The Use of Nonfinancial Measures for Executive Compensation in High-Technology Industries*

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Abstract

Innovation is an important driver of firm value for high-technology firms; however, its outcome is long deferred and highly uncertain. We examine the relation between innovation, a nonfinancial performance measure, and CEO compensation for high-technology firms. We find that CEO compensation is positively associated with corporate innovation performance, i.e., innovation output (measured by patent count) and innovation output value (measured by patent citations). We also find that CEO equity compensation, particularly option compensation, is more sensitive to these measures of innovation performance than is cash compensation. Overall, our evidence suggests that boards of directors view patent performance as an important non-financial performance measure for innovation and incorporate this information when determining CEO compensation. We also explore cross-sectional differences in the compensation relevance of patent performance. We find the relevance varies according to firm characteristics (noise in financial performance and R&D intensity) and CEO characteristics (CEO tenure and CEO age).

Key Words: non-financial performance measure, innovation, executive compensation, patent count, patent citations, implicit contract

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1. Introduction

A growing literature advocates the use of nonfinancial measures in performance evaluation to supplement traditional financial measures such as accounting earnings and stock returns (Luft 2009). Accounting measures are viewed as historical and backward-looking and hence may not fully reflect a manager's efforts in furthering the firm's long-term goals (Ittner and Larcker 1998a). Although stock price is an aggregate of publicly available information about the firm's future prospects, it may not be a sufficient statistic to assess managerial effort and determine appropriate compensation (Davila and Venkatachalam 2004). Many believe that nonfinancial indicators such as customer satisfaction, innovation, and product quality are relevant for the firm's long-term performance (Kaplan and Norton 1992). Empirical evidence suggests that these nonfinancial measures are leading predictors of a firm's accounting and stock price performance (Ittner and Larcker 1998b; Hirshleifer et al. 2013; Fornell et al. 2006; Gu 2005). We investigate the role of patents, a nonfinancial measure that is especially critical to the long-run success of high-technology companies, in executive compensation.

Innovation is important in the value-creating process of high-technology firms and is a key determinant for firm growth (Porter 1980; Lev and Sougiannis 1999; Lev et al. 2008). However, investments in innovation are highly risky and long deferred (Huang et al. 2015). Managers' innovation efforts are not directly observable and may not be fully reflected in accounting earnings or stock price. Firm's R&D expenditures need to be expensed according to GAAP and hence result in a reduction in current net income. The finance literature shows that it is difficult for investors to process information about assets that are less tangible and about firms whose future prospects are highly uncertain. As a result, stock prices do not fully incorporate information about intangible assets such as those that result from R&D and adverting expenditures (Hirshleifer et al. 2013; Peng and Xiong 2006; Chan et al. 2001).

Given the importance of innovation for high-technology firms and that accounting numbers and stock prices may not fully capture a manager's effort in innovative activities, nonfinancial measures could play an important role in executive compensation for these firms. Patent information is a relatively objective and easily accessible nonfinancial

measure of innovation. Since the Court of Appeals for the Federal Circuit was formed in 1982, firms have increasingly recognized the need to patent their innovations and been very active in patent activities (Hall 2005). Patents are thus among the most important measures of a high-technology firm's innovative output (Griliches 1990; Lev 2001; Hall et al. 2005; Hirshleifer et al. 2013). Given the importance of innovation to the long-run success of these firms, and given that CEOs reside at the strategic apexes of their firms and make critical resource allocations pertaining to investments in new products and technologies (Balkin et al. 2000), whether boards of directors provide managers with an incentive to sustain the firm's innovation capabilities by linking CEO pay to the firm's innovative outputs is clearly an important and relevant question.

Innovation performance may not be explicitly specified in compensation contracts because compensation plans are usually limited to a small number of performance measures given the contracting costs of designing and enforcing them (Murphy, 2000). However, executive incentive plans often allow the board of directors to exercise its discretion when evaluating and rewarding managers, i.e. implicit contracts (Hayes and Schaefer 2000, Ederhof 2010). As a result, innovation performance measures such as patent count and patent citations can provide the board of directors with useful information when assessing the quantity and value of a firm's innovation and hence influence executive compensation.

Since innovation performance could be part of the implicit contract rather than the explicit contract with managers, we do not attempt to examine the disclosures about compensation contracts in firms' proxy statements. Instead, we use a sample of high-technology firms drawn from the ExecuComp database from 1992 to 2006 and empirically test whether CEO compensation is associated with patent count and patent citations after controlling for traditional financial performance measures and firm characteristics previously found to be linked to CEO compensation.

We find that CEO compensation is positively associated with patent count and patent citations. These results are consistent with boards of directors considering patent count (i.e., innovation output quantity) and citations (i.e., innovation output value), to be important nonfinancial performance measures when exercising their discretion in rewarding CEOs. We also examine whether different components of executive compensation are differentially related to innovation performance. Our results indicate that both cash compensation and equity-based compensation are associated with innovation performance. The sensitivity of CEO equity compensation, particularly option compensation, to

innovation performance is higher than that of CEO cash compensation, consistent with compensation committees considering long-term risk-taking incentives to be important drivers of innovation and tying option compensation to innovation performance. Overall, the results of our empirical analyses indicate that boards of directors compensate CEOs of high-technology firms for both the quantity and the value of innovations.

Having documented a systematic relation between compensation of high-technology firms' CEOs and innovation performance, we next extend our analysis to explore cross-sectional differences in the association between CEO compensation and the quantity and the value of innovation. Specifically, we examine whether the association varies with firm characteristics (noise in financial performance and R&D intensity) and CEO characteristics (CEO tenure and CEO age). We find that the association between CEO compensation and innovation performance is stronger when earnings or stock returns are noisier, consistent with the information hypothesis from agency theory (Holmstrom 1979; Banker and Datar 1989; Feltham and Xie 1994). We also find that the weight on innovation performance is higher when firms are more R&D intensive, consistent with the use of non-financial performance measures being closely linked to a firm's business strategy (Ittner et al. 1997). In addition, we find that compensation committees increase the sensitivity of CEO compensation to innovation performance for retiring CEOs to mitigate the horizon problem, but reduce the weight on innovation outputs for new CEOs as innovation takes time to be patented and current innovation performance may be the result of innovation efforts by the previous CEO.

Our study contributes to the literature on the use of nonfinancial measures in performance evaluation by demonstrating the importance of innovation performance in high-technology industries. Patent count and patent citations have a statistically and economically significant relation with CEO compensation. Our study also provides insights into the sensitivity of different compensation components to nonfinancial performance measures. Our findings indicate that compensation committees tie equity compensation, particularly option compensation, to patent performance to motivate CEOs to focus on long-term success.[1]

Our study also enhances understanding of the relationship between corporate innovation and compensation. Prior studies focus on how to structure compensation plans

[1] Faurel et al. (2015) provide evidence that CEO incentives (holding of stock and options) are associated with future innovation performance. Our study focuses on the incentives provided by the ability of the compensation committee to reward CEOs based on signals that may not be revealed in financial performance measures or that even may not be publicly observable.

by varying the impact of accounting-based versus stock-based performance measures in order to affect the risk preference and time horizon of managers and hence incentivize them to invest in innovative activities (Cheng 2004; Sheich 2012; Holthausen et al. 1995; Prendergast 2002; Xue 2007; Manso 2011; Lerner and Wulf 2007; Francis, Hasan, and Sharma 2010; Yanadori and Marler 2006). Our study shows that in order to encourage innovation, firms could directly link executive compensation to innovative output instead of relying solely on adjusting the structure of financial-measure-based compensation. Although innovation may not be explicitly stated in compensation contracts, the board of directors could consider innovation outputs as part of the implicit contract when evaluating the CEO's performance. Our empirical evidence shows that, despite the difficulty of accurately measuring innovation outputs and mapping current period innovation to future firm profitability, boards incorporate innovation performance, particularly patent count and patent citations, when exercising their discretion in determining CEO compensation.

Finally, our study also sheds light on the trade-off between risk and incentives in executive compensation by supporting the argument that when outcome is long deferred and highly risky, boards base the reward to managers on criteria they can control and that are believed to increase firm value (Manso 2011; Ederer and Manso 2013; Prendergast 2002; Miller et al. 2002). Since innovation is a risky investment that may introduce high volatility in the firm's financial performance, compensating managers solely based on financial measures may impose excessive risk on them. Our study shows that when innovation is very important for the firm, the board will use nonfinancial performance measures such as innovation output (patent count) and innovation value (patent citations) in CEO compensation to reduce the financial risks managers bear and incentivize them to invest more in innovations.

The rest of this paper is organized as follows. The next section discusses the related literature and develops the hypotheses. Section 3 describes the measurement of variables and research design. Section 4 presents the sample selection and reports the empirical results. Section 5 explores cross-sectional differences in the predicted association between innovation performance and CEO compensation, and section 6 provides our conclusions.

2. Related Literature and Hypotheses Development

Agency theory on performance evaluation suggests that financial measures alone may not be optimal in motivating desired managerial actions (Holmstrom 1979; Banker

and Datar 1989; Feltham and Xie 1994). In theory, unless the financial measures are sufficient statistics for all available information about all the dimensions of managerial actions that owners desire, there is a role for nonfinancial measures in contracting (Feltham and Wu 1999; Bushman and Indjejikian 1993). Accounting numbers are often criticized for their backward-looking nature and limitations in reflecting investments in intangible assets that may help promote the firm's long-term success (Ittner and Larcker 1998a; Lambert and Larcker 1987; Sloan 1993). Although stock price aggregates forward-looking information about firm value, it does not fully incorporate the implications of nonfinancial performance measures (Rajgopal et al. 2003).

Empirical evidence demonstrates that nonfinancial measures such as customer satisfaction, product quality, market share, and innovative efficiency are leading indicators of future performance that help predict future accounting and stock price performance (Hirshleifer et al. 2013; Fornell et al. 2006; Gu, 2005; Banker et al. 2000; Nagar and Rajan 2001), confirming the potential usefulness of nonfinancial measures in contracting. Based on an examination of the disclosures about compensation plans in the proxy statements of 317 firms in 1993 and 1994, Ittner et al. (1997) show that about 36% of firms employ nonfinancial measures in evaluating CEO performance and the most widely used nonfinancial indicators are customer satisfaction, nonfinancial strategic objectives, and product quality. Davila and Venkatachalam (2004) document that passenger load factor is an important nonfinancial measure in the airline industry to determine CEO cash compensation.

Technological innovations are important economic resources that provide competitive advantage to the firm and enable it to generate profits (Drucker 1993). Thus, firms' capability in innovation has increased in importance relative to traditional factors such as labor, land, and capital. While traditional financial measures such as accounting earnings and stock prices are the most frequently observed performance measures in executive compensation contracts (Murphy 2000), they do not fully capture managers' innovation efforts.[2]

The mandated full expensing of R&D results in a negative impact of innovative

[2] A large extant of literature examines how compensation contracts substitute for accounting- and market-based performance measures when such measures are better indicators of managerial performance (e.g., Engel et al. 2003).

effort on current accounting earnings. Thus, when managerial compensation is tied to aggregate accounting measures such as ROA, ROE, or EPS, managers have the incentive to boost current accounting earnings by reducing R&D expenditures (Cheng 2004). Although stock prices impound information not reflected in accounting numbers, they may not fully incorporate the information about innovation. One explanation is that the market underreacts to such information because of limited investor attention, and this underreaction is especially pronounced for information that is less tangible and for firms whose future prospects are highly uncertain (Hirshleifer et al. 2013; Peng and Xiong 2006). In particular, investors and analysts do not fully incorporate the implications of innovation capabilities reflected in patent count or patent citations for future earnings into stock prices and earnings forecasts (Hirshleifer et al. 2013; Gu 2005). Thus, whether compensation committees incorporate innovation performance in evaluating managers' innovation efforts is an empirical question.

Despite the importance of innovation for sustaining the long-run success of a high-technology firm, there is limited empirical evidence on the role of innovation as a nonfinancial performance indicator in executive compensation. Ittner et al.'s (1997) review of proxy statements indicates that only a few firms disclose the use of new product development (6.1%) and innovation (2.6%) in bonus plans. The numbers reported in Ittner et al. (1997) likely understate the current importance of innovation as a nonfinancial measure in executive compensation. First, their study was conducted using a sample of firms in the early 1990s.[3] The relevance of technological innovations has significantly increased in the two decades since. Second, their study was based on 48 different industries, including industries such as banking for which innovation is likely not the firm's primary strategic focus. Third, examining the disclosures of bonus contracts can only reflect the use of innovation as an explicit contracting term. If most of the firms rely on implicit agreements to compensate for innovation instead of explicit contracts, reviewing the bonus plan in the proxy statement may not fully capture the role of innovation in executive compensation.

Firms can be viewed as a nexus of explicit and implicit contracts (Zingales 2000). Many public firms, including some of the largest, choose not to have comprehensive written

[3] Another early study by Balkin et al. (2000) that investigate the role of innovation in CEO pay is also based on a sample of firms in 1993-1994.

(or explicit) employment contracts with their CEOs but instead to rely on implicit agreements (Gillan et al. 2009). Explicit contracts are court-enforceable and thus the performance measures used in explicit compensation contracts are often objective performance measures that must be not only observable and verifiable, but also related to states of the world anticipated in the contract. Some performance measures are more subjective and less verifiable by the court and thus require the principal to retain discretion and are often part of implicit contracts (Rajan and Reichelstein 2009; Murphy and Oyer 2003). Empirical evidence suggests that boards use both contractible and non-contractible performance measures in determining executive compensation (Hayes and Schaefer 2000; Ederhof 2010).

Innovation activities are highly unpredictable and thus difficult to contract upon *ex ante* (Holmstrom 1989; Aghion and Tirole 1994; Ederer and Manso 2013). The difficulty of accurately measuring innovation performance and the practical considerations of contracting complexity and enforcement costs could inhibit the board from explicitly incorporating innovation in the firm's compensation contract. Thus, we expect that instead of explicitly tying CEO compensation to innovation performance in the incentive contracts, boards implicitly exercise their subjective assessment of CEO innovation effort if they consider corporate innovations to be an important value-enhancing responsibility of CEOs.

In order to capture both the explicit and implicit roles of innovation in executive contracts, we do not attempt to review the disclosures in the proxy statement. Instead, we directly examine the association between CEO compensation and firms' innovation performance. We focus on high-technology firms because innovation is a key determinant of these firms' success and hence should be an informative nonfinancial measure in performance evaluation.

Innovations are usually officially introduced to the public in the form of approved patents. Firms have increasingly recognized the importance of patenting their innovations to avoid imitation. Patents constitute entry barriers and help firms sustain their competitive advantage. Patents are often viewed as a nonfinancial indicator of technology firms' innovation capabilities.

Many studies use patents as indicators of company growth and show that patents are

strongly associated with subsequent gains in companies' productivity, earnings, and stock prices. For example, Deng et al. (1999) and Hall et al. (2005) find that patent count and patent citations are positively related to market-to-book ratio, stock return, and Tobin's Q. Matolcsy and Wyatt (2008) show that industry-level patent count and journal citations are positively associated with contemporaneous market valuation and future operating performance. Gu (2005) reports that change in patent citations is positively associated with future earnings, especially in industries with relatively short time lags between technological advances and profit realization.

If boards reward CEOs' innovation efforts, CEO compensation should be positively related to firms' innovation performance. Following the prior literature, we use patent count and patent citations to measure innovation performance. We formalize these predictions in the following hypotheses (stated in alternative form):

H1: *Ceteris paribus*, CEO compensation is positively associated with innovation performance.

H1a: *Ceteris paribus*, CEO compensation is positively associated with patent count.

H1b: *Ceteris paribus*, CEO compensation is positively associated with patent citations.

CEO compensation includes both cash components (salary and bonus) and equity components (options and restricted stock). The board could consider innovation performance when determining both components of CEO compensation. Davila and Venkatachalam (2004) argue that the cash components should be related to performance measures in the current period whereas the equity components could be used to motivate future actions instead of being rewards for current performance. Their results indicate that only cash compensation is associated with their nonfinancial measure, passenger load factor, in the airline industry. However, prior studies also document the importance of equity-based compensation, especially stock options, in motivating innovations (Cheng 2004; Lerner and Wulf, 2007; Manso 2011). As a result, it is ex ante unclear whether equity and/or cash compensation will be linked to current innovation performance. Therefore, we state our second hypothesis as follows.

H2: *Ceteris paribus*, both cash and equity CEO compensation are positively associated with innovation performance.

H2a: *Ceteris paribus*, both CEO cash and CEO equity CEO compensation are positively associated with patent count.

H2b: *Ceteris paribus*, both CEO cash and CEO equity CEO compensation are positively associated with patent citations.

We also examine whether there are cross-sectional differences in the relation between CEO compensation and innovation performance. We first explore two important firm characteristics that are likely to affect the importance of innovation performance as a non-financial performance measure, noise in the financial performance measures and the firm's R&D intensity.

Agency theory suggests that any performance measure that provides incremental information about an agent's efforts that the principal wishes to motivate should receive non-zero weight in compensation and the weight depends on the signal-to-noise ratio of the performance measure in reflecting the agent's efforts that can be extracted from the alternative measures (Holmstrom 1979; Banker and Datar 1989; Feltham and Xie 1994). Thus, the relative weight placed on a performance measure depends on the relative informativeness of financial and non-financial performance measures. One potential determinant of the relative information content of alternative performance measures is the noise in measuring financial performance. If the accounting or market-based performance measures are noisier, non-financial performance measures such as patent counts and patent citations should be relatively more informative in measuring managerial efforts and hence more closely related to CEO compensation. Therefore, we state our third hypothesis as follows.

H3: *Ceteris paribus*, CEO compensation is more positively associated with innovation performance when financial performance measures are noisier.

Prior research suggests that the manager's incentives should be aligned with the goal of the firm and thus the performance measures in compensation contracts should be closely linked to the firm's business strategy (Simons 1987; Ittner et al. 1997). For firms spending a lot on R&D, innovation is crucial for creating competitive advantage and motivating managerial efforts in innovation should be more important when determining CEO compensation. As a result, we expect greater weight on innovation performance when the firm is more R&D intensive. We state our fourth hypothesis as follows.

H4: *Ceteris paribus*, CEO compensation is more positively associated with innovation performance when the firm is more R&D intensive.

In addition to firm characteristics, we also examine whether the relationship between CEO compensation and innovation performance varies with CEO characteristics. We specifically focus on CEO age and CEO tenure. It is well documented in the literature that CEOs approaching retirement may have a horizon problem (Gibbons and Murphy 1992; Cheng 2004). As a CEO approaches retirement, it is less likely that the CEO will benefit from current innovation efforts that take long to realize. CEOs therefore are more likely to reduce current R&D investment to boost current earnings than invest in innovative projects that will benefit the firm in the long-run. To mitigate the horizon problem, the compensation committee may adjust CEO compensation structure to reduce such opportunistic behavior. One possible adjustment is to tie CEO compensation more closely to non-financial performance measures as it takes time for the innovation efforts to be reflected in the financial performance measures. Therefore, we expect a stronger relation between CEO compensation and innovation performance when CEOs are near retirement age. In contrast, new CEOs should have relatively longer horizons and stronger motivations to exert efforts in innovation. In addition, since it takes time for innovation efforts to be realized as patents, current patent output may reflect the innovation efforts of the previous CEO during the CEO turnover years. Therefore, we expect a weaker association between CEO compensation and innovation performance for new CEOs. We state our fifth and sixth hypotheses as follows.

H5: *Ceteris paribus*, CEO compensation is more strongly associated with innovation performance for CEOs near retirement age.

H6: *Ceteris paribus*, CEO compensation is less strongly associated with innovation performance for new CEOs.

3. Research Design

3.1 Measurement of innovation performance

Many prior studies use patent count as the measure of innovation productivity (e.g., Griliches 1990; Holthausen et al. 1995). However, according to Trajtenberg et al. (1997) and Kelley and Rice (2002), simple patent count is not a sufficient indicator of innovative performance because not all patents are equally valuable. Prior research indicates that the

number of patent citations provides incremental information regarding the value of patents (Griliches 1987；Shane 1993；Harhoff et al. 1999；Hall et al. 2005；Stolpe 2002; Pandit et al. 2011). While patent count reflects the quantity of innovation output, it does not capture the quality and economic significance of innovation, which is reflected in citations. Given the above, a likely reason for the incremental information in the number of patent citations is that it includes information about both the quantity and the quality of innovation output. For these reasons, we also use the number of patent citations as our measure of overall innovation performance and examine its relation with CEO compensation.

We measure patent count as the number of patents granted in year *t* and patent citations by summing the number of citations received by a firm's patents granted in year *t* over the years *t+1* to *t+3*. Although this measure of patent citations is an *ex post* proxy for overall innovation performance, our presumption is that boards of directors have additional information that allows them to assess overall innovation performance in terms of the expected benefits that the firm will obtain from the patents when determining executive compensation. Harhoff et al. (1999) find that the estimated value of a patent is correlated with subsequent citations and that the most highly cited patents are very valuable, with a single citation implying an average value of about $1 million. As a result, we use the number of citations as an *ex post* proxy for the expected value of the patent estimated by the board when evaluating innovation performance. It is worth noting that this measure allows us to examine whether boards devote attention to patent quality and incorporate this information in the executive's compensation structure, even though *ex post* citations information is not available to the boards when determining CEO compensation for the year.[4]

The NBER patent database contains two time placers for each patent: its application date and grant date. Although summing up the number of patents applied for during the year would be a timely proxy for CEO's innovation efforts, the database only contains information about successful patent grants and thus does not allow us to calculate total number of patents applied for during the year. To be consistent with prior studies (e.g. Hirshleifer et al. 2013), we use the number of patents granted during year *t* to calculate

[4] We also use citations received in year *t* for patents granted in year *t-3* to *t-1* to examine the association between CEO compensation and current patent citations. The results are qualitatively similar. However, a drawback of using current patent citations is that it may not really capture CEO current innovation efforts as it takes time to receive patent citations.

patent count.[5] We take the natural logarithms of these variables in the regression models because the distributions of patent count and patent citations are highly skewed.

3.2 Empirical Model

We infer the economic importance of non-financial innovation performance measures in CEO compensation by examining the association between CEO compensation and patent performance. Specifically, to test our hypotheses that CEO compensation is positively associated with patented performance, we examine the incremental importance of patent performance for CEO compensation after controlling for traditional financial performance measures and firm characteristics. We use the following regression model to examine the relation between innovation performance and CEO compensation:

$$\begin{aligned} Comp_{i,t} = {} & \beta_0 + \beta_1 PatentPerformance + \beta_2 ROA_{i,t} + \beta_3 RET_{i,t} + \beta_4\, ROASD_{i,t} + \\ & \beta_5 RETSD_{i,t} + \beta_6 R\&D + \beta_7 LEV_{i,t} + \beta_8 LSALES_{i,t} + \beta_9 MB_{i,t} + \beta_{10} CPS_{i,t} + \\ & \beta_{11} SDTA_{i,t} + \beta_{12} TAILS_{i,t} + Year\ and\ Industry\ Effects + \varepsilon_{i,t} \end{aligned} \quad (1)$$

where *Comp* is the log of CEO compensation. To test Hypotheses 1 and 2, we examine the incremental relevance of patent performance for CEO total compensation as well as for its components, cash compensation and equity compensation. We define cash compensation as the sum of salary and bonus and equity compensation as the sum of options and restricted stock. Because option compensation is particularly important for high-technology firms to motivate innovation, we also examine the relevance of patent performance for CEO option compensation (Cheng 2004). *PatentPerformance* represents either patent count or total patent citations. β_1 is our variable of interest; a positive value suggests that boards compensate CEOs for nonfinancial, patent performance.

Return on assets (*ROA*) and stock returns (*RET*) are commonly-used observable indicators for measuring contemporaneous financial performance (Hayes and Schaefer 2000, Murphy 2000). We expect that CEOs are compensated for the risks they face, i.e., they receive a risk premium (Banker and Datar 1989; Smith and Watts 1992; Core 1997; Cyert et al. 1997; Core et al. 1999). Following Hayes and Schaefer (2000), we use the standard deviation of return on assets (*ROASD*) and the standard deviation of stock returns (*RETSD*)

[5] Untabulated tests show that results are qualitatively similar if we use the number of patents applied for in year t.

measured over the prior five years to proxy for firm risk. We control for R&D expense deflated by total assets (*R&D*), as Cheng (2004) documents that CEO compensation is tied positively to R&D expense to avoid myopia and horizon problems. Although firms may link CEO compensation to R&D to motivate innovation, R&D only measures the input, not the output of firms' innovative activities. The non-financial measures we examine in this paper, i.e. patent count and patent citations, are output-based measures that provide the board with useful information incremental to the level of R&D expenditure in evaluating the CEO's efforts in innovation. We use the ratio of total liabilities to total assets (*LEV*) to measure financial leverage. We expect CEO compensation to be higher when firms are larger and have more complex operations and growth opportunities. Following Rosen (1982), Smith and Watts (1992), Core et al. (1999), and Brick et al. (2006), we use the natural logarithm of sales (*LSALES*) as a measure of size and complexity. Following Hayes and Schaefer (2000), we use market-to-book ratio (*MB*), computed as the average over the three fiscal years prior to year *t*, as a measure of growth opportunities.

We follow Ederhof (2010) and include the standard deviation of scaled total accruals over the prior five years (*SDTA*) to control for a company's susceptibility to earnings manipulation. In addition, we include CEO pay slice, *CPS*, defined as the percentage of total compensation paid to the top five executives that goes to the CEO, to control for executive power. We also include an indicator variable, *TAILS*, which equals 1 if the contractible performance falls in the tails of the distribution and zero otherwise, to capture whether a company's contractible performance has an extreme value that triggers discretionary compensation. We measure contractible performance as the change in EPS. Lastly, we include year and two-digit SIC industry fixed effects in the model.

To examine whether the relation between CEO compensation and innovation performance varies across the noise in financial measures and R&D intensity, we estimate the OLS regression in equation (1) for separate subsamples. To test Hypothesis 3, we use the volatility of ROA (stock return) as the proxy for the noise in accounting (market) based performance measures. We divide our sample into observations with standard deviation of ROA (*ROASD*) or stock returns (*RETSD*) over the five-year period above and below the median and estimate equation (1) separately for the subsamples. To test Hypothesis 4, we split the sample at the industry (2-digit SIC code) median level of R&D expenditure scaled by total assets (*R&D*).

To examine whether the association between CEO compensation and patent performance differs for retiring or new CEOs, we augment the model in equation (1) with a dummy variable related to CEO characteristics and its interaction with patent performance. We use the following regression model to test Hypotheses 5 and 6:

$$\begin{aligned} Comp_{i,t} = {} & \beta_0 + \beta_1 PatentPerformance + \beta_2 CEOCharacteristics + \\ & \beta_3 PatentPerformance \times CEOCharacteristics + \beta_4 ROA_{i,t} + \beta_5 RET_{i,t} + \\ & \beta_6 ROASD_{i,t} + \beta_7 RETSD_{i,t} + \beta_8 R\&D + \beta_9 LEV_{i,t} + \beta_{10} LSALES_{i,t} + \beta_{11} MB_{i,t} \\ & + \beta_{12} CPS_{i,t} + \beta_{13} SDTA_{i,t} + \beta_{14} TAILS_{i,t} + Year\ and\ Industry\ Effects \\ & + \varepsilon_{i,t} \end{aligned} \quad (2)$$

where *CEOCharacteristics* represents either a dummy variable for retiring CEOs (*Retire*) or new CEOs (*NewCEO*). *Retire* equals one if CEO age is over 62, and zero otherwise. *NewCEO* equals 1 if CEO tenure is less than 3 years, and zero otherwise.

4. Results

4.1 Data and Sample

Panel A of Table 1 describes our sample selection procedure. Our sample consists of high-technology firms drawn from the ExecuComp database during the period 1992-2006. Following prior studies (e.g., Gu 2005; Bowen, Davis, and Matsumoto 2005; Barton and Waymire 2004), we define high-technology firms as firms in the following industries: chemical, biotech and pharmaceutical (SIC 28), machinery and computer hardware (SIC 35), electrical and electronics components (SIC 36), transportation equipment (SIC 37), and medical and scientific instruments (SIC 38).

We obtain financial data from *Compustat,* CEO compensation data from *ExecuComp,* and patent data from the *National Bureau of Economic Research (NBER).* The patent database contains detailed information on all patents granted by the *US Patent and Trademark Office (USPTO)* between 1976 and 2006. Data items include patent assignee names, application dates, grant dates, number of citations of each patent, firms' Compustat-matched identifiers, and other details. Patents are included in the database only if they are granted by *USPTO* by the end of 2006.

Finally, we require firms to have sufficient data for calculating the control variables.

This leads to a sample of 607 firms and 4,145 firm-year observations for testing our hypotheses. Panels B and C of Table 1 show the breakdown of firm-year observations by industry and by year, respectively. The number of firm-year observations ranges from 1,098 (26.49%) in the chemical, biotech, and pharmaceutical industry (SIC 28) to 506 (12.21%) in the transportation equipment industry (SIC 37). The observations are evenly distributed over the sample years.[6]

4.2 Descriptive Statistics

Table 2 presents the descriptive statistics of the variables used in the regressions. The means of CEO total, cash, and option compensation are each larger than their corresponding medians. Without log transformations, the untabulated statistics show that the mean (median) of CEO total compensation and cash compensation are $4,684,014 ($1,798,955) and $1,303,088 ($966,571), respectively. The statistics indicate skewness of the data and the need for log transformation of the compensation variables. At the median, equity compensation represents about 55% of CEO total compensation, and stock options represent 81% of equity compensation.

Based on the untransformed data, firms on average receive 54 patent grants during a year and the median number of patent grants is 9, suggesting that the distribution of patent count is highly-skewed and justifying the use of the logarithmic transformation. The average citations per patent is 1.47 and the median is 1. Consistent with the observations in Hall et al. (2005), one-quarter of the one-million patents have no citations and 150,000 of them have only one citation during the 10-year-period after the grant.

The mean (median) *ROA* of the sample firms is 3.6% (5.7%) and the mean (median) one-year stock return is 19.5% (11.4%). The standard deviation of ROA (*ROASD*) over the past five years has a mean (median) of 0.064 (0.035) and the standard deviation of annual stock returns over the past five years (*RETSD*) has a mean (median) of 0.569 (0.387), suggesting that stock returns are generally more volatile than accounting returns. The mean annual R&D expenditure is 6.8% of total assets and the median is 4.6%. The mean and median for *LEV* are around 49% and the mean (median) for market-to-book (*MB*) ratio is 3.553 (2.724). The proportion of CEO compensation over total compensation for the five

[6] The number of firm-year observations is lower in the early sample period because of the data availability in the ExecuComp database.

highest-paid executives (*CPS*) is on average 37%. The value for the measure of accrual volatility (*STDA*) has a mean (median) of 0.065 (0.046).

Table 3 shows the correlation matrix of all the variables used in the regression. The correlations between CEO compensation and financial performance (*ROA* and *RET*) are positive, as expected. Of particular importance to our study, patent count and patent citations are both positively correlated with CEO total, cash, and equity compensation. We also find that CEO compensation is positively correlated with *LSALE*, *MB*, *LEV*, and *CPS*, and negatively correlated with risk (*ROASD* and *RETSD*), earnings manipulability (*SDTA*), and extreme financial outcomes (*TAILS*).

4.3 CEO Compensation and Innovation Performance

Tables 4 and 5 present estimation results for Equation (1). Table 4 reports the results relating CEO compensation to patent count and Table 5 reports the results relating CEO compensation to patent citations. The results reported in Column (1) of Table 4 indicate that CEO total compensation is positively associated with patent count (coefficient = 0.047, $p<0.01$), consistent with Hypothesis 1. The explanatory power of the model is relatively high with the adjusted R-square equal to 58.23%. We also find that CEO total compensation is positively associated with *RET* (coefficient = 0.114, $p<0.01$) and *RETSD* (coefficient = 0.107, $p<0.01$), suggesting that firms tie CEO total compensation to market performance and pay CEOs a risk premium for the risks inherent in financial performance and firm operations. The estimated coefficient on accounting returns (*ROA*) is significantly negative at the 1% level; however, we do not find the coefficient on *ROASD* to be significantly different from zero. The estimated coefficient on *R&D* is positive, consistent with the finding in Cheng (2004) that firms tie CEO compensation to R&D expense, perhaps to offset CEO incentives to cut R&D expenses to boost earnings. We also find a positive coefficient on the log of sales (coefficient = 0.414, $p<0.0001$), suggesting that larger firms compensate their CEOs more. The estimated coefficient on market-to-book ratio is significantly positive (coefficient = 0.045, $p<0.01$), consistent with CEO compensation being higher when firms have greater growth opportunities. The estimated coefficient on *CPS* is significantly positive (coefficient = 1.679, $p<0.01$), consistent with CEO power being reflected in higher compensation. We do not find the estimated coefficient on *SDTA* to be positive, indicating no evidence that CEOs of firms with higher earnings manipulability receive higher total compensation.

The results for CEO compensation components, reported in Columns (2)-(4) of Table 4, are consistent with Hypotheses 2a and 2b that CEO cash compensation and stock compensation are each positively associated with patent count. Specifically, the coefficients on patent count are positive and significant for cash compensation (coefficient = 0.020, $p<0.01$), equity compensation (coefficient = 0.146, $p<0.01$), and option compensation (coefficient = 0.174, $p<0.01$). A comparison of columns (2)-(4) reveals that the magnitude of the coefficient on patent count for option compensation is the greatest. An economic interpretation of our findings is that a 10% increase in patents increases cash compensation by 0.20%, equity compensation by 1.46%, and option compensation by 1.74%, suggesting that the increase in patent count has a greater impact on equity compensation, particularly option compensation, than on cash compensation.[7] As CEO stock options usually vest over time (i.e., 3 to five years) and expire after several years (i.e., up to 10 years), compensation committees use stock options to motivate CEOs to focus on long-term performance (Cheng 2004). Our finding is also consistent with Ederer and Manso (2013) who suggest that reward for long-term success is essential for inducing managers to pursue more innovative business strategies. A concurrent study by Faurel et al. (2015) also provides evidence that CEO holdings of stock and options are associated with future innovation performance and is consistent with stock and option compensation being important in motivating innovation.

The coefficients on *RET* are significantly positive across Columns (2)-(4), confirming that both cash and stock compensation components are positively related to market performance. However, the coefficient on ROA is not significantly different from zero for cash compensation. A plausible explanation for this result is that accounting returns may be a noisy performance measure for high-technology firms and thus firms reduce the sensitivity of CEO cash pay to accounting performance.[8] The coefficients on *ROA* are negative for equity compensation and option compensation. This result is consistent with stocks and options being granted to "restore" incentives and thereby motivate improvements in long-term performance for firms with poor current accounting performance (Davila and Venkatachalam 2004). The estimated coefficients on *R&D* are significantly positive across the different compensation components, consistent with a positive weight on R&D expense

[7] On the original scale without log transformation, the median patent count for our sample firms is 9. Thus, obtaining one more patent count/citations equals to an 11.1% increase in patent counts/citations. We use the approximate number of 10% to ease interpretation of the economic significance of the results.

[8] This result is consistent with the results of prior studies. For example, Davila and Venkatachalam (2004) also find that ROA is not significantly related to any of the compensation measures.

to mitigate the myopia problem. Leverage (*LEV*) is positively associated with cash compensation, but negatively associated with stock compensation, consistent with the agency conflicts between debtholders and stockholders. CEO pay slice (*CPS*) is positively associated with cash compensation and equity compensation, consistent with the notion that CEOs with greater power receive higher compensation. Another difference between CEO cash and equity compensation shown in the results is that the adjusted R-square is higher for CEO cash compensation (60.34%) than for CEO equity compensation (18.43%) and option compensation (14.82%). This finding may reflect the fact that the value of equity compensation is influenced by more factors than is cash compensation (Baber et al. 1991; Cheng 2004).

Table 5 presents the results relating CEO compensation to the *ex post* measure of overall innovation performance (i.e., patent citations) after controlling for financial performance measures. The estimated coefficients on *PatentCitations* are significantly positive for CEO total compensation (coefficient = 0.051, $p < 0.01$), cash compensation (coefficient = 0.011, $p < 0.05$), and equity compensation (coefficient = 0.120, $p < 0.01$). For option compensation, the estimated coefficient is the highest (coefficient = 0.126, $p < 0.01$). Overall, our evidence is consistent with Hypothesis 1 and Hypothesis 2 that patent citations, as a non-financial measure of innovation performance, are relevant to CEO compensation contracting. The results also suggest that compensation committees devote attention to assessing the value of innovation (which is not directly observable to outsiders) when determining CEO compensation. Among the compensation components, CEO option compensation is most sensitive to patent citations, suggesting that compensation committees consider option compensation to be a powerful mechanism for inducing managers to pursue more valuable innovations.

Overall, our results are consistent with our hypotheses that non-financial performance measures are relevant for contracting. CEO compensation is positively associated with innovation performance measured by patent count or patent citations. In addition, to induce managers to pursue high quality innovations, the relevance of innovation performance is higher for equity compensation (particularly option compensation) than for cash compensation.

4.4 Innovation Performance in Compensation and Noise in Financial Measures

Table 6 presents the regression results for subsamples partitioned by stock return volatility and Table 7 reports corresponding results for subsamples partitioned by the volatility in accounting earnings. Panels A and B of the two tables present the results when innovation performance is measured by patent count and patent citations, respectively.

When innovation performance is measured by patent count, the results for both return volatility and earnings volatility are consistent with our hypotheses for CEO total compensation. We find significantly positive coefficients on patent count for CEO total compensation for the high return volatility subsample (coefficient = 0.082, $p<0.01$), while the coefficient is not reliably different from zero for the low return volatility subsample. The coefficient on patent count for CEO total compensation is significantly larger for the high earnings volatility subsample compared with the low earnings volatility subsample (0.063 and 0.034, respectively, difference significant at the 5% level). When we examine the compensation components, the results for cash compensation are qualitatively similar to those for total compensation. However, for equity and option compensation, the coefficient on patent count is statistically indifferent between the high return (earnings) volatility and low return (earnings) subsamples.

When innovation performance is measured by patent citations, our results are consistent with our hypotheses for CEO total compensation. We find a significantly larger coefficient on patent citations for the high return (earnings) volatility subsample than for the low return (earnings) volatility subsample (difference significant at the 1% (10%) level). The results for the compensation components are similar to those for patent count. For equity or option compensation, the coefficient on patent citations is statistically indifferent between the high return (earnings) volatility and low return (earnings) volatility subsamples. For cash compensation, the coefficient on patent citations is significantly larger for the high return volatility subsample than the low return volatility subsample (difference significant at the 5% level), and statistically indifferent between the high and low earnings volatility subsamples.

Overall, our results are consistent with Hypothesis 3 that boards assign a larger weight to innovation performance in determining CEO total compensation and in particular CEO cash compensation, when the financial performance measures are noisier.

4.5 Innovation Performance in Compensation and R&D Intensity

Table 8 presents the regression results for separate subsamples partitioned by R&D intensity. Panel A and Panel B report the results for patent count and patent citations, respectively. For total compensation, the coefficients on patent count and patent citations are significantly larger for the high R&D intensity subsample than for the low R&D intensity subsample (difference significant at the 1% level). When examining the results for compensation components, equity and option compensation show qualitatively similar results with total compensation. However, we do not find the coefficients on patent count and patent citations to be significantly different between high and low R&D intensity subsamples for cash compensation.

Overall, our results are consistent with Hypothesis 4 that boards assign a larger weight to patent quantity and patent value in determining CEO compensation when the firm is more R&D intensive, suggesting that boards consider innovation performance more important when firms spend more resources on innovation.

4.6 Innovation Performance in Compensation and CEO Characteristics

Table 9 presents the results for the effect of CEO age on the relation between CEO compensation and innovation performance. Panel A and Panel B report the results for patent count and patent citations, respectively. We find that the coefficients on the interaction terms between *PatentPerformance* and *Retire* are significantly positive across compensation components, suggesting that the association between CEO compensation and innovation performance is stronger when CEOs approach retirement.

Table 10 presents the results for the effect of CEO tenure. Panel A and Panel B report the results for patent count and patent citations, respectively. The coefficient on the interaction term between *PatentCount* and *NewCEO* for total compensation is significantly negative (-0.024, $p<0.05$), suggesting that boards adjust CEO total compensation related to patent count downward for new CEOs. The coefficients on the interaction term are insignificant for the compensation components. The results for patent citations are similar in that the coefficients on the interaction term between *PatentCitations* and *NewCEO* are significantly negative for CEO total compensation (-0.031, $p<0.01$) and for CEO equity compensation (-0.070, $p<0.10$), suggesting the CEO compensation is less sensitive to patent quality information for new CEOs. We do not find the estimated coefficients on the

interaction term to be different from zero for cash compensation and option grants.

Overall, our results are consistent with our expectation in Hypotheses 5 and 6. The boards adjust the compensation structure for retiring (new) CEOs by increasing (decreasing) the weight on innovation performance when rewarding CEOs.

5. Additional Analyses

In our main tests, we consider patent count and patent citations as two separate measures for innovation performance and estimate two regressions instead of including both measures in one regression. One reason for doing so is that it takes time for new patent grants to receive patent citations. As a result, our measure of patent citations is an *ex post* measure of citations over the years *t+1* to *t+3* for patents granted in year *t* while patent count is a performance measure readily available at the end of fiscal year *t*. In addition, the number of total patent citations is highly correlated with patent count and thus would potentially result in severe multicollinearity if both measures were included in the same model. As a result, we are unable to assess the relative weights placed on each innovation performance measure using the approach in our main tests.

In this section, we take a different perspective and explore whether boards consider both innovation quantity and innovation quality when determining CEO compensation. Patent citations can be expressed as the product of patent count and citations per patent. In other words, patent citations can be considered as a measure of overall innovation performance. We examine the relation between CEO compensation and the two components of overall innovation performance, patent count and citations per patent. We measure patent count as the number of patents granted in year *t* and citations per patent as the number of citations received by a firm's patents granted in year *t* over the years *t+1* to *t+3* divided by the number of patents granted in year *t*.

If boards reward CEOs for innovation performance, then CEO compensation should be positively related to the number of patent citations. Furthermore, if boards reward managers for innovation quantity and innovation quality, then CEO compensation should be positively related to both patent count and citations per patent. Table 10 presents the results for patent citations and the two components: patent count and citations per patent. We find that CEO total compensation is positively associated with total patent citations, as well as with patent

count and citations per patent. These results are consistent with boards of directors considering total patent citations (i.e., overall innovation contribution) and its components, patent count (i.e., innovation output quantity) and citations per patent (i.e., innovation output quality), to be important nonfinancial performance measures when exercising their discretion in rewarding CEOs.

6. Conclusions

Based on a sample of high-technology firms during 1992-2006, we find that patent performance is an important non-financial measure for innovation performance when compensation committees determining CEO compensation, apart from the observed financial performance results and firm characteristics. We also find that the relevance of patent performance in contracting is higher for equity compensation (particularly option compensation) than for cash compensation. This evidence also supports the notion that compensation committees consider corporate innovation performance to be an important responsibility of the CEO when exercising their discretion in determining CEO compensation. We also find that the relevance of innovation performance for compensation varies cross-sectionally with firm characteristics and CEO characteristics.

Our findings also support the argument that when outcome is long deferred and highly uncertain, boards of directors base the reward to CEOs on criteria they can control and that boards expect will increase firm value (Manso 2011; Prendergast 2002). This incentive then induces the managers to take higher risks because the financial risks they bear are reduced to a certain extent.

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Appendix

Variable Name	Definition
LnTotal	Natural logarithm of CEO total compensation
LnCash	Natural logarithm of CEO cash compensation
LnEquity	Natural logarithm of CEO equity compensation (the sum of option and restricted stock)
LnOption	Natural logarithm of CEO option grant
PatentCount	Natural logarithm of the number of patents granted in year t
PatentCitations	Natural logarithm of the number of patent citations received by patents granted in year t over the period of year t+1 to year t+3
Citations per patent	Natural logarithm (the number of patent citations received during year t+1 to t+3 by patents granted in year t, divided by number of patents granted in year t)
ROA	Net income before extraordinary items and discontinued operations divided by total assets
RET	Annual stock return
ROASD	Standard deviation of return on assets over the prior five years
RETSD	Standard deviation of annual stock return over the prior five years
R&D	R&D expenditure divided by total assets
LEV	Debt-equity ratio
LnSALES	Natural logarithm of net sales
MB	Average ratio of market-to-book value of assets over the prior three years. The proxy of corporate growth
CPS	(Total CEO compensation/Aggregate total compensation for the five highest-paid executives)
SDTA	Natural logarithm of the standard deviation of (total accruals/average total assets) over the prior five years; where Total accruals =(Income before extraordinary items -operating cash flows)
TAILS	TAILS is set equal to 1 if ΔEPS falls in the bottom or top 15 percent of the distribution; where $\Delta EPS = ((EPS_t - EPS_{t-1}) / \text{Share Price}_{t-1})$
Retire	An indicator variable that equals to 1 if CEO age is over 62, and zero otherwise
NewCEO	An indicator variable that equals to 1 if CEO tenure less than 3 years, and zero otherwise

Table 1
Sample Selection and Sample Breakdown

Panel A:Sample Selection Procedure		
Description	Number of firm-years	Number of firms
Initial sample with CEO compensation data from ExecuComp (1992-2006)	23,900	3,038
Less: Observations with missing total compensation	(3,528)	(128)
Less: firms not in the high technology company	(14,684)	(2,143)
Less: firms with no patent data in NBER database	(393)	(71)
Less: firms with insufficient data for the control variables	(1,150)	(89)
Sample used in regression	4,145	607

Panel B:Sample breakdown by industry			
SIC CODE	Industry	Number of firm-years	Percentage (%)
28	Chemical, biotech, and pharmaceutical	1,098	26.49
35	Machinery and computer hardware	827	19.95
36	Electrical and electronics components	1,005	24.25
37	Transportation equipment	506	12.21
38	Medical and scientific instruments	709	17.1

Panel C: Sample breakdown by year		
Year	Number of firms	Percentage (%)
1992	17	0.41
1993	193	4.66
1994	255	6.15
1995	260	6.27
1996	270	6.51
1997	289	6.97
1998	299	7.21
1999	291	7.02
2000	285	6.88
2001	303	7.31
2002	334	8.06
2003	348	8.4
2004	348	8.4
2005	335	8.08
2006	318	7.67

Notes:
Table 1 reports information related to sample selection and distribution. Panel A explains the sample selection process. Panel B reports the industry distribution of the sample. Panel C reports the year distribution of the sample.

Table 2
Descriptive Statistics

Variable	N	Mean	Std. Dev.	Q1	Median	Q3
LnTotal	4,145	7.617	1.160	6.753	7.495	8.353
LnCash	4,145	6.904	0.711	6.397	6.874	7.394
LnEquity	3,903	6.059	2.893	5.591	6.889	7.896
LnOption	3,903	5.676	3.078	5.078	6.674	7.723
PatentCount	4,145	2.402	1.742	1.099	2.303	3.714
PatentCitations	3,144	2.423	2.030	0.693	2.197	3.970
Citations per Patent	2,647	0.747	0.529	0.405	0.693	1.083
ROA	4,145	0.036	0.127	0.019	0.057	0.096
RET	4,145	0.195	0.563	-0.134	0.114	0.376
ROASD	4,145	0.064	0.089	0.018	0.035	0.072
RETSD	4,145	0.569	0.528	0.252	0.387	0.673
R&D	4,145	0.068	0.068	0.021	0.046	0.098
LEV	4,145	0.483	0.226	0.315	0.493	0.628
LnSales	4,145	6.997	1.659	5.943	7.001	8.070
MB	4,145	3.553	3.001	1.863	2.724	4.152
CPS	4,145	0.369	0.142	0.277	0.353	0.447
SDTA	4,145	0.065	0.062	0.028	0.046	0.079
TAILS	4,145	0.301	0.459	0	0	1

Notes:
Table 2 reports the descriptive statistics for the sample. See Appendix for definitions of the variables.

TABLE 3
Pearson Correlations

	LnTotal	LnCash	LnEquity	LnOption	PatentCount	Citations	Citations per Patent	ROA	RET	ROASD	RETSD	R&D	LEV	LnSales	MB	CPS	SDTA	TAILS
LnTotal	1																	
LnCash	0.715***	1																
	<.0001																	
LnEquity	0.384***	0.320***	1															
	<.0001	<.0001																
LnOption	0.295***	0.252***	0.896***	1														
	<.0001	<.0001	<.0001															
PatentCount	0.388***	0.438***	0.280***	0.263***	1													
	<.0001	<.0001	<.0001	<.0001														
Citations	0.388***	0.404***	0.277***	0.262***	0.931***	1												
	<.0001	<.0001	<.0001	<.0001	<.0001													
Citations/Patent	0.106***	-0.011	0.108***	0.106***	0.261***	0.627***	1											
	<.0001	0.5642	<.0001	<.0001	<.0001	<.0001												
ROA	0.284***	0.267***	0.022	0.009	0.050***	0.030*	-0.021	1										
	<.0001	<.0001	0.1617	0.5682	0.0013	0.0939	0.2866											
RET	0.125***	0.072***	0.021	0.031**	-0.018	0.015	0.057***	0.161***	1									
	<.0001	<.0001	0.1801	0.0497	0.253	0.4161	0.0031	<.0001										
ROASD	-0.177***	-0.250***	0.001	0.023	-0.059***	-0.023	0.135***	-0.440***	0.049***	1								
	<.0001	<.0001	0.9561	0.1473	0.0002	0.2014	<.0001	<.0001	0.0016									
RETSD	-0.132***	-0.280***	-0.003	0.029*	-0.126***	-0.058***	0.191***	-0.226***	0.017	0.431***	1							
	<.0001	<.0001	0.8303	0.0707	<.0001	0.0012	<.0001	<.0001	0.2881	<.0001								
R&D	-0.087***	-0.215***	0.052***	0.103***	0.099***	0.165***	0.280***	-0.411***	0.070***	0.489***	0.285***	1						
	<.0001	<.0001	0.0011	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001							
LEV	0.127***	0.294***	0.069***	0.016	0.149***	0.080***	-0.223***	-0.224***	-0.058***	-0.050***	-0.261***	-0.211***	1					
	<.0001	<.0001	<.0001	0.3201	<.0001	<.0001	<.0001	<.0001	0.0002	0.0013	<.0001	<.0001						
LnSales	0.572***	0.708***	0.289***	0.228***	0.568***	0.516***	0.029	0.352***	-0.034**	-0.400***	-0.353***	-0.392***	0.391***	1				
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.1304	<.0001	0.0309	<.0001	<.0001	<.0001	<.0001					
MB	0.245***	0.101***	0.167***	0.165***	0.135***	0.157***	0.094***	0.093***	0.100***	0.123***	0.115***	0.281***	-0.067***	0.032**	1			
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0423				
CPS	0.597***	0.290***	0.151***	0.081***	0.038**	0.021	-0.020	0.082***	-0.015	-0.079***	-0.067***	-0.086***	0.065***	0.111***	0.020	1		
	<.0001	<.0001	<.0001	<.0001	0.0141	0.2403	0.3	<.0001	0.323	<.0001	<.0001	<.0001	<.0001	<.0001	0.1871			
SDTA	-0.167***	-0.234***	-0.025	0.006	-0.138***	-0.093***	0.146***	-0.308***	0.061***	0.771***	0.406***	0.352***	-0.113***	-0.339***	0.078***		1	
	<.0001	<.0001	0.1182	0.717	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001			
TAILS	-0.206***	-0.164***	-0.055***	-0.050***	-0.035**	-0.004	0.065***	-0.389***	0.021	0.255***	0.149***	0.140***	0.193***	-0.122***	-0.165***	-0.077***	0.231***	1
	<.0001	<.0001	0.0006	0.0019	0.0243	0.8309	0.0008	<.0001	0.1683	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	

Notes:

Table 3 reports Pearson correlation matrix for the variables. See Appendix for definitions of the variables.

***, **, and * denote significance at the 0.01, 0.05, and 0.10 levels, respectively.

Table 4 Regression of CEO Compensation on Patent Count

Variable	Exp. Sign	(1) Total compensation	(2) Cash compensation	(3) Equity compensation	(4) Option Grants
Intercept		3.553***	4.264***	-1.565**	-1.049
		(<.0001)	(<.0001)	(0.0259)	(0.1696)
PatentCount	+	**0.047*** **	**0.020*** **	**0.146*** **	**0.174*** **
		(<.0001)	**(0.0002)**	**(<.0001)**	**(<.0001)**
ROA	+	-0.570***	0.098	-1.408***	-1.257**
		(<.0001)	(0.2126)	(0.0028)	(0.0141)
RET	+	0.114***	0.125***	0.187**	0.207**
		(<.0001)	(<.0001)	(0.0200)	(0.0177)
ROASD	+	0.319	0.190	1.091	0.524
		(0.1336)	(0.1871)	(0.2069)	(0.5770)
RETSD	+	0.107***	-0.074***	0.271***	0.337***
		(<.0001)	(<.0001)	(0.0045)	(0.0012)
R&D	+	1.862***	0.718***	4.226***	5.910***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)
LEV	-	-0.346***	0.118***	-0.693***	-1.060***
		(<.0001)	(0.0041)	(0.0052)	(<.0001)
LSALES	+	0.414***	0.279***	0.572***	0.539***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)
MB	+	0.045***	0.004	0.069***	0.059***
		(<.0001)	(0.1642)	(<.0001)	(0.0007)
CPS	+	1.679***	1.012***	2.458***	1.327***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)
SDTA	-	-0.243	-0.008	-0.566	0.528
		(0.3694)	(0.9651)	(0.6039)	(0.6565)
TAILS	?	-0.135***	-0.107***	-0.243**	-0.297***
		(<.0001)	(<.0001)	(0.0191)	(0.0085)
Adj R^2		0.5823	0.6034	0.1843	0.1482
N		4,133	4,133	3,903	3,903

Notes:
Table 4 presents estimation results for the OLS regression relating CEO compensation to patent count. Column (1) to (4) reports the results for CEO total compensation, cash compensation, equity compensation, and option compensation respectively. Industry and year fixed effects are included. The numbers in parentheses represent p-values, which are calculated based on standard errors clustered by firm. See Appendix for definitions of the variables.
***, ** and * indicate significance at 1 percent, 5 percent and 10 percent levels, respectively, in a one-tailed test if sign is predicted; two-tailed test otherwise.

Table 5 Regression of CEO Compensation on Patent Citations

Variable	Exp. Sign	Total compensation	Cash compensation	Equity compensation	Option grants
Intercept		3.592***	4.127***	-1.686**	-1.236
		(<.0001)	(<.0001)	(0.0187)	(0.1095)
PatentCitations	**+**	**0.051*** **	**0.011** **	**0.120*** **	**0.126*** **
		(<.0001)	**(0.0336)**	**(0.0002)**	**(0.0003)**
ROA	+	-0.680***	0.110	-1.890***	-1.997***
		(<.0001)	(0.2009)	(0.0003)	(0.0003)
RET	+	0.092***	0.110***	0.176**	0.214**
		(<.0001)	(<.0001)	(0.0385)	(0.0195)
ROASD	+	0.368	0.374**	1.902*	1.211
		(0.1513)	(0.0253)	(0.0576)	(0.2618)
RETSD	+	0.128***	-0.060***	0.363***	0.418***
		(<.0001)	(0.0009)	(0.0009)	(0.0004)
R&D	+	1.551***	0.84***	3.444***	4.893***
		(<.0001)	(<.0001)	(0.0003)	(<.0001)
LEV	+/-	-0.404***	0.100**	-0.762***	-1.060***
		(<.0001)	(0.0335)	(0.007)	(0.0005)
LSALES	+	0.408***	0.293***	0.620***	0.598***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)
MB	+	0.050***	0.004	0.071***	0.062***
		(<.0001)	(0.2253)	(<.0001)	(0.0011)
CPS	+	1.718***	1.133***	2.245***	1.264***
		(<.0001)	(<.0001)	(<.0001)	(0.0004)
SDTA	+	-0.219	-0.329	-1.105	-0.108
		(0.4801)	(0.1044)	(0.3629)	(0.9339)
TAILS	?	-0.134***	-0.098***	-0.212*	-0.257**
		(<.0001)	(<.0001)	(0.0642)	(0.0372)
Adj R^2		0.5754	0.6215	0.1930	0.1590
N		3,132	3,132	3,132	3,132

Notes:
Table 5 presents estimation results for the OLS regression relating CEO compensation to patent citations. Column (1) to (4) reports the results for CEO total compensation, cash compensation, equity compensation, and option compensation respectively. Industry and year fixed effects are included. The numbers in parentheses represent p-values, which are calculated based on standard errors clustered by firm. See Appendix for definitions of the variables.
***, ** and * indicate significance at 1 percent, 5 percent and 10 percent levels, respectively, in a one-tailed test if sign is predicted; two-tailed test otherwise.

Table 6 Regressions of CEO Compensation on Patent Performance, Partitioned by Firms with Large RETSD and Small RETSD

Panel A: Regressions of CEO Compensation on Patent Count

	Exp	(1)		(2)		(3)		(4)	
Variable	Sign	Total compensation		Cash compensation		Equity compensation		Option grants	
		Large RETSD	Small RETSD	Large RETSD	Small RETSD	Large RETSD	Small RETSD	Large RETSD	Small RETSD
Intercept		4.254***	2.802***	4.690***	3.810***	-1.109	-2.676***	-0.385	-2.319**
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(0.3697)	(0.0017)	(0.7685)	(0.0156)
PatentCount	**+**	**0.082*** **	**0.008**	**0.037*** **	**-0.005**	**0.142*** **	**0.136*** **	**0.178*** **	**0.141*** **
		(<.0001)	**(0.2093)**	**(<.0001)**	**(0.2519)**	**(0.0025)**	**(0.0017)**	**(0.0005)**	**(0.0033)**
ROA	+	-0.491***	-0.571***	0.177*	0.040	-1.924***	0.383	-1.253**	-0.661
		(0.0014)	(0.0041)	(0.082)	(0.7714)	(0.0012)	(0.6608)	(0.0465)	(0.5001)
RET	+	0.068**	0.231***	0.104***	0.186***	0.121	0.419***	0.107	0.522***
		(0.0127)	(<.0001)	(<.0001)	(<.0001)	(0.2484)	(0.003)	(0.3352)	(0.001)
ROASD	+	0.431	0.302	0.104	0.169	1.184	2.378	1.106	-0.231
		(0.1168)	(0.4439)	(0.5695)	(0.5372)	(0.2700)	(0.1704)	(0.3305)	(0.9058)
RETSD	+	0.060*	0.480***	-0.060***	-0.086	0.219*	1.417**	0.261**	1.005
		(0.0557)	(0.0021)	(0.0041)	(0.4274)	(0.0750)	(0.0405)	(0.0447)	(0.1959)
R&D	+	1.195***	2.456***	0.474**	1.058***	3.180***	5.647***	4.222***	8.150***
		(<.0001)	(<.0001)	(0.0179)	(<.0001)	(0.0067)	(0.0001)	(0.0007)	(<.0001)
LEV	+/-	-0.421***	-0.184**	0.078	0.101*	-1.255***	0.274	-1.454***	-0.362
		(<.0001)	(0.0357)	(0.1725)	(0.0971)	(0.0002)	(0.4796)	(<.0001)	(0.4066)
LSALES	+	0.382***	0.464***	0.252***	0.323***	0.526***	0.619***	0.431***	0.670***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)
MB	+	0.046***	0.037***	-0.003***	0.009***	0.075***	0.037	0.086***	0.005
		(<.0001)	(<.0001)	(0.4605)	(0.0116)	(0.0008)	(0.1148)	(0.0003)	(0.8574)
CPS	+	1.506***	1.896***	0.871***	1.188***	2.494***	2.369***	1.798***	0.610
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(0.1984)
SDTA	+	-0.465	0.089	0.282	-0.377	-1.958	1.958	-1.501	5.107***
		(0.2028)	(0.8315)	(0.2467)	(0.1941)	(0.1667)	(0.2914)	(0.3168)	(0.0144)
TAILS	?	-0.123***	-0.144	-0.089***	-0.095***	-0.256*	-0.246*	-0.218	-0.406**
		(0.0016)	(<.0001)	(0.0006)	(<.0001)	(0.0919)	(0.0859)	(0.1758)	(0.0117)
Adj R^2		0.5124	0.6776	0.4987	0.6774	0.1516	0.2324	0.1323	0.179
N		2,066	2,067	2,066	2,067	1,956	1,947	1,956	1,947
Difference between PatentCount coefficients	**+**	**0.074*** ** **(<.0001)**		**0.041*** ** **(0.0001)**		**0.006** **(0.4646)**		**0.037** **(0.3110)**	

Table 6 (continued) Regressions of CEO Compensation on Patent Performance, Partitioned by Firms with Large RETSD and Small RETSD

Panel B: Regressions of CEO Compensation on Total Patent Citations

	Exp	(1)		(2)		(3)		(4)	
Variable	Sign	Total compensation		Cash compensation		Equity compensation		Option grants	
		Large RETSD	Small RETSD	Large RETSD	Small RETSD	Large RETSD	Small RETSD	Large RETSD	Small RETSD
Intercept		4.245***	2.967***	4.480***	3.832***	-1.116***	-2.719***	-0.424	-2.449**
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(0.3745)	(0.0019)	(0.7473)	(0.012)
PatentCitations	**+**	**0.077*** **	**0.027*** **	**0.022*** **	**0.002**	**0.127*** **	**0.117*** **	**0.144*** **	**0.107** **
		(<.0001)	**(0.0056)**	**(0.0036)**	**(0.3898)**	**(0.0037)**	**(0.0040)**	**(0.0019)**	**(0.0142)**
ROA	+	-0.618***	-0.578***	0.199*	0.027	-2.444***	-0.153	-2.024***	-1.398
		(0.0004)	(0.0092)	(0.0803)	(0.8515)	(0.0002)	(0.8702)	(0.0035)	(0.18)
RET	+	0.045	0.231***	0.091***	0.180***	0.090	0.466***	0.105	0.592***
		(0.1257)	(<.0001)	(<.0001)	(<.0001)	(0.4168)	(0.0019)	(0.3675)	(0.0004)
ROASD	+	0.494	-0.132	0.380**	-0.120	1.931	2.245	1.894	-0.837
		(0.1376)	(0.7723)	(0.0782)	(0.6846)	(0.1241)	(0.2409)	(0.1499)	(0.695)
RETSD	+	0.090**	0.476**	-0.041	-0.115	0.356**	0.957	0.381***	0.712
		(0.0164)	(0.0111)	(0.0867)	(0.3464)	(0.0115)	(0.2247)	(0.0098)	(0.4178)
R&D	+	1.018***	2.248***	0.769***	0.937***	2.218*	5.370***	3.059**	7.820***
		(0.0029)	(<.0001)	(0.0005)	(0.0002)	(0.0856)	(0.0008)	(0.0236)	(<.0001)
LEV	+/-	-0.492***	-0.193*	0.067	0.091	-1.409***	0.492	-1.556***	-0.065
		(<.0001)	(0.0663)	(0.3044)	(0.1827)	(0.0002)	(0.2656)	(0.0001)	(0.8949)
LSALES	+	0.384***	0.436***	0.277***	0.315***	0.565***	0.648***	0.491***	0.693***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)
MB	+	0.053***	0.036***	-0.004	0.013***	0.082***	0.027	0.091***	-0.004
		(<.0001)	(<.0001)	(0.3164)	(0.0024)	(0.0008)	(0.317)	(0.0004)	(0.8893)
CPS	+	1.544***	1.945***	1.004***	1.287***	2.371***	1.956***	1.651***	0.598
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(0.0009)	(0.2573)
SDTA	+	-0.306	-0.056	-0.053	-0.517*	-2.255	1.701	-1.913	4.616**
		(0.4674)	(0.908)	(0.846)	(0.0987)	(0.1564)	(0.401)	(0.2512)	(0.0411)
TAILS	?	-0.152***	-0.095**	-0.083***	-0.074***	-0.355**	-0.059	-0.323*	-0.180
		(0.0008)	(0.011)	(0.0042)	(0.0024)	(0.0362)	(0.7052)	(0.069)	(0.3011)
Adj R^2		0.5259	0.6533	0.5252	0.6891	0.1697	0.2355	0.1527	0.1851
N		1,566	1,566	1,566	1,566	1,566	1,566	1,566	1,566
Difference between PatentCitations coefficients	**+**	**0.051*** **		**0.020** **		**0.010**		**0.036**	
		(0.0009)		**(0.0297)**		**(0.4365)**		**(0.3006)**	

Notes:

Table 6 presents estimation results for the OLS regression of CEO compensation on innovation performance for the two subsamples partitioned by the sample median value of stock return volatility (*RETSD*). Panel A reports the results when innovation performance is measured using patent count. Panel B reports the results when innovation performance is measured using patent citations. Column (1) to (4) reports the results for CEO total compensation, cash compensation, equity compensation, and option compensation respectively. Industry and year fixed effects are included. The numbers in parentheses represent p-values, which are calculated based on standard errors clustered by firm. See Appendix for definitions of the variables.

***, ** and * indicate significance at 1 percent, 5 percent and 10 percent levels, respectively, in a one-tailed test if sign is predicted; two-tailed test otherwise.

Table 7 Regressions of CEO Compensation on Patent Performance, Partitioned by Firms with Large ROASD and Small ROASD

Panel A: Regressions of CEO Compensation on Patent Count

	Exp	(1)		(2)		(3)		(4)	
Variable	Sign	Total compensation		Cash compensation		Equity compensation		Option grants	
		Large ROASD	Small ROASD	Large ROASD	Small ROASD	Large ROASD	Small ROASD	Large ROASD	Small ROASD
Intercept		4.103***	3.039***	4.409***	3.946***	0.098	-3.169***	0.476	-2.473**
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(0.9322)	(0.0006)	(0.6985)	(0.0157)
PatentCount	**+**	**0.063*** **	**0.034*** **	**0.041*** **	**0.002**	**0.102** **	**0.186*** **	**0.158*** **	**0.193*** **
		(<.0001)	**(0.0004)**	**(<.0001)**	**(0.4082)**	**(0.0197)**	**(<.0001)**	**(0.0014)**	**(0.0002)**
ROA	+	-0.436***	-0.425	0.183**	0.887***	-1.382**	-1.639	-1.298**	-1.054
		(0.0028)	(0.1387)	(0.0477)	(<.0001)	(0.0105)	(0.2165)	(0.024)	(0.474)
RET	+	0.072***	0.177***	0.098***	0.174***	0.101	0.269*	0.137	0.265
		(0.0074)	(<.0001)	(<.0001)	(<.0001)	(0.3106)	(0.0697)	(0.1952)	(0.1085)
ROASD	+	0.395	-2.761*	0.109	-2.664**	1.506	13.248*	1.019	10.694
		(0.1324)	(0.0859)	(0.5115)	(0.024)	(0.1248)	(0.0747)	(0.3297)	(0.1947)
RETSD	+	0.059**	0.271***	-0.062***	-0.092**	0.062	0.872***	0.169	0.693**
		(0.0414)	(<.0001)	(0.0007)	(0.0193)	(0.5691)	(0.0005)	(0.1413)	(0.0122)
R&D	+	1.433***	2.051***	0.536***	0.329	2.955***	4.726***	4.139***	8.094***
		(<.0001)	(<.0001)	(0.0027)	(0.2498)	(0.005)	(0.009)	(0.0002)	(<.0001)
LEV	+/-	-0.471***	-0.190**	0.071	0.111*	-1.204***	-0.114	-1.515***	-0.606
		(<.0001)	(0.0351)	(0.1848)	(0.0951)	(0.0002)	(0.7848)	(<.0001)	(0.192)
LSALES	+	0.386***	0.451***	0.246***	0.326***	0.549***	0.633***	0.507***	0.61***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)
MB	+	0.044***	0.037***	0.002	-0.002	0.082***	0.025	0.081***	-0.014
		(<.0001)	(<.0001)	(0.569)	(0.7263)	(<.0001)	(0.38)	(0.0002)	(0.6511)
CPS	+	1.669***	1.671***	1.020***	0.996***	2.486***	2.340***	1.613***	0.856*
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(0.0003)	(0.0737)
SDTA	+	-0.257	0.095	0.115	0.374	-1.248	1.045	-0.068	2.191
		(0.4541)	(0.8488)	(0.5984)	(0.3061)	(0.329)	(0.6444)	(0.9602)	(0.3829)
TAILS	?	-0.129***	-0.127***	-0.066***	-0.069**	-0.291**	-0.320*	-0.382***	-0.221
		(0.0005)	(0.0009)	(0.005)	(0.0143)	(0.0354)	(0.0664)	(0.0096)	(0.2527)
Adj R^2		0.5402	0.6489	0.5726	0.6163	0.1753	0.2078	0.1633	0.1471
N		2,067	2,066	2,067	2,066	1,958	1,945	1,958	1,945
Difference between PatentCount coefficients	**+**	**0.028** ** **(0.0442)**		**0.039*** ** **(0.0003)**		**-0.085** **(0.8910)**		**-0.035** **(0.6786)**	

Table 7 (continued) Regressions of CEO Compensation on Patent Performance, Partitioned by Firms with Large ROASD and Small ROASD

Panel B: Regressions of CEO Compensation on Total Patent Citations

	Exp	(1)		(2)		(3)		(4)	
Variable	Sign	Total compensation		Cash compensation		Equity compensation		Option grants	
		Large ROASD	Small ROASD	Large ROASD	Small ROASD	Large ROASD	Small ROASD	Large ROASD	Small ROASD
Intercept		4.156***	3.078***	4.261***	3.906***	0.102	-3.513***	0.429	-2.741***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(0.9296)	(0.0003)	(0.7276)	(0.0088)
PatentCitations	**+**	**0.061*** **	**0.039*** **	**0.021*** **	**0.009***	**0.093** **	**0.138*** **	**0.099** **	**0.152*** **
		(<.0001)	**(0.0001)**	**(0.0053)**	**(0.0909)**	**(0.0220)**	**(0.0015)**	**(0.0220)**	**(0.0013)**
ROA	+	-0.59***	-0.735**	0.182*	0.810***	-1.917***	-2.293	-2.024***	-2.922*
		(0.0004)	(0.0258)	(0.0827)	(0.0003)	(0.0012)	(0.1188)	(0.0013)	(0.0679)
RET	+	0.065**	0.150***	0.085***	0.167***	0.122	0.236	0.170	0.262
		(0.0229)	(<.0001)	(<.0001)	(<.0001)	(0.2358)	(0.1415)	(0.1202)	(0.1343)
ROASD	+	0.371	-3.041	0.296	-2.864**	1.822	16.116*	1.489	12.201
		(0.2373)	(0.113)	(0.1387)	(0.0268)	(0.1036)	(0.0595)	(0.2124)	(0.1899)
RETSD	+	0.072**	0.285***	-0.045**	-0.121***	0.153	0.862***	0.245*	0.783**
		(0.0356)	(<.0001)	(0.0409)	(0.0047)	(0.209)	(0.0024)	(0.0596)	(0.0113)
R&D	+	0.986***	2.442***	0.696***	0.434	1.769	4.897**	3.260***	7.347***
		(0.0021)	(<.0001)	(0.0006)	(0.162)	(0.1211)	(0.0172)	(0.0075)	(0.001)
LEV	+/-	-0.539***	-0.226**	0.058	0.136*	-1.298***	-0.402	-1.604***	-0.724
		(<.0001)	(0.0345)	(0.3694)	(0.0589)	(0.0003)	(0.397)	(<.0001)	(0.1617)
LSALES	+	0.383***	0.442***	0.270***	0.320***	0.580***	0.728***	0.577***	0.670***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)
MB	+	0.052***	0.036***	0.003	-0.001	0.090***	0.008	0.078***	0.002
		(<.0001)	(<.0001)	(0.5066)	(0.8552)	(<.0001)	(0.8171)	(0.0008)	(0.9629)
CPS	+	1.659***	1.785***	1.106***	1.143***	2.239***	2.196***	1.320***	1.120**
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(0.0064)	(0.0375)
SDTA	+	-0.310	0.070	-0.228	0.159	-1.855	0.528	-0.870	1.593
		(0.4374)	(0.8988)	(0.3679)	(0.6712)	(0.1923)	(0.8308)	(0.5666)	(0.5536)
TAILS	?	-0.149***	-0.116***	-0.074***	-0.040	-0.275*	-0.261	-0.394**	-0.162
		(0.0005)	(0.0073)	(0.0066)	(0.1662)	(0.0699)	(0.1748)	(0.0151)	(0.4394)
Adj R^2		0.5435	0.6363	0.5763	0.6542	0.186	0.2166	0.1626	0.1685
N		1,566	1,566	1,566	1,566	1,566	1,566	1,566	1,566
Difference between PatentCitations coefficients	**+**	**0.022*** **(0.0927)**		**0.012** **(0.1384)**		**-0.045** **(0.7532)**		**-0.053** **(0.7753)**	

Notes:

Table 7 presents estimation results for the OLS regression of CEO compensation on innovation performance for the two subsamples partitioned by the sample median value of ROA volatility (*ROASD*). Panel A reports the results when innovation performance is measured using patent count. Panel B reports the results when innovation performance is measured using patent citations. Column (1) to (4) reports the results for CEO total compensation, cash compensation, equity compensation, and option compensation respectively. Industry and year fixed effects are included. The numbers in parentheses represent p-values, which are calculated based on standard errors clustered by firm. See Appendix for definitions of the variables.

***, ** and * indicate significance at 1 percent, 5 percent and 10 percent levels, respectively, in a one-tailed test if sign is predicted; two-tailed test otherwise.

Table 8 Regressions of CEO Compensation on Patent Performance, Partitioned by R&D Intensity

Panel A: Regressions of CEO Compensation on Patent Count

Variable	Exp. Sign	(1) Total compensation		(2) Cash compensation		(3) Equity compensation		(4) Option grants	
		High R&D	Low R&D	High R&D	Low R&D	High R&D	Low R&D	High R&D	Low R&D
Intercept		3.776***	2.885***	4.413***	3.695***	-0.593	-2.792***	-0.090	-2.287**
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(0.5969)	(0.003)	(0.9395)	(0.0286)
PatentCount	**+**	**0.067*** **	**0.002**	**0.024*** **	**0.016** **	**0.218*** **	**-0.016**	**0.328*** **	**-0.075***
		(<.0001)	**(0.4215)**	**(0.0023)**	**(0.02)**	**(<.0001)**	**(0.3752)**	**(<.0001)**	**(0.089)**
ROA	+	-0.541***	-0.077	0.124	0.749***	-1.149**	-2.005*	-0.643	-2.183*
		(0.0004)	(0.7331)	(0.2067)	(<.0001)	(0.0398)	(0.0605)	(0.2744)	(0.0656)
RET	+	0.081***	0.139***	0.107***	0.126***	0.093	0.337**	0.058	0.426***
		(0.0039)	(<.0001)	(<.0001)	(<.0001)	(0.3653)	(0.0126)	(0.5935)	(0.0045)
ROASD	+	0.082	1.018***	0.169	-0.215	0.931	1.851	0.650	0.059
		(0.762)	(0.008)	(0.3369)	(0.441)	(0.3508)	(0.3214)	(0.5359)	(0.9772)
RETSD	+	0.087***	0.085**	-0.076***	-0.040	0.298***	0.015	0.290**	0.123
		(0.0047)	(0.0261)	(0.0001)	(0.1482)	(0.0085)	(0.9338)	(0.015)	(0.5432)
R&D	+	0.538*	2.690***	0.345*	1.109**	0.606	12.335***	0.787	16.205***
		(0.0777)	(0.0001)	(0.0814)	(0.0306)	(0.5905)	(0.0002)	(0.507)	(<.0001)
LEV	+/-	-0.388***	-0.102	0.088	0.112*	-0.712**	-0.434	-0.926***	-0.870*
		(<.0001)	(0.2301)	(0.119)	(0.0708)	(0.0292)	(0.2815)	(0.0071)	(0.0521)
LSALES	+	0.369***	0.488***	0.253***	0.335***	0.466***	0.732***	0.337***	0.797***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)
MB	+	0.051***	0.023***	0.00001	0.002	0.103***	0.008	0.113***	-0.047
		(<.0001)	(0.0001)	(0.9976)	(0.6643)	(<.0001)	(0.7739)	(<.0001)	(0.1307)
CPS	+	1.346***	2.125***	0.862***	1.210***	1.920***	3.323***	1.540***	1.298**
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(0.0002)	(0.0109)
SDTA	+	-0.268	-0.254	0.005	0.450	-0.741	-0.387	-0.046	1.512
		(0.4573)	(0.5392)	(0.9839)	(0.1349)	(0.5772)	(0.8427)	(0.9739)	(0.4855)
TAILS	?	-0.063	-0.178***	-0.09***	-0.061**	0.072	-0.515***	0.126	-0.619***
		(0.11)	(<.0001)	(0.0004)	(0.0109)	(0.6232)	(0.0009)	(0.4127)	(0.0003)
Adj R^2		0.5739	0.6334	0.6072	0.6213	0.1984	0.1648	0.1782	0.1096
N		2,066	2,067	2,066	2,067	1,952	1,951	1,952	1,951
Difference between PatentCount coefficients	**+**	**0.065*** ** **(<0.0001)**		**0.008** **(0.2264)**		**0.234*** ** **(0.0012)**		**0.403*** ** **(<0.0001)**	

Table 8 (continued) Regressions of CEO Compensation on Patent Performance, Partitioned by R&D Intensity

Panel B: Regression of CEO Compensation on Total Patent Citations

	Exp	(1)		(2)		(3)		(4)	
Variable	Sign	Total compensation		Cash compensation		Equity compensation		Option grants	
		High R&D	Low R&D	High R&D	Low R&D	High R&D	Low R&D	High R&D	Low R&D
Intercept		3.838***	2.863***	4.263***	3.554***	-0.708	-2.761***	-0.133	-2.461**
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(0.5351)	(0.0044)	(0.9118)	(0.0202)
PatentCitations	**+**	**0.061*** **	**0.016***	**0.011***	**0.017****	**0.163*** **	**-0.004**	**0.248*** **	**-0.078***
		(<.0001)	**(0.0661)**	**(0.0925)**	**(0.0122)**	**(0.0003)**	**(0.47)**	**(<.0001)**	**(0.0744)**
ROA	+	-0.614***	-0.300	0.122	0.937***	-1.444**	-3.764***	-1.207*	-4.426***
		(0.0004)	(0.258)	(0.2536)	(<.0001)	(0.0184)	(0.0021)	(0.0599)	(0.0009)
RET	+	0.074**	0.113***	0.090***	0.125***	0.128	0.296**	0.140	0.346**
		(0.015)	(0.0003)	(<.0001)	(<.0001)	(0.2353)	(0.0409)	(0.2179)	(0.0285)
ROASD	+	0.150	1.486***	0.222	0.188	1.811	3.660	1.267	2.609
		(0.6396)	(0.0061)	(0.2628)	(0.6229)	(0.1117)	(0.1417)	(0.2884)	(0.3377)
RETSD	+	0.105***	0.097**	-0.059***	-0.048	0.404***	0.019	0.382***	0.137
		(0.0035)	(0.0385)	(0.0081)	(0.1486)	(0.0016)	(0.9287)	(0.0046)	(0.5584)
R&D	+	0.323	2.279***	0.608***	0.263	0.066	13.358***	0.061	17.075***
		(0.3538)	(0.0047)	(0.0049)	(0.6431)	(0.9577)	(0.0003)	(0.9625)	(<.0001)
LEV	+/-	-0.442***	-0.188*	0.091	0.089	-0.767**	-0.675	-0.995**	-0.932*
		(<.0001)	(0.059)	(0.1593)	(0.2059)	(0.0386)	(0.1402)	(0.0106)	(0.0624)
LSALES	+	0.366***	0.489***	0.269***	0.350***	0.515***	0.787***	0.392***	0.873***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)
MB	+	0.054***	0.025***	-0.002	0.007	0.102***	-0.002	0.112***	-0.061*
		(<.0001)	(0.0004)	(0.624)	(0.1734)	(<.0001)	(0.9581)	(<.0001)	(0.0844)
CPS	+	1.363***	2.193***	0.983***	1.303***	1.935***	2.753***	1.666***	0.880
		(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(0.0003)	(0.1201)
SDTA	+	-0.441	0.110	-0.282	0.311	-1.578	-0.186	-1.059	1.836
		(0.2965)	(0.8148)	(0.2808)	(0.349)	(0.2939)	(0.9313)	(0.5013)	(0.4364)
TAILS	?	-0.072	-0.183***	-0.074***	-0.062**	0.046	-0.499***	0.082	-0.602***
		(0.1144)	(<.0001)	(0.0089)	(0.0162)	(0.7796)	(0.0031)	(0.6317)	(0.0011)
Adj R^2		0.5679	0.6234	0.6313	0.6388	0.2056	0.1728	0.1820	0.1307
N		1,566	1,566	1,566	1,566	1,566	1,566	1,566	1,566
Difference between PatentCitations coefficients	**+**	**0.045*** ** **(0.0038)**		**-0.006** **(0.7133)**		**0.166*** ** **(0.0071)**		**0.326*** ** **(<0.0001)**	

Notes:

Table 8 presents estimation results for the OLS regression of CEO compensation on innovation performance for the two subsamples partitioned by the industry median level of R&D intensity (*R&D*). Panel A reports the results when innovation performance is measured using patent count. Panel B reports the results when innovation performance is measured using patent citations. Column (1) to (4) reports the results for CEO total compensation, cash compensation, equity compensation, and option compensation respectively. Industry and year fixed effects are included. The numbers in parentheses represent p-values, which are calculated based on standard errors clustered by firm. See Appendix for definitions of the variables.

***, ** and * indicate significance at 1 percent, 5 percent and 10 percent levels, respectively, in a one-tailed test if sign is predicted; two-tailed test otherwise.

Table 9 Regression of CEO Compensation on Patent Performance and Indicator for Retiring CEO

Panel A: Regression of CEO Compensation on Patent Count

Variable	Exp. Sign	(1) Total compensation	(2) Cash compensation	(3) Equity compensation	(4) Option grants
Intercept		3.580***	4.264***	-1.280*	-0.793
		(<.0001)	(<.0001)	(0.0684)	(0.2992)
PatentCount	+	0.042***	0.016***	0.104***	0.138***
		(<.0001)	(0.0041)	(0.0022)	(0.0003)
Retire	?	-0.077*	0.043	-0.890***	-0.824***
		(0.0552)	(0.1145)	(<.0001)	(<.0001)
PatentCount*Retire	+	0.018	0.025***	0.148***	0.119**
		(0.1088)	(0.0054)	(0.0051)	(0.028)
ROA	+	-0.576***	0.111	-1.496***	-1.343***
		(<.0001)	(0.1574)	(0.0014)	(0.0085)
RET	+	0.114***	0.126***	0.187**	0.207**
		(<.0001)	(<.0001)	(0.0196)	(0.0176)
ROASD	+	0.324	0.171	1.158	0.595
		(0.1282)	(0.2344)	(0.1786)	(0.5254)
RETSD	+	0.106***	-0.074***	0.253***	0.320***
		(<.0001)	(<.0001)	(0.0077)	(0.002)
R&D	+	1.840***	0.781***	3.873***	5.557***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)
LEV	-	-0.350***	0.119***	-0.751***	-1.113***
		(<.0001)	(0.0037)	(0.0024)	(<.0001)
LSALES	+	0.414***	0.280***	0.571***	0.538***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)
MB	+	0.045***	0.004	0.068 ***	0.058***
		(<.0001)	(0.1884)	(<.0001)	(0.0008)
CPS	+	1.681***	0.997***	2.508***	1.380***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)
SDTA	-	-0.247	0.045	-0.704	0.375
		(0.3605)	(0.8036)	(0.5177)	(0.7512)
TAILS	**?**	-0.138***	-0.103***	-0.283***	-0.335***
		(<.0001)	(<.0001)	(0.0061)	(0.0029)
Adj R^2		0.5825	0.6069	0.1916	0.1542
N		4,133	4,133	3,903	3,903

Table 9 (continued) Regression of CEO Compensation on Patent Performance and Indicator for Retiring CEO

Panel B: Regression of CEO Compensation on Patent Citations

Variable	Exp.Sign	(1) Total compensation	(2) Cash compensation	(3) Equity compensation	(4) Option grants
Intercept		3.612***	4.14***	-1.495**	-1.046
		(<.0001)	(<.0001)	(0.037)	(0.1757)
PatentCitations	+	0.048***	0.006	0.096***	0.102***
		(<.0001)	(0.1444)	(0.0027)	(0.0028)
Retire	?	-0.062	0.025	-0.730***	-0.738***
		(0.1491)	(0.3653)	(<.0001)	(<.0001)
PatentCitations*Retire	+	0.014	0.029***	0.080*	0.076*
		(0.1656)	(0.0008)	(0.0728)	(0.0999)
ROA	+	-0.685***	0.131	-1.994***	-2.105***
		(<.0001)	(0.1266)	(0.0001)	(0.0002)
RET	+	0.092***	0.110***	0.178**	0.216**
		(<.0001)	(<.0001)	(0.0354)	(0.0179)
ROASD	+	0.371	0.367**	1.956	1.266
		(0.1476)	(0.0276)	(0.0500)	(0.2389)
RETSD	+	0.127***	-0.062***	0.354***	0.409***
		(<.0001)	(0.0006)	(0.0011)	(0.0005)
R&D	+	1.528***	0.912***	3.023***	4.458***
		(<.0001)	(<.0001)	(0.0017)	(<.0001)
LEV	+/-	-0.410***	0.100**	-0.829***	-1.128***
		(<.0001)	(0.0337)	(0.0033)	(0.0002)
LSALES	+	0.408***	0.293***	0.623***	0.602***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)
MB	+	0.050***	0.003	0.070***	0.061***
		(<.0001)	(0.2406)	(<.0001)	(0.0014)
CPS	+	1.719***	1.117***	2.299***	1.320***
		(<.0001)	(<.0001)	(<.0001)	(0.0002)
SDTA	+	-0.216	-0.287	-1.167	-0.178
		(0.4877)	(0.1551)	(0.3348)	(0.8914)
TAILS	?	-0.136***	-0.094***	-0.246**	-0.292**
		(<.0001)	(<.0001)	(0.031)	(0.0175)
Adj R^2		0.5754	0.6253	0.1994	0.1649
N		3,132	3,132	3,132	3,132

Notes:
Table 9 presents estimation results for the OLS regression relating CEO compensation to innovation performance and its interaction with retiring CEOs. Retire is set equal to 1 if CEO age is over 62; else zero. Panel A reports the results when innovation performance is measured using patent count. Panel B reports the results when innovation performance is measured using patent citations. Column (1) to (4) reports the results for CEO total compensation, cash compensation, equity compensation, and option compensation respectively. Industry and year fixed effects are included. The numbers in parentheses represent p-values, which are calculated based on standard errors clustered by firm. See Appendix for definitions of the variables.
***, ** and * indicate significance at 1 percent, 5 percent and 10 percent levels, respectively, in a one-tailed test if sign is predicted; two-tailed test otherwise.

Table 10 Regression of CEO Compensation on Patent Performance and Indicator Variable for New CEO

Panel A: Regressions of CEO Compensation on Patent Count

Variable	Exp. Sign	(1) Total compensation	(2) Cash compensation	(3) Equity compensation	(4) Option grants
Intercept	**+**	3.607***	4.369 ***	-1.695**	-1.034
		(<.0001)	(<.0001)	(0.0178)	(0.1838)
PatentCount	+	0.061***	0.021***	0.174***	0.191***
		(<.0001)	(0.0017)	(<.0001)	(<.0001)
NewCEO	?	-0.012	-0.083***	0.171	0.026
		(0.7427)	(0.0011)	(0.2655)	(0.8746)
PatentCount* NewCEO	-	-0.024**	-0.003	-0.049	-0.030
		(0.023)	(0.3636)	(0.1638)	(0.2926)
ROA	+	-0.564***	0.112	-1.427***	-1.255**
		(<.0001)	(0.1561)	(0.0025)	(0.0143)
RET	+	0.115***	0.127***	0.185**	0.207**
		(<.0001)	(<.0001)	(0.0217)	(0.0177)
ROASD	+	0.333	0.202	1.093	0.531
		(0.1168)	(0.1598)	(0.2061)	(0.5722)
RETSD	+	0.107***	-0.069 ***	0.261***	0.335***
		(<.0001)	(<.0001)	(0.0065)	(0.0013)
R&D	+	1.85***	0.701 ***	4.239***	5.906***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)
LEV	-	-0.335***	0.128***	-0.694***	-1.050***
		(<.0001)	(0.0017)	(0.0052)	(0.0001)
LSALES	+	0.413***	0.277***	0.575***	0.539***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)
MB	+	0.044***	0.003	0.068***	0.058***
		(<.0001)	(0.2146)	(<.0001)	(0.0009)
CPS	+	1.648***	0.979***	2.466***	1.304***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)
SDTA	-	-0.206	0.026	-0.565	0.563
		(0.4465)	(0.8881)	(0.6048)	(0.6358)
TAILS	?	-0.133***	-0.105***	-0.243**	-0.296***
		(<.0001)	(<.0001)	(0.019)	(0.0088)
Adj R^2		0.5835	0.6064	0.1841	0.1479
N		4,133	4,133	3,903	3,903

Table 10 (continued) Regression of CEO Compensation on Patent Performance and Indicator Variable for New CEO

Panel B: Regressions of CEO Compensation on Patent Citations

Variable	Exp.Sign	(1) Total compensation	(2) Cash compensation	(3) Equity compensation	(4) Option grants
Intercept		3.659***	4.253***	-1.847**	-1.318*
		(<.0001)	(<.0001)	(0.0115)	(0.094)
PatentCitations	**+**	0.070***	0.011**	0.163***	0.156***
		(<.0001)	(0.0680)	(0.0001)	(0.0005)
NewCEO	?	-0.015	-0.107***	0.230	0.136
		(0.7089)	(<.0001)	(0.1537)	(0.4356)
PatentCitations*NewCEO	**-**	-0.031***	0.0003	-0.070*	-0.049
		(0.0054)	(0.4869)	(0.0731)	(0.1730)
ROA	+	-0.667***	0.136	-1.922***	-2.014***
		(<.0001)	(0.1148)	(0.0002)	(0.0003)
RET	+	0.092***	0.111***	0.172**	0.212**
		(<.0001)	(<.0001)	(0.0429)	(0.021)
ROASD	+	0.378	0.392**	1.882*	1.201
		(0.1392)	(0.0186)	(0.0603)	(0.2659)
RETSD	+	0.129***	-0.053***	0.347***	0.409***
		(<.0001)	(0.0035)	(0.0015)	(0.0005)
R&D	+	1.568***	0.842***	3.475***	4.915***
		(<.0001)	(<.0001)	(0.0003)	(<.0001)
LEV	+/-	-0.382***	0.118**	-0.757***	-1.053***
		(<.0001)	(0.0119)	(0.0075)	(0.0006)
LSALES	+	0.406***	0.291***	0.622***	0.599***
		(<.0001)	(<.0001)	(<.0001)	(<.0001)
MB	+	0.049***	0.003	0.069***	0.061***
		(<.0001)	(0.2966)	(<.0001)	(0.0015)
CPS	+	1.681***	1.099***	2.247***	1.257***
		(<.0001)	(<.0001)	(<.0001)	(0.0005)
SDTA	+	-0.159	-0.289	-1.070	-0.075
		(0.6079)	(0.1529)	(0.3785)	(0.9544)
TAILS	?	-0.134***	-0.098***	-0.214*	-0.258**
		(<.0001)	(<.0001)	(0.0611)	(0.0361)
Adj R^2		0.5776	0.6256	0.1931	0.1587
N		3,132	3,132	3,132	3,132

Notes:
Table 10 presents estimation results for the OLS regression relating CEO compensation to innovation performance and its interaction with new CEOs. NewCEO is set equal to 1 if CEO tenure less than 3 years; else zero. Panel A reports the results when innovation performance is measured using patent count. Panel B reports the results when innovation performance is measured using patent citations. Column (1) to (4) reports the results for CEO total compensation, cash compensation, equity compensation, and option compensation respectively. Industry and year fixed effects are included. The numbers in parentheses represent p-values, which are calculated based on standard errors clustered by firm. See Appendix for definitions of the variables. ***, ** and * indicate significance at 1 percent, 5 percent and 10 percent levels, respectively, in a one-tailed test if sign is predicted; two-tailed test otherwise.

Table 11 Regression of CEO Compensation on Patent Citations and Components

Variable	Exp. Sign	Total compensation	Total compensation
Intercept		3.592***	3.761***
		(<.0001)	(<.0001)
PatentCitations	+	0.051***	
		(<.0001)	
PatentCount	+		0.08***
			(<.0001)
Citations/patent	+		0.095***
			(0.0007)
ROA	+	-0.680***	-0.521***
		(<.0001)	(0.0004)
RET	+	0.092***	0.079***
		(<.0001)	(0.0013)
ROASD	+	0.368	0.032
		(0.1513)	(0.9115)
RETSD	+	0.128***	0.157***
		(<.0001)	(<.0001)
R&D	+	1.551***	1.406***
		(<.0001)	(<.0001)
LEV	+/-	-0.404***	-0.361***
		(<.0001)	(<.0001)
LSALES	+	0.408***	0.373***
		(<.0001)	(<.0001)
MB	+	0.050***	0.049***
		(<.0001)	(<.0001)
CPS	+	1.718***	1.609***
		(<.0001)	(<.0001)
SDTA	+	-0.219	-0.219
		(0.4801)	(0.531)
TAILS	?	-0.134***	-0.113***
		(<.0001)	(0.0004)
Adj R^2		0.5754	0.5735
N		3,132	2,638

Notes:
Table 11 presents estimation results for the OLS regression of CEO total compensation on total patent citation and its components. Column (1) reports the results relating CEO total compensation to total patent citations. Column (2) reports the results relating CEO total compensation to patent count and citations per patent. Industry and year fixed effects are included. The numbers in parentheses represent p-values, which are calculated based on standard errors clustered by firm. See Appendix for definitions of the variables.
***, ** and * indicate significance at 1 percent, 5 percent and 10 percent levels, respectively, in a one-tailed test if sign is predicted; two-tailed test otherwise.