Tournament incentives, firm risk, and corporate policies

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Latest version: June 2011

ABSTRACT

This paper tests the proposition that higher tournament incentives will result in greater risk taking by senior managers in order to increase their chance of promotion to the rank of CEO. Measuring tournament incentives as the pay gap between the CEO and the next layer of senior managers, we find a significantly positive relation between firm risk and tournament incentives. Further, we find that greater tournament incentives lead to higher R&D intensity, firm focus, and leverage but lower capital expenditures intensity. Our results support the hypothesis that option-like features of intra-organizational CEO promotion tournaments provide incentives to senior executives to increase firm risk by following riskier policies. Finally, the compensation levels and structures of executives of financial institutions have received a great deal of scrutiny after the financial crisis. In a separate examination of financial firms, we again find a significantly positive relation between firm risk and tournament incentives.

JEL classification: G31; G32; G34; J31; J33; L14

Keywords: Tournament incentives; Firm risk; Corporate policies

☆We thank Mark Chen, Gerry Gay, Lixin Huang, Linlin Ma, Reza Mahani, Vikram Nanda, Lalitha Naveen, Michael Rebello, and Chip Ryan for helpful comments. We are particularly indebted to Lalitha Naveen for her help in handling the transition in ExecuComp due to accounting changes imposed by the Financial Accounting Standards Board (FAS123R). We are also grateful to an anonymous referee whose comments enabled us to significantly improve the paper. We thank Bunyamin Onal for providing excellent research assistance. Ryan Williams acknowledges research support from the Center for the Economic Analysis of Risk (CEAR) at Georgia State University, the Max Burns Fellowship, and the Steven Smith Fellowship. The usual disclaimer applies.

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1. Introduction

Option-like payoff structures and corresponding risk-taking incentives are pervasive in managerial compensation contracts. The most commonly recognized of these payoff structures are created by option grants and holdings of the chief executive officer (CEO) and other senior executives. Specifically, option-based compensation enhances managerial risk-taking incentives by providing convex payoffs (e.g., Smith and Stulz, 1985; Guay, 1999; Coles, Daniel, and Naveen, 2006; and Chava and Purnanandam, 2010).[1] These risk-taking incentives are accentuated in the presence of large severance contracts (e.g., Lys and Sletten, 2006; and Rusticus, 2006). Such optionality can show up in peer group comparisons for compensation (e.g., Bizjak, Lemmon, and Naveen, 2008; and Faulkender and Yang, 2010).[2] There is optionality embedded in performance-vesting provisions attached to stock and option grants (e.g., Johnson and Tian, 2000; Brisley, 2006; and Bettis, Bizjak, Coles, and Kalpathy, 2010).[3] The literature on relative performance evaluation is also suggestive of embedded options.[4] Finally, there is convexity in part of the typical annual bonus plan (e.g., Healy, 1985; Gaver, Gaver, and Austin, 1995; and Murphy, 1999).

In a similar manner, option-like features of intra-organizational CEO promotion tournaments give senior executives incentives to increase firm risk. Promotion to the CEO's position represents being in the money and the prize is the increase in compensation accompanied by enhanced status and perks. Like risk-taking incentives *(Vega)* based on the functional form of the compensation scheme for a given managerial position (e.g., Guay, 1999; and Coles, Daniel, and Naveen, 2006), the option-like character of

[1] In addition, Chance, Kumar, and Todd (2000) find that managerial stock option exercise prices are frequently revised downwards after stock price declines but not upwards if stock prices increase.

[2] For example, a typical peer-group comparison compensation contract can state, "we pay at the peer median, with increasing pay if the firm outperforms the median." This compensation structure is, however, not without exception. Consider, for example, Pepsico's 2008 DEF-14A filing in which it states, "Our design ensures that our pay-for-performance programs only deliver total compensation at the 75th percentile when financial performance is at or above the peer group 75th percentile. If financial performance were to be below the peer group 75th percentile, total compensation awarded would be below the 75th percentile." Furthermore, in other peer-group compensations structures, the pay can be linear around the targeted peer percentile cutoff.

[3] For example, Bettis, Bizjak, Coles, and Kalpathy (2010) find that a large part of *Vega* incentives arise due to performance vesting provisions.

[4] Specifically, Garvey and Milbourn (2006) find that CEOs are rewarded for good luck but are not penalized for bad luck.

a CEO promotion tournament can provide the incentive for senior executives to increase risk of the outcomes used to evaluate and compare them.[5] In this paper, we use data on a large sample of firms from the ExecuComp database over the period 1994 – 2009 to empirically test the proposition that tournament incentives enhance risk taking within firms.

The compensation structures of the CEO and other top executives of the firm have generated a great deal of attention in the extant literature.[6] While the bulk of the studies have investigated performance-based incentives, there is a growing body of work on promotion-based incentives (also known as tournament incentives) within firms. In a corporation, the question of giving promotion-based incentives to the CEO does not arise because she already holds the highest position within the firm. Thus, she will need to only be given performance-based incentives for her to expend greater effort. The next layer of executives within the firm will, however, respond to both promotion-based and performance-based incentives (see, e.g., Green and Stokey, 1983; and Baker, Jensen, and Murphy, 1988). Senior executives will be judged by their performance because true underlying ability is not easily discernible. In a rank-order tournament, the senior executive with the highest relative output will typically win the tournament, get promoted to the rank of CEO, and receive the promotion prize. Lazear and Rosen (1981) and Prendergast (1999) argue that the effort expended by agents will increase with the magnitude of the promotion prize. Thus, if each senior executive views the likelihood of promotion to CEO as being the same, then firms can generate greater effort from them by increasing the size of the promotion prize, i.e., the pay gap between the CEO and these senior executives (Bognanno, 2001). Consequently, the payoff from this greater effort will be better firm performance and higher firm value. In a recent paper, Kale, Reis, and Venkateswaran (2009) provide evidence to this effect.

The focus of our paper is, however, on whether tournament incentives shape managerial risk taking behavior. In a recent paper primarily focused on CEO overconfidence, corporate governance, and

[5] Note that the incentives arising from the promotion tournament are distinct from and incremental to performance-based incentives (*Delta*) and risk-taking incentives (*Vega*) arising from the compensation schemes of the CEO and senior executives.

[6] See, for example, Aggarwal and Samwick (2003, 2006), Jensen and Murphy (1990), Core and Guay (2002), Core, Guay, and Larcker (2003), and Coles, Daniel, and Naveen (2006) for a review of this literature.

corporate behavior, Goel and Thakor (2008) also theoretically model the relation between tournament incentives and corporate risk taking. In their model, if every senior executive chooses the same level of risk as her competitors in the CEO promotion tournament then they will all have the same output at the end of the period. The probability of getting promoted for all the senior executives will also be the same because their ability is *a priori* the same. Each executive can increase her own promotion probability by taking on riskier projects. The logic here is that extreme outcomes will be more likely with greater project risk even if the mean outcome remains the same and, therefore, when the output of all executives is high, the risk-taking executive's output will tend to be higher than that of her competitors. The executive with the highest output will get promoted because the Board of Directors/CEO cannot discern whether it was the executive's ability or the higher project risk that resulted in the higher output. Given that each executive will have the same incentive to take on greater risk, a Nash equilibrium will imply that all executives take on greater risk than they would have in the absence of these tournament incentives. The basic trade-off in their model is between the costs to the executive due to reduced utility from riskier compensation versus the benefits to her from increasing her promotion probability. As a consequence of this tradeoff, the chosen risk level for all senior executives will increase with the promotion prize.

In this paper, we test the above proposition that option-like features of intra-organizational CEO promotion tournaments enhance risk taking within firms by first examining the relation between different proxies for firm risk and tournament incentives. We use stock return volatility and seasonally-adjusted cash flow volatility to proxy for risk and measure tournament incentives as the pay gap between the CEO and the next layer of senior managers. Our tests indicate that managerial risk taking behavior increases with tournament incentives for both non-financial and financial firms. In order to understand the mechanisms through which tournament incentives affect firm risk, we additionally investigate the manner in which promotion-based incentives influence various operating and financial policies of non-financial firms. We find that tournament incentives enhance R&D intensity, firm focus, and leverage but reduce capital expenditure intensity. These results are consistent with the notion that promotion-based incentives lead to riskier policy choices. In the process, we provide insight into the question of "how" these tournament-based incentives manifest themselves into higher firm risk. Further, all the above documented relations are not only statistically significant but also economically meaningful. In addition, our tests reveal that tournament incentives are higher in riskier, more focused, and possibly more innovative firms. Thus, we are inclined to conclude that the tournament incentives provided by the board are an optimal response to the opportunities and constraints facing the firm.

In our tests, we control for the performance-based incentives and risk-taking incentives of the CEO (*CEO Delta* and *CEO Vega*) and other senior executives (*VP Delta* and *VP Vega*) that arise from their holdings and grants of stocks and options. Our results are robust to different proxies for tournament incentives and also a variety of methods to control for endogeneity. Specifically, in addition to computing the pay gap in several different ways, we also repeat our tests using the Gini coefficient to compute income disparity among the top executives as an alternative measure of tournament incentives. Our empirical methodology includes the estimation of: (i) OLS regressions in which all the incentive variables are lagged, (ii) 2SLS regression models in which the lagged incentive variables are instrumented, (iii) simultaneous equation models in which firm risk/policy choice and incentive variables are simultaneously estimated using an instrumental variable approach, and (iv) 3SLS regression models in which the relation between firm risk/policy choice and incentive variables are simultaneously estimated. Finally, we also repeat our tests after removing CEO turnover-related years from our sample. Through all these tests, we find consistent support for the proposition that CEO promotion-based incentives have the effect of enhancing firm risk by giving senior executives incentives to implement riskier policy choices.

Our paper makes contributions to both the current public policy debate and the extensive literature on the incentives provided by the board of directors to top managers. First, it has direct implications for the heated public debate on the structure of compensation of top executives. Specifically, the structure of their incentive compensation has been blamed for excessive risk-taking in firms. This issue has generated a direct response from regulators. For example, in a speech before the 2010 National Association of Corporate Directors (NACD) Annual Corporate Governance Conference, the SEC Chairman, Mary L. Schapiro, states,

> "Further, since misaligned or poorly-calibrated incentive compensation programs were widely believed to have promoted inappropriate risk-taking that contributed to the financial crisis, we added a requirement that companies assess whether their compensation programs expose them to material risks.
>
> This requirement applies to compensation throughout the company—not just the executive ranks—and to companies in all industries, not just financial firms. I think it is vital that boards understand how compensation practices affect risk-taking, and this new requirement brought that issue front and center for boards."

The findings in our paper provide boards of both non-financial and financial firms with an additional dimension—tournament incentives—that they need to consider in assessing whether their compensation programs expose their firms to material risk.

Second, it also has implications for the recent public outcry regarding high CEO compensation. CEO salaries have been under fire from politicians, unions, regulators, and academics for being too high in relation to the average workers' salary mainly based on arguments related to fairness and equity.[7] These high salaries have also been cited as examples of CEOs hijacking the pay setting process in firms (e.g., Bertrand and Mullainathan, 2001; and Bebchuk and Fried, 2004).[8] We find that the correlation between CEO pay and tournament incentives is about 0.75 and, thus, senior executives are likely to have greater risk-taking incentives in firms in which the CEO's compensation is higher. We, thus, add another dimension to the debate about the level of CEO pay that has been ignored thus far; that is, high CEO compensation can also provide greater risk-taking incentives through increased tournament incentives.

Third, the extant literature has typically focused on the incentives of the CEO partly due to the belief that senior executives below the rank of the CEO are unlikely to have a significant influence in shaping firm investment and financial policies. More recently, however, studies have started to examine the

[7] As a response, the 2010 Dodd-Frank Wall Street Reform and Consumer Protection Act requires firms to report the total compensation of the CEO, the median annual compensation of all employees other than the CEO, and the ratio of these two amounts. Given concerns about excessive risk taking, our study would call for firms to report the median (mean) total compensation of senior executives or more directly the "pay gap" measured as the difference between the total compensation of the CEO and the median (mean) total compensation of senior executives. Further, as a benchmark, they can also be asked to provide the mean (median) pay gap in the firm's industry or for its peer group.

[8] Gabaix and Landier (2008) offer an opposing perspective. Specifically, they document that the increase in both the level of CEO pay and its ratio to that of the average worker has been accompanied by a corresponding increase in the size and complexity of U.S. publicly traded firms from 1980-2003.

incentives of senior executives of the firm and typically document that their incentives also do matter. Not surprisingly, the accounting and financial economics literatures focus on the incentives of the CFO on firms' financial policies (e.g., Geczy, Minton, and Schrand, 2007; Jiang, Petroni, and Wang, 2010; and Chava and Purnanandam, 2010). For example, Jiang, Petroni, and Wang (2010) find that greater equity-based incentives of the CFO have an effect on accrual management that is independent of the CEO's incentives. Chava and Purnanandam (2010) find that CFOs' risk-taking incentives lead to riskier debt maturity choices and lesser accrual management. In contrast to just examining the incentives of the CFO, Coles, Daniel, and Naveen (2006) examine the *Delta* and *Vega* incentives of *all* senior executives and find that management team *Delta*, and to a lesser extent, management team *Vega*, affect firm policy choices. In a similar vein, Kale, Reis, and Venkateswaran (2009) find that larger tournament incentives faced by senior executives are associated with better firm performance and firm value. We add to this nascent literature by documenting that senior executives facing option-like features of intra-organizational promotion tournaments will increase firm riskiness by undertaking riskier investment and financial policies.

Fourth, our paper informs on the literature related to CEO succession planning. The extant literature on succession planning has typically cast it in terms of two alternative models of succession – passing the baton versus horse race/tournament (see, e.g., Vancil, 1987; Baliga, Moyer, and Rao, 1996; Brickley, Coles, and Jarrell, 1997; and Naveen, 2006). We, however, view these two models of succession as being intrinsically linked with one another. Consistent with the passing the baton model, we find that both the proportion of firms with a succession plan in place (a VP with the title of either COO or President) and the proportion of firms in which the CEO also holds the title of Chairman (CEO duality) increase steadily with CEO tenure. Over our entire sample period 1994 – 2009, the mean proportion of firm-year observations with a designated successor is 63%. The number of firms that had a designated successor at any point over our entire sample period is 96%.[9] It, therefore, appears that almost all firms in the ExecuComp sample do some form of succession planning and that a pure horserace/tournament is the exception rather than the rule. Interestingly, in about 26% of cases, where there is CEO turnover with a succession plan in place and the new CEO is from inside the firm (inside CEO succession), some insider other than the designated successor is promoted to the rank of CEO. Perhaps, the most telling statistic is that amongst all the designated successors listed on the ExecuComp database, 77% of them never became the CEO in the firm in which they are listed as the designated successor.[10] Naveen (2006) gives the example of the board of Abbott Labs sacking its Chairman and CEO Robert Schoellhorn after he fired three consecutive designated successors. Thus, we believe that CEO promotion tournaments, and their resulting risk taking incentives, are always in play regardless of whether there is a designated successor or not.

Fifth, we complement the work by Kale, Reis, and Venkateswaran (2009) who demonstrate that firms with larger tournament incentives tend to perform better and have higher firm value. Our study shows that these same tournament incentives also increase managerial risk-taking behavior in firms. The evidence in these two papers is not incongruent but, taken together, suggests that boards that try to create value by providing promotion-based incentives to their senior executives to motivate them to expend greater effort, do so by also inducing them to choose riskier firm policies. Further, our results also suggest that senior executives in riskier, more focused, and possibly innovative firms are given greater tournament incentives. Taken together, we believe that these results appear to indicate that tournament incentives are optimal responses by boards to the economic forces facing the firm. Finally, Coles, Daniel, and Naveen (2006) argue that "…it is critical to account for how policy choices and characteristics of managerial compensation scheme are jointly determined." We extend their paper by *also* simultaneously determining

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[9] These numbers are likely to be understated because a firm may not make the name of the designated successor publicly known or the designated successor may have been given a title other than COO or President (see, e.g., Naveen, 2006).

[10] Note that although this number is likely to be overstated because it includes successors who may be promoted to CEO in the future, this number never falls below 70% even after various attempts to control for right censoring (such as eliminating successors still waiting to be promoted to CEO in 2009).

promotion-based incentives. Consistent with the results reported in their paper, we find that firms with greater *CEO Delta* (*VP Delta*) tend to choose less risky firm policies.

The remainder of this paper is organized as follows. Section 2 gives an overview of the sample selection procedure and describes the data. Section 3 examines the relation between firm risk/corporate policies and tournament incentives after exercising experimental control for the CEO's *Delta* and *Vega* incentives. In Section 4, we examine the effect of tournament incentives on firm risk/corporate policies after also controlling for the *Delta* and *Vega* incentives of the senior executives of the firm. Section 5 presents a description of the robustness tests that we conduct. We examine the relation between firm risk and tournament incentives for a sample of financial firms in Section 6. Section 7 provides a summary of our results and some concluding remarks.

2. Sample selection and data description

Our initial sample consists of all ExecuComp firms from 1994 to 2009. We include a firm-year in the sample even if ExecuComp lists just one senior executive in addition to the CEO in that year.[11] Following Kale, Reis, and Venkateswaran (2009), we refer to these non-CEO senior executives as "VPs". We exclude utilities and financial firms (SIC codes between 4900 – 4999 and 6000 – 6999, respectively). We obtain all financial statement data from the Compustat files and stock returns data from the CRSP files. We calculate *Pay Gap*, *CEO Delta*, and *CEO Vega* as measures of tournament incentives, CEO alignment incentives, and CEO risk-taking incentives, respectively using data on ExecuComp. This database was modified for the post-2005 period in response to the passage of FAS 123R on December 12, 2004. Our procedure is designed to deal with this transition in such a way to make the computation of all relevant ExecuComp variables consistent throughout the entire sample period, and is detailed in the Appendix. The descriptive statistics on compensation structure variables, firm characteristics, and industry characteristics are provided in Table 1. All variables are winsorized at their 1% and 99% values.

[11] There are no firms on the ExecuComp database that have information on CEO compensation and do not have data on the compensation of at least one senior executive. Our results are similar when we restrict our sample to firms that have compensation data available on at least two senior executives on ExecuComp.

2.1. Tournament or promotion-based incentives

We measure tournament or promotion-based incentives as the pay gap between the CEO and the next rung of senior managers (*Pay Gap*). It is defined as the difference between the CEO's total compensation package (ExecuComp variable *TDC1*) and the median VP's total compensation package. This variable serves as a proxy for a firm's tournament incentives by capturing the increase in a median VP's salary if she wins the promotion tournament. We remove former CEOs who remain with the firm in an executive role from the tournament by eliminating their compensation when identifying the median VP compensation.[12] After this correction, we have 1,118 firm-year observations where the pay gap between the CEO and median VP is negative; these observations are dropped from our sample in our primary set of tests.[13] Our final sample consists of 19,333 firm-year pay gaps with a mean (median) pay gap of around $3.03 million ($1.42 million). The above statistics reflect the fact that the *Pay Gap* is adjusted for inflation to 2003 dollars.

2.2. CEO alignment incentives and risk-taking incentives

We control for CEO alignment and CEO risk-taking incentives by constructing her total portfolio delta (*CEO Delta*) and total portfolio vega (*CEO Vega*), respectively. *CEO Delta* is the dollar increase in a CEO's portfolio wealth for a percentage increase in the underlying stock price, while *CEO Vega* is the dollar increase in a CEO's portfolio wealth for a 0.01 increase in the standard deviation of underlying stock volatility. We follow Coles, Daniel, and Naveen (2006) in constructing these variables. The portfolio delta is a weighted average of the delta of a CEO's stock holdings and her option holdings. The portfolio vega is the vega of a CEO's option holdings. The vega of stock is ignored because Guay (1999)

[12] For example, upon retiring as CEO, Bill Gates became the "Chief Software Architect" and continued to be compensated significantly more than Steve Ballmer, who replaced Gates as CEO.

[13] We manually examine the firm-years with negative pay gaps. We use newspaper articles and CEO biographies and note that nearly all of these observations were cases where the current CEO was a founder and received nominal or no compensation. For these observations, the calculated pay gap is unlikely to be a good proxy for the firm's tournament incentives. In robustness tests described later in the paper, we keep these firms in the sample but compute the *Pay Gap* for them by either replacing the CEO's compensation by the industry median CEO compensation, replacing the pay gap with the industry median pay gap, replacing the CEO's compensation with the CEO's compensation of an industry- and size-matched firm, or by adding a constant that makes the pay gap positive for all firm-years in the sample.

finds that the vega incentives provided by stock compensation is insignificant compared to the effect from options.

To value the options for the delta and vega calculations, we use the dividend-adjusted Black-Scholes model (see, e.g., Black and Scholes, 1973; and Merton, 1973). Because ExecuComp only explicitly gives detailed information on current option grants, we make the following assumptions about T, the time to maturity, and X, the exercise price: (i) If there are no option grants in the current year, we set T equal to nine years for unvested previously granted options and six years for previously vested options, (ii) If there are current option grants with T less than three years, we set the T for all previously granted options equal to the T for current options, and (iii) For current option grants with T greater than or equal to three years, we set unvested previously granted options to (T – 1), and vested previously granted options to (T – 2).

We obtain the "moneyness" of previously granted options by finding the realizable value of previously granted options (the difference between the realizable value of all options less the realizable value of current options), and then divide it by the number of previously granted options. We estimate the exercise prices of previously granted options by subtracting this calculated moneyness from the current stock price. We compute the delta and vega separately for newly granted options, vested options, and unvested options. The weighted averages of these three categories are the total option delta and vega, respectively.

Our final sample has a mean (median) total portfolio delta (*CEO Delta*) of $421,787 ($158,450) and a mean (median) total portfolio vega (*CEO Vega*) of $194,437 ($70,637). Again, these statistics reflect the fact that both *CEO Delta* and *CEO Vega* are adjusted for inflation by scaling to 2003 dollars. We express *CEO Delta* and *CEO Vega* in millions of dollars in our multivariate tests.

2.3. Firm policies and characteristics

We use seasonally-adjusted cash flow volatility (*Cash Flow Volatility*) and one-year stock return volatility (*Return Volatility*) as proxies for firm risk. *Cash Flow Volatility* is the seasonally-adjusted standard deviation of cash flows over assets for a five year window (year t to year t+4). We require at least a three-year window to compute this variable. The variable is calculated using Compustat quarterly data. We first define quarterly cash flows over assets as EBITDA/Total Assets (Compustat data items *EBITDA/AT*). For each of the four quarters in the year, we first calculate their mean values across the five-year window and then subtract these quarterly mean values from their respective quarterly values. We then compute the standard deviation of these seasonally-adjusted cash flows over assets over the period year t to year t+4.[14] This variable has a mean (median) value of 0.017 (0.011). *Return Volatility* is defined as the standard deviation of daily CRSP stock returns for a given calendar year. This variable has a mean (median) value of 0.029 (0.025).

We also examine whether firm policies, specifically R&D intensity, capital expenditures intensity, firm focus, and firm leverage are influenced by tournament incentives. We define *R&D Intensity* as R&D expenditures divided by total assets (Compustat data items *XRD/AT*) and *CAPEX Intensity* as capital expenditures divided by total assets (Compustat data items *CAPX/AT*). If a firm does not report *XRD* (or *CAPX*), we assume its value to be zero. *Firm Focus* is computed as the segment sales-based Herfindahl index. We use the Compustat segment file to identify a firm's segment sales. These segments are identified at the four-digit SIC code level. *Firm Focus* is equal to one if the firm operates solely in one segment, and decreases as the firm diversifies. *Book Leverage* is defined as short-term interest bearing debt plus long-term debt divided by total assets (Compustat data items *(DLC+DLTT)/AT*). The mean (median) values for *R&D Intensity*, *CAPEX Intensity*, *Firm Focus*, and *Book Leverage* are 0.033 (0.002), 0.059 (0.043), 0.844 (1.000), and 0.225 (0.211), respectively.

2.4. Control variables and instruments

We also use a number of firm characteristics and managerial characteristics as control variables and instruments. We define *Ln[Assets]* as the natural logarithm of total book assets (Compustat data item *AT*), and *Sales Growth* as [($Sales_t$/ $Sales_{t-1}$) – 1], using Compustat data item *REVT* for sales. The mean (median) value for *Ln[Assets]* is \$7.721 million (\$7.077 million). This translates into the mean (median) value of total assets being equal to \$2,255.21 million (\$1,184.41 million). The mean (median) value for

[14] Our regression results are similar if we compute the volatility of cash flows over assets without the seasonal adjustment.

Sales Growth is 0.106 (0.077). *Tobin's Q* is defined as the market value of assets divided by the book value of assets (Compustat data items *(AT + CSHO*PRCC – CEQ – TXDB)/AT*). *ROA* is defined as net income divided by total assets (Compustat data items *NI/AT*). The mean (median) values for *Tobin's Q* and *ROA* are 2.013 (1.607) and 0.028 (0.050), respectively.

CEO Turnover is a dummy variable equal to one if a turnover occurred in the observation year, and is equal to zero otherwise. We find that 11.7% of CEOs turn over each year. *CFO is VP* is a dummy variable equal to one if the CFO is listed as a top five highest paid executive in the current year, and is equal to zero otherwise. We find that the CFO is a senior executive in 80.1% of our firm-year observations. *Inside CEO* is a dummy variable equal to one if the current CEO ascended to his position from within the firm, and zero if he was an outside hire. In our sample, 65.2% of the CEOs are insiders. *Succession Plan* is a dummy variable equal to one if the firm lists a President and/or COO as a top five highest paid executive in the current year, and is equal to zero otherwise. We find that 62.8% of firms in our sample have a succession plan. *CEO Tenure* is the number of years since the CEO was promoted to her position, and *CEO Age* is the current age of the CEO. The mean (median) values for *CEO Tenure* and *CEO Age* are 7.84 years (6.00 years) and 55.28 years (55.00 years), respectively. Finally, *Number of VPs* is the number of non-CEO senior executives with compensation information listed on the ExecuComp database. The mean (median) value for *Number of VPs* is 4.94 (5.00).

Following Kale, Reis, and Venkateswaran (2009), all the above variables are potential instruments for tournament incentives in our tests that use instruments to correct for endogeneity. The specific instruments that we employ for tournament incentives in the paper are *Number of VPs*, *CFO is VP*, *Succession Plan*, and *Inside CEO*. Roberts and Whited (2011) argue that the most important characteristic for a valid instrument is that it should affect the second-stage variable only through its effect on the first-stage endogenous variable based purely on economic arguments. We believe that the above instruments meet this condition. For example, Kale, Reis, and Venkateswaran (2009) argue that if the number of VPs is higher, then the probability of any given VP winning the tournament is lower, thereby resulting in a higher pay gap to compensate for the lower probability of succession. Similarly, they argue that if the

CFO is a VP, the probability of other VPs being promoted is higher because CFOs typically have a low probability of becoming CEOs (e.g., Mian, 2001). Thus, the probability of one of the other VPs being promoted to the rank of CEO will be higher and, therefore, will result in a lower pay gap. Clearly, we can make economic arguments why these instruments will have a bearing on the pay gap. We would, however, be hard pressed to make intuitive economic arguments why the *Number of VPs* or *CFO is VP* will have a direct systematic effect on either firm risk and/or any of the firm policies we examine in this paper.

We employ *Industry-Median CEO Delta* and *Industry-Median CEO Vega* as instruments for *CEO Delta* and *CEO Vega*, respectively. The mean (median) value for *Industry-Median CEO Delta* is $185,982 ($163,985), while the mean (median) value for *Industry-Median CEO Vega* is $89,623 ($74,540). We believe that these are valid instruments because industry compensation structure may set the standard for the compensation structure of any given firm in the industry. At the same time, it is unlikely that these industry-level instruments will have a direct impact on firm risk/policy (after adjusting for industry and year fixed effects).[15] Further, it is less likely that industry-level variables will be affected by any individual firm's decisions and, therefore, they are more likely to be orthogonal to the residuals of the second-stage firm risk/policy regression than any firm-level instruments.

We use *Industry-Median Cash Flow Volatility* and *Industry-Median Return Volatility* as instruments for *Cash Flow Volatility* and *Return Volatility*. The mean (median) values for *Industry-Median Cash Flow Volatility* and *Industry-Median Return Volatility* are 0.012 (0.011) and 0.027 (0.025), respectively. Finally, we utilize *Industry-Mean R&D Intensity*, *Industry-Median Sales Growth, Industry-Median Firm Focus*, and *Industry-Median Z-Score* (Altman, 1968) as instruments for *R&D Intensity*, *CAPEX Intensity*, *Firm Focus, and Book Leverage*; and the mean (median) values for these instruments are 0.033 (0.011), 0.078 (0.082), 0.928 (1.000), and 5.931 (5.101), respectively.[16]

[15] With industry and year fixed effects, the identification of the coefficients on the endogenous variables is based on the time-series and cross-sectional variation of the industry level instruments.

[16] In addition to the instruments listed above, we also use *Average Moneyness* of the CEO's option holdings as a potential instrument for either *CEO Delta* or *CEO Vega*. In an earlier draft of their paper, Coles, Daniel, and Naveen

3. Firm risk, corporate policies, and tournament incentives

In this section, we first examine whether rank-order tournament incentives affect the level of risk undertaken by managers. We examine two measures of risk. The first measure is *Cash Flow Volatility* measured from year t through year t+4, while the second measure is *Return Volatility* for the calendar year t. We next examine the avenues through which these tournament incentives affect firm risk. Specifically, we examine whether tournament incentives affect corporate policies like R&D intensity, capital expenditures intensity, firm focus, and firm leverage. For each measure of firm risk/policy, we estimate the following specification using an OLS regression approach.[17]

$$Risk/Policy_{i,t} = \beta_0 + \beta_1 Ln[Pay\ Gap]_{i,t-1} + \beta_2 CEO\ Delta_{i,t-1} + \beta_3 CEO\ Vega_{i,t-1} + \beta_4 CEO\ Tenure_{i,t} + \beta_5 Ln[Assets]_{i,t} + \beta_6 Tobin's\ Q_{i,t} + \beta_7 Sales\ Growth_{i,t} + \beta_8 Book\ Leverage_{i,t} + \beta_9 ROA_{i,t} + \text{Two-digit SIC industry dummies} + \text{Year dummies} + \varepsilon_{i,t.} \quad (1)$$

Notice that in both these approaches, all the incentive variables are lagged by one year. Using lagged independent variables alleviates but does not eliminate issues related to endogeneity in the OLS approach (Column 2 in the subsequent tables). Therefore, in the second specification, we use a 2SLS regression approach to better account for the fact the *Pay Gap*, *CEO Delta*, and *CEO Vega* are all determined endogenously (Column 3 in the subsequent tables). Under this approach, we first compute the predicted values of *Ln[Pay Gap]*, *CEO Delta*, and *CEO Vega* by estimating three first-stage regressions in which each incentive variable is the dependent variable and the independent variables include all the exogenous variables from the second-stage risk/firm policy regression and the chosen instruments. The predicted values of *Ln[Pay Gap]*, *CEO Delta*, and *CEO Vega* are then employed as independent variables in lieu of their actual values in the second-stage risk/firm policy regression. Thus, we estimate the following specification using the 2SLS regression methodology:

(2006) demonstrate that *Average Moneyness* is related to both *CEO Delta* and *CEO Vega* incentives and, thus, it can serve as a potential instrument for either of them. We also employ *Industry-Median CAPEX Intensity* and *Industry-Median Book Leverage* as potential instruments for *CAPEX Intensity* and *Book Leverage*, respectively. These instruments did not pass the relevance and validity conditions for instruments that we describe later in the paper.

[17] For the specifications where the dependent variable is *Book Leverage*, we remove it from the right-hand side and control for *R&D Intensity* instead.

$$Risk/Policy_{i,t} = \beta_0 + \beta_1 Predicted\ Ln[Pay\ Gap]_{i,t-1} + \beta_2 Predicted\ CEO\ Delta_{i,t-1} + \beta_3 Predicted\ CEO\ Vega_{i,t-1} + \beta_4 CEO\ Tenure_{i,t} + \beta_5 Ln[Assets]_{i,t} + \beta_6 Tobin's\ Q_{i,t} + \beta_7 Sales\ Growth_{i,t} + \beta_8 Book\ Leverage_{i,t} + \beta_9 ROA_{i,t} + \text{Two-digit SIC industry dummies} + \text{Year dummies} + \varepsilon_{i,t.} \quad (2)$$

As we argue earlier, we employ instruments in our 2SLS regression methodology that are likely to affect the second-stage firm risk/policy variable only through their effect on the endogenous incentive variables (see, e.g., Roberts and Whited, 2011). In addition to selecting our instruments based on economic arguments, we require them to pass an array of relevance (correlation with the endogenous variable) and validity (orthogonality to the residual) conditions. First, we require the coefficient for each instrument to be statistically significant in the first stage regressions, thereby indicating that the instruments are individually relevant. Second, we ensure that the *F*-statistic associated with each endogenous variable is statistically significant, thereby indicating that the chosen instruments are jointly relevant. Third, we make sure that the Hansen J-statistic is unable to reject the null of exogeneity, thus providing support for the validity of our instruments. Fourth, we employ the Anderson-Rubin F-statistic to test whether the endogenous variables are jointly significant. Finally, we use the difference in the Sargan C-statistic (χ^2) to check for the presence of omitted variables that potentially bias our coefficient estimates, and thereby make sure that the use of the 2SLS methodology is appropriate. We report the results of these tests along with the instruments we use in the first stage regressions in the bottom panel of the estimated 2SLS regressions in the tables that follow.

Finally, we use *contemporaneous* values for *Risk/Policy*, *Ln[Pay Gap]*, *CEO Delta*, *CEO Vega*, and all the control variables specified in Equation (1), and then estimate the system *simultaneously* using an instrumental variables approach. The structural setup is described in equations (3) – (6):

$$Risk/Policy_{i,t} = \beta_0 + \beta_1 Predicted\ Ln[Pay\ Gap]_{i,t} + \beta_2 Predicted\ CEO\ Delta_{i,t} + \beta_3 Predicted\ CEO\ Vega_{i,t} + \beta_4 CEO\ Tenure_{i,t} + \beta_5 Ln[Assets]_{i,t} + \beta_6 Tobin's\ Q_{i,t} + \beta_7 Sales\ Growth_{i,t} + \beta_8 Book\ Leverage_{i,t} + \beta_9 ROA_{i,t} + \beta_{10} Risk/Policy\ Instrument_{i,t} + \text{Two-digit SIC industry dummies} + \text{Year dummies} + \varepsilon_{i,t.} \quad (3)$$

$$CEO\ Delta_{i,t} = \beta_0 + \beta_1 Predicted\ Ln[Pay\ Gap]_{i,t} + \beta_2 Predicted\ CEO\ Vega_{i,t} + \beta_3 Predicted\ Risk/Policy_{i,t} + \beta_4 CEO\ Tenure_{i,t} + \beta_5 Ln[Assets]_{i,t} + \beta_6 Tobin's\ Q_{i,t} + \beta_7 Sales\ Growth_{i,t} + \beta_8 Book\ Leverage_{i,t} + \beta_9 ROA_{i,t} + \beta_{10} CEO\ Delta\ Instrument_{i,t} + \text{Two-digit SIC industry dummies} + \text{Year dummies} + \varepsilon_{i,t.} \quad (4)$$

$$CEO\ Vega_{i,t} = \beta_0 + \beta_1 Predicted\ Ln[Pay\ Gap]_{i,t} + \beta_2 Predicted\ CEO\ Delta_{i,t} + \beta_3 Predicted\ Risk/Policy_{i,t} + \beta_4 CEO\ Tenure_{i,t} + \beta_5 Ln[Assets]_{i,t} + \beta_6 Tobin's\ Q_{i,t} + \beta_7 Sales\ Growth_{i,t} + \beta_8 Book\ Leverage_{i,t} + \beta_9 ROA_{i,t} + \beta_{10} CEO\ Vega\ Instrument_{i,t} + \text{Two-digit SIC industry dummies} + \text{Year dummies} + \varepsilon_{i,t.} \quad (5)$$

$$Ln[Pay\ Gap]_{i,t} = \beta_0 + \beta_1 Predicted\ CEO\ Delta_{i,t} + \beta_2 Predicted\ CEO\ Vega_{i,t} + \beta_3 Predicted\ Risk/Policy_{i,t} + \beta_4 CEO\ Tenure_{i,t} + \beta_5 Ln[Assets]_{i,t} + \beta_6 Tobin's\ Q_{i,t} + \beta_7 Sales\ Growth_{i,t} + \beta_8 Book\ Leverage_{i,t} + \beta_9 ROA_{i,t} + \beta_{10} Tournament\ Instrument_{i,t} + \text{Two-digit SIC industry dummies} + \text{Year dummies} + \varepsilon_{i,t.} \quad (6)$$

The instruments that we use for the incentive measures are identical to those that pass all the relevance and validity conditions in the estimated 2SLS specifications. We also add an instrument for the simultaneously estimated risk/policy measure. In this methodology, each endogenous variable in the system (*Risk/Policy*, *Ln[Pay Gap]*, *CEO Delta*, and *CEO Vega*) is first regressed against all the exogenous variables in the system, and then their predicted values are computed. Next, each endogenous variable is regressed against both the predicted values of the other three endogenous variables and the control variables. Thus, we report four estimated regressions for the system where the dependent variable in each specification is *Risk/Policy*, *CEO Delta*, *CEO Vega*, and *Ln[Pay Gap]*, respectively (Columns 4 through 7 in subsequent tables).

Because our regressions make use of firm-year level observations, the residuals in our regressions may be correlated since each firm can enter the sample several times, thereby overstating *t*-statistics because of the "cluster sample" problem (e.g., Wooldridge, 2002; and Petersen, 2009). We correct for this problem by employing adjusted standard errors that account for possible correlations between residuals for observations for a firm. These standard errors are also robust to the presence of arbitrary heteroskedasticity. Finally, we also control for industry and year fixed effects in all the regression specifications. The industry fixed effects are at the two-digit SIC level.

Finally, we assess the economic impact of each of our incentive variables on firm risk/policy by computing the change in the measure of firm risk/policy expressed in terms of its standard deviation for a one standard deviation change in the incentive variable of interest. For *CEO Delta* and *CEO Vega*, we multiply the coefficient on the incentive variable by its standard deviation to obtain the change in firm risk/policy. We then divide this change by the standard deviation of the firm risk/policy variable in the relevant regression sample to compute economic significance. Because we use *Ln[Pay Gap]* as the measure of tournament incentives in the regressions, the economic significance is easier to interpret if it is computed in terms of a one standard deviation change in *Pay Gap* itself. To achieve this goal, we first compute the level of pay gap that is 0.5 standard deviations below its mean (low pay gap) and 0.5 standard deviations above its mean (high pay gap). We then compute the difference between the natural logarithm of the high pay gap less the natural logarithm of the low pay gap. We apply this difference to the coefficient on *Ln[Pay Gap]* in our regressions to compute the change in the firm risk/policy variable. Finally, we divide this change by the standard deviation of the firm risk/policy variable in the relevant regression sample to compute economic significance. By doing so, we assess the economic significance of tournament incentives as the number of standard deviation changes in firm risk/policy for a standard deviation change in *Pay Gap* centered on its mean.

3.1. Risk and tournament incentives

In this sub-section we examine the relation between measures of firm risk and tournament incentives. In Table 2, we use *Cash Flow Volatility* as the proxy for risk, and in Table 3 we use *Return Volatility* as the proxy for risk.

3.1.1. Cash flow volatility and tournament incentives

Table 2 reports the findings from our investigation of the relation between seasonally-adjusted cash flow volatility and tournament incentives. The results from the OLS regression are reported in Column 2. We find that the coefficient on *Ln[Pay Gap]* is 0.0009 and is significantly positive at the one percent level. This result is consistent with the proposition that greater tournament incentives will result in higher risk taking by firm managers. In terms of economic significance, a one standard deviation increase in *Pay Gap* (and not *Ln[Pay Gap])* centered on its mean results in 0.10 standard deviations increase in *Cash Flow Volatility*. In addition, the coefficient on *CEO Vega* is 0.0022 and is also significantly positive at the one percent level. Although Coles, Daniel, and Naveen (2006) do not examine this particular measure of risk, it is consistent with their findings that the firm's risk level is higher if the CEO has greater risk-taking incentives. Again, in terms of economic impact, a one standard deviation change in *CEO Vega* results in 0.04 standard deviations change in *Cash Flow Volatility*.

Using lagged values for risk-taking and alignment incentives may only partially account for the fact that these incentives are endogenous. To more explicitly account for endogeneity, we utilize the 2SLS regression methodology. In this analysis, we endogenize *Ln[Pay Gap]*, *CEO Delta*, and *CEO Vega*. We employ *Number of VPs*, *Inside CEO*, *Industry-Median CEO Delta*, and *Industry-Median CEO Vega* as instruments in this analysis. Each instrument was individually significant at the ten percent level or less in at least one of the first stage regressions. Further, the F-statistics for each endogenous variable (first-stage regression) are all greater than 10.00 and are statistically significant at the one percent level. The Anderson-Rubin F-test for joint relevance indicates that endogenous variables are jointly significant at the one percent level. The Hansen J-statistic is 0.006 and is insignificantly different from zero, thereby indicating that the instruments are valid. Finally, the difference in Sargan C-statistic is significant at the one percent level indicating that endogeneity is an issue given the chosen instruments, and that the 2SLS methodology is appropriate.

The coefficient estimates from the second-stage of the 2SLS regression methodology are presented in Column 3. The coefficient on *Predicted Ln[Pay Gap]* is now 0.0072 and is significantly positive at the five percent level. This coefficient implies that a one standard deviation increase in *Pay Gap* centered on its mean results in 0.88 standard deviations increase in *Cash Flow Volatility*. Thus, even after controlling for endogeneity, we find that risk taking is higher in firms when top-level managers are given greater tournament incentives. Furthermore, the economic impact of tournament incentives on risk taking in firms appears to be highly significant. The coefficients on both *Predicted CEO Delta* and *Predicted CEO Vega* are insignificant.

Columns 4 – 7 present results from the simultaneous estimation of the determinants of *Cash Flow Volatility*, *Ln[Pay Gap]*, *CEO Vega*, and *CEO Delta*. In these estimations, all the variables are contemporaneous. The instruments that we employ in these simultaneous regressions are the same as in the 2SLS regressions reported above since they previously passed our relevance and validity conditions. The only additional instrument we use in this approach is *Industry-Median Cash Flow Volatility*, which we employ as the instrument for our measure of firm risk. The dependent variable in Column 4 is *Cash Flow Volatility*. The coefficient on *Predicted Ln[Pay Gap]* is 0.0244 and is significantly positive at the one percent level, whereas the coefficient on *Predicted CEO Vega* is 0.0143 but is statistically insignificant at conventional levels of significance. The coefficient on *Predicted CEO Delta* is significantly negative at the ten percent level with a coefficient of -0.0071. In terms of economic significance, a one standard deviation increase in *Pay Gap* around its mean results in 1.44 standard deviations increase in *Cash Flow Volatility*, whereas a one standard deviation increase in *CEO Delta* results in 0.31 standard deviations decrease in *Cash Flow Volatility*. In summary, regardless of the methodology we use to control for endogeneity, we find a statistically and economically significant relation between firm risk and tournament incentives.

In Column 5, we find that firm risk, tournament incentives, and CEO risk-taking incentives do not have a significant effect on *CEO Delta*. The coefficients presented in Column 6 indicate that both the CEO alignment incentive and firm risk positively affect CEO risk-taking incentives. Finally, in Column 7, we find the CEO incentive alignment (CEO risk-taking incentives) has no (positive) effect on tournament incentives. Tournament incentives are, however, significantly higher in riskier firms at the one percent level of significance. This last result is consistent with the notion that boards provide greater tournament incentives and, consequently higher risk-taking incentives, to senior executives in firms that operate in riskier environments.

3.1.2. Stock return volatility and tournament incentives

Table 3 reports the results from our investigation of the relation between stock return volatility and tournament incentives. We report the results from the OLS specification in Column 2. We find that the coefficient on *Ln[Pay Gap]* is 0.0004 and is significantly positive at the one percent level. This coefficient suggests that a one standard deviation increase in *Pay Gap* around its mean results in 0.06 standard deviations increase in *Return Volatility*.

The coefficient estimates from the second-stage of the 2SLS regression methodology are reported in Column 3. We treat *Ln[Pay Gap]*, *CEO Vega*, and *CEO Delta* as endogenous variables in this analysis. We employ *Succession Plan*, *Inside CEO*, *Industry-Median CEO Vega*, and *Industry-Median CEO Delta* as instruments in this analysis. These instruments meet all our relevance and validity conditions. The coefficient on *Ln[Pay Gap]* is now 0.0159 and is significantly positive at the one percent level. In terms of economic impact, a one standard deviation in *Pay Gap* results in a 2.07 standard deviations increase in *Return Volatility*. Thus, even after controlling for endogeneity, we find that risk taking is higher in firms when senior executives are given greater tournament incentives. The coefficient on *Predicted CEO Delta* is insignificant, while the coefficient on *Predicted CEO Vega* becomes significantly negative.

Columns 4 – 7 present results from the simultaneous estimation of the determinants of *Return Volatility*, *Ln[Pay Gap]*, *CEO Vega*, and *CEO Delta*. As before, in these estimations, all the variables are contemporaneous. The instruments that we employ in these simultaneous regressions are the same as in the 2SLS regressions reported above since they previously passed our relevance and validity conditions, with the addition of *Industry-Median Return Volatility* to instrument for firm risk. The dependent variable in Column 4 is *Return Volatility*. The coefficient on *Predicted Ln[Pay Gap]* is 0.0180 and is significantly positive at the one percent level. This coefficient translates into 2.27 standard deviations increase in *Return Volatility* for a one standard deviation increase in *Pay Gap* around its mean. Here too the coefficient on *Predicted CEO Delta* is insignificant, while the coefficient on *Predicted CEO Vega* is significantly negative.

In Column 5, we find that *Predicted Return Volatility*, *Predicted CEO Vega*, and *Predicted Ln[Pay Gap]* do not have a significant effect on *CEO Delta*. The coefficients presented in Column 6 indicate that tournament incentives positively affect CEO risk-taking incentives. Finally, in Column 7, we find that *Predicted CEO Delta* has no effect on tournament incentives, while *Predicted CEO Vega* positively affects tournament incentives. Consistent with the result we reported earlier for *Cash Flow Volatility*, we find that tournament incentives are significantly higher in firms with greater *Return Volatility* at the five percent level of significance. This result also provides support for the argument that boards provide higher risk-taking incentives to senior executives in firms that operate in riskier environments.

In summary, regardless of the methodology we use to control for endogeneity or the proxy for risk, we find a significant positive relation between firm risk and tournament incentives. These results support the contention that greater tournament incentives lead to higher risk taking by firm managers. Further, we also document that tournament incentives tend to be higher for firms operating in riskier environments.

3.2. Corporate policies and tournament incentives

In the earlier sub-section, we demonstrated that tournament incentives have a significantly positive effect on risk taking in firms. In this sub-section, we will attempt to understand the avenues through which tournament incentives can influence firm risk. Towards this end, we examine the relation between corporate policies such as R&D intensity, capital expenditures intensity, firm focus, and firm leverage with tournament incentives. Capital expenditures are investments in harder, more tangible assets, as compared to R&D expenditures. Furthermore, the benefits of investments in R&D expenditures are more uncertain than capital expenditures (see, e.g., Bhagat and Welch, 1995; Kothari, Laguerre, and Leone, 2002; and Eberhart, Maxwell, and Siddique, 2004). Thus, R&D expenditures can be viewed as being relatively more risky investments than capital expenditures. The extant literature has also suggested that managerial risk aversion can lead to greater firm diversification (see, e.g., Amihud and Lev, 1981; May, 1995; and Tufano, 1996). Finally, managers can increase firm risk through more aggressive debt policy (see, e.g., Coles, Daniel, and Naveen, 2006). Thus, if greater tournament incentives lead to more aggressive corporate policies, then we expect a higher pay gap to be positively related with R&D intensity, firm focus, and firm leverage; and negatively related with capital expenditures intensity.

In all these tests, we control for the effect of CEO risk taking and alignment incentives on these corporate policies. The formats of all the tables that follow use the same structure as in Tables 2 and 3 with the primary exception being that we replace the proxy for risk with a specific corporate policy.

3.2.1. R&D intensity and tournament incentives

Table 4 reports the results from our analysis of the relation between R&D intensity and tournament incentives. The results from our OLS regression are reported in Column 2. The coefficient on *Ln[Pay Gap]* is equal to 0.0028 and is significantly positive at the one percent level. This coefficient implies a change in *R&D Intensity* of 0.10 standard deviations for a one standard deviation change in *Pay Gap*. The coefficient on *CEO Vega* is 0.0091 and is also significantly positive at the one percent level. This coefficient implies that a one standard deviation increase in *CEO Vega* increases *R&D Intensity* by 0.05 standard deviations. Thus, both tournament incentives and CEO risk-taking incentives appear to increase *R&D Intensity*.

The coefficients from the second-stage regression in our 2SLS analysis are presented in Column 3. The instruments that pass our battery of relevance and validity tests in this context are *Succession Plan*, *Inside CEO*, *Industry-Median CEO Delta*, and *Industry-Median CEO Vega*. The coefficient associated with *Predicted Ln[Pay Gap]* equals 0.0619 and is again statistically significant at the one percent level. The economic impact is highly significant with a one standard deviation increase in *Pay Gap* increasing *R&D Intensity* by 2.17 standard deviations. The coefficient associated with *Predicted CEO Vega*, however, becomes insignificant. The coefficient associated with *Predicted CEO Delta* is significantly negative at the one percent level. This coefficient implies that a one standard deviation increase in *CEO Delta* will tend to decrease *R&D Intensity* by 0.45 standard deviations.

Finally, the results from our simultaneous determination of *R&D Intensity*, *CEO Delta*, *CEO Vega*, and *Ln[Pay Gap]* are presented in Columns 4 – 7, respectively. The instruments that we employ in these simultaneous regressions are the same as in the 2SLS regressions reported above since they previously passed our relevance and validity conditions, with the addition of *Industry-Mean R&D Intensity* to instrument for firm-level *R&D Intensity*. The coefficient on *Predicted Ln[Pay Gap]* is 0.1022 and is statistically significant at the one percent level. In terms of economic significance, a one standard deviation increase in *Pay Gap* will increase *R&D Intensity* by 3.44 standard deviations. Here too the coefficient on *Predicted CEO Vega* is statistically insignificant, while the coefficient on *Predicted CEO Delta* is negative but not significant at conventional levels (t-value = -1.57). In Column 7, *Predicted CEO Vega* positively affects tournament incentives at the five percent level. Overall, we find consistent support for a significantly positive relation between *R&D Intensity* and tournament incentives.

3.2.2. Capital expenditures intensity and tournament incentives

Table 5 reports the results from our analysis of the relation between capital expenditures intensity and tournament incentives. The results from our OLS regression are reported in Column 2. The coefficients on *Ln[Pay Gap]* and *CEO Vega* are insignificantly different from zero. The coefficient on *CEO Delta* is significantly positive at the one percent level, and implies a 0.04 standard deviations increase in *CAPEX Intensity* for a one standard deviation change in *CEO Delta*. The coefficients from the second-stage regression in our 2SLS analysis are presented in Column 3. The instruments that pass our array of relevance and validity tests are *CFO is VP*, *Inside CEO*, *Industry-Median CEO Delta*, and *Industry-Median CEO Vega*. The coefficient associated with *Predicted Ln[Pay Gap]* is -0.0271 and is significantly negative at the five percent level. This coefficient implies that a one standard deviation change in *Pay Gap* will decrease *CAPEX Intensity* by 1.03 standard deviations. The coefficient associated with *Predicted CEO Vega* is insignificantly different from zero. The coefficient on *Predicted CEO Delta* is significant at the one percent level and implies a 0.48 standard deviations increase in *CAPEX Intensity* for a one standard deviation increase in *CEO Delta*.

Finally, the results from our simultaneous determination of *CAPEX Intensity*, *CEO Delta*, *CEO Vega*, and *Ln[Pay Gap]* are presented in Columns 4 – 7, respectively. We use the same instruments as the previous 2SLS estimation with the addition of *Industry-Median Sales Growth*, which we use as an instrument for *CAPEX Intensity*. The coefficient on *Predicted Ln[Pay Gap]* is -0.0207 and is significantly negative at the ten percent level. A one standard deviation increase in *Pay Gap* will, on average, decrease *CAPEX Intensity* by 0.74 standard deviations. Here too the coefficient on *Predicted CEO Vega* is statistically insignificant. The coefficient on *Predicted CEO Delta* is again significantly positive, thereby suggesting that better aligned CEOs are likely to invest more in capital expenditures.

Taken together, Tables 4 and 5 suggest that firms with larger tournament incentives tend to invest more in relatively riskier investments with uncertain benefits like R&D expenditures; and less in hard, tangible assets like capital expenditures.

3.2.3. Firm focus and tournament incentives

Table 6 presents the results from our analysis of the relation between *Firm Focus* and tournament incentives. Our measure of *Firm Focus* is the segment sales-based Herfindahl index. Thus, a larger value for *Firm Focus* indicates that the firm is more focused or, alternatively, it is less diversified and, therefore, more risky. The results from our OLS regression are reported in Column 2. The coefficients on *Ln[Pay Gap]*, *CEO Vega* and *CEO Delta* are all insignificantly different from zero.

The coefficients from the second-stage regression in our 2SLS analysis are presented in Column 3. We use *Succession Plan*, *Inside CEO*, *Industry-Median CEO Delta*, and *Industry-Median CEO Vega* as instruments since they pass all our relevance and validity conditions. The coefficient associated with *Predicted Ln[Pay Gap]* is 0.2226 and is positive and significant at the one percent level. This coefficient implies that a one standard deviation increase in *Pay Gap* will increase *Firm Focus* by 2.05 standard deviations. The coefficient associated with *Predicted CEO Delta* is negative and statistically significant at the five percent level, suggesting that CEOs with higher *Predicted CEO Delta* manage less focused (and more diversified) firms.

The results from our simultaneous determination of *Firm Focus*, *CEO Delta*, *CEO Vega*, and *Ln[Pay Gap]* are presented in Columns 4 – 7, respectively. The instruments that we employ in these simultaneous regressions are the same as in the 2SLS regressions reported above since they previously passed our relevance and validity conditions, with the addition of *Industry-Median Firm Focus* to proxy for firm-level focus. The coefficient on *Predicted Ln[Pay Gap]* is 0.2529 and is significantly positive at the five percent level. Its magnitude is similar to the magnitude of the coefficient on *Predicted Ln[Pay Gap]* in the IV (2SLS) analysis. The coefficients on *Predicted CEO Vega* and *Predicted CEO Delta* are statistically insignificant. Thus, the results in Table 6 suggest that firms with greater tournament incentives have a higher degree of focus. Interestingly, the results in Column 7 indicate that more focused firms tend to have higher tournament incentives, thereby suggesting that boards in these firms provide their senior executives with greater risk-taking incentives.

3.2.4. Firm leverage and tournament incentives

Table 7 reports the results from our analysis of the relation between book leverage and tournament incentives. The results from our OLS regression are reported in Column 2. The coefficient on *Ln[Pay Gap]* is 0.0044 and is significantly positive at the five percent level. The coefficients on *CEO Vega* and *CEO Delta* are both significantly negative. The coefficients from the second-stage regression in our 2SLS analysis are presented in Column 3. The instruments that pass our array of relevance and validity tests are *CFO is VP*, *Inside CEO*, *Industry-Median CEO Delta*, and *Industry-Median CEO Vega*. The coefficient on *Predicted Ln[Pay Gap]* is 0.0924 and is significantly positive at the five percent level. This coefficient suggests that a one standard deviation increase in *Pay Gap* results in *Book Leverage* increasing by 1.01 standard deviations. The coefficients associated with *Predicted CEO Delta* remains significantly negative, while the coefficient on *Predicted CEO Vega* becomes insignificant.

Finally, the results from our simultaneous determination of *Book Leverage*, *CEO Delta*, *CEO Vega*, and *Ln[Pay Gap]* are presented in Columns 4 – 7, respectively. We use the same instruments as the previous 2SLS estimation with the addition of *Industry-Median Z-Score* (Altman, 1968), which we use as an instrument for *Book Leverage*. In Column 4, the coefficient on *Predicted Ln[Pay Gap]* is 0.0925 and is positive and significant at the ten percent level. The coefficient on *Predicted CEO Vega* becomes statistically insignificant, while the coefficient on *Predicted CEO Delta* remains significantly negative. Interestingly, the results in Column 7 indicate that firms with higher leverage tend to provide senior executives with lower tournament incentives.[18] Overall, the results reported in Table 7 suggest that firms with greater tournament incentives have higher leverage, while firms with greater CEO alignment of interest have lower leverage.[19]

4. Controlling for the delta and vega incentives of senior executives

The focus of our paper is on the incentives of participants in the tournament to shape firm risk/policies. In all our tests so far, we have only controlled for the incentives of the CEO (*CEO Delta* and *CEO Vega*) by including them as control variables in our analysis. Because tournament incentives focus on the behavior of senior executives, a natural question that arises is whether our results are robust also to additional controls for *VP Delta* and *VP Vega*. To compute *VP Delta* (*VP Vega*), we sum each executive's total portfolio delta (total portfolio vega) and divide it by the number of all senior executives listed on ExecuComp. The mean (median) *VP Delta* and *VP Vega* are \$64,999.23 (\$23,706.07) and \$37,471.32 (\$15,001.32), respectively.

The results from our analysis are reported in Table 8. Because specification errors are more likely to permeate through a larger system of equations (e.g., Coles, Daniel, and Naveen, 2006) and for brevity, we report results only from OLS and IV (2SLS) analysis.[20] We report the results from OLS regressions just for comparison purposes. In the table, for each risk or policy measure, the first column contains the results from an OLS regression and the second column contains the results from the second-stage regression in the IV (2SLS) methodology. *Ln[Pay Gap], CEO Delta, CEO Vega, VP Delta,* and *VP Vega* are predicted values for the IV(2SLS) estimates. The reported 2SLS regressions employ instruments that pass all our relevance and validity criteria. We use *Industry-Median VP Delta* and *Industry-Median VP Vega* as

[18] This result is consistent with Smith and Watts (1992) who find a negative association between CEO compensation and leverage.
[19] We arrive at similar conclusions when we use market leverage (defined as *(DLC+DLTT)/(AT-CEQ+CSHO*PRCC_F))* instead of book leverage in the specifications reported in Table 7. Specifically, the coefficient on *Ln[Pay Gap]* is insignificant in the OLS regression, but is significantly positive in the IV (2SLS) and 2SLS (simultaneous system) methodologies.
[20] Nevertheless, we also estimate 2SLS (simultaneous system) and 3SLS (simultaneous system) and find results consistent with those reported in Table 8 for the IV (2SLS) methodology.

instruments for *VP Delta* and *VP Vega*, respectively. These two variables are constructed as the median values of *VP Delta* and *VP Vega* for all firms in the same two-digit SIC industry.

In the IV (2SLS) regressions, we find that *Ln[Pay Gap]* is significantly positively related to measures of risk (*Cash Flow Volatility* and *Return Volatility*), *R&D Intensity*, *Firm Focus*, and *Book Leverage*, and significantly negatively related with *CAPEX Intensity*. Thus, even after controlling for the incentives of senior executives, we continue to find that tournament incentives increase risk taking in firms. This increase in risk is attributable to the firm taking on riskier corporate policies. The effect of *VP Delta* and *CEO Delta* on corporate policies is similar in the sense that they are both significantly negatively related with *R&D Intensity* and *Book Leverage*, and significantly positively related with *CAPEX Intensity*. *VP Vega*, on the other hand, provides senior managers incentives to invest more in research and development and less in capital expenditures.

5. Additional robustness tests

In this section, we discuss the results from numerous robustness tests. These robustness tests generally relate to: (i) measurement of incentives, (ii) use of alternative constructs to proxy for rank-order tournament incentives, (iii) exclusion of years associated with CEO turnover, and (iv) 3SLS methodology to estimate the simultaneous relation between risk/corporate policies and tournament incentives. Table 9 provides a summary of the tournament incentives coefficient and related statistical significance for each robustness specification using the instrumental variables approach with lagged incentive variables and the 2SLS simultaneous approach with contemporaneous variables. We discuss each of these below.

5.1. *Alternative ways to measure incentives*

In the pre-2005 period, ExecuComp makes certain assumptions regarding option grant dates, dividend yields, stock return volatility, etc. In the post-2005 (post-FAS 123R) period, ExecuComp reported more detailed information regarding grant dates. To be consistent with ExecuComp's treatment of grant dates in the pre-2005 period, in all the results reported so far, we ignore actual grant dates in the post-2005 period and instead assume that they are granted on July 1 of each year. Thus, throughout the paper, we are consistent in the manner in which Black-Scholes option values are computed in both the pre- and post-2005 periods. To check whether this assumption has any bearing on our results, we recompute the Black-Scholes values in the post-2005 period using actual grant dates. Using these values, we recompute *CEO Delta*, *CEO Vega*, and *Pay Gap* for the post-2005 period. We then replicate the relevant tests reported in Tables 2 – 7 and report the effect of tournament incentives on measures of firm risk and corporate policies in Row 1 of Table 9. The results are similar to those reported earlier in the paper. Specifically, tournament incentives lead to greater risk taking in firms, and the choice of riskier corporate policies is the avenue through which firm risk is increased.

In all the regression tables previously reported in the paper, we follow Kale, Reis, and Venkateswaran (2009) and use the natural logarithm of the difference between the total compensation of the CEO and that of the median VP in the firm as our measure of tournament incentives. Further, to make our results comparable with Coles, Daniel, and Naveen (2006), we use the level of *CEO Delta* and *CEO Vega*. To make the scale comparable across these three types of incentives, we replicate all our tests using the natural logarithm of *CEO Delta* and *CEO Vega*. In these tests, we add one to *CEO Delta* and *CEO Vega* before taking their natural logarithm to avoid losing any observations in which their values are zeros. In addition, we also replicate all our tests using unlogged *Pay Gap*, *CEO Delta*, and *CEO Vega* as measures of tournament incentives, CEO alignment incentives, and CEO risk-taking incentives, respectively. Finally, we also measure *Pay Gap* relative to the mean VP compensation rather than the median VP compensation. These three robustness specifications are summarized in Rows 2 – 4 of Table 9. In general, these results are consistent with the results reported earlier in the paper. Using both the lagged instrumental variables approach and the simultaneous approach, the coefficients on the proxies for tournament incentives are generally statistically significant and their signs are in the predicted direction.

We investigate all cases where the *Pay Gap* is negative and find that this typically occurs when: (i) a founder is the CEO but gets either no salary or a very nominal salary and (ii) one of the VPs is a former CEO. Clearly, a negative *Pay Gap* does not necessarily imply that there are no promotion-based incentives in the firm in the upper echelon of management.[21] Consequently, in our robustness tests, we take the following four distinct approaches that allow us to retain firm-year observations with negative pay gaps in our sample. First, we replace the negative pay gap observations with the median pay gap for all firms in the industry-year. Second, we replace the negative pay gap observations with the difference between the median CEO pay for all firms in the industry-year and the firm's median VP pay. Third, we replace the negative pay gap observations with the difference between the CEO pay for a size- and industry-year matched firm and the firm's median VP pay. Finally, we construct a new pay gap measure by adding a constant value to each pay gap such that the resulting new pay gap value is positive for every firm-year observation in the sample (e.g., Kale, Reis, and Venkateswaran, 2009). Note that the addition of the constant does not change the relative ranking of the tournament incentives. The results from these additional tests are reported in Rows 5 – 8 in Table 9. The results are qualitatively similar to those reported in Tables 2 – 7, with tournament incentives leading to greater firm risk through the implementation of riskier corporate policies.

5.2. Alternative construct to measure rank-ordered tournament incentives

We follow Kale, Reis, and Venkateswaran (2009) and compute the Gini Coefficient as an alternative proxy for tournament incentives. This construct has been used as a measure of income disparity in the macroeconomics literature (see, e.g., Donaldson and Weymark, 1980; La Porta, Lopez-de-Silanes, Shleifer, and Vishny, 1998; and Biais and Perotti, 2001). In our context, it is a gauge of the income disparity among all the top executives of the firm including the CEO. More specifically, it is computed as follows:

$$\textit{Gini Coefficient} = 1 + (1/n) - (2/(n^2 TC_{mean}))(TC_1 + TC_2 + \ldots\ldots + TC_n) \quad (7)$$

[21] In results not reported in the paper for brevity, we estimate probit models where the dependent variable takes the value of one if the pay gap is positive, and zero otherwise. We find that firms with positive pay gaps tend to be older, hold less cash, have higher leverage, are more profitable, and have a smaller Tobin's Q. We then estimate both OLS and IV (2SLS) regression models where the dependent variable is a proxy for firm risk as in Tables 2 and 3 but include the Inverse Mill's ratio obtained from the first-stage probit regression as an additional explanatory variable in the second-stage regression to control for selection, i.e., the sample used for estimation consists only of positive pay gap firms. We bootstrap standard errors 1,000 times in the second-stage regressions. As before, we find a significantly positive relation between tournament incentives and firm risk.

where n is the number of senior executives (including the CEO) for firm i in year t in the ExecuComp database; TC_1, TC_2, …., TC_n are the total compensations for each of the n senior executives; and TC_{mean} is their mean total compensation. Results using the *Gini Coefficient* in place of *Pay Gap* are reported in the seventh row in Table 9. The lagged IV approach shows that the *Gini Coefficient* is significantly positively related to *Cash Flow Volatility*, *Return Volatility*, *R&D Intensity*, *Firm Focus*, and *Book Leverage* as predicted. In the simultaneous methodology, the *Gini Coefficient* yields similar results with the exception that its relation with *Book Leverage* is positive but insignificant.

5.3. Exclusion of CEO-turnover events

The turnover of an old CEO signals the end of one tournament and the start of another for the firm. It will typically be a period of great turmoil within the firm as some of the old VPs who were passed over for promotion to the position of CEO explore other lucrative opportunities outside the firm. In addition, the new CEO may want to put his/her own team of new VPs in place. Finally, the new CEO may take a "big bath" in the turnover year which affects firm policies, and consequently, his/her compensation may take a few years to stabilize (Murphy and Zimmerman, 1993). For these reasons, we replicate all the tests reported in the paper after removing: (i) all firm-year observations that coincide with the CEO turnover year and (ii) all firm-year observations that coincide either with the CEO turnover year or the year after. The results from these two sets of robustness tests are reported in the eighth and ninth row in Table 9. In the lagged IV approach, we continue to find that *Ln[Pay Gap]* is positively related to *Cash Flow Volatility*, *Return Volatility*, *R&D Intensity*, *Firm Focus*, and *Book Leverage*, and is negatively related to *CAPEX Intensity*. We obtain qualitatively similar results using the 2SLS (Simultaneous) regression methodology with the exceptions that coefficients on *CAPEX Intensity* and *Book Leverage* are no longer significant at conventional levels.

5.4. 3SLS methodology

We also repeat all our tests by using the 3SLS regression methodology to simultaneously estimate the relation between *Firm Risk/Corporate Policies*, *Pay Gap*, *CEO Delta*, and *CEO Vega*. Our setup is identical to the equations used in the 2SLS simultaneous equations methodology. We again find evidence consistent with the results reported in Tables 2 – 7. Specifically, we document evidence which indicates that *Cash Flow Volatility*, *Return Volatility*, *R&D Intensity*, *Firm Focus*, and *Book Leverage* all increase with tournament incentives, whereas *CAPEX Intensity* decreases with tournament incentives. We do not report these results in the paper for purposes of brevity but they are available upon request from the authors.[22]

6. Tournament incentives and managerial risk taking in financial firms

The financial crisis has been partly blamed on the compensation levels and structures of top executives of financial services firms. The populist anger at the federal bailout of financial firms was directed at what was perceived as obscene levels of compensation at these firms. This public anger prompted politicians to push for greater regulatory controls over executive compensation in these firms. The ensuing Emergency Economic Stabilization Act of 2008 contained provisions that severely restricted executive compensation in any financial firm in which the federal government took a significant debt or equity stake and also severely limited incentives to take excessive risks that could threaten the value of these firms. The job of enacting the provisions of this Act fell to Kenneth Feinberg who was appointed the Special Master of Troubled Asset Relief Program (TARP) Executive Compensation by Treasury Secretary, Timothy Geithner, in June 2009.[23] While his primary responsibility was to make compensation decisions for firms that received "exceptional assistance" from the federal government, he could make nonbinding determinations about the compensation of other TARP recipients. As we discussed earlier, most of the conversation regarding risk taking incentives has focused on the compensation structure. What has been neglected in the discussion is that any restrictions on the CEO's compensation level and that of other top level executives in financial firms will have a bearing on the pay gap and, consequently, on the risk taking incentives in these firms. We had earlier investigated whether tournament incentives

[22] We arrive at similar inferences when we only include tournament incentives (but not *CEO Delta* and *CEO Vega*) in our tests. Additionally, our findings are generally similar to those reported in Coles, Daniel, and Naveen (2006) when we include *CEO Delta* and *CEO Vega* (but not tournament incentives) in our tests.

affect firm risk taking in non-financial firms. In this section, we empirically investigate this issue for financial firms.

The results from our analysis are reported in Table 10. Our tests include all financial firms on ExecuComp (SIC 6000 – 6999) over the period 1994 – 2009. The dependent variable in the first two specifications is cash flow volatility (*Cash Flow Volatility*), while it is stock return volatility (*Return Volatility*) in the next two specifications. The first specification in each set is an OLS regression model and the second specification is an IV (2SLS) regression model. Both *Cash Flow Volatility* and *Return Volatility* are computed in the same manner as before with the only exception being that we now compute cash flow as earnings before taxes (EBT) plus depreciation rather than earnings before depreciation, interest, and taxes (EBITDA). We make this change because debt instruments are not just financing for a financial firm, but also considered to be its products/output. As such, it is not possible to obtain a measure of performance that separates investment/financing decisions for financial firms that we get with EBITDA for non-financial firms. The instruments that we use in the IV (2SLS) regression models belong to the same set that we used earlier in the paper with the only difference being that *Industry-Median CEO Delta* and *Industry-Median CEO Vega* are now computed at the four-digit SIC level. These instruments pass all our relevance and validity conditions.

The coefficient estimates on *Ln[Pay Gap]* and *Predicted Ln[Pay Gap]* are statistically significant in all four reported specifications, thereby indicating that tournament incentives promote greater risk taking in financial firms too. For example, the coefficient on *Predicted Ln[Pay Gap]* is 0.0131 in the 2SLS regression in Model 2 and is statistically significant at the 10% level. This coefficient implies that a one standard deviation increase in *Pay Gap* results in 1.70 standard deviations increase in *Cash Flow Volatility*. Further, the coefficient estimate on *Predicted Ln[Pay Gap]* is 0.0114 in Model 4 and is statistically significant at the 5% level. In terms of economic significance, a one standard deviation increase in *Pay Gap* will increase *Return Volatility* by 1.35 standard deviations. Thus, while the impact of compensation structure on risk taking incentives in financial firms has gotten all the attention in public

[23] This position has been held by Patricia Geoghegan since September 2010.

policy circles, these results indicate that some attention needs to be given to the effect of the pay gap on risk taking incentives too. The challenge is to determine the appropriate level of tournament incentives for a financial firm that shapes a risk profile which allows its managers to take advantage of its product market landscape.

7. Summary and concluding remarks

There are a multitude of option-like payoff structures and corresponding risk-taking incentives in managerial compensation contracts. One such payoff structure is related to the option-like features of relative performance evaluation among senior executives who are part of the horse race for the CEO slot. The promotion to the CEO's position represents being in the money and the promotion prize is the increase in compensation accompanied by enhanced status accompanying perks. The option-like character of the promotion tournament for a higher managerial position can provide the incentive for senior executives to increase risk of the outcomes used to evaluate and compare them. Goel and Thakor (2008) theoretically provide support for the above intuition by demonstrating that higher tournament incentives will result in greater risk taking by senior managers to enhance their chance of promotion to the rank of CEO. An implication of their model is that firm risk will increase with greater promotion-based incentives. We test this proposition using a large sample of firms on the ExecuComp database over the period 1994 – 2009.

We first examine the relation between different proxies for firm risk and tournament incentives. Measuring tournament incentives as the pay gap between the CEO and the next layer of senior managers, we find a significantly positive relation between firm risk and promotion-based incentives for both non-financial and financial firms. We then examine the relation between various corporate policies and tournament incentives for non-financial firms to provide insight into the mechanisms through which promotion-based incentives affect firm risk. Consistent with the notion that promotion-based incentives lead to riskier policy choices, we find that greater tournament incentives enhance R&D intensity, firm focus, and leverage, but reduce capital expenditure intensity. In our main tests, we control for the performance-based incentives (*CEO Delta*) and risk-taking incentives (*CEO Vega*) of the CEO. Furthermore, we obtain similar results when we also control for the incentives of the senior executives. Our results are robust to different proxies for tournament incentives and various methods to control for endogeneity. Overall, we find consistent support for the proposition that option-like features of intra-organizational CEO promotion tournaments will give incentives to senior executives to increase firm riskiness by undertaking riskier investment and financial policies.

Our paper makes contributions to the extensive literature on the incentives provided by the board of directors to senior executives. First, our paper provides new perspectives on the current public policy debate on compensation. Specifically, any assessment by a firm on how its compensation policy can have a material impact on firm risk has to also necessarily consider the effect of tournament incentives on corporate risk taking behavior. Second, our paper contributes to a nascent literature which indicates that the incentives of senior executives have an independent effect to that of the CEO's incentives on the firm's operating and financial policies. Third, our paper informs on the literature related to CEO succession planning (see, e.g., Vancil, 1987; Baliga, Moyer, and Rao, 1996; Brickley, Coles, and Jarrell, 1997; and Naveen, 2006). Fourth, we complement the work by Kale, Reis, and Venkateswaran (2009) who demonstrate that firms with larger tournament incentives tend to perform better and have higher firm value. Our study shows that these same incentives also increase managerial risk-taking behavior in firms.

Finally, Coles, Daniel, and Naveen (2006) argue that it is imperative to simultaneously determine corporate policy choices and managerial compensation structure to infer any causal relationships. We extend their paper by also simultaneously determining promotion-based incentives and obtain some important insights. Consistent with the results reported in their paper, we find that firms with greater performance-based incentives to the CEO and senior executives (have higher *Deltas*) tend to choose less risky firm policies. We, however, no longer find a systematic causal relation between firm risk and managerial risk-taking incentives (*Vega*). In this respect, our results are consistent with Hayes, Lemmon, and Qiu (2010) who do not find any evidence that the decline in stock option usage due to the adoption of FAS 123R resulted in less risky firm policies.[24]

In conclusion, in coming up with the optimal compensation structure for the senior managers of the firm, corporate boards need to carefully consider the design of performance-based incentives for the CEO and both the design of performance-based and promotion-based incentives for the next layer of senior managers. The design of performance-based incentive systems can be used to generate greater effort by these managers. Nevertheless, to the extent that the option-based component in the compensation plan provides a convex payoff, it can also possibly be used to influence managerial risk taking. Similarly, while the design of a promotion-based incentive system can be employed to induce senior executives to expend greater effort; it can also be used to shape the amount of risk taken by them. This paper will help corporate boards and future researchers tackle these design issues by providing insights into the causal relation between tournament incentives and managerial risk taking activities.

[24] FAS 123R eliminated the ability of firms to report stock option grants at their intrinsic value and instead required firms to report these grants at their fair value. Needless to say, while the accounting advantage to stock option usage was eliminated, the economic costs remained the same.

Appendix. Methodology for post-2005 ExecuComp transition

Main methodology

ExecuComp modified its database for the post-2005 period due to the passage of FAS 123R on December 12, 2004. For fiscal years 1992 – 2005, ExecuComp reports compensation data using the old format (pre-FAS 123R). For fiscal years 2006 and later, ExecuComp reports compensation using the new format (post-FAS 123R).[25] In the post-FAS 123R period, firms calculate and expense equity-based compensation at fair value using their own valuation models. Thus, for the post-2005 data, ExecuComp does not calculate the Black-Scholes value of current year stock option grants, nor do they provide the volatility and dividend yield assumptions used in the Black-Scholes calculation. Instead, ExecuComp reports the firm's own calculated fair values of equity-based compensation.

Using the new ExecuComp data directly presents two problems. *CEO Delta*, *CEO Vega*, and *Pay Gap* (which uses ExecuComp Variable *TDC1*) are not comparable across firms within the same year if firms are using different valuation methods. Additionally, for the same firm, *CEO Delta*, *CEO Vega*, and *Pay Gap* are not comparable pre- and post-FAS 123R. We solve this problem by recalculating the value of equity-based compensation for all firms in the post-FAS 123R period using ExecuComp's pre-FAS 123R methodology. Specifically, we use the ExecuComp Black-Scholes assumptions to first calculate the Black-Scholes values for each stock option grant from 2006 – 2009. The ExecuComp assumptions, as listed on the Wharton Data Research Services website, are as follows:

1. *Strike price per share:* The strike price per share is what is specified by the company in its proxy statement.
2. *Market price per share:* The market price per share at the time of grant was assumed to be equal to the strike price per share unless the company specified otherwise in its proxy statement.
3. *Option grant terms:* The term of the grant are determined as follows:

    - Options were assumed to be granted on July 1st of the particular year for which data were reported.
    - The nominal term of the option was calculated as the time span between July 1st of the year of grant and the actual expiration date reported by the company in its proxy statement. Figures thus calculated were then rounded to the nearest whole year.
    - The term of the option was reduced by 30% to an amount of 70% of the actual term. ExecuComp implements this reduction because executives rarely wait until the expiration date to exercise their options.

4. *Risk-free interest rate:* The risk-free rate of interest used was the approximate average yield that could have been earned in the particular year by investing in a U.S. Treasury bond carrying a seven-year term.
5. *Estimated stock price volatility:* ExecuComp uses a 60-month volatility number. If a company is in the bottom or top 5% of volatilities, they increase or decrease its volatility to the 5th or 95th percentile values. If a stock has traded for less than 60 months, they use as many months as possible to do the calculation. If the stock has traded for less than one year, they input the average volatility value for the S&P 1500.
6. *Estimated future dividend yield:* ExecuComp uses average dividend yields over a three-year period. If the average dividend yield was above the 95th percentile, they reduce it to the 95th percentile.

[25] For 2006, a small number of ExecuComp firms report in the old format. We recalculate the Black-Scholes values for these firms.

After estimating the inputs, we recalculate the Black-Scholes values for 2005 and compare it to ExecuComp's reported values and find a correlation of 0.968. We then proceed to calculate Black-Scholes values for the period 2006 – 2009. We then use this value to estimate *CEO Delta* and *CEO Vega* using the methodology outlined earlier in the paper. For *Pay Gap*, we must recalculate our own value of ExecuComp variable *TDC1* using the calculated Black-Scholes values of stock option grants. We follow Coles, Daniel, and Naveen (2010) and calculate post- FAS 123R *TDC1* as:

TDC1 = SALARY + BONUS + NONEQ_INCENT + OTHCOMP + STOCK_AWARDS_FV[26]
+ option_awards_calculated_value + DEFER_RPT_AS_COMP_TOT

Coles, Daniel, and Naveen (2010) find that this calculation achieves a 0.996 correlation with ExecuComp's reported values of *TDC1* in the pre-FAS 123R period.[27]

Alternative Methodology

As a robustness check in Table 9, we compute *CEO Delta*, *CEO Vega*, and *Pay Gap* using slightly different assumptions from the main results. In the post-FAS 123R period, ExecuComp has more detailed information regarding the grant date. We calculate the Black-Scholes values using the actual grant dates instead of using the July 1 assumption, and then recalculate *CEO Delta*, *CEO Vega*, and *TDC1* using these new values. The 2006 – 2009 Black-Scholes values using this alternative assumption have a correlation of 0.997 with the values used in the remainder of the paper.

[26] Note that firms also report their "own" valuation of stock grants in the post-FAS 123R period. Nevertheless, ExecuComp's methodology in the pre-FAS 123R period and the accounting treatment in the post-FAS 123R period appear identical.

[27] We thank Lalitha Naveen for helpful discussions regarding the procedure to account for the post-2005 ExecuComp transition as well for making her programs available to us.

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Table 1
Summary Statistics

This table presents summary statistics for ExecuComp firms from 1994 – 2009. Financial firms and utilities are excluded from the sample. *Pay Gap* is the difference between the CEO's total compensation and the total compensation of the median VP. *CEO Delta* is a CEO's total portfolio delta, and is computed as her dollar increase in wealth for a 1% increase in stock price. *CEO Vega* is the CEO's total portfolio vega, or her increase in option-wealth for a 0.01 standard deviation increase in stock volatility. *Cash Flow Volatility* is the seasonally-adjusted standard deviation of EBITDA from year *t* to year *t+4*. *Return Volatility* is the standard deviation of daily stock returns for year *t*. *R&D Intensity* is firm R&D expenses divided by total assets. *CAPEX Intensity* is capital expenditures divided by total assets. *Firm Focus* is the Herfindahl index of a firm's own segments, and *Book Leverage* is interest bearing debt divided by total assets. *Ln[Assets]* is the natural logarithm of Book Assets. *Sales Growth* is the percentage increase in net sales from year *t-1* to year *t*. *Tobin's Q* is market value of the firm divided by the book value of the firm. Firm *ROA* is prior year net income divided by total assets. *CEO Turnover* is a dummy variable equal to "1" if a turnover occurred in the observation year, "0" otherwise. *CFO is VP* is a dummy variable equal to "1" if the CFO was listed as a top five highest paid executive in the current year, "0" otherwise. *Inside CEO* is a dummy variable equal to "1" if the current CEO was promoted from within, "0" otherwise. *Succession Plan* is a dummy variable equal to "1" if the firm lists a President and/or COO, "0" otherwise. *CEO Tenure* is the number of years the CEO has held the position, and *CEO Age* is the current age of the CEO. *Number of VPs* is the number of non-CEO executives a firm lists in ExecuComp. *Z-Score* is a measure of bankruptcy risk from Altman (1968). Our industry instruments are based on two-digit SIC codes. All variables are winsorized at 1% and 99% and all compensation variables are expressed in 2003 dollars.

	Mean	Median	Min	Max	Observations
Compensation Variables					
Pay Gap (in 000s)	3030.46	1418.453	0.020	39206.300	19333
CEO Delta (in 000s)	421.787	158.450	0.000	5733.171	19333
CEO Vega (in 000s)	194.437	70.637	0.000	2491.589	19333
Volatility Measures					
Cash Flow Volatility	0.017	0.011	0.002	0.132	14640
Return Volatility	0.029	0.025	0.010	0.091	18639
Firm Policies					
R&D Intensity	0.033	0.002	0.000	0.302	19309
CAPEX Intensity	0.059	0.043	0.000	0.293	19309
Firm Focus	0.844	1.000	0.177	1.000	19046
Book Leverage	0.225	0.211	0.000	0.875	19309
Firm/CEO Characteristics					
Ln[Assets] ($ m.)	7.721	7.077	-1.911	13.590	19309
Sales Growth	0.106	0.077	-0.540	1.417	19311
Tobin's Q	2.013	1.607	0.720	8.340	19271
ROA	0.028	0.050	-0.716	0.268	19303
CEO Turnover	0.117	0.000	0.000	1.000	18829
CFO is VP	0.801	1.000	0.000	1.000	19156

Continued…

Table 1 (Continued)

	Mean	Median	Min	Max	Observations
Inside CEO	0.652	1.000	0.000	1.000	19333
Succession Plan	0.628	1.000	0.000	1.000	19156
CEO Tenure (years)	7.840	6.000	0.000	57.000	19333
CEO Age (years)	55.280	55.000	29.000	91.000	19291
Number of VPs	4.941	5.000	1.000	14.000	19333
Other Instruments					
Industry-Median CEO Delta (in 000s)	185.982	163.985	0.000	3748.050	19333
Industry-Median CEO Vega (in 000s)	89.623	74.540	0.000	2166.894	19333
Industry-Median Cash Flow Volatility	0.012	0.011	0.002	0.073	17805
Industry-Median Return Volatility	0.027	0.025	0.010	0.091	19328
Industry-Mean RD Intensity	0.033	0.011	0.000	0.101	19333
Industry-Median Sales Growth	0.078	0.082	-0.540	0.552	19333
Industry-Median Firm Focus	0.928	1.000	0.371	1.000	19299
Industry-Median Z-Score	5.931	5.101	-1.392	407.203	19332

Table 2

Cash flow volatility and tournament incentives

Multivariate tests using ExecuComp firms from 1994 – 2009. Financial firms and utilities are excluded. Presented are OLS, Instrumental Variables (IV) estimation, and Simultaneous Equations estimation using 2SLS. The dependent variable in the OLS and IV specifications is *Cash Flow Volatility*$_t$, which is the seasonally-adjusted standard deviation of EBITDA divided by total assets from year *t* to year *t+4*. *Ln[Pay Gap]*$_{t-1}$ is the natural logarithm of the lagged difference between the CEO's total compensation and the total compensation of the median VP. *CEO Delta* $_{t-1}$ is lagged CEO's total portfolio delta, or her dollar increase in wealth (in millions) for a 1% increase in stock price. *CEO Vega* $_{t-1}$ is lagged CEO's total portfolio vega, or her increase in option-wealth (in millions) for a 0.01 standard deviation increase in stock volatility. The dependent variables in the Simultaneous Equations system are the *Cash Flow Volatility* measure and the three contemporaneous compensation measures: *CEO Delta*$_t$, *CEO Vega*$_t$, and *Ln[Pay Gap]*$_t$. *CEO Tenure* is the number of years the CEO has held the position. *Ln[Total Assets]* is the natural logarithm of book assets. *Tobin's Q* is market value of the firm divided by the book value of the firm. *Book Leverage* is interest bearing debt divided by total assets. *ROA* is prior year net income divided by total assets. *Sales Growth* is the percentage increase in net sales from year *t-1* to year *t*. *Industry-Median Cash Flow Volatility*, *Industry-Median CEO Delta* and *Industry-Median CEO Vega* are the industry-year median values of our *Cash Flow Volatility*, *CEO Delta*, and *CEO Vega* measures, respectively based on two-digit SIC codes. *Inside CEO* is a dummy variable equal to "1" if the current CEO was promoted from within, "0" otherwise. *Number of VPs* is the number of non-CEO executives a firm lists in ExecuComp. All models contain year fixed-effects and two-digit SIC industry fixed-effects. All variables are winsorized at 1% and 99% and all compensation variables are expressed in 2003 dollars. T-statistics are calculated from robust standard errors clustered by firm and are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Estimation Type	OLS	IV (2SLS)	Simultaneous Equations (2SLS)			
Dependent Variable	*Cash Flow Volatility*$_t$	*Cash Flow Volatility*$_t$	*Cash Flow Volatility*$_t$	*CEO Delta*$_t$	*CEO Vega*$_t$	*Ln[Pay Gap]*$_t$
Ln[Pay Gap]$_{t-1}$	0.0009***					
	(4.160)					
CEO Delta$_{t-1}$	-0.0003					
	(-1.227)					
CEO Vega$_{t-1}$	0.0022***					
	(2.618)					
Predicted Ln[Pay Gap]$_{t-1}$		0.0072**				
		(2.435)				
Predicted CEO Delta$_{t-1}$		0.0019				
		(0.912)				
Predicted CEO Vega$_{t-1}$		0.0060				
		(1.166)				
Predicted Ln[Pay Gap]$_t$			0.0244***	-0.0796	-0.0804	
			(4.732)	(-0.523)	(-0.996)	
Predicted CEO Delta$_t$			-0.0071*		0.1140**	0.1424
			(-1.661)		(2.068)	(1.052)
Predicted CEO Vega$_t$			0.0143	0.4735		0.7994**
			(1.335)	(1.414)		(2.383)

Continued…

Table 2 (Continued)

Predicted Cash Flow Volatility$_t$				1.8593	4.2818**	13.9404***
				(0.507)	(2.502)	(4.117)
CEO Tenure$_t$	-0.0001***	-0.0001**	0.0000	0.0178***	0.0022	-0.0068**
	(-2.819)	(-2.338)	(0.451)	(7.031)	(1.553)	(-2.157)
Ln[Assets]$_t$	-0.0037***	-0.0078***	-0.0161***	0.1609	0.1738***	0.4079***
	(-11.450)	(-6.704)	(-6.437)	(1.558)	(3.781)	(7.918)
Tobin's Q$_t$	0.0024***	0.0011***	-0.0016	0.1153***	0.0739***	0.0273
	(8.530)	(2.933)	(-1.622)	(3.229)	(5.273)	(0.901)
Sales Growth$_t$	0.0044***	0.0054***	0.0014	0.1371***	0.0015	0.0363
	(4.290)	(4.480)	(0.874)	(4.403)	(0.086)	(0.724)
Book Leverage$_t$	-0.0021	-0.0006	-0.0008	-0.2212***	-0.1314***	0.1453
	(-1.012)	(-0.269)	(-0.220)	(-2.681)	(-3.706)	(1.360)
ROA$_t$	-0.0419***	-0.0389***	-0.0377***	0.0653	0.1134*	0.4988***
	(-8.790)	(-8.293)	(-7.631)	(0.465)	(1.661)	(2.822)
Industry-Median Cash Flow Volatility$_t$			0.5728***			
			(3.940)			
Industry-Median CEO Delta$_t$				0.6605***		
				(5.674)		
Industry-Median CEO Vega$_t$					0.4971***	
					(3.782)	
Inside CEO$_t$						-0.0659*
						(-1.876)
Number of VPs$_t$						0.0413***
						(3.906)
Constant	0.0486***	0.0374***	-0.0256	-0.2939	-1.0744***	3.2558***
	(7.974)	(2.802)	(-1.146)	(-0.348)	(-4.960)	(7.010)
Number of Observations	14542	14542	13829	13829	13829	13829
R^2	0.257					

Anderson-Rubin Wald F-statistic for joint relevance	6.23***	Instruments used in IV (2SLS)	Instrumental Variables
Hansen J-statistic	0.006		*Inside CEO*$_{t-1}$
Difference in Sargan-Hansen statistics (Test for endogeneity)	20.388***		*Number of VPs*$_{t-1}$
First-stage F-statistics			*Industry-Median CEO Delta*$_{t-1}$
Ln[Pay Gap]$_{t-1}$	16.18***		*Industry-Median CEO Vega*$_{t-1}$
CEO Delta$_{t-1}$	18.35***		
CEO Vega$_{t-1}$	20.54***		

Table 3
Stock return volatility and tournament incentives

Multivariate tests using ExecuComp firms from 1994 – 2009. Financial firms and utilities are excluded. Presented are OLS, Instrumental Variables (IV) Estimation, and Simultaneous Equations estimation using 2SLS. The dependent variable in the OLS and IV specifications is *Return Volatility*$_t$, which is the standard deviation of daily stock returns for year *t*. *Ln[Pay Gap]*$_{t-1}$ is the natural logarithm of the lagged difference between the CEO's total compensation and the total compensation of the median VP. *CEO Delta*$_{t-1}$ is lagged CEO's total portfolio delta, or her dollar increase in wealth (in millions) for a 1% increase in stock price. *CEO Vega*$_{t-1}$ is lagged CEO's total portfolio vega, or her increase in option-wealth (in millions) for a 0.01 standard deviation increase in stock volatility. The dependent variables in the Simultaneous Equations system are the *Return Volatility* measure and the three contemporaneous compensation measures: *CEO Delta*$_t$, *CEO Vega*$_t$, and *Ln[Pay Gap]*$_t$. *CEO Tenure* is the number of years the CEO has held the position. *Ln[Total Assets]* is the natural logarithm of book assets. *Tobin's Q* is market value of the firm divided by the book value of the firm. *Sales Growth* is the percentage increase in net sales from year *t-1* to year *t*. *Book Leverage* is interest bearing debt divided by total assets. *ROA* is prior year net income divided by total assets. *Industry-Median Return Volatility*, *Industry-Median CEO Delta*, and *Industry-Median CEO Vega* are the industry-year median values of our *Return Volatility*, *CEO Delta*, and *CEO Vega* measures, respectively based on two-digit SIC codes. *Succession Plan* is a dummy variable equal to "1" if the firm lists a President and/or COO, "0" otherwise. *Inside CEO* is a dummy variable equal to "1" if the current CEO was promoted from within, "0" otherwise. All models contain year fixed-effects and two-digit SIC industry fixed-effects. All variables are winsorized at 1% and 99% and all compensation variables are expressed in 2003 dollars. T-statistics are calculated from robust standard errors clustered by firm and are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Estimation Type	OLS	IV (2SLS)	Simultaneous Equations (2SLS)			
Dependent Variable	*Return Volatility*$_t$	*Return Volatility*$_t$	*Return Volatility*$_t$	*CEO Delta*$_t$	*CEO Vega*$_t$	*Ln[Pay Gap]*$_t$
Ln[Pay Gap]$_{t-1}$	0.0004***					
	(4.331)					
CEO Delta$_{t-1}$	0.0006***					
	(3.416)					
CEO Vega$_{t-1}$	0.0003					
	(0.741)					
Predicted Ln[Pay Gap]$_{t-1}$		0.0159***				
		(3.611)				
Predicted CEO Delta$_{t-1}$		0.0002				
		(0.085)				
Predicted CEO Vega$_{t-1}$		-0.0194***				
		(-2.821)				
Predicted Ln[Pay Gap]$_t$			0.0180***	0.4003	0.2466**	
			(2.651)	(1.117)	(2.281)	
Predicted CEO Delta$_t$			-0.0009		-0.0278	0.1908
			(-0.289)		(-0.439)	(1.221)
Predicted CEO Vega$_t$			-0.0197*	-0.1954		1.0225***
			(-1.889)	(-0.268)		(2.885)
Predicted Return Volatility$_t$				-0.9190	-1.3286	6.0551**
				(-0.275)	(-1.035)	(2.067)
CEO Tenure$_t$	-0.0001***	0.0001	0.0001	0.0204***	0.0050***	-0.0094***
	(-3.376)	(0.752)	(0.799)	(4.972)	(3.274)	(-3.042)

Continued…

Table 3 (Continued)

Ln[Assets]$_t$	-0.0029***	-0.0081***	-0.0090***	-0.0077	0.0103	0.3584***
	(-23.769)	(-5.590)	(-4.001)	(-0.064)	(0.194)	(8.535)
Tobin's Q$_t$	0.0007***	0.0001	-0.0001	0.1093***	0.0560***	0.0277
	(5.137)	(0.333)	(-0.253)	(2.955)	(3.538)	(0.921)
Sales Growth$_t$	0.0036***	0.0066***	0.0014	0.0821*	-0.0129	0.0837*
	(8.505)	(5.499)	(1.268)	(1.716)	(-0.672)	(1.899)
Book Leverage$_t$	0.0017*	-0.0012	-0.0008	-0.2879**	-0.1562***	0.1489
	(1.758)	(-0.582)	(-0.341)	(-2.439)	(-4.646)	(1.533)
ROA$_t$	-0.0447***	-0.0418***	-0.0426***	-0.0779	-0.1066*	0.2663
	(-29.228)	(-17.759)	(-19.077)	(-0.457)	(-1.764)	(1.640)
Industry-Median Return Volatility$_t$			0.6758***			
			(12.204)			
Industry-Median CEO Delta$_t$				0.6370***		
				(5.292)		
Industry-Median CEO Vega$_t$					0.4100***	
					(3.845)	
Succession Plan$_t$						-0.0307
						(-1.219)
Inside CEO$_t$						-0.0706**
						(-2.287)
Constant	0.0362***	-0.0137	-0.0432	-2.3333	-1.7133***	4.2871***
	(17.929)	(-0.658)	(-1.543)	(-1.521)	(-5.764)	(11.019)
Number of Observations	18436	18436	17316	17316	17316	17316
R^2	0.566					

Anderson-Rubin Wald F-statistic for joint relevance	16.24***	Instruments used in IV (2SLS)	Instrumental Variables
Hansen J-statistic	0.800		*Succession Plan*$_{t-1}$
Difference in Sargan-Hansen statistics (Test for endogeneity)	60.551***		*Inside CEO*$_{t-1}$
First-stage F-statistics			*Industry-Median CEO Delta* $_{t-1}$
Ln[Pay Gap]$_{t-1}$	14.09***		*Industry-Median CEO Vega* $_{t-1}$
CEO Delta$_{t-1}$	27.36***		
CEO Vega$_{t-1}$	18.50***		

Table 4

R&D intensity and tournament incentives

Multivariate tests using ExecuComp firms from 1994 – 2009. Financial firms and utilities are excluded. Presented are OLS, Instrumental Variables (IV) Estimation, and Simultaneous Equations estimation using 2SLS. The dependent variable in the OLS and IV specifications is *R&D Intensity*$_t$, which is firm R&D expenses divided by total assets. *Ln[Pay Gap]*$_{t-1}$ is the natural logarithm of the lagged difference between the CEO's total compensation and the total compensation of the median VP. *CEO Delta*$_{t-1}$ is lagged CEO's total portfolio delta, or her dollar increase in wealth (in millions) for a 1% increase in stock price. *CEO Vega*$_{t-1}$ is lagged CEO's total portfolio vega, or her increase in option-wealth (in millions) for a 0.01 standard deviation increase in stock volatility. The dependent variables in the Simultaneous Equations system are the *R&D Intensity* measure and the three contemporaneous compensation measures: *CEO Delta*$_t$, *CEO Vega*$_t$, and *Ln[Pay Gap]*$_t$. *CEO Tenure* is the number of years the CEO has held the position. *Ln[Total Assets]* is the natural logarithm of book assets. *Tobin's Q* is market value of the firm divided by the book value of the firm. *Sales Growth* is the percentage increase in net sales from year *t-1* to year *t*. *Book Leverage* is interest bearing debt divided by total assets. *ROA* is prior year net income divided by total assets. *Industry-Mean R&D Intensity* is the industry-year mean value of R&D Intensity. *Industry-Median CEO Delta* and *Industry-Median CEO Vega* are the industry-year median values of the *CEO Delta* and *CEO Vega* measures, respectively based on two-digit SIC codes. *Succession Plan* is a dummy variable equal to "1" if the firm lists a President and/or COO, "0" otherwise. *Inside CEO* is a dummy variable equal to "1" if the current CEO was promoted from within, "0" otherwise. All models contain year fixed-effects and two-digit SIC industry fixed-effects. All variables are winsorized at 1% and 99% and all compensation variables are expressed in 2003 dollars. T-statistics are calculated from robust standard errors clustered by firm and are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Estimation Type	OLS	IV (2SLS)	Simultaneous Equations (2SLS)			
Dependent Variable	*R&D Intensity*$_t$	*R&D Intensity*$_t$	*R&D Intensity*$_t$	*CEO Delta*$_t$	*CEO Vega*$_t$	*Ln[Pay Gap]*$_t$
Ln[Pay Gap]$_{t-1}$	0.0028***					
	(5.931)					
CEO Delta$_{t-1}$	-0.0011					
	(-1.492)					
CEO Vega$_{t-1}$	0.0091***					
	(4.243)					
Predicted Ln[Pay Gap]$_{t-1}$		0.0619***				
		(3.286)				
Predicted CEO Delta$_{t-1}$		-0.0344***				
		(-3.089)				
Predicted CEO Vega$_{t-1}$		-0.0336				
		(-1.146)				
Predicted Ln[Pay Gap]$_t$			0.1022***	1.0774	0.3149	
			(2.772)	(1.613)	(1.582)	
Predicted CEO Delta$_t$			-0.0281		-0.0498	0.2151
			(-1.571)		(-0.555)	(1.362)
Predicted CEO Vega$_t$			-0.0706	-0.7211		0.8691**
			(-1.297)	(-0.792)		(2.460)
Predicted RD Intensity$_t$				-6.7127	-1.0000	3.0217
				(-1.446)	(-0.629)	(1.074)

Continued…

Table 4 (Continued)

CEO Tenure$_t$	-0.0001	0.0008**	0.0009*	0.0225***	0.0053***	-0.0089***
	(-1.050)	(2.511)	(1.781)	(4.306)	(2.582)	(-2.976)
Ln[Assets]$_t$	-0.0051***	-0.0238***	-0.0406***	-0.3021	-0.0221	0.3696***
	(-7.428)	(-3.828)	(-3.181)	(-1.151)	(-0.234)	(9.004)
Tobin's Q$_t$	0.0109***	0.0102***	0.0062**	0.1264**	0.0585***	0.0083
	(14.700)	(6.842)	(2.022)	(2.570)	(3.629)	(0.205)
Sales Growth$_t$	0.0021	0.0160***	-0.0076	0.0111	-0.0180	0.0883**
	(0.855)	(3.005)	(-1.267)	(0.122)	(-0.707)	(2.046)
Book Leverage$_t$	-0.0367***	-0.0527***	-0.0513***	-0.5828**	-0.1919**	0.2519*
	(-7.955)	(-5.999)	(-4.176)	(-2.147)	(-2.477)	(1.780)
ROA$_t$	-0.1493***	-0.1380***	-0.1480***	-0.9998	-0.1811	0.4194
	(-17.268)	(-13.738)	(-12.083)	(-1.422)	(-0.773)	(0.931)
Industry-Mean R&D$_t$			0.4325**			
			(1.986)			
Industry-Median CEO Delta$_t$				0.5245***		
				(3.030)		
Industry-Median CEO Vega$_t$					0.4073***	
					(3.346)	
Succession Plan$_t$						-0.0185
						(-0.661)
Inside CEO$_t$						-0.0577
						(-1.578)
Constant	0.0614***	-0.1935**	-0.4095**	-4.9553*	-2.1244***	4.2220***
	(4.163)	(-2.146)	(-2.324)	(-1.693)	(-3.211)	(9.856)
Number of Observations	19104	19104	17891	17891	17891	17891
R^2	0.499					

Anderson-Rubin Wald F-statistic for Joint relevance	9.56***	Instruments used in IV (2SLS)	Instrumental Variables
Hansen J-statistic	1.035		*Succession Plan*$_{t-1}$
Difference in Sargan-Hansen statistics (tests for endogeneity)	29.417***		*Inside CEO*$_{t-1}$
First-stage F-statistics			*Industry-Median CEO Delta*$_{t-1}$
Ln[Pay Gap]$_{t-1}$	14.86***		*Industry-Median CEO Vega*$_{t-1}$
CEO Delta$_{t-1}$	26.07***		
CEO Vega$_{t-1}$	17.83***		

Table 5

Capital expenditures and tournament incentives

Multivariate tests using ExecuComp firms from 1994 – 2009. Financial firms and utilities are excluded. Presented are OLS, Instrumental Variables (IV) Estimation, and Simultaneous Equations estimation using 2SLS. The dependent variable in the OLS and IV specifications is *CAPEX Intensity*$_t$, which is capital expenditures divided by total assets. *Ln[Pay Gap]*$_{t-1}$ is the natural logarithm of the lagged difference between the CEO's total compensation and the total compensation of the median VP. *CEO Delta*$_{t-1}$ is lagged CEO's total portfolio delta, or her dollar increase in wealth (in millions) for a 1% increase in stock price. *CEO Vega*$_{t-1}$ is lagged CEO's total portfolio vega, or her increase in option-wealth (in millions) for a 0.01 standard deviation increase in stock volatility. The dependent variables in the Simultaneous Equations system are *CAPEX Intensity* and the three contemporaneous compensation measures: *CEO Delta*$_t$, *CEO Vega*$_t$, and *Ln[Pay Gap]*$_t$. *CEO Tenure* is the number of years the CEO has held the position. *Ln[Total Assets]* is the natural logarithm of book assets. *Tobin's Q* is market value of the firm divided by the book value of the firm. *Sales Growth* is the percentage increase in net sales from year *t-1* to year *t*. *Book Leverage* is interest bearing debt divided by total assets. *ROA* is prior year net income divided by total assets. *Industry-Median Sales Growth*, *Industry-Median CEO Delta*, and *Industry-Median CEO Vega* are the industry-year median values of *Sales Growth*, *CEO Delta*, and *CEO Vega* measures, respectively based on two-digit SIC codes. *CFO is VP* is a dummy variable equal to "1" if the CFO was listed as a top five highest paid executive in the current year, "0" otherwise. *Inside CEO* is a dummy variable equal to "1" if the current CEO was promoted from within, "0" otherwise. All models contain year fixed-effects and two-digit SIC industry fixed-effects. All variables are winsorized at 1% and 99% and all compensation variables are expressed in 2003 dollars. T-statistics are calculated from robust standard errors clustered by firm and are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Estimation Type	OLS	IV (2SLS)	Simultaneous Equations (2SLS)			
Dependent Variable	*CAPEX Intensity*$_t$	*CAPEX Intensity*$_t$	*CAPEX Intensity*$_t$	*CEO Delta*$_t$	*CEO Vega*$_t$	*Ln[Pay Gap]*$_t$
Ln[Pay Gap]$_{t-1}$	0.0002					
	(0.491)					
CEO Delta$_{t-1}$	0.0029***					
	(3.296)					
CEO Vega$_{t-1}$	-0.0024					
	(-1.094)					
Predicted Ln[Pay Gap]$_{t-1}$		-0.0271**				
		(-2.055)				
Predicted CEO Delta$_{t-1}$		0.0338***				
		(3.200)				
Predicted CEO Vega$_{t-1}$		0.0349				
		(1.175)				
Predicted Ln[Pay Gap]$_t$			-0.0207*	0.0155	0.0772	
			(-1.702)	(0.081)	(1.088)	
Predicted CEO Delta$_t$			0.0171**		0.1099	-1.0757
			(2.311)		(1.340)	(-0.936)
Predicted CEO Vega$_t$			0.0186	0.4688		0.4719
			(0.672)	(0.805)		(0.301)
Predicted CAPEX Intensity$_t$				-14.0412	-6.5020	67.2330
				(-1.130)	(-1.483)	(0.992)

Continued…

Table 5 (Continued)

CEO Tenure$_t$	0.0000	-0.0007***	-0.0004**	0.0177***	0.0023	0.0099
	(0.272)	(-2.678)	(-2.039)	(5.256)	(1.432)	(0.527)
Ln[Assets]$_t$	-0.0019***	0.0019	0.0044	0.0644	0.0705*	0.8336*
	(-3.049)	(0.455)	(0.828)	(0.737)	(1.882)	(1.823)
Tobin's Q$_t$	0.0035***	0.0011	0.0021	0.1651***	0.0787***	-0.0232
	(6.762)	(0.835)	(1.321)	(2.666)	(4.998)	(-0.198)
Sales Growth$_t$	0.0061***	-0.0017	0.0056**	0.1964**	0.0353	-0.0267
	(3.592)	(-0.464)	(1.975)	(2.115)	(1.132)	(-0.103)
Book Leverage$_t$	-0.0039	0.0113	-0.0350	0.1177	-0.4294*	-2.6727
	(-0.933)	(1.567)	(-1.001)	(0.197)	(-1.699)	(-1.257)
ROA$_t$	0.0149***	0.0131**	0.0024	0.3316	-0.0360	-2.0121
	(3.420)	(2.213)	(0.177)	(1.191)	(-0.345)	(-1.322)
Industry-Median Sales Growth$_t$			0.0153*			
			(1.833)			
Industry-Median CEO Delta$_t$				0.8496***		
				(4.153)		
Industry-Median CEO Vega$_t$					0.5214***	
					(5.478)	
CFO is VP$_t$						0.2097
						(1.422)
Inside CEO$_t$						-0.2479
						(-1.305)
Constant	0.0293***	0.1748**	0.1440**	-0.0486	-0.9870**	-1.1014
	(3.598)	(2.502)	(2.236)	(-0.034)	(-2.422)	(-0.190)
Number of Observations	19104	18939	17891	17891	17891	17891
R^2	0.384					

Anderson-Rubin Wald F-statistic for joint relevance	6.44***	Instruments used in IV (2SLS)	Instrumental Variables
Hansen J-statistic	0.930		*CFO is VP$_{t-1}$*
Difference in Sargan-Hansen statistics (Test for endogeneity)	24.076***		*Inside CEO$_{t-1}$*
First-stage F-statistics			*Industry-Median CEO Delta$_{t-1}$*
Ln[Pay Gap]$_{t-1}$	16.77***		*Industry-Median CEO Vega$_{t-1}$*
CEO Delta$_{t-1}$	23.65***		
CEO Vega$_{t-1}$	18.15***		

Table 6

Firm focus and tournament incentives

Multivariate tests using ExecuComp firms from 1994 – 2009. Financial firms and utilities are excluded. Presented are OLS, Instrumental Variables (IV) Estimation, and Simultaneous Equations estimation using 2SLS. The dependent variable in the OLS and IV specifications is *Firm Focus*$_t$, which is the Herfindahl index of a firm's own segments. *Ln[Pay Gap]*$_{t-1}$ is the natural logarithm of the lagged difference between the CEO's total compensation and the total compensation of the median VP. *CEO Delta*$_{t-1}$ is lagged CEO's total portfolio delta, or her dollar increase in wealth (in millions) for a 1% increase in stock price. *CEO Vega*$_{t-1}$ is lagged CEO's total portfolio vega, or her increase in option-wealth (in millions) for a 0.01 standard deviation increase in stock volatility. The dependent variables in the Simultaneous Equations system are *Firm Focus* and the three contemporaneous compensation measures: *CEO Delta*$_t$, *CEO Vega*$_t$, and *Ln[Pay Gap]*$_t$. *CEO Tenure* is the number of years the CEO has held the position. *Ln[Total Assets]* is the natural logarithm of book assets. *Tobin's Q* is market value of the firm divided by the book value of the firm. *Sales Growth* is the percentage increase in net sales from year *t-1* to year *t*. *Book Leverage* is interest bearing debt divided by total assets. *ROA* is prior year net income divided by total assets. *Industry-Median Firm Focus*, *Industry-Median CEO Delta*, and *Industry-Median CEO Vega* are the industry-year median values of *Firm Focus*, *CEO Delta*, and *CEO Vega* measures, respectively based on two-digit SIC codes. *Succession Plan* is a dummy variable equal to "1" if the firm lists a President and/or COO, "0" otherwise. *Inside CEO* is a dummy variable equal to "1" if the current CEO was promoted from within, "0" otherwise. All models contain year fixed-effects and two-digit SIC industry fixed-effects. All variables are winsorized at 1% and 99% and all compensation variables are expressed in 2003 dollars. T-statistics are calculated from robust standard errors clustered by firm and are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Estimation Type	OLS	IV (2SLS)	Simultaneous Equations (2SLS)			
Dependent Variable	*Firm Focus*$_t$	*Firm Focus*$_t$	*Firm Focus*$_t$	*Delta*$_t$	*Vega*$_t$	*Ln[Pay Gap]*$_t$
Ln[Pay Gap]$_{t-1}$	0.0016					
	(0.786)					
CEO Delta$_{t-1}$	0.0019					
	(0.458)					
CEO Vega$_{t-1}$	-0.0033					
	(-0.261)					
Predicted Ln[Pay Gap]$_{t-1}$		0.2226***				
		(3.074)				
Predicted CEO Delta$_{t-1}$		-0.0989**				
		(-2.195)				
Predicted CEO Vega$_{t-1}$		-0.1848*				
		(-1.669)				
Predicted Ln[Pay Gap]$_t$			0.2529**	0.6017	0.2740**	
			(2.263)	(1.485)	(2.270)	
Predicted CEO Delta$_t$			-00710		-0.0345	0.1891
			(-1.493)		(-0.519)	(1.245)
Predicted CEO Vega$_t$			-0.1816	-0.4103		0.9683***
			(-1.109)	(-0.553)		(2.796)
Predicted Firm Focus$_t$				-0.3903	-0.2208	0.7124**
				(-0.897)	(-1.450)	(2.315)

Continued…

Table 6 (Continued)

CEO Tenure$_t$	-0.0008**	0.0020*	0.0017	0.0207***	0.0048***	-0.0085***
	(-2.104)	(1.660)	(1.185)	(5.160)	(3.137)	(-2.847)
Ln[Assets]$_t$	-0.0350***	-0.1059***	-0.1279***	-0.0970	-0.0089	0.3787***
	(-12.142)	(-4.494)	(-3.403)	(-0.658)	(-0.148)	(9.280)
Tobin's Q$_t$	0.0141***	0.0106*	0.0020	0.1009***	0.0544***	0.0270
	(6.295)	(1.931)	(0.233)	(2.633)	(3.448)	(0.929)
Sales Growth$_t$	0.0396***	0.0872***	0.0169	0.0767	-0.0072	0.0680
	(5.620)	(4.422)	(0.994)	(1.524)	(-0.368)	(1.558)
Book Leverage$_t$	-0.0132	-0.0698**	-0.0391	-0.2991**	-0.1506***	0.1443
	(-0.760)	(-2.080)	(-1.066)	(-2.453)	(-4.460)	(1.543)
ROA$_t$	-0.0346**	0.0094	-0.0111	-0.0010	-0.0344	-0.0227
	(-2.062)	(0.293)	(-0.349)	(-0.012)	(-1.000)	(-0.230)
Industry-Median Firm Focus$_t$			0.3123***			
			(6.102)			
Industry-Median CEO Delta$_t$				0.6184***		
				(4.835)		
Industry-Median CEO Vega$_t$					0.4125***	
					(3.917)	
Succession Plan$_t$						-0.0207
						(-0.802)
Inside CEO$_t$						-0.0686**
						(-2.232)
Constant	0.9491***	0.1635	-0.3471	-3.0207*	-1.8100***	3.6631***
	(15.039)	(0.472)	(-0.657)	(-1.691)	(-4.916)	(7.560)
Number of Observations	18984	18984	17863	17863	17863	17863
R^2	0.188					

Anderson-Rubin Wald F-statistic for joint relevance	6.18***	Instruments used in IV (2SLS)	<u>Instrumental Variables</u>
Hansen J-statistic	0.735		*Succession Plan*$_{t-1}$
Difference in Sargan-Hansen statistics (Test for endogeneity)	22.79***		*Inside CEO*$_{t-1}$
First-stage F-statistics			*Industry-Median CEO Delta*$_{t-1}$
Ln[Pay Gap]$_{t-1}$	15.19***		*Industry-Median CEO Vega*$_{t-1}$
CEO Delta$_{t-1}$	26.02***		
CEO Vega$_{t-1}$	17.79***		

Table 7

Book leverage and tournament incentives

Multivariate tests using ExecuComp firms from 1994 – 2009. Financial firms and utilities are excluded. Presented are OLS, Instrumental Variables (IV) Estimation, and Simultaneous Equations estimation using 2SLS. The dependent variable in the OLS and IV specifications is *Book Leverage*$_t$, which is interest bearing debt divided by total assets. *Ln[Pay Gap]*$_{t-1}$ is the natural logarithm of the lagged difference between the CEO's total compensation and the total compensation of the median VP. *CEO Delta*$_{t-1}$ is lagged CEO's total portfolio delta, or her dollar increase in wealth (in millions) for a 1% increase in stock price. *CEO Vega*$_{t-1}$ is lagged CEO's total portfolio vega, or her increase in option-wealth (in millions) for a 0.01 standard deviation increase in stock volatility. The dependent variables in the Simultaneous Equations system are *Book Leverage* and the three contemporaneous compensation measures: *CEO Delta*$_t$, *CEO Vega*$_t$, and *Ln[Pay Gap]*$_t$. *CEO Tenure* is the number of years the CEO has held the position. *Ln[Total Assets]* is the natural logarithm of book assets. *Tobin's Q* is market value of the firm divided by the book value of the firm. *Sales Growth* is the percentage increase in net sales from year *t-1* to year *t*. *ROA* is prior year net income divided by total assets. *Industry-Median Z-Score*, *Industry-Median CEO Delta*, and *Industry-Median CEO Vega* are the industry-year median values of *Z-Score*, *CEO Delta*, and *CEO Vega* measures, respectively based on two-digit SIC codes. *CFO is VP* is a dummy variable equal to "1" if the CFO was listed as a top five highest paid executive in the current year, "0" otherwise. *Inside CEO* is a dummy variable equal to "1" if the current CEO was promoted from within, "0" otherwise. All models contain year fixed-effects and two-digit SIC industry fixed-effects. All variables are winsorized at 1% and 99% and all compensation variables are expressed in 2003 dollars. T-statistics are calculated from robust standard errors clustered by firm and are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Estimation Type	OLS	IV (2SLS)	Simultaneous Equations (2SLS)			
Dependent Variable	*Book Leverage*$_t$	*Book Leverage*$_t$	*Book Leverage*$_t$	*Delta*$_t$	*Vega*$_t$	*Ln[Pay Gap]*$_t$
Ln[Pay Gap]$_{t-1}$	0.0044**					
	(2.413)					
CEO Delta$_{t-1}$	-0.0083**					
	(-2.566)					
CEO Vega$_{t-1}$	-0.0441***					
	(-4.919)					
Predicted Ln[Pay Gap]$_{t-1}$		0.0924**				
		(2.029)				
Predicted CEO Delta$_{t-1}$		-0.0856***				
		(-2.803)				
Predicted CEO Vega$_{t-1}$		-0.1179				
		(-1.582)				
Predicted Ln[Pay Gap]$_t$			0.0925*	0.2414	0.1280*	
			(1.746)	(1.290)	(1.782)	
Predicted CEO Delta$_t$			-0.0617**		0.0524	0.0676
			(-2.246)		(0.932)	(0.437)
Predicted CEO Vega$_t$			-0.1333	0.1656		0.7863**
			(-1.636)	(0.341)		(2.416)
Predicted Book Leverage$_t$				0.8360	0.6318**	-2.3539**
				(1.024)	(2.389)	(-2.238)

Continued…

Table 7 (Continued)

CEO Tenure$_t$	-0.0003	0.0015*	0.0012	0.0188***	0.0037***	-0.0076**
	(-1.052)	(1.879)	(1.616)	(6.017)	(2.724)	(-2.476)
Ln[Assets]$_t$	0.0274***	0.0042	0.0037	-0.0032	0.0406	0.4635***
	(11.098)	(0.263)	(0.186)	(-0.040)	(1.082)	(8.666)
Tobin's Q$_t$	-0.0060*	-0.0014	-0.0010	0.1142***	0.0661***	0.0344
	(-1.937)	(-0.328)	(-0.175)	(3.156)	(5.446)	(1.197)
Sales Growth$_t$	0.0238***	0.0469***	0.0265***	0.0732	-0.0294	0.1796***
	(3.325)	(3.520)	(2.667)	(1.604)	(-1.460)	(3.040)
RD Intensity$_t$	-0.5445***	-0.6569***	-0.6654***	0.2023	0.5582***	-0.1543
	(-7.787)	(-6.663)	(-6.744)	(0.371)	(2.932)	(-0.220)
ROA$_t$	-0.4004***	-0.3910***	-0.4073***	0.3740	0.2848**	-0.8655*
	(-14.036)	(-13.270)	(-13.220)	(1.101)	(2.568)	(-1.958)
Industry-Median Z-Score$_t$			-0.0018***			
			(-3.458)			
Industry-Median Delta$_t$				0.6837***		
				(5.293)		
Industry-Median Vega$_t$					0.5066***	
					(5.143)	
CFO is VP$_t$						0.1024***
						(3.160)
Inside CEO$_t$						-0.0908***
						(-2.675)
Constant	0.0309	-0.3715*	-0.3846	-1.6877	-1.5593***	4.2010***
	(0.623)	(-1.682)	(-1.511)	(-1.425)	(-5.516)	(11.632)
Number of Observations	19104	18939	17891	17891	17891	17891
R^2	0.280					
Anderson-Rubin Wald F-statistic for joint relevance		4.63***	Instruments used in IV (2SLS)		Instrumental Variables	
Hansen J-statistic		0.272			*CFO is VP$_{t-1}$*	
Difference in Sargan-Hansen statistics (tests for endogeneity)		14.035***			*Inside CEO$_{t-1}$*	
First-stage F-statistics					*Industry-Median CEO Delta$_{t-1}$*	
Ln[Pay Gap]$_{t-1}$		16.00***			*Industry-Median CEO Vega$_{t-1}$*	
CEO Delta$_{t-1}$		23.70***				
CEO Vega$_{t-1}$		16.00***				

Table 8

Effect of tournament incentives on firm risk taking and policies: Controlling for the effect of VP Delta and Vega

Multivariate tests using ExecuComp firms from 1994 – 2009. Financial firms and utilities are excluded. Presented are OLS and Instrumental Variables (IV) Estimations. The dependent variables in the OLS and IV specifications are *Cash Flow Volatility*, *Return Volatility*, *R&D Intensity*, *CAPEX Intensity*, *Firm Focus*, and *Book Leverage*, which are the seasonally-adjusted standard deviation of EBITDA divided by total assets from year *t* to year *t+4*, the standard deviation of daily stock returns for year *t*, firm R&D expenses divided by total assets, capital expenditures divided by total assets, the Herfindahl index of a firm's own segments, and long-term debt divided by total assets. *Ln[Pay Gap]*$_{t-1}$ is the natural logarithm of the lagged difference between the CEO's total compensation and the total compensation of the median VP. *CEO Delta*$_{t-1}$ is lagged CEO's total portfolio delta. *CEO Vega*$_{t-1}$ is lagged CEO's total portfolio vega. *VP Delta*$_{t-1}$ is lagged mean VP's total portfolio delta, or her dollar increase in wealth (in millions) for a 1% increase in stock price. *VP Vega*$_{t-1}$ is lagged mean VP's total portfolio vega, or her increase in option-wealth (in millions) for a 0.01 standard deviation increase in stock volatility. For IV specifications, *Ln[Pay Gap]*$_{t-1}$, *CEO Delta*$_{t-1}$, *CEO Vega*$_{t-1}$, *VP Delta*$_{t-1}$, and *VP Vega*$_{t-1}$ are predicted values. *CEO Tenure* is the number of years the CEO has held the position. *Ln[Total Assets]* is the natural logarithm of book assets. *Tobin's Q* is market value of the firm divided by the book value of the firm. *Sales Growth* is the percentage increase in net sales from year t-1 to year t. *Book Leverage* is interest bearing debt divided by total assets. *ROA* is prior year net income divided by total assets. *Industry-Median CEO (VP) Delta* and *Industry-Median CEO (VP) Vega* are the industry-year median values of *CEO (VP) Delta* and *CEO (VP) Vega* measures, respectively based on two-digit SIC codes. *Succession Plan* is a dummy variable equal to "1" if the firm lists a President and/or COO, "0" otherwise. *Number of VPs* is the number of non-CEO executives a firm lists in ExecuComp. *Inside CEO* is a dummy variable equal to "1" if the current CEO was promoted from within, "0" otherwise. *CFO is VP* is a dummy variable equal to "1" if the CFO was listed as a top five highest paid executive in the current year, "0" otherwise. All models contain year fixed-effects and two-digit SIC industry fixed-effects. All variables are winsorized at 1% and 99% and all compensation variables are expressed in 2003 dollars. T-statistics are calculated from robust standard errors clustered by firm and are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Robustness Methodology	*Cash Flow Volatility*$_t$		*Return Volatility*$_t$		*R&D Intensity*$_t$		*CAPEX Intensity*$_t$		*Firm Focus*$_t$		*Book Leverage*$_t$	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Ln[Pay Gap]$_{t-1}$	0.0009***	0.0082**	0.0005***	0.0100***	0.0030***	0.0770***	0.0002	-0.0304**	0.0021	0.2641***	0.0039**	0.0789*
	(4.059)	(2.411)	(4.465)	(4.082)	(6.287)	(2.972)	(0.494)	(-2.130)	(1.007)	(2.767)	(2.126)	(1.708)
CEO Delta$_{t-1}$	-0.0002	0.0020	0.0005***	-0.0014	-0.0007	-0.0253**	0.0023***	0.0251**	0.0017	-0.0757*	-0.0074**	-0.0675**
	(-0.924)	(0.933)	(2.810)	(-0.863)	(-0.862)	(-2.182)	(2.665)	(2.373)	(0.390)	(-1.708)	(-2.318)	(-2.508)
CEO Vega$_{t-1}$	0.0015*	-0.0005	0.0001	-0.0058	0.0023	-0.0794	-0.0012	0.0675*	-0.0175	-0.3049*	-0.0254***	-0.0740
	(1.854)	(-0.058)	(0.181)	(-0.909)	(1.115)	(-1.598)	(-0.522)	(1.755)	(-1.370)	(-1.655)	(-2.955)	(-0.771)
VP Delta$_{t-1}$	-0.0000***	-0.0001*	0.0000***	0.0001***	-0.0000***	-0.0003**	0.0000**	0.0003***	0.0000	-0.0009	-0.0001**	-0.0005*
	(-2.649)	(-1.913)	(3.302)	(3.682)	(-3.410)	(-2.167)	(2.406)	(2.589)	(0.622)	(-1.468)	(-2.146)	(-1.705)
VP Vega$_{t-1}$	0.0000**	0.0001*	-0.0000	-0.0001**	0.0001***	0.0004	-0.0000*	-0.0004*	0.0001	0.0012	-0.0001*	0.0000
	(2.313)	(1.716)	(-0.912)	(-2.246)	(6.526)	(1.490)	(-1.948)	(-1.783)	(1.344)	(1.012)	(-1.858)	(0.005)
CEO Tenure$_t$	-0.0001***	-0.0001	-0.0001***	-0.0000	-0.0001	0.0010**	0.0000	-0.0008***	-0.0008**	0.0026*	-0.0003	0.0017**
	(-2.633)	(-1.486)	(-3.597)	(-0.651)	(-1.214)	(2.362)	(0.251)	(-2.823)	(-2.248)	(1.661)	(-0.902)	(2.022)
Ln[Assets]$_t$	-0.0037***	-0.0082***	-0.0030***	-0.0067***	-0.0058***	-0.0267***	-0.0019***	0.0017	-0.0368***	-0.1149***	0.0296***	0.0183
	(-11.013)	(-5.456)	(-23.718)	(-5.902)	(-8.024)	(-3.155)	(-3.032)	(0.369)	(-12.169)	(-3.689)	(11.536)	(1.118)
Tobin's Q$_t$	0.0024***	0.0012**	0.0006***	-0.0001	0.0107***	0.0114***	0.0034***	0.0001	0.0133***	0.0133*	-0.0045	0.0048
	(8.502)	(2.403)	(4.453)	(-0.275)	(14.433)	(5.778)	(6.458)	(0.032)	(5.917)	(1.823)	(-1.431)	(0.989)
Sales Growth$_t$	0.0044***	0.0065***	0.0040***	0.0050***	0.0032	0.0209***	0.0059***	-0.0045	0.0415***	0.1001***	0.0213***	0.0382**
	(4.286)	(4.252)	(9.411)	(5.281)	(1.271)	(2.653)	(3.470)	(-0.939)	(5.818)	(3.490)	(2.919)	(2.524)
Book Leverage$_t$	-0.0023	-0.0013	0.0019**	0.0010	-0.0362***	-0.0604***	-0.0036	0.0149*	-0.0107	-0.0892**		
	(-1.094)	(-0.518)	(2.006)	(0.677)	(-7.810)	(-5.287)	(-0.840)	(1.869)	(-0.611)	(-2.120)		

Continued…

Table 8 (Continued)

R&D Intensity$_t$											-0.5376***	-0.6086***
											(-7.640)	(-5.892)
ROA$_t$	-0.0417***	-0.0387***	-0.0447***	-0.0419***	-0.1483***	-0.1391***	0.0152***	0.0154**	-0.0303*	0.0089	-0.3995***	-0.3965***
	(-8.875)	(-8.210)	(-29.304)	(-20.734)	(-17.250)	(-12.493)	(3.469)	(2.439)	(-1.797)	(0.240)	(-14.127)	(-13.939)
Constant	0.0482***	0.0327**	0.0561***	0.0185*	0.0709***	-0.2868**	0.0600***	0.2098***	0.9602***	-0.0856	0.0388	-0.3974*
	(7.871)	(2.272)	(28.019)	(1.776)	(4.807)	(-2.284)	(7.500)	(2.798)	(15.163)	(-0.184)	(0.783)	(-1.762)
Number of Observations	14454	14528	18431	18431	18936	18936	18936	18936	18817	18817	18936	18936
R^2	0.258		0.561		0.502		0.384		0.189		0.281	
Anderson-Rubin Wald F-statistic		3.52***		16.27***		6.94***		6.15***		4.19***		4.46***
Hansen J-statistic		0.044		0.187		0.005		0.031		0.035		1.770
Difference in Sargan-Hansen statistics (Test for endogeneity)		17.328***		22.600***		30.968***		21.040***		21.889***		12.034***
Instruments used in IV (2SLS):	*Industry-Median CEO Delta$_{t-1}$* *Industry-Median CEO Vega$_{t-1}$* *Industry-Median VP Delta$_{t-1}$* *Industry-Median VP Vega$_{t-1}$* *Succession Plan$_{t-1}$* *Number of VPs$_{t-1}$*		*Industry-Median CEO Delta$_{t-1}$* *Industry-Median CEO Vega$_{t-1}$* *VP Industry-Median VP Delta$_{t-1}$* *Industry-Median VP Vega$_{t-1}$* *Succession Plan$_{t-1}$* *Number of VPs$_{t-1}$*		*Industry-Median CEO Delta$_{t-1}$* *Industry-Median CEO Vega$_{t-1}$* *Industry-Median VP Delta$_{t-1}$* *Industry-Median VP Vega$_{t-1}$* *Succession Plan$_{t-1}$* *Inside CEO$_{t-1}$*		*Industry-Median CEO Delta$_{t-1}$* *Industry-Median CEO Vega$_{t-1}$* *VP Industry-Median VP Delta$_{t-1}$* *Industry-Median VP Vega$_{t-1}$* *CFO is VP$_{t-1}$* *Inside CEO$_{t-1}$*		*Industry-Median CEO Delta$_{t-1}$* *Industry-Median CEO Vega$_{t-1}$* *Industry-Median VP Delta$_{t-1}$* *Industry-Median VP Vega$_{t-1}$* *Succession Plan$_{t-1}$* *Inside CEO$_{t-1}$*		*Industry-Median CEO Delta$_{t-1}$* *Industry-Median CEO Vega$_{t-1}$* *VP Industry-Median VP Delta$_{t-1}$* *Industry-Median VP Vega$_{t-1}$* *CFO is VP$_{t-1}$* *Inside CEO$_{t-1}$*	
First stage F-statistics												
Ln[Pay Gap]$_{t-1}$		9.61***		11.14***		11.55***		13.36***		11.78***		12.86***
CEO Delta$_{t-1}$		12.53***		17.98***		17.57***		16.19***		17.50***		16.20***
CEO Vega$_{t-1}$		12.78***		13.78***		12.37***		12.53***		12.35***		12.53***
VP Mean Delta$_{t-1}$		21.76***		28.64***		21.25***		22.58***		21.00***		22.85***
VP Mean Vega$_{t-1}$		17.57***		20.18***		11.73***		11.76***		11.59***		11.84***

Table 9

Summary of robustness results

Multivariate tests using ExecuComp firms from 1994 – 2009. Financial firms and utilities are excluded. All listed coefficients are the coefficients for the *Pay Gap* measure for the noted robustness specification after controlling for the control variables in Tables 2 - 7. We report Instrumental Variables (IV) Estimation and Simultaneous Equations (SIMULT.) estimation using 2SLS for all robustness specifications. The dependent variable in all specifications is the listed volatility/policy measure. "*Alternative Compensation 06-09*" uses actual grant information provided from 2006-2009 to calculate *CEO Delta*, *CEO Vega*, and *Pay Gap*. "*CEO Delta logged* and *CEO Vega logged*" uses Ln[Delta +1] and Ln[Vega + 1], respectively instead of the dollar amounts of Delta and Vega. "*Pay Gap unlogged*" uses *Pay Gap* instead of *Ln[Pay Gap]*. "*Tournament-Mean VP*" uses the mean VP total compensation to measure the pay gap instead of the median VP. "*Negative Pay Gap - Industry Year Pay Gap*" reports *Ln[Pay Gap]*, but sets the Pay Gap to the industry-year median for firms with a negative Pay Gap. "*Negative Pay Gap - Industry Year CEO, Firm VPs*" reports *Ln[Pay Gap]*, but computes the Pay Gap as the gap between the industry-year median CEO and the firm's median VP for firms with a negative Pay Gap. "*Negative Pay Gap – Matched CEO*" reports *Ln[Pay Gap]*, but computes the Pay Gap as the gap between an industry-year CEO matched by size and the firm's median VP for firms with a negative Pay Gap. "*Negative Pay Gap - Add Constant*" adds $8,321,000 to Pay Gap$_{t-1}$ ($8,851,000 to Pay Gap$_t$) in order to retain all firms prior to taking the logarithm. "*Gini Coefficient*" replaces our *Ln[Pay Gap]* measure with the Gini Coefficient, a macroeconomic measure of inequality. "*No CEO Turnover*" omits CEO turnover years. "*No CEO Turnover (t, t+1)*", omits CEO turnover years as well as the year after the CEO turnover. All models contain year fixed-effects and two-digit SIC industry fixed-effects. All variables are winsorized at 1% and 99% and all compensation variables are expressed in 2003 dollars. T-statistics are calculated from robust standard errors clustered by firm and are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Robustness Methodology	*Cash Flow Volatility*		*Return Volatility*		*R&D Intensity*		*CAPEX Intensity*		*Firm Focus*		*Book Leverage*	
	IV	SIMULT.	IV	SIMULT.	IV	SIMULT.	IV	SIMULT.	IV	SIMULT.	IV	SIMULT.
1. Alternative Compensation 2006-2009	0.0072**	0.0243***	0.0158***	0.0176***	0.0614***	0.0991***	-0.0270**	-0.0204*	0.2222***	0.2439**	0.0919**	0.0908*
	(2.435)	(4.735)	(3.627)	(2.697)	(3.291)	(2.825)	(-2.050)	(-1.701)	(3.069)	(2.287)	(2.025)	(1.741)
2. CEO Delta and Vega logged	0.0059**	0.0196***	0.0145***	0.0165***	0.0890***	0.0912***	-0.0226**	-0.0165*	0.2214**	0.2223**	0.0703*	0.0916**
	(1.972)	(4.633)	(3.101)	(2.912)	(3.090)	(3.064)	(-2.106)	(-1.719)	(2.571)	(2.473)	(1.836)	(2.105)
3. Pay Gap unlogged	0.0014*	0.0031***	0.0048***	0.0054***	0.0261***	0.0272***	-0.0094*	-0.0067	0.0639**	0.0620**	0.0334	0.0287
	(1.662)	(3.190)	(3.129)	(2.658)	(2.727)	(2.583)	(-1.683)	(-1.450)	(2.305)	(2.141)	(1.615)	(1.320)
4. Tournament - Mean VP	0.0069**	0.0243***	0.0133***	0.0135***	0.0561***	0.0845***	-0.0271**	-0.0213*	0.1997***	0.2104**	0.0964**	0.0838
	(2.300)	(4.449)	(3.927)	(3.050)	(3.593)	(3.262)	(-2.064)	(-1.708)	(3.305)	(2.555)	(2.124)	(1.619)
5. Negative Pay Gap - Industry Year Pay Gap	0.0073**	0.0215***	0.0184***	0.0192***	0.0488***	0.0433***	-0.0255*	-0.0169	0.2348***	0.2295**	0.1122**	0.1087**
	(2.236)	(4.516)	(3.447)	(2.741)	(3.020)	(2.877)	(-1.819)	(-1.585)	(2.813)	(2.245)	(2.143)	(2.120)
6. Negative Pay Gap - Industry Year CEO, Firm VPs	0.0068**	0.0198***	0.0169***	0.0159***	0.0490***	0.0455***	-0.0232*	-0.0149	0.2290***	0.1756**	0.1115**	0.0954**
	(2.151)	(4.551)	(3.634)	(3.029)	(3.075)	(3.058)	(-1.721)	(-1.497)	(2.866)	(2.267)	(2.130)	(1.964)
7.Negative Pay Gap – Matched CEO, Firm VPs	0.0075**	0.0239***	0.0173***	0.0181***	0.0653***	0.0972***	-0.0257*	-0.0174	0.2356***	0.2444**	0.1144**	0.1128**
	(2.163)	(4.551)	(3.578)	(2.880)	(3.175)	(2.971)	(-1.790)	(-1.639)	(2.958)	(2.447)	(2.099)	(2.140)
8. Negative Pay Gap - Add Constant	0.0266**	0.0709***	0.0711***	0.0837***	0.2333***	0.3626**	-0.0448	-0.0999	0.8451***	0.7473*	0.4043*	0.4918
	(2.257)	(4.091)	(3.600)	(2.739)	(2.827)	(2.546)	(-0.894)	(-1.436)	(2.633)	(1.856)	(1.745)	(1.417)
9. Gini Coefficient	0.0157**	0.0248***	0.0148***	0.0097***	0.3562***	0.5087***	-0.0448	-0.0999	1.2305***	1.0567**	0.7062**	0.4805
	(2.542)	(3.196)	(4.496)	(3.082)	(3.283)	(3.334)	(-0.894)	(-1.436)	(2.923)	(2.053)	(2.060)	(1.233)
10. No CEO Turnover	0.0074**	0.0259***	0.0158***	0.0214**	0.0644***	0.1126**	-0.0307**	-0.0201	0.2264***	0.2654**	0.0933**	0.0803
	(2.503)	(4.679)	(3.455)	(2.385)	(3.144)	(2.503)	(-2.065)	(-1.526)	(2.910)	(2.046)	(2.100)	(1.460)
11. No CEO Turnover (t, t+1)	0.0074**	0.0269***	0.0167***	0.0206**	0.0601***	0.1151**	-0.0263*	-0.0224	0.2185***	0.2509*	0.0974*	0.0828
	(2.246)	(4.567)	(3.193)	(2.301)	(2.939)	(2.398)	(-1.803)	(-1.494)	(2.683)	(1.902)	(1.886)	(1.362)

Table 10

Tournament incentives and risk taking in financial firms

Multivariate tests using ExecuComp financial firms (SIC 6000 – 6999) from 1994 – 2009. Presented are OLS and Instrumental Variables (IV) estimations. The dependent variables in the OLS and IV specifications are *Cash Flow Volatility*$_t$, which is the seasonally-adjusted standard deviation of earnings before taxes plus depreciation divided by total assets from year t to year t+4, and *Return Volatility*$_t$, which is the standard deviation of daily stock returns for year *t*. *Ln[Pay Gap]*$_{t-1}$ is the natural logarithm of the lagged difference between the CEO's total compensation and the total compensation of the median VP. *CEO Delta*$_{t-1}$ is lagged CEO's total portfolio delta, or her dollar increase in wealth (in millions) for a 1% increase in stock price. *CEO Vega*$_{t-1}$ is lagged CEO's total portfolio vega, or her increase in option-wealth (in millions) for a 0.01 standard deviation increase in stock volatility. *CEO Tenure* is the number of years the CEO has held the position. *Ln[Total Assets]* is the natural logarithm of book assets. *Tobin's Q* is market value of the firm divided by the book value of the firm. *Sales Growth* is the percentage increase in net sales from year t-1 to year t. *Book Leverage* is interest bearing debt divided by total assets. *ROA* is prior year net income divided by total assets. *Industry-Median Cash Flow Volatility*, *Industry-Median CEO Delta* and *Industry-Median CEO Vega* are the industry-year median values of our *Cash Flow Volatility*, *CEO Delta*, and *CEO Vega* measures, respectively based on four-digit SIC codes. *Inside CEO* is a dummy variable equal to "1" if the current CEO was promoted from within, "0" otherwise. *Number of VPs* is the number of non-CEO executives a firm lists in ExecuComp. *CFO is VP* is a dummy variable equal to "1" if the CFO is one of the top five VPs. *Ln(CEO Age)* is the natural logarithm of CEO age. T-statistics are calculated from robust standard errors clustered by firm and are in parentheses. All models contain year fixed-effects and two-digit SIC industry fixed-effects. All variables are winsorized at 1% and 99% and all compensation variables are expressed in 2003 dollars.

Estimation Type	OLS	IV (2SLS)	OLS	IV (2SLS)
Dependent Variable	*Cash Flow Volatility*$_t$	*Cash Flow Volatility*$_t$	*Return Volatility*$_t$	*Return Volatility*$_t$
Ln[Pay Gap]$_{t-1}$	0.0024***		0.0008***	
	(4.118)		(2.877)	
CEO Delta$_{t-1}$	-0.0007		0.0003	
	(-0.838)		(1.314)	
CEO Vega$_{t-1}$	0.0049		-0.0010	
	(1.224)		(-1.381)	
Predicted Ln[Pay Gap]$_{t-1}$		0.0131*		0.0114**
		(1.825)		(2.384)
Predicted CEO Delta$_{t-1}$		0.0007		-0.0016
		(0.182)		(-0.578)
Predicted CEO Vega$_{t-1}$		-0.0155*		-0.0087
		(-1.721)		(-1.018)
CEO Tenure$_t$	-0.0000	0.0000	-0.0001**	0.0000
	(-0.574)	(0.131)	(-2.163)	(0.024)
Ln[Assets]$_t$	-0.0041***	-0.0059***	-0.0010***	-0.0039***
	(-5.808)	(-2.849)	(-4.272)	(-3.081)
Tobin's Q$_t$	0.0077***	0.0070***	0.0045***	0.0032**
	(5.560)	(3.485)	(6.554)	(2.458)
Sales Growth$_t$	0.0004	0.0016	0.0018	0.0021
	(0.151)	(0.505)	(1.476)	(1.179)
Book Leverage$_t$	0.0025	-0.0038	0.0005	0.0008
	(0.947)	(-0.625)	(0.210)	(0.202)
ROA$_t$	-0.0821***	-0.0986***	-0.1141***	-0.1217***
	(-3.251)	(-3.834)	(-8.038)	(-7.226)
Constant	0.0303***	-0.0200	0.0492***	0.0055
	(4.188)	(-0.654)	(19.671)	(0.236)
Number of Observations	2597	2534	3020	3013
R^2	0.230		0.654	

Continued…

Table 10 (Continued)

Anderson-Rubin Wald F-statistic for joint relevance	1.82*	5.34***
Hansen J-statistic	1.183	0.795
Difference in Sargan-Hansen statistics (tests for endogeneity)	9.504**	14.774***
First-stage F-statistics		
Ln[Pay Gap]$_{t-1}$	10.23***	17.82***
CEO Delta$_{t-1}$	14.51***	20.76***
CEO Vega$_{t-1}$	18.24***	27.21***
Instruments used in IV (2SLS):	*Inside CEO$_{t-1}$* *Number of VPs$_{t-1}$* *CFO is VP$_{t-1}$* *Ln(CEO Age)$_{t-1}$* *Industry-Median Delta$_{t-1}$* *Industry-Median Vega$_{t-1}$*	*Number of VPs$_{t-1}$* *CFO is VP$_{t-1}$* *Industry-Median Delta$_{t-1}$* *Industry-Median Vega$_{t-1}$*