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Reexamining the managerial ownership effect on firm value

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ABSTRACT

Whether equity-based compensation and equity ownership align the interests of managers with stockholders is an important question in finance. Early studies found an inverted U-shaped relation between managerial ownership and firm value, but later studies using firm fixed effects found no relation. Managerial ownership levels change very slowly over time which may mask an ownership effect on firm value when using a fixed effect model. This is due to a much smaller within firm variation than between firm variation. We demonstrate that using pay-performance semi-elasticity, rather than pay-performance sensitivity as a measure of managerial ownership incentives, results in meaningful variation within firm over time. The greater within firm variation increases the power to detect a relation between managerial ownership and firm value with fixed effect regressions. As in the early research on this issue, we find a significant inverted U-shaped relation between managerial ownership and Tobin's *Q* in fixed effects regressions and after controlling for endogeneity with both two-stage and three-stage least squares regressions. Our results are consistent with *incentive alignment* at low levels and *risk aversion* at high levels of managerial ownership.

1. Introduction

There has been a long-standing debate in the literature concerning how equity-based compensation and equity ownership motivate managers and whether they alleviate agency problems. Theoretically, higher pay-performance sensitivity should result in a convexity payoff that encourages managers to work harder and take on value enhancing risky projects (Jensen and Meckling, 1976; Myers, 1977; Haugen and Senbet, 1981). Thus, increasing the sensitivity of CEO wealth to stock price may better align managerial behavior with the interests of shareholders. Conversely, an unintended effect of high managerial ownership is that it exposes managers to more risk relative to diversified shareholders. Guay (1999) and Ross (2004), for example, present models in which the concavity of the manger's utility function overcomes the convexity of the payoff causing managers to be more risk averse.[2] To the extent that mangers are undiversified with respect to firm-specific wealth, increasing equity-based pay may induce managers to reduce the overall risk of the firm so as to reduce shareholder value. "While executive compensation can be a powerful tool for reducing the agency conflicts between managers and the firm, compensation can also be a substantial source of agency costs if it is not managed properly" (Jenson et al., 2004, p. 98).

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[2] High equity-based compensation and equity ownership (in the form of options) may also be symptomatic of a managerial-owner agency problem where managers use option compensation to camouflage the CEO's true payoff (Bebchuk et al., 2002).

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Empirical studies, however, have been unable to reach consensus about the actual relation between managerial ownership and firm value. [3] Given the increasing importance of internal governance mechanisms documented by Netter et al. (2009), the question of whether equity-based compensation and equity ownership are related to firm value or endogenous to the firm is very relevant question. Studies find a positive relation between managerial ownership and firm performance (Mehran, 1995; Core and Larcker, 2002), or a positive but 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). This suggests that low levels of managerial ownership have an *incentive alignment* effect, but at high levels it induces a *risk aversion* effect.[4]

However, the interpretation of a positive relation between managerial ownership and firm performance has been criticized for ignoring potential endogeneity. Demsetz (1983) argues that market forces drive the observed managerial ownership to levels optimal for each firm and that the observed cross-sectional relation between managerial ownership and firm value is spurious. Studies by 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) find no relation between managerial ownership and firm performance, supporting the Demsetz argument that firms *optimally contract* with management after controlling for other firm and manager specific variables using firm fixed effects.

Zhou (2001), however, notes that a potential problem of inferences based on the fixed effects approach is that the method has low power to detect a relation because managerial ownership levels change very slowly across time. The slow change may mask a significant ownership effect when using firm fixed effects because of much smaller within firm variation than between firm variation.[5] While Zhou's critique focuses on the power of the estimator, another problem is that the traditional incentive measure used in these studies, percentage owned or pay-performance sensitivity (*pps*), is strongly influenced by firm size. As noted by Hall and Liebman (1998), firm size strongly influences the pay-performance relation in large firms because the denominator is so large that "a several million dollar change in CEO wealth appears very small when divided by the market value of a Fortune 500 company" (p. 656). Furthermore, the optimal pay-performance relation may also decline with firm size because the variance of changes in firm value increases with firm size and because the manager's direct effect on firm value may decrease with firm size (Gibbons and Murphy, 1992).[6] Since managerial ownership studies tend to use data on large industrial firms from sources such as Standard and Poor's *Execucomp* database, the resulting *pps* levels are small in magnitude with little year to year change, further complicating the firm fixed effects approach.[7]

Hall and Liebman (1998) propose another measure of incentive strength, dollars at stake or pay-performance semi-elasticity (*ppse*), calculated as the dollar change in executive wealth for a percentage change in firm value. Executives of large firms commonly have large equity stakes, in dollar terms, and the large dollar amount may provide them with strong incentives. A small percentage change in firm value may still lead to multi-million dollar changes in executive wealth.[8] Pay-performance semi-elasticity has an additional benefit. This measure results in an increase in both the magnitude and year to year change in managerial ownership incentive levels which increases the effect size and provides a solution for the low power of the test.[9]

Using sample data from 1309 firms and 9424 firm years from 1995 to 2003, we reexamine the relation between managerial ownership and firm value using *ppse*. We find a significant inverted U-shaped relation between managerial ownership and Tobin's *Q* in both fixed effects regressions and after controlling for potential endogeneity. As in previous studies, this relation is absent in regressions using *pps* as a proxy for managerial ownership incentives in fixed effects regressions. Our results are consistent with both the empirical and theoretical literature which predicts managerial *incentive alignment* at low levels of equity-based compensation and equity ownership, but managerial *risk aversion* at high levels of managerial equity-based compensation and equity ownership. Furthermore, our results suggest that the inability of previous studies to find a relation between managerial ownership and

[3] The equivocal findings are not just a trivial academic debate. At a speech before the Stanford Directors' College, Frederick W. Cook (2005), Frederick W. Cook & Co., stated that "it is my belief that currently high stock and option grant values for executives have gone beyond any rational motivation value" (p. 9). He argued that it is not unusual for annual stock option and other equity grants for CEOs to average 600% of salary, the equivalent of 20 times salary per year using Black Scholes values at grant. Assuming stock price appreciation, he points out that after five years a CEO with a $1 million salary could have total carried interest in $100 million or more in stock value, leading to paper gains of $5–10 million a year. His point is that: "If the goal is to provide a sufficient equity carried interest so that executives think and act like an owner, the goal has been met many times over. In fact, the carried interest may be so high as to make the executives risk averse" (p. 5).

[4] The decline in performance may also be due to managerial entrenchment (Stulz, 1988) or to increased cost of capital caused by lower liquidity (Fama and Jensen, 1983).

[5] Zhou's (2001) comment focuses on the Himmelberg et al. (1999) study and the use of both the firm fixed effects estimator and the failure to account for stock options in the calculation of ownership levels. The other studies account for executive stock options in the calculation of ownership levels (Palia, 2001; Brick et al. 2005; Coles et al., 2003). However, these studies fail to account for the low power of ownership percentage when using the firm fixed effects estimator.

[6] Jensen and Murphy (1990), Garen (1994), Hadlock and Lumer (1997), Schaefer (1998), Murphy (1999), and Jin (2002) have also documented an inverse relationship between firm size and *pps*. Similarly, Cichello (2005) documents the importance of properly controlling for firm size when estimating *pps* and interpreting regression results using *pps* as an independent variable.

[7] *Execucomp* includes annual compensation data from proxy statements for the five highest paid executives for firms in the S&P 500, the S&P MidCap 400, and the S&P SmallCap 600.

[8] Baker and Hall (2004) state that both measures are helpful in understanding managerial incentive strength. For example, percent owned (sensitivity) is more appropriate when analyzing incentives to allocate resources, such as the use of a corporate jet, while dollars at stake (semi-elasticity) is more appropriate when analyzing incentives to undertake strategies that scale with firm size, such as corporate reorganization.

[9] There are three possible ways to increase the power of these tests: increase alpha, increase the sample size, or increase the effect size. The first solution is unattractive because increasing alpha reduces the confidence levels of significant results. The second solution, increasing the sample size, involves increasing the number of years used to track each CEO's ownership levels and changes. However, the low power problem of ownership percentage when using the firm fixed effect estimator in relation to sample size, *N*, is primarily a problem of small time, *t*, and the resulting small within variation. While increasing the number of firms, *i*, would also increase *N*, this would be expected to primarily influence the between variation and have a minimal effect on the within variation.

Tobin's Q using fixed effects regressions may have been due to the low power of the managerial incentive measure, *pps*, used in previous tests.

We organize the remainder of this paper as follows. Section 2 provides additional evidence of how *ppse* increases the effect size of the test. Section 3 presents an overview of our data and methodology. Section 4 presents empirical results. Section 5 explores causality. Section 6 presents robustness tests. Finally, Section 7 concludes.

Table 1
Variation in CEO pay-performance measures.

Company	1995	1996	1997	1998	1999	2000	2001	2002	2003	Average	S.D.
Panel A: sensitivity (*pps* — $)											
ALBERTO-CULVER CO	0.016	0.019	0.018	0.016	0.020	0.023	0.019	0.011	0.025	0.019	0.004
ALLIANCE PHARMA. CP	0.021	0.017	0.019	0.023	0.020	0.023	0.026	0.024	0.015	0.021	0.003
AMEREN CORP	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.001	0.001	0.001	0.000
AMERICAN ELECTRIC POWER	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.001	0.001	0.001	0.001
ARKANSAS BEST CORP	0.107	0.109	0.117	0.118	0.115	0.107	0.090	0.088	0.088	0.104	0.012
ASTEC INDUSTRIES INC	0.223	0.132	0.143	0.139	0.136	0.137	0.131	0.146	0.147	0.148	0.029
AT&T INC	0.001	0.002	0.002	0.002	0.001	0.001	0.002	0.002	0.002	0.001	0.000
BARD (C.R.) INC	0.005	0.006	0.007	0.013	0.016	0.017	0.022	0.020	0.012	0.013	0.006
BEAR STEARNS COMP. INC	0.040	0.046	0.052	0.052	0.057	0.072	0.075	0.075	0.081	0.061	0.015
BJ SERVICES CO	0.015	0.013	0.012	0.015	0.002	0.011	0.007	0.013	0.013	0.011	0.004
BLACK & DECKER CORP	0.023	0.021	0.024	0.018	0.020	0.030	0.024	0.022	0.114	0.033	0.031
BRUSH ENGINEERED MAT.	0.012	0.013	0.017	0.015	0.017	0.015	0.013	0.013	0.016	0.014	0.002
CARDINAL HEALTH INC	0.079	0.051	0.045	0.040	0.017	0.020	0.018	0.017	0.017	0.034	0.022
CASCADE NAT. GAS CORP	0.001	0.001	0.001	0.001	0.002	0.003	0.004	0.003	0.004	0.002	0.001
CENTURYTEL INC	0.006	0.006	0.007	0.001	0.002	0.008	0.010	0.010	0.011	0.007	0.003
CHARTER ONE FINANCIAL INC	0.008	0.011	0.008	0.007	0.007	0.008	0.009	0.010	0.012	0.009	0.002
CISCO SYSTEMS INC	0.003	0.002	0.003	0.004	0.004	0.003	0.004	0.004	0.005	0.004	0.001
CLOROX CO/DE	0.003	0.007	0.008	0.000	0.009	0.010	0.007	0.011	0.010	0.007	0.003
COMMERCIAL METALS	0.014	0.017	0.018	0.018	0.012	0.021	0.023	0.021	0.023	0.018	0.004
COOPER INDUSTRIES LTD	0.001	0.001	0.001	0.003	0.004	0.008	0.006	0.009	0.013	0.005	0.004
COSTCO WHOLESALE CORP	0.015	0.015	0.015	0.013	0.012	0.012	0.012	0.012	0.010	0.013	0.002
DATASCOPE CORP	0.180	0.180	0.180	0.220	0.238	0.227	0.174	0.185	0.160	0.194	0.027
DEVRY INC	0.149	0.148	0.140	0.139	0.137	0.134	0.135	0.134	0.134	0.139	0.006
DISNEY (WALT) CO	0.020	0.025	0.027	0.015	0.006	0.016	0.015	0.014	0.014	0.017	0.006
DOVER CORP	0.002	0.002	0.003	0.003	0.004	0.005	0.005	0.005	0.007	0.004	0.001
Average	0.038	0.034	0.035	0.035	0.034	0.037	0.033	0.034	0.037		
S.D.	0.061	0.051	0.052	0.057	0.059	0.056	0.048	0.051	0.050		
Panel B: semi-elasticity (*ppse* — *$Mil*)											
ALBERTO-CULVER CO	0.134	0.227	0.316	0.218	0.254	0.377	0.411	0.314	0.874	0.347	0.215
ALLIANCE PHARMA. CP	0.043	0.084	0.061	0.031	0.023	0.122	0.029	0.006	0.001	0.045	0.039
AMEREN CORP	0.005	0.007	0.012	0.021	0.026	0.063	0.018	0.075	0.111	0.038	0.037
AMERICAN ELECTRIC POWER	0.007	0.018	0.036	0.040	0.031	0.190	0.054	0.130	0.153	0.073	0.066
ARKANSAS BEST CORP	0.164	0.093	0.224	0.135	0.273	0.396	0.635	0.570	0.695	0.354	0.229
ASTEC INDUSTRIES INC	0.222	0.126	0.223	0.731	0.489	0.348	0.373	0.285	0.357	0.350	0.178
AT&T INC	0.499	0.527	1.064	1.781	1.599	1.565	2.044	1.478	1.649	1.356	0.544
BARD (C.R.) INC	0.096	0.097	0.136	0.324	0.437	0.407	0.734	0.608	0.487	0.370	0.228
BEAR STEARNS COMP. INC	1.006	1.276	2.081	3.485	3.163	3.622	4.340	4.777	6.011	3.307	1.644
BJ SERVICES CO	0.108	0.177	0.330	0.172	0.056	0.561	0.205	0.523	0.691	0.314	0.226
BLACK & DECKER CORP	0.707	0.589	0.885	0.861	0.899	0.950	0.713	0.735	4.397	1.193	1.207
BRUSH ENGINEERED MAT.	0.034	0.035	0.068	0.042	0.046	0.049	0.031	0.012	0.041	0.040	0.015
CARDINAL HEALTH INC	1.575	2.347	2.796	4.111	3.002	4.026	5.600	4.646	4.997	3.678	1.328
CASCADE NAT. GAS CORP	0.001	0.002	0.002	0.002	0.004	0.006	0.009	0.007	0.008	0.005	0.003
CENTURYTEL INC	0.120	0.111	0.215	0.081	0.101	0.403	0.453	0.406	0.506	0.266	0.173
CHARTER ONE FINANCIAL INC	0.107	0.219	0.329	0.343	0.274	0.487	0.559	0.635	0.915	0.430	0.247
CISCO SYSTEMS INC	0.410	0.675	1.660	3.836	7.219	15.909	5.231	4.182	7.093	5.135	4.759
CLOROX CO/DE	0.112	0.295	0.514	0.042	1.175	1.004	0.538	1.032	0.883	0.622	0.420
COMMERCIAL METALS	0.060	0.076	0.083	0.063	0.052	0.077	0.094	0.113	0.125	0.082	0.024
COOPER INDUSTRIES LTD	0.040	0.057	0.087	0.130	0.152	0.338	0.195	0.302	0.689	0.221	0.203
COSTCO WHOLESALE CORP	0.500	0.574	1.131	1.321	2.050	1.898	1.988	1.761	1.506	1.414	0.584
DATASCOPE CORP	0.499	0.514	0.567	0.912	1.168	1.216	1.185	0.757	0.688	0.834	0.296
DEVRY INC	0.494	1.108	1.300	2.120	2.120	2.470	3.386	2.142	2.187	1.925	0.846
DISNEY (WALT) CO	5.997	10.756	14.818	7.844	3.221	12.704	5.486	4.348	5.721	7.877	3.997
DOVER CORP	0.096	0.132	0.221	0.255	0.403	0.386	0.377	0.305	0.533	0.301	0.140
Average	0.522	0.805	1.166	1.156	1.130	1.983	1.388	1.206	1.653		
S.D.	1.199	2.139	2.933	1.869	1.649	3.887	1.863	1.560	2.143		

This table shows the difference between the within firm variation and between firm (cross-sectional) variation in CEO pay-performance sensitivity (*pps*) and pay-performance semi-elasticity (*ppse*). The data includes both stock and option portfolios measured using the Core and Guay (2002) one-year approximation method. Data are obtained from the *Execucomp* and *Compustat* databases and consist of an unbalanced panel of 9424 firm-year observations from 1995 to 2003. To reduce the influence of CEO turnover, firms with CEO changes during the period are excluded from the table. The table includes the first 25 companies in alphabetical order for 110 firms without CEO changes during the period.

2. Between and within firm variance of managerial ownership measures

We noted earlier that using pay-performance semi-elasticity (*ppse*) in place of pay-performance sensitivity (*pps*) results in an increase in both the value and year to year change in managerial ownership incentive levels. To illustrate this point, we show the variation in CEO pay-performance measures in Table 1, which displays pay-performance sensitivity (*pps*) and pay-performance semi-elasticity (*ppse*) levels for a subsample of 110 firms that had only one CEO during the period 1995 to 2003.[10] The table displays managerial stock and option portfolio *pps* and *ppse* levels as in Core and Guay (2002).

Panel A demonstrates that while sensitivity levels vary drastically between firms, they change slowly over time. For example, the mean sensitivity level ($) for the CEO at CISCO Systems is 0.004 with a standard deviation of 0.001. The sensitivity ranges from only from 0.002 to 0.005, and is either 0.003 or 0.004 for seven of the nine years. Conversely, Panel B demonstrates that semi-elasticity measures have been both meaningful between and within firm variation over time. The mean semi-elasticity level ($Mil) for the same CEO at CISCO Systems during the period is 5.135 with a standard deviation of 4.759. The values range from 0.410 to 15.909, with large year to year changes. While pay-performance sensitivity levels do not vary much over time, pay-performance semi-elasticity levels have considerable variation. The greater within firm variation amplifies the effect size and increases the power to detect a relation between managerial ownership and firm value using firm fixed effects.

3. The data and summary statistics

We obtain our sample from Standard and Poor's *Execucomp* database. *Execucomp* includes annual compensation data from proxy statements for the five highest paid executives for firms in the S&P 500, the S&P MidCap 400, and the S&P SmallCap 600. The initial sample includes 13,866 observations for 2461 firms between the years of 1995 and 2003. The period of our sample is comparable to other studies examining the relation between equity-based compensation and ownership with firm value (Brick et al., 2005; Coles et al., 2003). The database is matched to *Compustat*.

To account for differences in ownership and corporate governance structure due to regulation, we exclude financial firms (SIC Codes 6000 to 6999) and utilities (SIC Codes 4000 to 4999). Following Coles et al. (2003) and Himmelberg et al. (1999), firms must exist for the first 3 years of our sample period (1995, 1996, and 1997) to be included. We then follow those firms until the end of our sample period allowing them to come in and out of the sample. This results in an unbalanced panel of 1309 firms and 9424 firm years for our full sample. To account for the influence of internal and external monitoring on equity-based compensation and ownership, we obtain board of director characteristics from the RiskMetrics IRRC database and institutional ownership data from the Thomson 13F database. Due to data limitations in IRRC, board characteristics are only available from 1996 onward, with board committee variables only available from 1998. This results in an unbalanced panel of 1063 firms and 5545 firm years for the monitoring subsample.

3.1. Variable descriptions

We rely on *ExecuComp* for managerial ownership data and *Compustat* for accounting data. Board and CEO characteristics come from IRRC and *ExecuComp*. We obtain institutional ownership data from the Thomson 13F database. We winsorize all continuous variables at the upper and lower 1% to reduce any possible impact of outliers.

Firm value. Earlier work on association between corporate arrangements and firm performance has used Tobin's *Q* as the measure of firm value (Demsetz and Lehn, 1985; Morck et al., 1988; Lang and Stultz, 1994; Yermack, 1996; Himmelberg et al., 1999; Palia, 2001; Gompers et al., 2003; Coles et al., 2003; Bebchuk et al., 2007). Following Smith and Watts (1992), we calculate Tobin's *Q* (*Q*) as the market value of equity (fiscal year closing stock price × common shares outstanding) minus the book value of equity plus the book value of assets all divided by the book value of assets.[11]

Managerial ownership incentives. As proxies for managerial ownership incentives, we calculate pay-performance sensitivity and pay-performance semi-elasticity for each CEO's stock and option portfolio. Pay-performance sensitivity (*pps*) is defined as the dollar change in wealth for a dollar change in firm value:

$$pps \approx \left[\frac{\#\,shares\,of\,stock\,owned + \sum_{i=1}^{N} (e^{-dm}(N(D_1))(\#\,shares\,of\,stock\,options\,granted\,in\,award))_i}{common\,shares\,outstanding} \right] \quad (1)$$

[10] Managerial stock ownership may change significantly surrounding managerial turnover as new CEO's accumulate equity ownership. For demonstrational purposes, firms with CEO changes during the period are excluded so that we do not artificially inflate the year to year changes.

[11] We also measure firm value using market to book. Merton Miller (2005) argues that the market to book ratio is an appropriate measure of company value. When the market to book ratio equals one, the market value of the firm is equal to its book value. When it is greater than one, the market expects the firm to earn economic profit and values it at an amount greater than the investment made by shareholders. Using market to book also accounts for debt to assets on both the right-hand side and a large portion of the left-hand side of our regressions with Tobin's *Q* as a dependent variable. Our conclusions are unchanged using market to book as a dependent variable, and these tests are included in the Appendix.

Table 2
Summary statistics.

Variable	N	Mean	Median	Std. deviation	Minimum	Maximum
Q	9424	1.8901	1.4438	1.2852	0.7474	8.2195
Stock & option *pps* ($)	9424	0.0340	0.0117	0.0596	0.0000	0.3389
Stock & option *ppse* ($Mil)	9424	0.7955	0.1841	2.2415	0.0000	17.0216
TD/TA	9424	0.2489	0.2450	0.1742	0.0000	0.7911
R&D/TA	9424	0.0244	0.0000	0.0515	0.0000	0.2863
ADV/TA	9424	0.0104	0.0000	0.0287	0.0000	0.1740
TA ($Mil)	9424	9625.9530	1642.0910	27607.8900	43.8290	212,168.1000
LN TA	9424	7.5437	7.4037	1.7464	3.7803	12.2651
SALES ($Mil)	9424	4568.8010	1415.2400	8569.5680	16.2310	54,553.0000
LN Sales	9424	7.3121	7.2551	1.5571	2.7869	10.9069
Board independence	5545	0.2883	0.2083	0.2465	0.0238	0.9167
Institutional %	5545	60.4311	63.7700	21.1420	0.0000	99.9900
Collat	5545	0.4750	0.4756	0.2292	0.0067	0.9223
CashVol	5545	0.4859	0.1913	1.2525	0.0215	10.3070
CashDef	5545	0.0748	0.0513	0.0772	0.0017	0.5192
Q_{t-1}	5544	2.0429	1.5716	1.3732	0.7685	8.2642
CEO Age	5544	55.5314	56.0000	6.9341	39.0000	75.0000
CEO Tenure	5167	8.5309	6.0000	7.4265	1.0000	36.0000
Option vega ($Mil)	5545	0.1288	0.0508	0.2129	0.0000	1.2294

This table displays summary statistics for the sample. Data are obtained from the *Execucomp* and *Compustat* databases and consist of an unbalanced panel of 9424 firm-year observations from 1995 to 2003.

where: *d* equals the dividend yield, *m* equals time to maturity, *P* equals the fiscal year closing stock price, *N*(.) is the standard normal cumulative density function, $D_1 = \frac{\log\left(\frac{P}{X}\right) + \left(rf - d + \frac{\sigma^2}{2}\right)(m)}{\sigma\sqrt{m}}$, *X* equals the exercise price, *rf* equals the risk-free rate, and σ equals volatility.

Pay-performance semi-elasticity (*ppse*) is defined as the dollar change in wealth for a 1% change in firm value:

$$ppse \approx \left[\#\,shares\,of\,stock\,owned + \sum_{i=1}^{N}\left(e^{-dm}(N(D_1))(\#\,shares\,of\,stock\,options\,granted\,in\,award)\right)_i\right](0.01)(P) \quad (2)$$

where: *d* equals the dividend yield, *m* equals time to maturity, *P* equals the fiscal year closing stock price, *N*(.) is the standard normal cumulative density function, $D_1 = \frac{\log\left(\frac{P}{X}\right) + \left(rf - d + \frac{\sigma^2}{2}\right)(m)}{\sigma\sqrt{m}}$, *X* equals the exercise price, *rf* equals the risk-free rate, and σ equals volatility.

We use data from the *ExecuComp* database to construct each CEO's aggregate stock holdings at the end of each fiscal year. *ExecuComp* reports the aggregate number of shares, which includes both contractually unrestricted and restricted stock. We estimate each CEO's portfolio of stock options as in Core and Guay (2002). The procedure involves two steps, determining the exercise price and time-to-maturity of new options, and estimating the exercise price and time-to-maturity of previous option grants. We obtain the data for new grants from *Execucomp*, which reports the number of options granted for each grant series, the exercise price for each series, the expiration date of each option, the volatility estimates for each firm year calculated over the past 60 months, the firm's average dividend yield over the past three years, and the closing price of the firm's stock for the fiscal year. These six inputs, along with the risk-free rate of interest, allow for the calculation of the incentive effect of executive stock option grants each year.[12] We estimate the exercise price of the unexercisable options by finding the difference between the fiscal year end stock price and value of unexercisable in-the-money options, excluding the value of new option grants, to the number of unexercisable options, excluding the number of new grants.[13] To estimate the exercise price of exercisable options, we take the difference between the fiscal year end stock price and the value of exercisable in-the-money options to the number of unexercised exercisable in-the-money options. These calculations yield average estimates for the exercise price of exercisable and unexercisable options. We set the time-to-maturity of the unexercisable options equal to one minus the time-to-maturity of the current year's new option grants. The time-to-maturity of exercisable options is set to three minus the time-to-maturity of the unexercisable options. When no grant is made in the current year, the time-to-maturity of unexercisable and exercisable options is set to nine and six years respectively, as in Core and Guay (2002).

Capital structure (*leverage*). We proxy for the firm's capital structure using the debt ratio (*TD/TA*), calculated as the book value of long-term debt to the book value total assets.

Board monitoring. Following Brick et al. (2005) we compute a measure of board independence (*BI*), calculated as the product of the inverse of board size and the ratio of the number of independent directors to the number of inside directors. We treat gray or affiliated directors, those with business ties to the firm, as inside directors.

[12] We use the risk-free rate of interest used by *Execucomp* to calculate option values using its modified Black–Scholes methodology This method uses a risk-free interest rate that is the approximate average yield that could have been earned in a particular year by investing in a U.S. Treasury bond carrying a seven-year term. Accordingly, these rates are $rf_{1995} = 5.49$, $rf_{1996} = 6.34$, $rf_{1997} = 5.77$, $rf_{1998} = 4.73$, $rf_{1999} = 6.55$, $rf_{2000} = 5.16$, $rf_{2001} = 4.84$, $rf_{2002} = 3.36$, and $rf_{2003} = 3.77$. Other researchers have employed a risk-free rate equal to the rate of interest on a ten-year constant-maturity Treasury bond (e.g. Palia, 2001; Brick et al., 2005). We believe that matching the term on the risk-free rate to the early exercise behavior of executives (typically seven years) is more appropriate (see Carpenter, 1998; Huddart and Lang, 1996; Bizjak et al., 2003).

[13] When the number of new options granted exceeds the number of unexercisable options, such as in the case of immediate vesting of some or all new grants, the excess realizable value and number of options is deducted from the number and realizable value of exercisable options.

Institutional ownership. In a literature survey, Holderness (2003) concludes that outside block ownership appears to play a role in monitoring the compensation of top executives. Hartzell and Starks (2003), for example, find that the concentration of institutional investor ownership is positively related to pay-performance sensitivity and negatively related to the level of managerial compensation. We construct a measure of institutional investor ownership percentage (*Inst*), which is the percentage of shares held by institutions during the year.

Growth opportunities and intangible assets. We use R&D expenditures scaled by total assets (*R&D/TA*) and advertising expenditures scaled by total assets (*ADV/TA*) to proxy for firm growth opportunities and intangible assets. Many firms in the *Compustat* database have missing values for R&D and advertising expenditures. We set R&D expenditures and advertising expenditures equal to zero, when the value is missing. We also include a dummy variable equal to one when the value is missing in some regressions.[14]

Firm size. We control for firm size using the log of assets (*LN TA*) and the log of sales (*LN Sales*).

Instruments. To ensure comparability of our results to those from previous studies on ownership and value, we restrict our set of instruments to those used in them. Following Brick et al. (2005) and Coles et al. (2006), we include *CEO Age*, *CEO Tenure*, and *vega* as instruments for managerial ownership. CEO age reflects the CEO's age in each given year. CEO Tenure is the difference between the year of the observation and the year in which the executive became CEO. Vega (*vega*) is the change in the dollar value of the executive's wealth for a 1% change in the annualized standard deviation of stock returns:

$$vega \approx \sum_{i=1}^{N} \left(e^{-dm} e^{-\frac{D_1^2}{2}} \left(\frac{1}{\sqrt{2\pi}} \right) (\sqrt{m})(\#\, shares\, of\, stock\, options\, granted\, in\, award)(0.01)(P) \right)_i \tag{3}$$

where: d equals the dividend yield, m equals time to maturity, P equals the fiscal year closing stock price, $D_1 = \frac{log\left(\frac{P}{X}\right) + \left(rf - d + \frac{\sigma^2}{2}\right)(m)}{\sigma\sqrt{m}}$, X equals the exercise price, rf equals the risk-free rate, σ equals volatility, and we estimate each CEO's portfolio of stock options as in Core and Guay (2002).

The convex payoffs of option-based compensation, vega, can potentially reduce risk aversion arising from equity-based compensation and equity ownership. Thus firms may choose a mix of equity-based ownership and equity-based compensation (measured using pps and ppse) and vega. Guay (1999) shows that option vega is many times higher than stock vega. Following Knopf et al. (2002), Rajgopal and Shevlin (2002) and Coles et al. (2006), we use the vega of the option portfolio to measure the total vega of the stock and option portfolio.

Control variables. As in Brick et al. (2005), we include several additional control variables. We include a control variable for collateral (*Collat*), measured as the sum of inventory and net property, plant and equipment divided by total assets (Titman and Wessels, 1988). We include the cash deficit variable (*CashDef*), computed as the ratio of capital expenditures, plus the mean aggregate dividend payment over the previous 3 years, minus the leverage ratio times the capital expenditure minus the operating cash flow to net sales (MacKie-Mason, 1990). Aggregate dividend payment is the product of dividends per share and the number of common shares outstanding. We also include a variable for risk (*CashVol*), measured as the standard deviation of the percentage change in operating income for the past five years.

3.2. Summary statistics

Table 2 contains descriptive statistics for our sample of 9424 firm year observations for 1309 firms between the years of 1995 and 2003. The mean (median) value for Q is 1.8901 (1.4438) and ranges from 0.7474 to 8.2195. Our sample consists of large industrial firms. The mean (median) value of total assets is $9.625 ($1.642) billion and the mean (median) value of total sales is $4.568 ($1.415) billion. However, the sample includes a broad range of firms with total assets ranging from $43.829 million to $212.168 billion and total sales ranging from $16.231 million to $54.553 billion. Finally, firms in our sample have long-term debt to total assets of approximately 25%, on average, which is similar to other studies examining the relation between managerial ownership and firm value (Coles et al., 2003).

The mean (median) stock and option pay-performance sensitivity (*pps*) is 0.0340 (0.0117), which is in line with recent studies examining the same relation (see Brick et al., 2005; Coles et al., 2003). The mean (median) pay-performance sensitivity indicates that on average a CEO's wealth increases $34.0 ($11.7) for each $1000 increase in shareholder wealth which has increased from Jensen and Murphy's (1990) estimate of $3.25 increase for every $1000 increase in shareholder wealth and Murphy's (1999) estimate of $6.03.

The mean (median) stock and option pay-performance semi-elasticity (*ppse*) is 0.8071 (0.1877), which is much larger than the pay-performance sensitivity measure. The mean (median) pay-performance semi-elasticity indicates that on average a CEO's wealth increases $795.1 ($184.1) thousand for a 1% increase in shareholder wealth.[15]

[14] Researchers have used R&D scaled by total assets (Coles et al., 2006; Coles et al., 2003) or R&D scaled by total sales (Bebchuk et al., 2007). For comparability to previous studies examining the relation between managerial ownership and firm value, we report results using R&D/TA. However, our conclusions are unchanged using R&D/Sales and reported in the Appendix.

[15] A correlation matrix (reported in the Appendix) suggests that stock and option pay-performance sensitivity (*pps*) also has a negative and significant correlation ($\rho = -0.25$) correlation with firm size. Pay-performance sensitivity decreases with firm size. However, pay-performance semi-elasticity (*ppse*) does has a positive and significant correlation ($\rho = 0.26$) with firm size. Pay-performance semi-elasticity increases with firm size.

Table 3
Executive fixed effects regressions of Tobin's Q on stock & option pay-performance sensitivity and semi-elasticity.

Dependent variable = Tobin's Q										
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Stock & option *pps*			0.807	−0.577	0.883					
			(0.64)	(−0.44)	(0.70)					
Stock & option pps^2			−0.299	3.000	−0.150					
			(−0.07)	(0.69)	(−0.04)					
Stock & option *ppse*						0.491***	0.546***	0.506***	0.144***	
						(7.95)	(8.55)	(8.12)	(2.93)	
Stock & option $ppse^2$						−0.0193***	−0.0210***	−0.0196***	−0.00603**	
						(−6.02)	(−6.46)	(−6.04)	(−2.21)	
ppse residuals										0.115***
										(2.74)
ppse residuals^2										−0.00569*
										(−1.95)
TD/TA	−1.072***	−1.224***		−1.073***	−1.231***		−0.734***	−0.973***	−0.374*	−0.375*
	(−5.90)	(−6.53)		(−5.91)	(−6.58)		(−3.72)	(−4.65)	(−1.75)	(−1.75)
R&D/TA	1.517	2.629**		1.527	2.635**		1.862	3.223**	4.987***	4.988***
	(1.16)	(2.10)		(1.16)	(2.11)		(1.31)	(2.36)	(3.99)	(3.98)
ADV/TA	1.853	2.092		1.902	2.168		1.750	2.337	2.296	2.284
	(1.14)	(1.27)		(1.19)	(1.34)		(1.02)	(1.30)	(1.36)	(1.35)
LN TA	−0.414*			−0.408*			−0.204			
	(−1.68)			(−1.67)			(−0.71)			
LN TA^2	0.00498			0.00464			−0.0214			
	(0.33)			(0.30)			(−1.16)			
LN SALES		−0.00798			−0.00000528			0.249		
		(−0.03)			(−0.00)			(0.76)		
LN SALES^2		−0.00229			−0.00234			−0.0308		
		(−0.13)			(−0.13)			(−1.45)		
LN MVE									−0.0765	−0.0165
									(−0.44)	(−0.09)
LN MVE^2									0.0518***	0.0515***
									(4.08)	(4.08)
Executive	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	9424	9424	9424	9424	9424	9424	9424	9424	9424	9424
Adj. R^2	0.072	0.054	0.029	0.072	0.054	0.126	0.188	0.153	0.296	0.295
F-statistic										
$pps + pps^2 = 0$			0.76	0.29	1.07					
$ppse + ppse^2 = 0$						36.07***	41.96***	37.94***	4.79**	4.07***

This table reports results from executive fixed effects regressions of Tobin's Q against the pay-performance sensitivity (*pps*: the $ Δ in wealth for a $ Δ in firm value: the Black–Scholes' delta times the number of shares of stock options granted plus the number of shares of stock all scaled by common shares outstanding) and pay-performance semi-elasticity (*ppse*: the $ Δ in wealth for a 1% Δ in firm value: the Black–Scholes' delta times the number of shares of stock options granted plus the number of shares of stock all multiplied by 1% of the stock price) of stockholdings and of an estimate for the entire portfolio of options held by the CEO in a given year, total debt to total assets (*TD/TA*), the ratio of research and development expenses to total assets with missing values set equal to zero (*R&D/TA*), the ratio of advertising expenditures to total assets with missing values set equal to zero (*ADV/TA*), and the log and log squared of total assets (*LN TA*, *LN TA*^{2}), or the log and squared log of sales (*LN SALES*, *LN SALES*^{2}). Data are obtained from the *Execucomp* and *Compustat* databases and consist of an unbalanced panel of 9424 executive-year observations from 1995 to 2003. All regressions include dummy variables for year (The coefficients for year are not reported). The *t*-statistics are reported using robust standard errors clustered at the executive level (see Rogers, 1993; Wooldridge, 2002). Robust *t*-statistics are given in parentheses. Superscripts */**/*** indicate levels of significance of 10%, 5%, and 1%, respectively.

4. Analysis of the effect of managerial ownership on firm value

We begin by examining whether managerial ownership is related to firm performance. We assume that managerial ownership is exogenous to the firm and control for unobserved executive-firm heterogeneity, or omitted variable bias, using executive fixed effects regression.[16] The model we test is as follows:

$$\text{Tobin}'\text{s}\,Q_{it} = \beta_1(Ownership)_{it} + \beta_2(Ownership^2)_{it} + \beta_k(Controls)_{it} + \beta_y\sum(year\,dummy\,variables)_t + \in_{it} \quad (4)$$

where Tobin's *Q* is a function of stock and option ownership and ownership^2 (measured by *pps* or *ppse*), controls (capital structure, growth opportunities and intangible assets, and firm size), and dummy variables for year. The specification used in Eq. (4) is similar to that used in previous studies (see Himmelberg et al., 1999; Coles et al., 2003). Our primary variables of interest in Eq. (4) are the

[16] Many of the firms in our sample have CEO changes over the period. For example, firms average 7.2 years in our sample, while CEO's average only 4.2 years. The year to year change in pay-performance may be influenced by CEO turnover, rather than year to year changes in pay-performance. Therefore, we use executive fixed effects, which include a dummy variable for each unique CEO-firm combination. This results in an unbalanced panel of 2319 CEO-firm combinations and 9424 firm years.

coefficients on stock and option ownership and ownership^2, β_1 and β_2. A finding of a positive sign for β_1 and a negative sign for β_2 is consistent with *incentive alignment/risk aversion*. However, a finding of no relation between *Q* and β_1 and β_2 would be more consistent with *optimal contracting*.

Table 3 reports results of executive fixed effects regressions with *Q* as the dependent variable. Independent variables include stock and option portfolio pay-performance sensitivity (*pps*) and pay-performance semi-elasticity (*ppse*), total long-term debt to total assets (*TD/TA*), the ratio of research and development expenses to total assets (*R&D/TA*), and the ratio of advertising expenditures to total assets (*ADV/TA*), and the log of total assets and its squared term (*LN TA*, *LN TA*^{2}), or the log of sales and its squared term (*LN SALES*, *LN SALES*^{2}). All regressions include dummy variables for year (not reported in the tables).[17] The *t*-statistics are reported using robust standard errors clustered at the executive level (Rogers, 1993; Wooldridge, 2002).

Regressions 1 and 2 contain estimated results for the control variables. Regression 3 includes only the quadratic specification of stock and option pay-performance sensitivity, *pps* and *pps*^{2}. While the estimated coefficients for stock and option *pps* are positive and option *pps*^{2} is negative, neither is individually or jointly significant.[18] Regressions 4 and 5 add additional controls using either total assets or sales to control for firm size. Neither the estimated coefficients for *pps* or *pps*^{2} terms are significant, nor are they jointly significant.

Regression 6 includes only the quadratic specification of stock and option pay-performance semi-elasticity, *ppse* and *ppse*^{2}. The estimated coefficient for stock and option *ppse* is 0.491, significant at the 1% level ($t=7.95$) and the estimated coefficient for stock and option *ppse*^{2} is −0.0193, significant at the 1% level ($t=-6.02$). The two estimated coefficients are jointly significant at the 1% level ($F=36.07$). Regressions 7 and 8 add the control variables. Here, managerial ownership continues to exhibit a non-monotonic relation with *Q*. The estimated coefficients on *ppse* are positive and significant at the 1% level ($t=8.55$; 8.12), and the estimated coefficients on stock and option *ppse*^{2} are negative and significant at the 1% level ($t=-6.46$; −6.04). The two estimated coefficients are jointly significant at the 1% level ($F=41.96$; 37.94) in both regressions.

Overall, our results using the pay-performance sensitivity measure are consistent with the conclusions reached by Himmelberg et al. (1999) and support *optimal contracting*. After controlling for unobserved executive-firm characteristics there is no effect of changes in managerial ownership on *Q*. However, our results using pay-performance semi-elasticity are consistent with *incentive alignment/risk aversion*. After controlling for unobserved executive-firm characteristics, changes in managerial ownership when measured using pay-performance semi-elasticity, exhibit a non-monotonic relation with *Q*.

4.1. Testing for a spurious relation between PPSE and Tobin's Q

Both pay-performance semi-elasticity and Tobin's *Q* are functions of equity value. Pay-performance semi-elasticity is defined as pay-performance sensitivity scaled by firm size (the market value of equity) and Tobin's *Q* is defined as the market value assets scaled by the book value of assets. Therefore, it is possible that the relation between *ppse* and Tobin's *Q* is the result of exogenous changes in equity values rather than changes in the contracting environment. In this section, we examine whether the relation between pay-performance semi-elasticity and Tobin's *Q* is spurious, or the result of a third variable, market value of equity. If the significant relation between *ppse* and Tobin's *Q* is the result of changes in market value of equity, the estimated coefficients for *ppse* and *ppse*^{2} will no longer be significant when market value of equity is included in the model. However, if the estimated coefficients for *ppse* and *ppse*^{2} remain significant when market value of equity is included in the model, the relation is not spurious. As an additional test, we also estimate a model for Tobin's *Q* using a *ppse* variable that is orthogonal to market value of equity. We do so by first regressing *ppse* on market value of equity to obtain the residual values. The residuals represent the portion of *ppse* unexplained by market value of equity. We then regress Tobin's *Q* on the *ppse* residuals from the initial regression. If the estimated coefficients on the *ppse* residuals are significant, the relation between *ppse* and Tobin's *Q* should not be the spurious result of market value of equity. Table 3, Regressions 9 and 10 report results of tests for a spurious relation between *ppse* and Tobin's *Q*.

Regression 9 includes the quadratic specification of stock and option pay-performance semi-elasticity, *ppse* and *ppse*^{2} and the controls. The estimated coefficient for stock and option *ppse* is 0.144, significant at the 1% level ($t=2.93$), and the estimated coefficient for stock and option *ppse*^{2} is −0.00603, significant at the 5% level ($t=-2.21$). The two estimated coefficients are jointly significant at the 5% level ($F=4.79$). Regression 10 includes the quadratic specification of the residuals from first stage regressions of stock and option pay-performance semi-elasticity *ppse* on market value of equity, *ppse residuals* and *ppse residuals*^{2} and controls. The estimated coefficient for the stock and option *ppse residuals* is 0.115, significant at the 1% level ($t=2.74$), and the estimated coefficient for the stock and option *ppse residuals*^{2} is −0.00569, significant at the 10% level ($t=-1.95$). The two estimated coefficients are jointly significant at the 1% level ($F=4.07$).

Our results including market value of equity suggest that the relation between pay-performance semi-elasticity and Tobin's *Q* are not the spurious result of exogenous changes in market value of equity. After including market value of equity in the model and creating measures of *ppse* that are orthogonal to market value of equity, a significant non-monotonic relation between pay-performance semi-elasticity and Tobin's *Q* continues to persist.

[17] Pooling tests for executive fixed effects and year fixed effects are significant at the 1% level, supporting the inclusion of executive and time effects in the model. The conclusion of subject specific parameters in the model is also supported by a modified Wald statistic for groupwise heteroskedasticity in the residuals of a fixed effect regression model, following Green (2003, p. 598). This statistic is significant at the 1% level. Finally, a Hausman tests for random effects is significant at the 1% level, supporting the use of the fixed effects model over the random effects model in our analysis.

[18] The maximum for *pps*, where the relation turns from positive to negative, is 28.24%, which is slightly higher than Coles et al. (2003), who estimate a maximum of about 22.8% using firm fixed effects. The corresponding maximum for *ppse* is $12.69 million for a 1% change in firm value using firm effects. The results are reported in the Appendix.

4.2. The variance between and within

As noted earlier, pay-performance sensitivity (*pps*) exhibits little time series (within firm) variation and as a result has low power to detect a relation using a fixed effects estimator. In particular, the between firm standard deviation in *pps* of 0.0510 is approximately 2.8 times larger than the within firm standard deviation in *pps* of 0.0183. Conversely, pay-performance semi-elasticity (*ppse*) has greater time series variation, or within firm variation, so it has greater power when using the fixed effects estimator. The within firm standard deviation in *ppse* of 0.8222 is much larger than *pps* and only 2.18 times smaller than the between firm standard deviation in *ppse* of 1.7913. As a result, when using pay-performance semi-elasticity we detect a relation that is absent using pay-performance sensitivity. In Table 4, we explore why this occurs by reporting regressions of Tobin's *Q* on stock and option pay-performance sensitivity (*pps*), or pay-performance semi-elasticity (*ppse*), and control variables using the pooled OLS estimator, the between estimator, and the fixed effects estimator. The between estimator measures the effect of *x* when *x* changes between firm, while the fixed effects estimator measures the effect of *x* when *x* changes within firm. If the majority of the variance occurs between firms, we would expect the pooled OLS estimator, which combines the between and within variation, to be similar in magnitude to the between estimator and the fixed effects estimator to be substantially smaller in magnitude than the pooled OLS and between estimators.

Regressions 1–3 report the estimated coefficients for stock and option pay-performance sensitivity (*pps*). Unlike the fixed effects regressions in Table 3, regression 1 using the pooled OLS regression documents the significant non-monotonic relation between managerial ownership that has been shown in the literature. However, the significant relation appears to be primarily driven by variance between firms, rather than variance within firms. The coefficients for pooled estimator and the between estimator are extremely close in magnitude. The estimated coefficients for stock and option *pps* and pps^2 using the pooled OLS estimator are 3.392 and −9.403, while the estimated coefficients using the between estimator are 3.831 and −10.50. In each case the estimated coefficients on the *pps* and pps^2 terms are individually and jointly significant at the 5% level or above. However, the estimated coefficients for stock and option *pps* and pps^2 using the fixed effects estimator are 0.883 and −0.150, which are significantly lower in magnitude than the estimated coefficients from the pooled OLS and between regressions. Furthermore, the estimated coefficients on the *pps*

Table 4
Pooled, between, & FE regressions of Tobin's *Q* on stock and option pay-performance sensitivity and semi-elasticity.

Dependent variable = Tobin's *Q*						
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)
Model	OLS	BE	FE	OLS	BE	FE
Stock & Option *pps*	3.392**	3.831***	0.883			
	(2.58)	(3.35)	(0.70)			
Stock & Option pps^2	−9.403**	−10.50**	−0.150			
	(−2.20)	(−2.49)	(−0.04)			
Stock & Option *ppse*				0.426***	0.434***	0.506***
				(9.22)	(12.43)	(8.12)
Stock & Option $ppse^2$				−0.0201***	−0.0204***	−0.0196***
				(−6.37)	(−8.58)	(−6.04)
TD/TA	−1.283***	−0.903***	−1.231***	−0.979***	−0.692***	−0.973***
	(−8.11)	(−7.14)	(−6.58)	(−6.56)	(−5.72)	(−4.65)
R&D/TA	9.391***	8.523***	2.635**	9.023***	8.209***	3.223**
	(12.28)	(19.34)	(2.11)	(12.80)	(19.60)	(2.36)
ADV/TA	5.206***	5.947***	2.168	4.810***	5.472***	2.337
	(5.21)	(8.21)	(1.34)	(5.20)	(7.95)	(1.30)
LN SALES	−0.106	−0.0794	−0.00000528	−0.0651	−0.0522	0.249
	(−0.76)	(−0.88)	(−0.00)	(−0.48)	(−0.61)	(0.76)
$LN\ SALES^2$	0.0109	0.00961	−0.00234	0.000968	0.00122	−0.0308
	(1.21)	(1.58)	(−0.13)	(0.11)	(0.21)	(−1.45)
Year	Yes	Yes	Yes	Yes	Yes	Yes
N	9424	9424	9424	9424	9424	9424
adj. R^2	0.225	0.243	0.054	0.299	0.314	0.153
F-Statistic						
$pps + pps^2 = 0$	3.59**	7.21***	1.07			
$ppse + ppse^2 = 0$				55.59***	126.85***	37.94***

This table reports results from pooled (ordinary least squares), between (regression on means) and FE (executive fixed effects) regressions of Tobin's *Q* against the pay-performance sensitivity (*pps*: the $ Δ in wealth for a $ Δ in firm value: the Black–Scholes' delta times the number of shares of stock options granted plus the number of shares of stock all scaled by common shares outstanding) and pay-performance semi-elasticity (*ppse*: the $ Δ in wealth for a 1% Δ in firm value: the Black–Scholes' delta times the number of shares of stock options granted plus the number of shares of stock all multiplied by 1% of the stock price) of stockholdings and of an estimate for the entire portfolio of options held by the CEO in a given year, total debt to total assets (*TD/TA*), the ratio of research and development expenses to total assets with missing values set equal to zero (*R&D/TA*), the ratio of advertising expenditures to total assets with missing values set equal to zero (*ADV/TA*), and the log and squared log of sales (*LN SALES, LN SALES*^{2}). Models 1 and 4 report results from ordinary least squares regressions. Models 2 and 5 report results from between firm regressions. Models 3 and 6 report results from executive fixed effects regressions. Data are obtained from the *Execucomp* and *Compustat* databases and consist of an unbalanced panel of 9424 executive-year observations from 1995 to 2003. All regressions include dummy variables for year (The coefficients for year are not reported). The *t*-statistics are reported using robust standard errors clustered at the executive level (see Rogers, 1993; Wooldridge, 2002). Robust *t*-statistics are given in parentheses. Superscripts */**/*** indicate levels of significance of 10%, 5%, and 1%, respectively.

or pps^2 terms are insignificant, and they are not jointly significant either. This suggests that the majority of the variance when using pay-performance sensitivity (*pps*) occurs between firms, not within firms. It provides further support for Zhou's (2001) argument that using this measure in conjunction with firm fixed effects results in low power to detect a possible relation. This may result in a type II error, failure to reject the null when it is false.

In regressions 4–6, we report the estimated coefficients for stock and option pay-performance semi-elasticity (*ppse*). In contrast to estimated coefficients using the pay-performance sensitivity measure, the coefficients for stock and option performance

Table 5
Executive fixed effects regressions and two-stage least squares with executive fixed effects regressions of Tobin's *Q* on stock and option pay-performance sensitivity and pay-performance semi-elasticity.

Dependent variable = Tobin's *Q*							
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Stock & option *pps*		2.459	2.371				
		(1.04)	(1.02)				
Stock & option pps^2		−2.942	−2.153				
		(−0.37)	(−0.27)				
Predicted stock & option *pps*						44.90*	
						(1.94)	
Predicted stock & option pps^2						−126.3*	
						(−1.77)	
Stock & option *ppse*				0.498***	0.494***		
				(6.59)	(6.43)		
Stock & option $ppse^2$				−0.0181***	−0.0179***		
				(−4.49)	(−4.30)		
Predicted stock & option *ppse*							0.312
							(1.27)
Predicted stock & option $ppse^2$							−0.0170
							(−0.70)
BI			0.0898		0.0871	0.0638	0.0979
			(0.74)		(0.70)	(0.56)	(1.05)
Inst	0.000473**		0.00274**		0.00235**	0.00104	0.00148
	(2.54)		(2.46)		(2.24)	(1.02)	(1.55)
TD/TA	−0.0250		−1.883***		−1.516***	−1.754***	−1.480***
	(−0.48)		(−6.58)		(−5.52)	(−7.41)	(−7.15)
Q_{t-1}						0.281***	0.256***
						(7.89)	(6.73)
Collat	−0.0242		0.407		0.581*	0.431	0.528*
	(−0.36)		(1.12)		(1.66)	(1.43)	(1.81)
CashVol	−0.00185		0.0141		0.00959	0.0138	0.00684
	(−0.52)		(0.74)		(0.55)	(0.98)	(0.44)
CashDef	0.163*		−0.612		−1.039*	−1.151**	−1.536***
	(1.79)		(−0.95)		(−1.71)	(−2.13)	(−3.03)
R&D/TA	−0.255		4.138*		4.372**	3.759**	3.964**
	(−1.42)		(1.92)		(2.08)	(2.05)	(2.16)
R&D Dummy	−0.00319		0.172		0.142	0.188	0.161
	(−0.09)		(1.18)		(1.06)	(1.25)	(1.41)
LN Sales	−0.0402***		0.00270		−0.181*	0.0270	−0.236***
	(−2.98)		(0.03)		(−1.83)	(0.20)	(−3.54)
Executive	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	5545	5545	5545	5545	5545	4832	4832
Adj. R^2	0.062	0.057	0.101	0.165	0.204	−0.319	−0.044
F-statistic							
$pps + pps^2 = 0$		1.90	2.30			3.90	
$ppse + ppse^2 = 0$				24.46***	23.69***		6.31**

This table reports results from executive fixed effects regressions and two-stage least squares with executive fixed effects regressions of Tobin's *Q* against the pay-performance sensitivity (*pps*: the $ Δ in wealth for a $ Δ in firm value: the Black–Scholes' delta times the number of shares of stock options granted plus the number of shares of stock all scaled by common shares outstanding) and pay-performance semi-elasticity (*ppse*: the $ Δ in wealth for a 1% Δ in firm value: the Black–Scholes' delta times the number of shares of stock options granted plus the number of shares of stock all multiplied by 1% of the stock price) of stockholdings and of an estimate for the entire portfolio of options held by the CEO in a given year; board independence (*BI*), the ratio of independent to inside directors all scaled by board size; institutional investor percentage (*Inst*), the number of shares held by institutions scaled by common shares outstanding; total debt to total assets (*TD/TA*), lagged *Q* (Q_{t-1}), collateralizable assets (*Collat*), inventory plus net property, plant and equipment scaled by total assets; cash volatility (*CashVol*), the standard deviation of the percentage change in operating income for the previous 5 years; cash deficit (*CashDef*), the ratio of capital expenditures plus the mean aggregate dividend payment over the previous 3 years minus the leverage ratio times the capital expenditure minus operating cash flow to sales; research and development expenditures to total assets with missing values set equal to zero (*R&D/TA*), a dummy equal to 1 if the value for research and development expenditures is missing (*R&D Dummy*), and the log of sales (*LN Sales*). Models 1–5 report results from executive fixed effects regressions. Models 6 and 7 report results from two-stage least squares with executive fixed effects regressions. Data are obtained from the *Execucomp*, *Compustat*, *RiskMetrics IRRC*, and *Thomson 13F* databases and consist of an unbalanced panel of 5545 executive-year observations from 1996 to 2003. All regressions include dummy variables for year (The coefficients for year are not reported). The *t*-statistics are reported using robust standard errors clustered at the executive level (see Rogers, 1993; Wooldridge, 2002). Robust *t*-statistics are given in parentheses. Superscripts */**/*** indicate levels of significance of 10%, 5%, and 1%, respectively.

semi-elasticity (*ppse*) using the fixed effects estimator are greater in magnitude than those using the between estimator. The estimated coefficients for stock and option *ppse* and $ppse^2$ using the between estimator are 0.434 and −0.0204, while the estimated coefficients using the fixed effects estimator are 0.506 and −0.0196. Both sets of estimated coefficients for stock and option *ppse* and $ppse^2$ are similar to the estimated coefficients using the OLS estimator, which are 0.426 and −0.0201, respectively. In all three cases, estimated coefficients on the *ppse* and $ppse^2$ terms are individually and jointly significant at the 1% level. These results suggest that pay-performance semi-elasticity has considerable between firm and within firm variation. It also explains why the pay-performance semi-elasticity (*ppse*) measure detects a relation using executive fixed effects that is absent using the pay-performance sensitivity (*pps*) measure with executive fixed effects. The greater power of the test decreases the probability of making a type II error.

5. Exploring causality

While our previous results provide support for the *incentive alignment/risk aversion* hypothesis, our analysis to this point has treated the independent variables as exogenous. If any one of these variables is determined simultaneously with Q it violates the least squares regression assumption that the regressors are uncorrelated with the error term. Therefore, we use executive fixed effects to control for unobserved executive-firm heterogeneity, examine whether the governance variables are endogenous, and employ two-stage least squares and simultaneous equations regressions as additional tools to deal with potential simultaneity.[19] The model we test is as follows:

$$\begin{aligned}\text{Tobin}'\text{s}\,Q_{it} = {} & \beta_1(Ownership)_{it} + \beta_2(Ownership^2)_{it} + \beta_3(Board\,Independence)_{it} + \beta_4(Institutional\,Ownership)_{it} \\ & + \beta_5(Capital\,Structure)_{it} + \beta_k(Controls)_{it} + \beta_y\sum(year\,dummy\,variables)_t + \in_{it} \end{aligned} \quad (5)$$

where Tobin's Q is a function of stock and option ownership and ownership^2 (measured alternately by *pps* or *ppse*), board independence, institutional ownership, capital structure, and controls (collateralizable assets, cash volatility, cash deficit, growth opportunities and intangible assets, and firm size), and dummy variables for year. The specification used in Eq. (5) is similar to that used by Brick et al. (2005). Again, our primary variables of interest in Eq. (5) are the coefficients on stock and option ownership and ownership^2, β_1 and β_2. A finding of a positive relation between Q and β_1 and a negative relation between Q and β_2 is consistent with *incentive alignment/risk aversion*. However, a finding of no relation between Q and β_1 and β_2 would be more consistent with *optimal contracting*.

Table 5 reports results of executive fixed effects regressions of Tobin's Q on stock and option pay-performance sensitivity (*pps*) or pay-performance semi-elasticity (*ppse*), board independence (*BI*), institutional investor percentage (*Inst*), total debt to total assets (*TD/TA*), collateralizable assets (*Collat*), cash volatility (*CashVol*), cash deficit (*CashDef*), research and development expenditures to total assets (*R&D/TA*), a dummy equal to 1 if the value for research and development expenditures is missing (*R&D Dummy*), and the log of sales (*LN Sales*). All regressions include dummy variables for year (not reported in the tables).[20] The *t*-statistics are reported using robust standard errors clustered at the executive level (Rogers, 1993; Wooldridge, 2002).

Regression 1 contains the results for the control variables while regression 2 contains the estimated results for *pps* and pps^2. Regression 3 includes both the test and control variables. The estimated coefficient for stock and option *pps* is 2.371 and the estimated coefficient for stock and option pps^2 is −2.153. The two coefficients are not individually or jointly significant.

Regression 4 reports results using stock and option pay-performance semi-elasticity (*ppse*) and executive fixed effects, while regression 5 includes both test and control variables. The estimated coefficient for stock and option *ppse* is 0.494, significant at the 1% level ($t = 6.43$) and the estimated coefficient for stock and option $ppse^2$ is −0.0179, significant at the 1% level ($t = -4.30$). The two coefficients are jointly significant at the 1% level ($F = 23.69$).

Our analysis to this point has treated our test variables as exogenous variables, but if any one of these variables is determined simultaneously with Q it violates the least squares regression assumption that the regressors are uncorrelated with the error term. Therefore, we also report results from two-stage least squares (2SLS) regressions of Q on stock and option pay-performance sensitivity (*pps*) and pay-performance semi-elasticity (*ppse*).[21] We use *CEO Age*, *CEO Tenure*, and *vega* as instruments for *pps* or *ppse*.[22] We also include Q prior to our independent variables, lagged Q (Q_{t-1}), to partially control for simultaneity in our regressions.

Regression 6 reports results for the quadratic form of stock and option pay-performance sensitivity (*pps*). The estimated coefficient for *pps* is 44.90 and the estimated coefficient for pps^2 is −126.3. While both terms are marginally significant at the

[19] In order to maintain consistency with our treatment of the fixed effects in Section 4, we use executive fixed effects, which include a dummy variable for each unique CEO-firm combination. This accounts for the fact that many of the firms in our sample have CEO changes over the period. This results in an unbalanced panel of 1646 CEO-firm combinations and 5545 firm years.

[20] Pooling tests for executive fixed effects and year fixed effects are significant at the 1% level, supporting the inclusion of executive and time effects in the model. The conclusion of subject specific parameters in the model is also supported by a modified Wald statistic for groupwise heteroskedasticity in the residuals of a fixed effect regression model, following Green (2003, p. 598). This statistic is significant at the 1% level. Finally, a Hausman (1978) tests for random effects is significant at the 1% level, supporting the use of the fixed effects model over the random effects model in our analysis.

[21] In the absence of specification problems, the use of a systems procedure, such as 3SLS, is asymptotically more efficient than a single-equation procedure such as 2SLS. But single-equation methods are more robust to misspecification (Wooldridge, 2002 p. 222). Our conclusions are unchanged using the potentially more efficient 3SLS method (reported in the Appendix).

[22] Davidson–MacKinnon tests for endogeneity are significant at the 1% supporting the use of the 2SLS model over the fixed effects model. The set of instruments is supported by estimated coefficients and *F* statistics for the set of instruments that are significant at the 1% level, with the exception of pps^2 which is significant at the 10% level (reported in the Appendix), a high Shea (1997) partial R^2, a Kleibergen-Paap (2006) LM statistic for *pps* and pps^2 that is significant at the 1% level, and an insignificant Hansen *J*-statistic.

10 percent level, they are not jointly significant. Regression 7 reports results for the quadratic specification of stock and option pay-performance semi-elasticity (*ppse*). The estimated coefficient for stock and option *ppse* is 0.312 and the estimated coefficient for option $ppse^2$ is −0.0170. Conversely, while the terms are not individually significant, they are jointly significant at the 5% level ($F=6.31$).[23]

Contrary to previous studies using fixed effects regressions, our results using pay-performance semi-elasticity (*ppse*) support *incentive alignment/risk aversion*. After controlling for unobserved executive-firm characteristics and endogeneity, changes in managerial ownership, measured using pay-performance semi-elasticity (*ppse*), exhibit a non-monotonic relation with *Q*. Again, this relation is absent in regressions using pay-performance sensitivity (*pps*) as a proxy for managerial ownership.

6. Robustness tests

We perform several robustness tests to determine if our results are driven by other factors. The following results are reported in the Appendix.

6.1. Firm fixed effects

Our study uses executive fixed effects to control for year to year changes in pay-performance due to CEO turnover. However, previous studies have employed firm fixed effects (see Himmelberg et al., 1999, Palia, 2001, Coles et al., 2003, and Brick et al., 2005). Therefore, we also run firm fixed effects on the unbalanced panel of 1309 firms and 9424 firm-year observations. The conclusions of our study are unchanged using firm fixed effects.

6.2. Options and shares

Our measures of managerial ownership percentage used both stock and option ownership to the executives' "effective ownership". However, Ofek and Yermack (2000) show a differential trading behavior for stock acquired from new options depending on ownership levels. They note that increased equity ownership (in the form of stock and options) succeeds in increasing incentives for lower-ownership managers. On the other hand, the incentive effect of new option grants to higher-ownership managers is negated because when executives exercise options to acquire stock, the acquired shares are sold. Our study measures managerial ownership using a proxy for the entire portfolio of stock and options held by each CEO in a given year. Measuring the entire pool of equity holdings year to year, rather than using year to year grants, should account for any such differential incentive effects due to trading behavior. However, for robustness, we also run separate equations for stock or only options. Our conclusions are unchanged when we use only stock or only options to measure managerial ownership incentives, and these results are available from the authors upon request.

6.3. Option measurement

We note that the previous results relied on the Core and Guay (2002) one-year approximation method to estimate the executive's portfolio of options. To determine if this method is biasing our results, we reexamine the option portfolio results using only current year options. We use the Murphy (1999) and Coles et al. (2003) one-year approximation method and the Hall and Knox (2002) algorithm to estimate the executive's option portfolio. The correlations of the various option estimation methods are above 99%. Therefore we feel that our results will be unchanged using the various measures of option portfolio estimation (available from the authors upon request).

6.4. Market to book

Previous research has used Tobin's *Q* as a proxy for firm value as a dependent variable and also included debt as an independent variable. This variable and model specification results in debt on the right-hand side and a large portion of the left-hand side. To account for this issue, we rerun our analysis using market to book as the dependent variable. Our conclusions are unchanged using market to book as a dependent variable.

6.5. R&D to sales

Studies have used both R&D scaled by total assets and R&D scaled by total sales as measures of growth opportunities and intangible assets. While we use R&D to total assets in our previous analysis, we also rerun results using R&D to total sales. Our overall conclusions are unchanged using a different specification of the variable.

[23] The Kleibergen-Paap (2006) rk LM statistic for *ppse* and $ppse^2$ is not significant, suggesting that the equation may be underidentified. However, dropping the $ppse^2$ term from the equation results in a Kleibergen-Paap (2006) rk LM statistic that is significant at the 1% level. Our conclusions are unchanged using this model specification. The estimated coefficient for stock and option *ppse* is 0.160, significant at the 5% level ($t=2.42$). The results are reported in the Appendix.

6.6. Specification of incentive measure

Other studies have documented a relation between pay-performance semi-elasticity and risk (Coles et al., 2006) or performance (Brick et al., 2008) using the log of ppse. We rerun our analysis using the log of both *pps* and *ppse*. Our conclusions are unchanged and do not appear to be the result of variable misspecification.

7. Conclusions

Netter et al. (2009) show that corporate control research has increasingly been focused on internal governance mechanisms while attention has turned away from external control. They point out that the research emphasis of the past decade likely reflects what is important in the financial markets. Given the importance of executive compensation and equity ownership as internal governance tools, the question of their relation to firm value is important. Prior research using pay-performance sensitivity as the measure of executive compensation has found equivocal results. We argue that tests with this measure may not have the power to detect a relation should one exist.

Managerial ownership levels change slowly over time. The slow change masks a significant ownership effect when testing the relation between managerial ownership and firm value using firm fixed effects to control for unobserved firm heterogeneity. This occurs because of much smaller within firm variation than between firm variation. We show that pay-performance sensitivity has little year to year change within firm and low power to detect a relation between managerial ownership and firm value. We demonstrate that using pay-performance semi-elasticity as a measure of managerial ownership incentives results in meaningful changes within firm over time and higher power to detect a relation between managerial ownership and firm value.

We also show that the significant non-monotonic relation between managerial ownership percentage, or pay-performance sensitivity, and Tobin's *Q* documented in the literature using pooled OLS regression is driven primarily by the variation between firms. This increases the probability of a type II error when using pay-performance sensitivity with firm fixed effects. However, the coefficients using the between and firm fixed effects estimator with pay-performance semi-elasticity are similar in magnitude. This suggests that when using pay-performance semi-elasticity as a proxy for managerial ownership incentives, the variance within firms is similar in magnitude to the variance between firms. The greater within firm variation amplifies the effect size and increases the power to detect a relation between managerial ownership and firm value using firm fixed effects.

Using pay-performance semi-elasticity, we document a significant inverted U-shaped relation between managerial ownership and Tobin's *Q* in firm fixed effects regression and two-stage least squares regression with firm fixed effects to control for potential endogeneity. Similar to previous studies, this significant U-shaped relation is absent in regressions using pay-performance sensitivity and firm fixed effects. The lack of a relation between pay-performance sensitivity and value may be due to the lack of within firm variability of this measure.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.jcorpfin.2009.08.002.

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