	-0.090**	0.039**	0.039**
	(0.016)	(0.016)	(0.036)	(0.036)	(0.015)	(0.015)
Hard assets	0.015	0.017	-0.213	-0.211	-0.021	-0.023
	(0.051)	(0.051)	(0.145)	(0.145)	(0.056)	(0.056)
R&D/TA	0.841***	0.812***	1.426***	1.398***	-0.193	-0.139
	(0.228)	(0.224)	(0.515)	(0.516)	(0.201)	(0.203)
Missing R&D	-0.060***	-0.061***	0.058	0.057	0.056**	0.058**
	(0.022)	(0.022)	(0.060)	(0.060)	(0.025)	(0.025)
Advertising/TA	0.842**	0.857**	2.694**	2.709**	-0.074	-0.099
	(0.339)	(0.339)	(1.086)	(1.087)	(0.442)	(0.440)
Missing Advertising	0.006	0.007	0.041	0.041	-0.036	-0.038
	(0.020)	(0.020)	(0.065)	(0.065)	(0.024)	(0.024)
Capital expenditure	0.252***	0.258***	-0.141	-0.135	-0.376***	-0.384***
	(0.046)	(0.045)	(0.137)	(0.137)	(0.050)	(0.050)
Ln(CEO wealth) (Lagged)	-0.120***	-0.121***	0.777***	0.777***	0.229***	0.229***
	(0.015)	(0.015)	(0.042)	(0.042)	(0.013)	(0.013)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
FF48 fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,710	14,710	14,710	14,710	14,710	14,710
R-squared	0.299	0.299	0.547	0.547	0.476	0.477

Panel B: Firm size measured as Ln(Market Capitalization)

Dependent variable	PPE		PPSE		PPS	
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(Market capitalization)	0.188***	0.188***	0.062***	0.061***	-0.221***	-0.218***
	(0.014)	(0.014)	(0.023)	(0.023)	(0.014)	(0.014)
Total risk	-0.005**		-0.007		-0.004***	
	(0.002)		(0.005)		(0.002)	
Idiosyncratic risk		-0.004*		-0.009*		-0.001
		(0.002)		(0.005)		(0.002)
Systematic risk		-0.003		0.001		-0.007**
		(0.004)		(0.007)		(0.003)
Ln(CEO age)	-0.329***	-0.329***	-0.290	-0.289	-0.046	-0.047
	(0.066)	(0.065)	(0.213)	(0.213)	(0.067)	(0.067)
Ln(CEO tenure)	-0.009	-0.009	-0.073*	-0.073*	-0.009	-0.009

	(0.018)	(0.018)	(0.039)	(0.039)	(0.015)	(0.015)
Hard assets	-0.034	-0.034	-0.230	-0.228	0.035	0.035
	(0.048)	(0.048)	(0.144)	(0.143)	(0.053)	(0.053)
R&D/TA	0.554***	0.556***	1.328**	1.314**	0.166	0.191
	(0.206)	(0.202)	(0.519)	(0.519)	(0.188)	(0.188)
Missing R&D	-0.019	-0.019	0.071	0.070	0.012	0.013
	(0.020)	(0.020)	(0.059)	(0.059)	(0.022)	(0.022)
Advertising/TA	0.528*	0.527*	2.589**	2.604**	0.351	0.333
	(0.316)	(0.317)	(1.078)	(1.078)	(0.410)	(0.409)
Missing Advertising	0.006	0.006	0.041	0.041	-0.033	-0.034
	(0.019)	(0.019)	(0.065)	(0.065)	(0.023)	(0.023)
Capital expenditure	0.051	0.051	-0.210	-0.203	-0.109**	-0.116**
	(0.038)	(0.038)	(0.130)	(0.131)	(0.045)	(0.045)
Ln(CEO wealth) (Lagged)	-0.180***	-0.180***	0.757***	0.757***	0.290***	0.290***
	(0.018)	(0.018)	(0.043)	(0.043)	(0.016)	(0.016)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
FF48 fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,705	14,705	14,705	14,705	14,705	14,705
R-squared	0.348	0.348	0.548	0.548	0.531	0.531

Table A11: Multivariate analysis of the determinants of incentive measures using full sample for each model

This table examines the determinants of CEO incentives for all ExecuComp firms with maximum number of observations available for each individual model. All independent variables are lagged, except for Ln(CEO age) and Ln(CEO tenure). All non-logged incentive measures are top coded at 2% and all other continuous variables are winsorized at 1%. See Appendix A for variable definitions. All standard errors are double clustered at firm & year level and shown in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Panel A: Firm size measured as Ln(sales)

Dependent variable	PPE		PPSE		PPS	
Sample period	1996-2010		1992-2010		1992-2010	
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(sales)	0.127***	0.124***	0.056***	0.056***	-0.165***	-0.159***
	(0.013)	(0.014)	(0.018)	(0.018)	(0.009)	(0.008)
Total risk	-0.013***		-0.003		0.005***	
	(0.002)		(0.004)		(0.002)	
Idiosyncratic risk		-0.017***		-0.002		0.013***
		(0.003)		(0.005)		(0.002)
Systematic risk		0.005		-0.002		-0.016***
		(0.004)		(0.006)		(0.003)
Ln(CEO age)	-0.372***	-0.368***	-0.149	-0.150	0.052	0.047
	(0.067)	(0.067)	(0.186)	(0.186)	(0.068)	(0.067)
Ln(CEO tenure)	-0.067***	-0.066***	-0.077**	-0.077**	0.052***	0.051***
	(0.016)	(0.016)	(0.037)	(0.037)	(0.016)	(0.016)
Hard assets	0.018	0.020	-0.197	-0.197	-0.029	-0.029
	(0.053)	(0.053)	(0.132)	(0.132)	(0.052)	(0.052)
R&D/TA	1.009***	0.956***	1.023**	1.028**	-0.610***	-0.517***
	(0.226)	(0.220)	(0.464)	(0.463)	(0.188)	(0.186)
Missing R&D	-0.059**	-0.060***	0.033	0.033	0.035	0.037
	(0.023)	(0.023)	(0.054)	(0.054)	(0.023)	(0.023)
Advertising/TA	0.391	0.429	2.292**	2.292**	0.837**	0.792**
	(0.323)	(0.321)	(1.064)	(1.065)	(0.387)	(0.384)
Missing Advertising	-0.005	-0.003	0.009	0.009	-0.014	-0.017
	(0.021)	(0.020)	(0.058)	(0.058)	(0.022)	(0.022)
Capital expenditure	0.170***	0.182***	-0.053	-0.053	-0.184***	-0.201***
	(0.046)	(0.044)	(0.103)	(0.103)	(0.044)	(0.044)
Ln(CEO wealth) (Lagged)	-0.116***	-0.117***	0.616***	0.617***	0.195***	0.197***
	(0.014)	(0.015)	(0.037)	(0.037)	(0.011)	(0.011)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
FF48 fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,714	14,714	20,375	20,375	20,371	20,371
R-squared	0.292	0.293	0.476	0.476	0.437	0.442

Panel B: Firm size measured as Ln(Market Value of Assets)

Dependent variable	PPE		PPSE		PPS	
Sample period	1996-2010		1992-2010		1992-2010	
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(Market Value of	0.160***	0.159***	0.081***	0.083***	-0.198***	-0.193***

Assets)	(0.014)	(0.014)	(0.021)	(0.022)	(0.011)	(0.011)
Total risk	-0.010***		-0.001		0.003*	
	(0.002)		(0.005)		(0.002)	
Idiosyncratic risk		-0.011***		0.002		0.008***
		(0.002)		(0.005)		(0.002)
Systematic risk		-0.001		-0.005		-0.009***
		(0.004)		(0.006)		(0.003)
Ln(CEO age)	-0.346***	-0.344***	-0.145	-0.146	0.015	0.012
	(0.066)	(0.065)	(0.186)	(0.186)	(0.065)	(0.065)
Ln(CEO tenure)	-0.030*	-0.030*	-0.057	-0.056	0.017	0.018
	(0.016)	(0.016)	(0.037)	(0.038)	(0.016)	(0.016)
Hard assets	-0.001	0.001	-0.210	-0.211	-0.006	-0.007
	(0.049)	(0.049)	(0.131)	(0.131)	(0.050)	(0.050)
R&D/TA	0.679***	0.664***	0.896*	0.918**	-0.241	-0.195
	(0.208)	(0.204)	(0.458)	(0.455)	(0.170)	(0.168)
Missing R&D	-0.041**	-0.042**	0.044	0.045	0.015	0.017
	(0.021)	(0.021)	(0.053)	(0.053)	(0.021)	(0.021)
Advertising/TA	0.651**	0.661**	2.419**	2.412**	0.471	0.454
	(0.305)	(0.305)	(1.064)	(1.063)	(0.379)	(0.378)
Missing Advertising	0.008	0.008	0.017	0.017	-0.031	-0.033
	(0.020)	(0.020)	(0.059)	(0.059)	(0.021)	(0.021)
Capital expenditure	0.168***	0.172***	-0.047	-0.051	-0.163***	-0.173***
	(0.042)	(0.041)	(0.102)	(0.103)	(0.042)	(0.041)
Ln(CEO wealth) (Lagged)	-0.154***	-0.154***	0.596***	0.596***	0.233***	0.234***
	(0.017)	(0.017)	(0.036)	(0.036)	(0.013)	(0.013)
Year fixed effect	-0.046	-0.047	-0.464	-0.471***	-0.031	0.091
FF48 fixed effect	-0.089	-0.091	-0.057	-0.054	-0.099	-0.092
Observations	14,714	14,714	20,373	20,373	20,369	20,369
R-squared	0.324	0.324	0.477	0.477	0.481	0.483

Table A12: CEO incentives and firm performance using full sample for each model

This table compares across CEO incentives in their relation to firm performance with largest number of observations in each model during 1992-2010. For Panel A, the dependent variable is Return on Assets (ROA), which equals net income over total assets, both measured in the subsequent year. For Panel B, the dependent variable is Tobin's Q. All incentive measures are top coded at 2% and all other continuous variables are winsorized at 1%. See Appendix A for variable definitions. Standard errors are in parentheses. For regressions with Fama-French 48 industry and year fixed effects, the standard errors are double clustered at year and firm levels; and for regressions with CEO-firm pair and year fixed effects, the standard errors are clustered at CEO-firm pair level; *** p<0.01, ** p<0.05, * p<0.1.

Panel A: The relation between incentives and ROA in full sample

	Dependent Variable = ROA in subsequent year					
	(1)	(2)	(3)	(4)	(5)	(6)
PPE	6.153***	4.024***				
	(0.939)	(0.899)				
PPE^2	-1.637***	-0.934***				
	(0.269)	(0.278)				
PPSE			2.948***	2.661***		
			(0.277)	(0.358)		
PPSE^2			-0.314***	-0.219***		
			(0.0361)	(0.0436)		
PPS					0.655	1.438
					(0.899)	(1.357)
PPS^2					0.0450	-0.0176
					(0.314)	(0.479)
Nondiscretionary Accrual	0.542***	0.363***	0.465***	0.410***	0.513***	0.433***
	(0.0705)	(0.0659)	(0.0866)	(0.0461)	(0.0882)	(0.0470)
Ln(CEO tenure)	0.349**	0.392	-0.100	-0.555*	0.306**	-0.468
	(0.168)	(0.437)	(0.140)	(0.285)	(0.141)	(0.293)
Leverage	-12.11***	-2.539*	-12.22***	-3.046**	-12.87***	-3.948***
	(1.396)	(1.479)	(1.221)	(1.222)	(1.196)	(1.213)
R&D/TA	-30.49***	16.38	-39.34***	8.598	-38.79***	5.935
	(7.998)	(11.56)	(5.680)	(8.109)	(5.780)	(8.077)
Advertising/TA	9.746	27.01	5.385	15.87	6.042	14.31
	(8.150)	(18.31)	(6.262)	(13.87)	(6.307)	(13.92)
Ln(sales)	11.99***	3.224	9.374***	-1.389	9.606***	-1.450
	(1.123)	(3.587)	(0.873)	(1.872)	(0.886)	(1.878)
[Ln(sales)]^2	-0.723***	-0.254	-0.592***	0.0146	-0.577***	0.0668
	(0.0732)	(0.218)	(0.0576)	(0.123)	(0.0587)	(0.123)
Missing R&D	-0.298	1.333	-0.387	1.077*	-0.453	1.107*
	(0.409)	(0.909)	(0.342)	(0.631)	(0.349)	(0.658)
Missing advertising	-0.825**	0.327	-0.549	0.487	-0.532	0.488
	(0.400)	(0.781)	(0.349)	(0.530)	(0.357)	(0.535)
Capital expenditure	0.416	-1.037	0.198	-1.905	1.006	-1.355
	(1.386)	(1.511)	(1.644)	(1.201)	(1.570)	(1.199)
Hard assets	3.868***	0.860	3.859***	0.328	4.131***	0.0130
	(1.025)	(2.594)	(0.892)	(2.005)	(0.916)	(2.022)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	No	Yes	No	Yes	No
CEO-Firm fixed effect	No	Yes	No	Yes	No	Yes
Observations	14,526	14,526	24,502	24,502	24,492	24,492
R-squared	0.221	0.627	0.193	0.596	0.182	0.593

Panel B: The relation between incentives and Tobin's Q in full sample

	Dependent Variable = Tobin's Q					
	(1)	(2)	(3)	(4)	(5)	(6)
PPE	0.511***	0.694***				
	(0.0913)	(0.0775)				
PPE^2	-0.130***	-0.153***				
	(0.0278)	(0.0261)				
PPSE			0.678***	0.948***		
			(0.0714)	(0.0619)		
PPSE^2			-0.0559***	-0.0704***		
			(0.00752)	(0.00795)		
PPS					-0.0940	0.0389
					(0.0980)	(0.148)
PPS^2					0.0610*	0.0184
					(0.0365)	(0.0515)
Nondiscretionary Accrual	0.0885***	0.0554***	0.0880***	0.0653***	0.105***	0.0768***
	(0.00974)	(0.00577)	(0.00600)	(0.00474)	(0.00704)	(0.00509)
Ln(CEO tenure)	0.0281	-0.00268	-0.131***	-0.0881***	0.0246	-0.0390
	(0.0223)	(0.0493)	(0.0210)	(0.0305)	(0.0170)	(0.0317)
Leverage	-0.850***	-0.927***	-0.631***	-0.703***	-0.845***	-1.001***
	(0.180)	(0.163)	(0.153)	(0.122)	(0.149)	(0.128)
R&D/TA	4.961***	2.245**	3.980***	2.296***	4.009***	1.311
	(0.776)	(1.017)	(0.543)	(0.835)	(0.591)	(0.878)
Advertising/TA	3.958***	4.371***	2.891***	3.047***	3.474***	2.317**
	(1.102)	(1.592)	(0.834)	(1.037)	(0.957)	(1.097)
Ln(sales)	0.122	-0.0524	-0.354***	-0.346**	-0.332***	-0.515***
	(0.112)	(0.202)	(0.115)	(0.157)	(0.123)	(0.169)
[Ln(sales)]^2	-0.00620	-0.0148	0.0158**	-0.00486	0.0221***	0.0226*
	(0.00739)	(0.0135)	(0.00753)	(0.0113)	(0.00826)	(0.0117)
Missing R&D	-0.0529	-0.00586	-0.0545	-0.00395	-0.0622	0.0165
	(0.0484)	(0.0751)	(0.0443)	(0.0551)	(0.0480)	(0.0549)
Missing advertising	0.0192	0.193*	0.0167	0.132**	0.0176	0.137**
	(0.0531)	(0.109)	(0.0398)	(0.0570)	(0.0450)	(0.0630)
Capital expenditure	1.722***	1.080***	1.560***	1.022***	1.799***	1.269***
	(0.192)	(0.152)	(0.150)	(0.0997)	(0.180)	(0.111)
Hard assets	0.546***	0.219	0.643***	0.315*	0.686***	0.244
	(0.141)	(0.245)	(0.118)	(0.189)	(0.125)	(0.198)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	No	Yes	No	Yes	No
CEO-Firm fixed effect	No	Yes	No	Yes	No	Yes
Observations	15,171	15,171	25,508	25,508	25,508	25,508
R-squared	0.316	0.792	0.417	0.787	0.341	0.749

Table A13: CEO incentives and firm performance controlling for Vega

This table compares across CEO incentives in their relation to firm performance for all firm-year observations with all relevant variables during 1996-2010 controlling for Vega. For Panel A, the dependent variable is the Return on Assets (ROA), which equals net income over total assets, both measured in the subsequent year. For Panel B, the dependent variable is Tobin's Q. All incentive measures are top coded at 2% and all other continuous variables are winsorized at 1%. See Appendix A for variable definitions. Robust standard errors are in parentheses. For regressions with Fama-French 48 industry and year fixed effects, the standard errors are double clustered at year and firm levels; and for regressions with CEO-firm pair and year fixed effects, the standard errors are clustered at CEO-firm pair levels;*** p<0.01, ** p<0.05, * p<0.1.

Panel A: CEO incentives and ROA controlling for Vega

	Dependent Variable = ROA in subsequent year					
	(1)	(2)	(3)	(4)	(5)	(6)
PPE	6.204***	5.151***				
	(0.888)	(0.976)				
PPE^2	-1.642***	-1.185***				
	(0.258)	(0.291)				
PPSE			3.114***	2.356***		
			(0.304)	(0.428)		
PPSE^2			-0.310***	-0.162***		
			(0.0402)	(0.0525)		
PPS					0.365	2.058
					(0.995)	(1.832)
PPS^2					0.256	-0.427
					(0.366)	(0.650)
Ln(1+Vega)	-0.0191	-0.385***	0.277**	-0.100	0.458***	0.0251
	(0.128)	(0.130)	(0.132)	(0.117)	(0.138)	(0.119)
Ln(CEO tenure)	0.354**	0.482	-0.633***	0.159	-0.0854	0.284
	(0.179)	(0.430)	(0.168)	(0.429)	(0.175)	(0.437)
Leverage	-12.26***	-2.535*	-11.13***	-2.003	-12.28***	-2.913**
	(1.408)	(1.475)	(1.376)	(1.501)	(1.402)	(1.478)
R&D/TA	-32.68***	16.44	-33.68***	18.00	-32.40***	15.83
	(8.390)	(11.91)	(8.026)	(12.09)	(8.288)	(12.04)
Advertising/TA	10.97	26.96	7.368	26.37	8.452	24.64
	(8.535)	(19.12)	(8.472)	(19.21)	(8.659)	(19.16)
Ln(sales)	11.76***	2.142	11.53***	2.724	12.02***	2.511
	(1.135)	(3.436)	(1.122)	(3.487)	(1.137)	(3.486)
[Ln(sales)]^2	-0.705***	-0.183	-0.726***	-0.255	-0.724***	-0.202
	(0.0734)	(0.209)	(0.0729)	(0.211)	(0.0736)	(0.212)
Missing R&D	-0.339	1.247	-0.297	1.128	-0.334	1.306
	(0.409)	(0.894)	(0.413)	(0.905)	(0.416)	(0.940)
Missing advertising	-0.845**	0.283	-0.892**	0.243	-0.831**	0.238
	(0.406)	(0.778)	(0.393)	(0.778)	(0.410)	(0.786)
Capital expenditure	0.401	-1.030	-0.141	-1.378	0.725	-0.871
	(1.469)	(1.537)	(1.643)	(1.539)	(1.512)	(1.544)
Hard assets	4.225***	0.888	4.151***	0.565	4.647***	0.591
	(1.058)	(2.612)	(1.048)	(2.605)	(1.095)	(2.629)
Nondiscretionary Accrual	0.649***	0.411***	0.640***	0.423***	0.702***	0.444***
	(0.0753)	(0.0673)	(0.0802)	(0.0676)	(0.0778)	(0.0686)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	No	Yes	No	Yes	No

CEO-Firm fixed effect	No	Yes	No	Yes	No	Yes
Observations	14,519	14,519	14,519	14,519	14,519	14,519
R-squared	0.218	0.628	0.224	0.629	0.209	0.626

Panel B: CEO incentives and Tobin's Q controlling for Vega

	Dependent Variable = Tobin's Q					
PPE	0.515***	0.875***				
	(0.0922)	(0.0849)				
PPE^2	-0.129***	-0.196***				
	(0.0271)	(0.0267)				
PPSE			0.615***	0.796***		
			(0.0628)	(0.0675)		
PPSE^2			-0.0490***	-0.0557***		
			(0.00704)	(0.00895)		
PPS					-0.0776	0.196
					(0.124)	(0.141)
PPS^2					0.0572	-0.0634
					(0.0465)	(0.0527)
Ln(1+Vega)	-0.00747	-0.0680***	0.00991	-0.0453***	0.0355**	0.00746
	(0.0174)	(0.0125)	(0.0147)	(0.0104)	(0.0156)	(0.0106)
Ln(CEO tenure)	0.0279	0.0190	-0.173***	-0.0724*	-0.00344	-0.0130
	(0.0210)	(0.0452)	(0.0222)	(0.0428)	(0.0218)	(0.0463)
Leverage	-0.871***	-0.932***	-0.577***	-0.708***	-0.874***	-0.987***
	(0.174)	(0.148)	(0.158)	(0.138)	(0.172)	(0.148)
R&D/TA	4.862***	2.065**	4.582***	2.726***	4.864***	1.970**
	(0.753)	(0.976)	(0.687)	(0.924)	(0.748)	(0.987)
Advertising/TA	4.091***	4.380***	3.280***	4.664***	3.897***	3.870**
	(1.145)	(1.586)	(1.028)	(1.534)	(1.151)	(1.594)
Ln(sales)	0.140	0.00570	0.0818	0.170	0.156	0.0476
	(0.110)	(0.200)	(0.106)	(0.184)	(0.108)	(0.197)
[Ln(sales)]^2	-0.00719	-0.0168	-0.0118*	-0.0382***	-0.00865	-0.0193
	(0.00723)	(0.0134)	(0.00684)	(0.0124)	(0.00718)	(0.0132)
Missing R&D	-0.0528	-0.0172	-0.0509	-0.0751	-0.0519	-0.00674
	(0.0469)	(0.0709)	(0.0455)	(0.0721)	(0.0469)	(0.0769)
Missing advertising	0.0198	0.183*	0.0155	0.178*	0.0202	0.177*
	(0.0520)	(0.101)	(0.0476)	(0.0931)	(0.0524)	(0.103)
Capital expenditure	1.693***	1.045***	1.517***	0.898***	1.721***	1.072***
	(0.180)	(0.143)	(0.152)	(0.134)	(0.177)	(0.146)
Hard assets	0.544***	0.178	0.508***	0.117	0.581***	0.132
	(0.142)	(0.225)	(0.136)	(0.211)	(0.145)	(0.226)
Nondiscretionary Accrual	0.0953***	0.0569***	0.0846***	0.0549***	0.101***	0.0633***
	(0.0103)	(0.00532)	(0.00880)	(0.00505)	(0.0103)	(0.00549)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	No	Yes	No	Yes	No
CEO-Firm fixed effect	No	Yes	No	Yes	No	Yes
Observations	15,171	15,171	15,171	15,171	15,171	15,171
R-squared	0.324	0.802	0.404	0.827	0.318	0.795

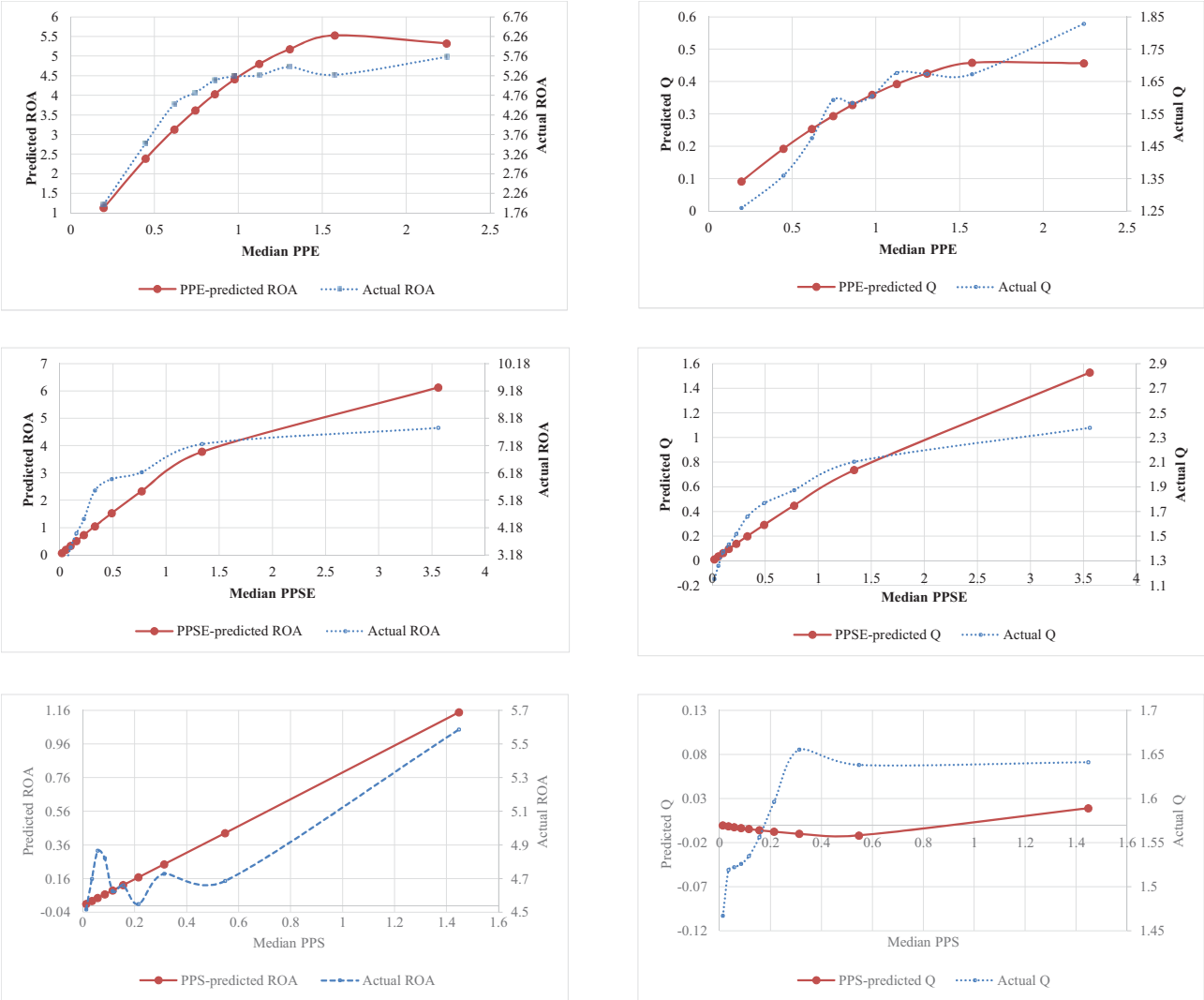


Figure 1. This figure shows the median ROA/Tobin's Q in each incentive decile. The ROA is measured in the subsequent year of incentives and Tobin's Q is measured in the concurrent year. In particular, in each year, we first calculate the median performance/incentive in each incentive decile portfolio, and then take a time-series average of the median over the sample years to get the performance/incentive measure for each decile. For the incentive-predicted performance measures, we use only the incentive and its square term to make the prediction as shown in columns (1), (3) and (5) of Tables 7 and 8 respectively.

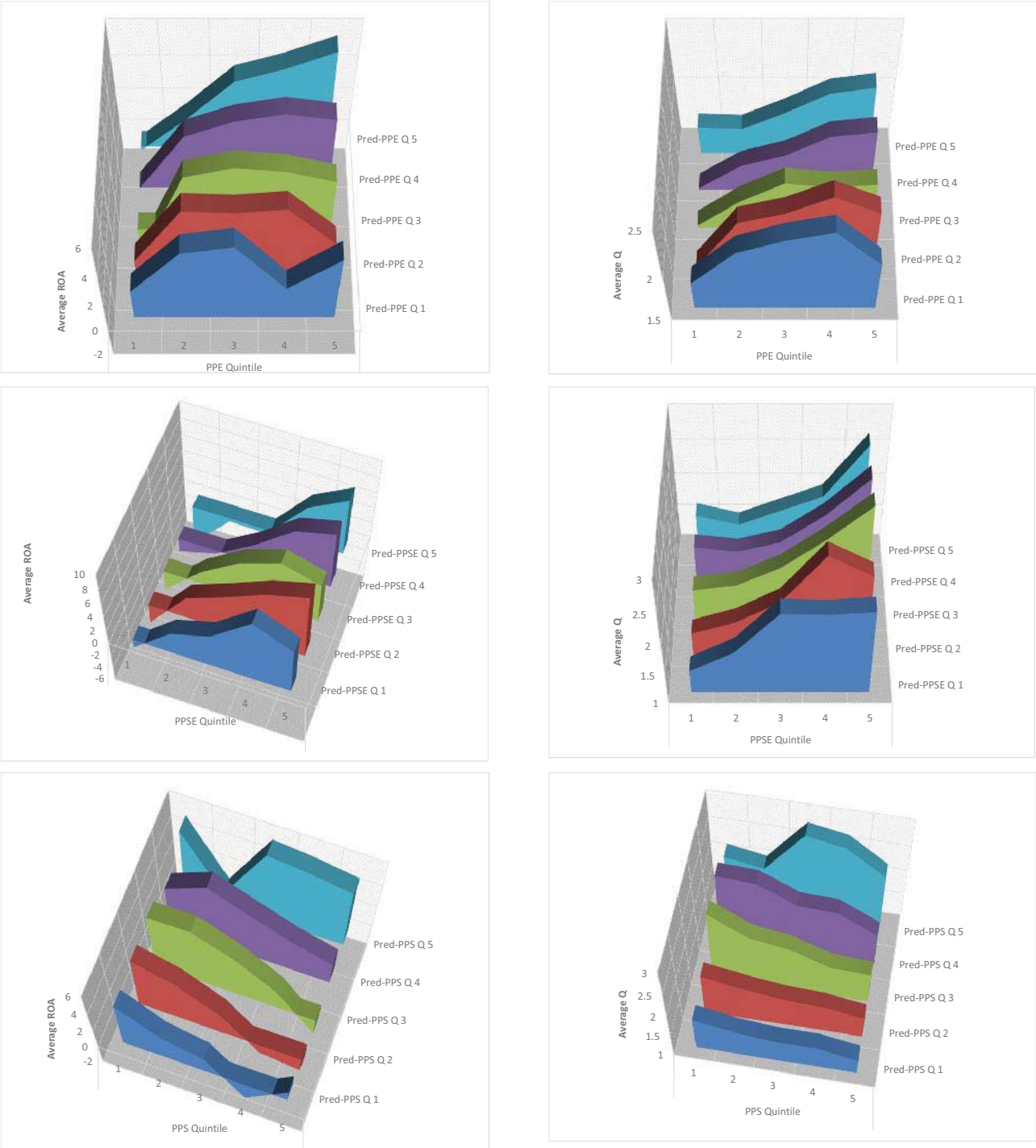
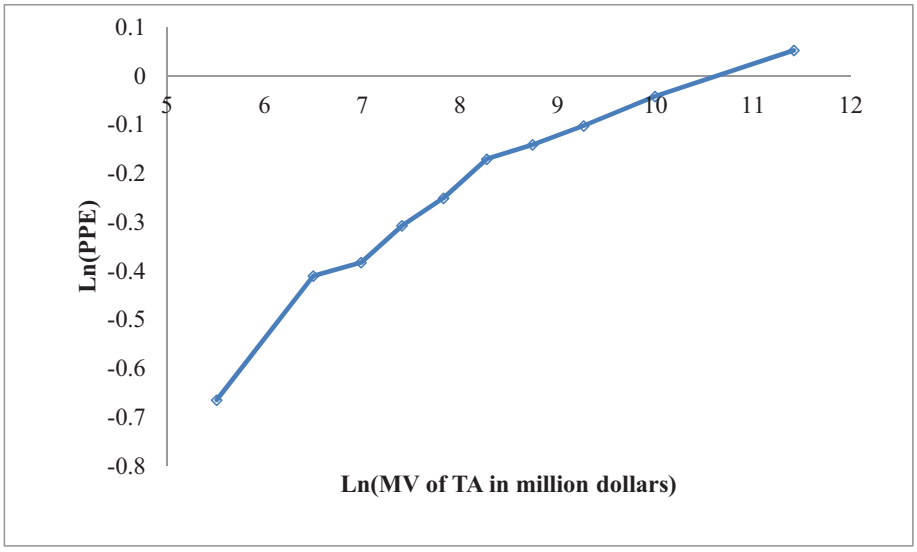
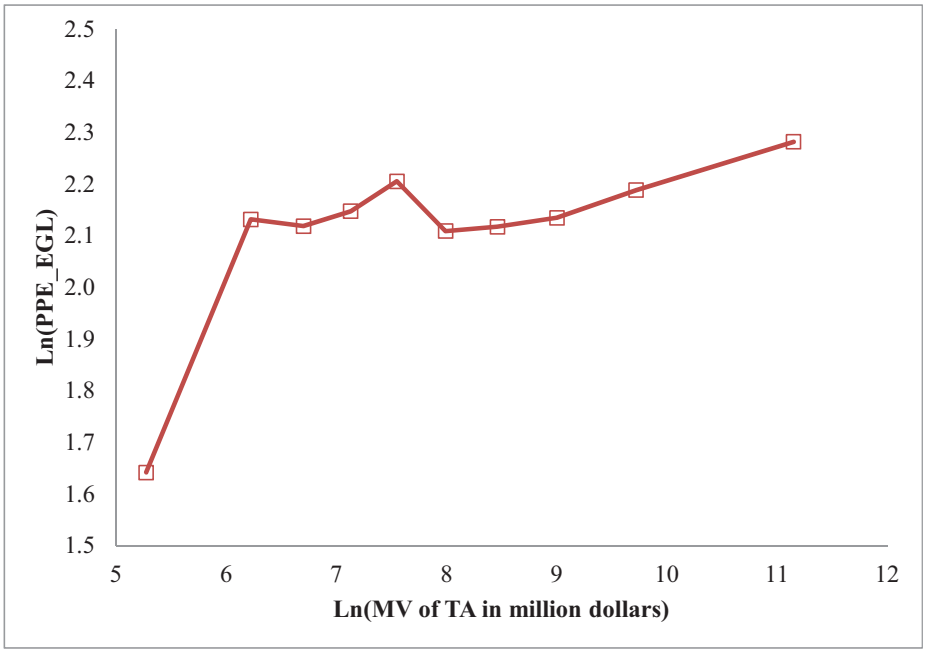


Figure 2. This figure shows the average ROA/Tobin's Q in each independently double-sorted predicted and actual incentive quintile portfolio. The ROA is measured in the subsequent year of incentives and Tobin's Q is measured in the concurrent year. In particular, in each year, we calculate the mean ROA/Tobin's Q in each independently double-sorted portfolio using predicted and actual incentive quintile respectively. We then take a time-series average over the sample years to get the performance measure for each of the 25 portfolios. The predicted incentives for each firm-year is based on the regressions in columns (2), (4) and (6) of Table 6.

Figure 3: PPE as a function of firm size



Panel A: This panel illustrates Ln(PPE) as a function of firm size, where firm size is measured as the natural logarithm of market value of total assets denoted in million dollars. In particular, in each year during 1996-2010, we classify firms into deciles by their sizes. The horizontal axis shows the time-series average of annual mean firm size within each size decile. The vertical axis shows the time-series average of annual mean Ln(PPE) within each size decile.



Panel B: This panel illustrates Ln(PPE_EGL) as a function of firm size, where firm size is measured as the natural logarithm of market value of total assets denoted in million dollars. In particular, in each year during 1992-2010, we classify firms into deciles by their sizes. The horizontal axis shows the time-series average of annual mean firm size within each size decile. The vertical axis shows the time-series average of annual mean Ln(PPE_EGL) within each size decile.