CEO Incentives and Product Development Innovation: Insights from Trademarks

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We introduce trademarks as a new measure of innovation output, and examine the relation between CEO incentives and trademarks in a broad set of industries. Our new dataset contains 123,545 USPTO trademark registrations by S&P 1500 firms from 1993 to 2011. As compared with patents, trademarks measure innovation over a wider range of industries and focus on the product development portion of innovation. We find that the fraction of CEO pay in the form of stock options, the convexity of CEO incentives, and the amount of unvested stock options held by the CEO are strongly positively associated with future trademarks. We also examine subsets of industries based on their technology-intensity, and find generally similar results for low-tech, mid-tech and high-tech industries. In contrast, the relation between patents and CEO incentives is concentrated in high-tech, and to a lesser extent mid-tech, industries and is insignificant in low-tech industries, highlighting the different inferences that arise by focusing on trademarks. Finally, we document a positive relation between changes in stock option compensation around the implementation of SFAS 123(R) and subsequent changes in trademark creation, suggesting that stock option compensation is an important driver of product development innovation.

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1. Introduction

In this study, we investigate whether and how the structure of CEO incentives affects the amount of innovation by the firm. This topic is not new.[1] Our primary contribution is in introducing a large novel dataset of U.S. *trademarks* as a new measure of innovative output, allowing us to address the incentives to innovate for a segment of the economy that was largely ignored in the previous literature using more traditional measures of innovation. Using this new measure of innovation, we test whether CEO incentives affect the number of new trademarks created by firms. We consider three related dimensions of CEO incentives which result from compensation structure; the fraction of CEO compensation that is in the form of stock options, the overall convexity of the CEO's incentives with respect to firm value, and the amount of unvested stock options held by the CEO.

Previous research has shown that CEOs play a critical role in the pursuit and success of patent innovation.[2] Innovative activity is inherently risky and requires effort. The traditional assumption in principal-agent models is that CEOs are averse to effort and risk, so that incentives are required to motivate CEOs to undertake risky innovation. Theoretical research suggests that convex CEO incentives with long-term payoffs can increase CEOs' willingness to engage in such risky activities, and past empirical research has verified that these incentives encourage activities such as R&D spending and *patent-related* innovative activities.[3]

A key limitation of these past studies is that patents and R&D spending reflect only a subset

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[1] Researchers in many fields have long recognized the importance of innovation for economic growth and as a key driver of firm value (see, for example, Mansfield, 1965; Scherer, 1965; Pakes, 1985; Hall, 1996; Giliches, 1998; and Hall and Rosenberg, 2010). It is therefore important to study how firms can motivate chief executive officers (CEOs) to undertake innovation projects. Footnotes 2 and 3 list specific papers on CEOs, incentives, and innovation.

[2] See Dechow and Sloan (1991), Barker and Mueller (2002), Galasso and Simcoe (2011), Hirshleifer, Low, and Teoh (2012), Bereskin and Hsu (2013), and Custodio, Ferreira and Matos (2014).

[3] See Smith and Stulz (1985), Hirshleifer and Suh (1992), Datta, Iskandar-Datta, and Raman (2001), Rajgopal and Shevlin (2002), Coles, Daniel and Naveen (2006), Xue (2007), Francis, Hasan and Sharma (2011), Manso (2011), Currim, Lim and Kim (2013), and Baranchuk, Kieschnick, and Moussawi (2014).

of all innovative activities undertaken by corporations. The Organization of Economic Cooperation and Development (OECD) includes a broader range of activities in their definition of innovation: "*An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations*" (OECD, 2005, p. 46). In several reports on innovation, the OECD encourages consideration of activities related to the development of new products, processes, organization, and marketing as innovative activities, as well as pursuit of new measures for these dimensions (OECD, 2010a, b). Patents and R&D spending are mainly concentrated in industries associated with scientific inventions and intensive research into new technology, which we label as "high-technology" (high-tech) industries. Other industries, such as recreational products, food products, printing and publishing, and entertainment, which are lower-technology (low-tech) or medium-technology (mid-tech) industries, innovate more through new product development. Trademarks capture the product development innovation pursued by all of these groups of industries. Thus, trademarks complement patents and R&D to provide researchers and policymakers with a more comprehensive measure of innovation by companies and for the economy as a whole. Given the importance of innovation, we investigate whether incentive structures affect trademark-related innovation, both for firms in general and specifically for firms in the subsets of low-tech, mid-tech, and high-tech industries.

Trademark information is available from the United States Patent and Trademark Office (USPTO). However, the information is not in a form that is directly usable by researchers. Therefore, we compile a comprehensive dataset of firm-level U.S. trademarks.[4] See details of the procedure for gathering, cleaning, and matching trademark information to Compustat firms in

[4] Von Graevenitz (2007) builds a dataset of European trademarks, and the Australian government compiles patents and trademark data publicly available (Oct 9, 2014).

Faurel, Li, Shanthikumar, and Teoh (2015). Currently, our dataset contains 123,545 U.S. trademark registrations for all firms in the S&P 1500 for the fiscal years 1993 through 2011. To distinguish between product development innovation and marketing development innovation, we classify new trademarks as either product trademarks or marketing trademarks. See Section 3 and Appendix A for details. There are several indications of the value of trademarks. Faurel, Li, Shanthikumar, and Teoh (2015) show that new trademarks have value in that they are positively associated with increases in future sales. Bloomberg-Businessweek/Interbrand valued the brands in its top 100 brands list (in 2003) at an average (median) of 53% (27%) of the value of the associated companies' total assets. Finally, firms spend significant amounts of money defending trademarks in courts, and large amounts of money are often awarded in these cases.[5]

Before we test whether compensation structure is related to trademark innovation, we first examine whether trademarks are associated with firm risk. We find evidence that firms with more trademarks have higher risk, as measured by stock return volatility and earnings volatility, both in the development phase and in the post-trademark registration period. The positive relation between the number of trademarks and risk is stronger for product trademarks than for marketing trademarks, consistent with the intuition that the later phases of the innovation cycle, such as marketing innovation, are less risky than the earlier phases.

To induce high CEO effort and tolerance for undertaking risky projects, agency theory suggests that the compensation schedule should have a long-term incentive component that is convex and increasing in shareholder value, so that expected compensation is increasing with the

[5] Two high-dollar examples include "Pods" and Adidas shoes. In PODS Enterprises Inc. v. U-Haul International Inc., PODS Inc. was awarded over $60 million in damages in the trademark infringement case it brought against U-Haul for the use of "pods" and "pod" in advertising of their products (http://www.bloomberg.com/news/2014-09-26/activision-pods-u-haul-nfl-intellectual-property.html). In Adidas America Inc. et al. v. Payless ShoeSource Inc., Adidas was initially awarded over $300 million over Payless' infringement of Adidas' product design and logo trademarks for its 3-striped shoes (http://blogs.wsj.com/law/2008/05/07/adidas-v-payless-100-million-for-every-stripe-payless-could-pay-more/), though this was reportedly lowered to $35 million in a post-appeal settlement.

riskiness of shareholder value. This can be implemented by offering stock option compensation with a multiple-year vesting period. Thus, our main empirical tests examine stock option compensation, and our research question asks whether new product trademarks are positively associated with the fraction of total compensation that is in the form of stock options; with a measure of incentive compensation convexity, Vega, estimated from the sensitivity of the CEO's expected wealth to stock volatility; and with the amount of unvested stock options the CEO holds. Consistent with the theoretical predictions, we find that all three measures significantly positively predict the number of new product trademarks the firm subsequently creates, including controls for CEO total compensation and firm characteristics, such as sales, R&D intensity, profitability, investment opportunities, and leverage.

The unique advantages of our data lie in addressing a type of innovation formerly unresearched, and including a set of firms and industries formerly neglected in innovation research. We further examine whether the positive relation between CEO incentives and future trademarks holds in all subsets of technology-intensive industries. On the one hand, patent production may lead to trademark production. Thus, we examine whether the relation we document is driven by underlying patent innovation, e.g. within high-tech industries, or by trademark innovation itself, e.g. within low-tech industries. On the other hand, high-tech companies may focus their risky innovative efforts on increased creation of new patents rather than new trademarks, when incentives for innovation are high, given that patents are likely to be a higher-risk form of innovation. We find that the positive relations between both CEO incentive convexity (i.e., Vega) and the CEO's current unvested option holdings, and new product trademarks are significant in all three subsets: low-tech, mid-tech, and high-tech industries. The relation between option compensation and new product trademarks is strongest and significant in low-tech and mid-tech industries, and insignificant in high-tech industries. These findings suggest that our trademark results are indeed distinct from the effects of CEO incentives on patents documented in prior studies, and emphasize the importance of CEO incentives for innovation in all types of industries, including low- and mid-tech industries.

We further examine the relation between the production of new *patents* and CEO incentives in these three groups of industries. We find that the relation is strongest in high-tech industries, insignificant for two measures and significantly positive for one measure in mid-tech industries, and consistently near zero and statistically insignificant for low-tech industries. These findings further indicate a contrast between trademark innovation and patent innovation.

Finally, since compensation is endogenous, one explanation for our results is that firms with risky innovation opportunities selecting convex compensation schemes. This endogeneity is not cause for concern. In particular, the reason firms with risky innovation opportunities would offer convex compensation schemes is that the board believes that such schemes induce managers to innovate. Nevertheless, to address potential endogeneity of the compensation structure, we consider an event that likely represents an exogenous shock to the use of option compensation. A revised accounting rule, SFAS 123(R), required firms to expense stock option compensation beginning in 2005. This reduced many firms' use of option compensation for an exogenous reason that is unrelated to trademark-related innovation. We find a significantly positive relation between changes in stock option compensation around SFAS 123(R) and changes in trademark creation. This evidence is consistent with option compensation having a causal effect on trademark-related innovation.

Our study contributes to a large body of research on the determinants of innovation and the effects of stock-based compensation in accounting, economics, finance, and management.[6] In

[6] On determinants of innovation, see Rajgopal and Shevlin (2002), Argyres and Silverman (2004) Lerner and Wulf (2007), Aghion, Reenen, and Zingales (2013), Amore, Schneider, and Žaldokas (2013), Chang, Hilary, Kang, and

addition to our results regarding CEO compensation and trademark creation, we develop and use a novel measure of innovation output based on new trademarks. We hope this study encourages future research on innovation to include trademarks as a measure of innovation output.

The remainder of the paper is structured as follows. Section 2 describes the differences between trademarks, patents, and R&D as measures of innovation, discusses the related literature on innovation, and develops hypotheses. Section 3 presents new trademarks as a measure of product and marketing development innovation, describing the data and relating trademarks to firm volatility. Section 4 examines the relation between CEO incentive structure and the creation of new trademarks, both for the full sample and for subsets of low-tech, mid-tech, and high-tech industries. Section 4 also presents the analysis of changes in option compensation and trademark creation around SFAS 123(R) as well as additional analyses. Section 5 concludes.

2. Motivation and Hypotheses Development

2.1. Trademarks as a Measure of Innovation

Firms engage in a variety of innovative activities. Research activities can result in new inventions and breakthroughs in science and new technology, which are patentable. However, new patents by themselves, in the absence of further development, do not often result in marketable products for users. Even after marketable products are obtained, the firm may need to mount a marketing campaign to connect users with products, and to make continuous adjustments and improvements to the new products to stay competitive. The OECD's definition of innovation quoted in the introduction suggests that all these activity phases are part of the innovation process.

Zhang (2013), He and Tian (2013), and Baranchuk, Kieschnick, and Moussawi (2014). On effects of stock-based compensation, see Mehran, Nogler, and Schwartz (1998), Datta, Iskandar-Datta, and Raman (2001), Fenn and Liang (2001), Nagar, Nanda, and Wysocki (2003), Cheng and Warfield (2005), Erkens (2011), Armstrong, Larcker, Ormazabal, and Taylor (2013), Jayaraman and Milbourn (2014), and Wowak, Mannor, and Wowak (2014).

We propose trademarks as a new innovation output measure, specifically for product development and marketing innovation as envisioned in the OECD's Oslo Manual. Trademarks capture aspects of innovation that are missing from patent-related measures of innovation. We first describe what trademarks are, and then contrast them with patents. We also discuss R&D, a commonly-used measure for inputs into the innovation process.

The United States Patent and Trademark Office (USPTO) defines a trademark as: "*A trademark is a brand name. A trademark or service mark includes any word, name, symbol, device, or any combination, used or intended to be used to identify and distinguish the goods/services of one seller or provider from those of others, and to indicate the source of the goods/services.*"[7] A firm files for a new trademark when they have a new product or service, or a new name, logo, etc., for an existing product or service. Examples of trademarks include "Microsoft Office," "Microsoft Office XP" and "Windows Phone" registered by Microsoft Corp., "Escort" and "Mustang" registered by Ford Motor Co., and all versions of Hot Wheels and Barbie toy products and their individual logos registered by Mattel Inc.

Thus, new trademarks capture two types of innovation. First, they capture product development that the firm believes is novel and distinct from those of its competitors or its own product lines. For example, Coke filed a trademark for "Coke Zero" to differentiate it from their main "Coke" product and protect the new product's name. Similarly, Yoplait filed a trademark for "Yoplait Pro-Force" Greek Yogurt, a kid-focused Greek Yogurt, to differentiate it from their existing product lines and from other companies' Greek Yogurt lines. We discuss product development innovation, and its relation to patent innovation, more below. Second, trademarks capture marketing innovations such as those associated with logos and slogans from marketing

[7] www.uspto.gov/trademarks/ (last accessed in March 2014). Consistent with the USPTO's definition, we use the term "trademark" to refer to trademarks and service marks.

campaigns of either new or existing products.[8,9] Creative activities pursued to develop new or redesigned marketing campaigns are innovative activities which directly contribute to firms' abilities to earn revenues, and which are included in the OECD definition of innovation. Appendix A describes how we identify and separate new product development trademarks from new marketing trademarks to distinguish between the two components of innovation that trademarks capture. Trademarks are unique in capturing these two dimensions of innovation, as opposed to research or technological innovation.

Patents and patent citations are the primary innovation output measure used in prior literature. Patent laws restrict granting of patents only to innovations that satisfy the patentability criteria,[10] which in practical application results in patents being granted primarily for inventions of new technology or discoveries of fundamental science. However, this omits a broad array of other types of innovative activity. For high-tech firms and industries, patents omit the later stages of product development innovation. For low-tech firms and industries, which do not develop patents, patents will exclude the full range of innovation pursued.

High-tech firms usually develop new products and services from their patented

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[8] Throughout the paper, we use the term "product development innovation" to refer to innovation in the goods and services sold by firms. These can be new product or service offerings, or updates, modifications or improvements of existing products and services. We differentiate product development innovation from research innovation, which pertains more to fundamental research, which may or may not ultimately lead to future sales of new products or services. The two concepts overlap for the subset of new products or services in the market which use relatively new technology to warrant both trademarks and patents. See Appendix A for further discussion of their differences.

[9] The USPTO places an additional requirement prior to registration of a trademark: the applicant must demonstrate that they have "used the mark in commerce in connection with all the goods/services listed" in the trademark application (USPTO, 2012). (A trademark application may be filed under the "use in commerce" basis, if the trademark has already been used in commerce, or the "intent to use" basis, if the trademark has not been used in commerce yet. For an application filed under the "intent to use" basis, a "statement of use" must be submitted prior to the registration to confirm the use in commerce of the trademark.) This requirement makes it highly unlikely that firms file extraneous trademarks in case of future use or to block competitors from using them, the way they can register domain names. The USPTO's requirements are designed to ensure that any registered trademark is tied to actual products or services.

[10] See the United States Patents and Trademarks Office's (USPTO) Manual of Patent Examining Procedure available at http://www.uspto.gov/web/offices/pac/mpep/mpep-2100.html. The patentability criteria generally are that the invention must be of certain subject matter determined as patentable, novel or at least new in some aspect, non-obvious (U.S. patent law) or involve an inventive step (European patent law), and useful (U.S. patent law) or susceptible of industrial application (European patent law).

technologies, but only after further innovative efforts to creatively conceptualize and design products. These later stages of innovation often do not result in further patents. Furthermore, they generally need to expend resources on incremental improvements to generate new products or refresh existing products. Again, such efforts often do not yield new patents, owing to failure to meet the novelty criteria for patenting, even if new and distinctive products result. In contrast, trademarks uniquely capture the additional innovation effort of firms in converting patents into marketable products and services, and improving existing products and services. Thus, for these high-tech firms, trademarks would capture a different *stage* of innovation than patents; patents capture outputs from the earlier *research* phase of innovation, whereas trademarks are outputs of the later *development* phase of innovation leading to marketed products and services.

While high-tech firms often engage in both types of innovation, there is a large set of firms which do not develop patents. In particular, low-tech firms often develop products using unprotected technologies. However, these low-tech industries will still engage in the type of product innovation which results in trademarks. In the sample period from 1993 to 2008 when availability of trademarks and patent data overlaps, 50.3% of firms register no patents, and for those with at least one trademark, 42.1% register no patents.

Figure 1 illustrates the difference in industry concentration between new trademarks and patents. The intuition that patents will be concentrated among a smaller set of high-tech industries is borne out by the data. The top three patent producing industries account for over 50% of patents. In contrast, new trademarks cover a wide range of industries, with the top three industries representing less than 25% of all new product and marketing trademarks. Additionally, as we describe in Section 3 and illustrate in Table 1, Panel E, there are significant differences in which industries have higher levels of patent intensity (e.g., Aircraft, Electronic Equipment, and Pharmaceutical Products) and which have higher levels of trademark intensity (e.g., Recreational

Products, Alcoholic Beverages, and Printing and Publishing), with a few industries overlapping (e.g., Consumer Goods). These statistics reinforce the intuition that trademarks capture a dimension of innovation which is distinct from patents and potentially important for both high-tech and low-tech industries.

Some past research studies on innovation use measures from surveys such as the European Community Innovation Surveys, which asks managers to quantify or rate the firm's innovative activities, such as the number of new products, the extent of introduction of new processes and technologies, the type of R&D activity, etc. While these studies focus on self-reported innovation measures, they are informative about the potential usefulness of trademarks as an innovation measure. In particular, several Australian and European studies find a strong and significantly positive relation between these survey measures of innovation and trademarks for their sample firms (Mendonca, Pereira, and Godinho, 2004; Jensen and Webster, 2009; Millot, 2012; Flikkeman, de Man, and Wolters, 2010). Overall, these prior studies suggest that new trademarks are likely associated with product and service innovation, and to a lesser extent marketing innovation. They also suggest that trademarks are potentially useful as innovation measures for a wide range of industries, including lower technology and service industries in which patent-producing technological innovation is less relevant.[11]

Another commonly-used measure for innovation, given the difficulty in measuring innovation outputs, is R&D expense. R&D expenditures can, in principle, measure the inputs to both the *research* and *development* phases of innovation. However, in practice many firms do not report all expenditures associated with research and development activities as separate R&D

[11] Another innovation measure that was used in a few old studies is from the U.S Small Business Administration's Innovation Data Base (SBIDB) consisting of 8,074 commercial innovations introduced in the U.S. in 1982. The Futures Group, a private firm, compiled the data for the U.S. Small Business Administration by examining over one hundred technology engineering and trade journals listing innovations and new products.

expenses in the financial statements, even if those firms engage in innovative activities (Koh and Reeb, 2014).[12] Over the sample period 1993-2011, 61.6% of all Compustat firms, and 56.8% of S&P 1500 firms, do not report R&D expense. Moreover, 50.8% of S&P 1500 firms with at least one trademark do not report R&D expense. Finally, even among S&P 1500 firms that file patents during the 1993-2008 period, 27.2% of the firms have no R&D expense reported in Compustat. Thus, there are many practical challenges to using reported R&D expense as an innovation measure.

2.2. Motivating Product Development Innovation with Incentive Structure

Our main research question is whether certain structures of CEO incentives motivate managers to innovate. The way in which we motivate managers, however, depends on how risky is the desired activity. Given the dearth of research which uses new trademarks as a measure of innovation, particularly for U.S. companies,[13] we begin our analysis by validating that new trademarks are associated with higher firm risk. We examine the relation between new trademarks and firm volatility, as measured by stock return, sales, and earnings volatility. We explain the relations we examine in more detail, and report results, in Section 3.2.

Based on our interpretation of product trademarks as reflecting risky product development

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[12] There are several potential reasons for the lack of consistent R&D expense reporting. First, accounting rules impose restrictions on the classification of expenditures as R&D expenses (see FASB Accounting Standards Codification 730-15-4 and OECD, 2005), and implementing these rules involves considerable discretion. For example, expenditures deemed as being for "incremental" improvements of products or product lines, even when they result in new products, are often excluded, and the definition of "incremental" is highly subjective. Second, marketing-related expenditures are also excluded, even when they result in new marketing campaigns. Finally, because there is discretion in how items are aggregated in financial statements, R&D expenses may be pooled with other operating expenses in the income statement if the R&D expenditures are deemed immaterial, and materiality thresholds are discretionary and vary across firms.

[13] Gonzalez-Pedraz and Mayordomo (2013) use trademarks as a measure of the marketing and advertising of product innovation for U.S. commercial banks. They find a relation between trademark creation and stock returns as well as between the banks' trademark portfolios and their values as measured by market-to-book ratios. However, they do not examine industries outside of commercial banking. Krasnikov, Mishra, and Orozco (2009) interpret the set of trademarks which have been previously registered and have not expired as a measure of a firm's brand assets, and partition these trademarks into "brand-identification" and "brand-association" groups, based on whether they help build brand awareness or associations, respectively. They find that brand-association trademarks are positively related with measures of financial performance, such as return on assets. However, they do not examine trademark creation.

innovation, we examine whether certain incentive structures motivate managers to engage in this type of innovative behavior. Basic agency theory suggests that owners should tie managers' wealth to firm value in order to reduce agency conflicts (Jensen and Meckling, 1976). This is often done through equity-based pay. However, because managers are risk averse, the resulting (under-diversified) sensitivity of managers' wealth to firm value incentivizes managers to reduce firm risk (e.g., Smith and Stulz, 1985; Lambert, Larcker, and Verrecchia, 1991).

Theory suggests that using instruments such as stock options, that include convex payoffs with respect to firm value, can help offset the incentive to reduce risk. For example, Smith and Stulz (1985) show that, in their model, increasing the convexity of managers' wealth with respect to firm value increases the managers' willingness to make risky investments and decreases hedging. Hirshleifer and Suh (1992) conclude that stock option compensation should be higher when there are more risky desirable growth opportunities due to the convexity that they induce.

Stock option compensation can also increase innovation incentives due to its multi-year vesting schedule, which provides long-term incentives. Cadman, Rusticus, and Sunder (2013) provide evidence that stock option grants to CEOs have mean and median vesting periods of 36 months, and Gopalan, Milbourn, Song, and Thakor (2013) provide evidence that vesting periods cluster around three to four years. In several models, the possibility of short-term failure associated with risky innovation reduces managers' willingness to innovate. In Holmstrom and Ricart i Costa (1986) and Hirshleifer and Thakor (1992), long-term compensation helps to insulate managers and induce them to innovate. Most relevant for our study, Manso's (2011) model specifically focuses on the structure of compensation incentives to motivate innovation. He shows that the optimal incentive structure is tolerant of short-term failure and rewards long-term success. He argues that this can be implemented in part using executive compensation, and specifically long-term compensation plans such as stock options with long vesting periods.

Thus, due to both the convexity of payoffs with respect to firm value and the long-term nature of stock-option compensation in practice, stock option compensation should increase managers' incentives to pursue innovation. Existing evidence is largely supportive of these theories. Francis, Hasan, and Sharma (2011) find that patent innovation is increasing in stock option compensation. Datta, Iskandar-Datta, and Raman (2001) find that executives with higher stock option compensation make riskier acquisitions. Lerner and Wulf (2007) focus on compensation for the head of R&D and show that long-term incentives, in the form of stock option compensation or restricted stock, increases the number, originality, and citations of patents. Currim, Lim, and Kim (2012) show that increases in stock and stock option compensation increase R&D and advertising spending. Finally, Baranchuk, Kieschnick, and Moussawi (2014) find that CEO incentive compensation, made up largely of option compensation, is positively associated with post-IPO patent production at newly public firms.

The empirical studies in the executive compensation literature also consider an empirical measure of the theoretical construct of incentive convexity using the sensitivity of CEO option holdings to stock return volatility, i.e. Vega. Guay (1999) provides evidence that stock return volatility is increasing in Vega. Rajgopal and Shevlin (2002) show that Vega increases risky exploration activities in the oil and gas industry, and Coles, Daniel, and Naveen (2006) show that Vega increases managers' implementation of several risky policies, including high R&D spending. Xue (2007) finds evidence that Vega increases internal development of new technology, as measured by R&D spending by high-tech firms.

Finally, several papers suggest that unvested stock options in particular are likely to provide longer-run incentives which are appropriate for risky innovation (Devers, McNamara, Wiseman, and Arrfel, 2008; Erkens 2011; Sunder and Bromiley 2012).

In line with these prior studies and based on their findings, we examine three measures of

CEO incentive structure. First, we examine the proportion of CEO pay which is in the form of stock options, which will affect the convexity of CEO incentives and provide long-term incentives to the CEO, and which can be set by a firm's board. Second, we examine the convexity of managers' incentives, measured using the incentive convexity of managers' option portfolio. This is a more direct measure of the theoretical construct of incentive convexity, but has the disadvantages of including vested stock options, which do not provide a long-term incentive and which can be immediately exercised by a CEO at any time. Third, we examine the value of unvested stock options held by the CEO, given that these options provide both convexity and are not immediately exercisable. Based on the above discussions, we predict that all three of these characteristics will motivate the CEO to engage in more *product development innovation* as measured by trademark creation. Our main hypothesis, stated for each of the three incentive measures, in alternative form, is:

> *H1a: The portion of CEO compensation in the form of stock options is positively associated with product development innovation, as measured by product trademark creation.*
>
> *H1b: The convexity of the relation between CEO wealth and stock price (i.e., Vega) is positively associated with product development innovation, as measured by product trademark creation.*
>
> *H1c: The value of unvested stock options held by the CEO is positively associated with product development innovation, as measured by product trademark creation.*

Given our discussion in Section 2.1 of the types of innovation conducted in high-tech and low-tech firms, we further predict that these relations will hold for all groups of industries, including low-tech and mid-tech, and will not be restricted to high-tech industries. In contrast, these CEO incentives may drive patent innovation more strongly, rather than trademark innovation, in high-tech industries. Thus, our second set of tests examines the relations hypothesized in H1, but for the subsets of low-tech, mid-tech, and high-tech industries, as well as, for comparison, the relation between CEO incentives and patent innovation in these industries. Finally, to more directly address causation, we examine changes in trademark creation following an exogenous shock to option compensation driven by the change in accounting rules introduced by SFAS 123(R). We discuss this test in more detail in Section 4.

3. Trademark Creation as a Measure of Development Innovation

3.1. Sample Selection and Trademark Data Description

We obtain data from the USPTO, the Compustat Execucomp database, and the Compustat annual database. We restrict our analysis to firms in the Execucomp database (i.e., S&P 1500 firms) with strictly positive total assets and strictly positive sales. The sample covers fiscal years starting in 1993 due to data availability in Execucomp and ending in 2011 due to trademark data availability on the USPTO website.

We obtain trademark data from the USPTO's website.[14] Each trademark application goes through four steps: filing, examination by the USPTO, publication for opposition, and registration. After an application is filed, the USPTO examines the filing and determines whether the trademark is registrable. If the registration is refused or pending with additional requirements, the USPTO issues a letter of "office action" to which the applicant must respond. If the registration request is accepted without additional requirements, or if additional requirements are met in the applicant's response, the trademark is published online in the Official Gazette, which corresponds to the third step. The public may raise objections to the registration of the trademark within 30 days. If no opposition is received, the USPTO proceeds with the registration. For applications filed under the "use in commerce" basis (i.e., the trademark has been used in commerce at the time of the filing), the USPTO directly approves the registration. For applications filed under the "intent to use" basis

[14] The USPTO provides data on 6.7 million trademark applications filed with, or registrations issued by, the USPTO between January 1870 and September 2012 through the website http://www.uspto.gov/products/catalog/trademarks.jsp.

(i.e., the trademark has not been used in commerce yet at the time of the filing), the registration is not complete until the receipt of a "statement of use" or other equivalent forms.[15] The average length of time between the filing date and the registration date is approximately 15 months.

To compile a comprehensive sample of new trademarks, we first download from the USPTO's website all trademark applications filed between January 1, 1992 and September 8, 2012, with at least one U.S. corporation in the list of owners of each trademark. This yields 2,653,464 trademark applications. We then select new trademarks owned by U.S. corporations, with no change in ownership from the filing date until the registration date (or throughout the trademark's history if no registration date is provided). This reduces the sample to 1,606,170 new trademarks. Next, we restrict our sample to trademarks that are registered, which decreases the sample to 1,316,985 new trademarks. Then, using company names and locations, we manually merge the trademark data with the Execucomp data. We include in our dataset trademark information for firms' subsidiaries. To that end, we employ the Orbis database to identify firms' subsidiaries. This is particularly important as many firms establish intellectual property holding companies in Delaware or Nevada to reduce corporate income tax (see Simpson, 2002), and thus hold trademarks under the names of these holding companies rather than the corporate parent. Finally, restricting to Execucomp firms and requiring trademark registration dates to be within fiscal years 1993-2011, reduces the sample to 123,545 unique new trademarks registered by 2,445 distinct firms.[16]

To distinguish between product development innovation and marketing development innovation, we classify each trademark as either a new product trademark or a new marketing

[15] Detailed information regarding the filing and registration process of trademarks is available at http://www.uspto.gov/trademarks/basics/BasicFacts.pdf.

[16] We exclude 177 firms from the Trademark Execucomp Sample because they each have only one registered trademark throughout the period January 1, 1992 to September 8, 2012. The single trademark generally corresponds to the firm name, which is not an indication of product or marketing innovation. These firms remain in our Full Execucomp Sample.

trademark. Trademarks registered for innovations in logos (i.e., drawings), slogans (identified as trademarks with at least four words of text), or sounds capture marketing development innovation and are classified as new marketing trademarks. Conversely, trademarks registered for innovations in product names, service names, brand names, etc., identified as trademarks with three words or less of text, capture product development innovation and are classified as new product trademarks. Appendix A discusses this distinction in more detail. In our final sample of 123,545 unique new trademarks, 85,209 are classified as new product trademarks and 38,336 are classified as new marketing trademarks, registered by 2,354 and 2,189 distinct firms, respectively.

Table 1 presents the distribution of newly registered trademarks ("new trademarks") in our sample by year (Panel A), by industry (Panel B), and across firm-years (Panel C). The distributions reported in Panels A and B are generally in line with the findings reported in studies describing the entire population of trademarks (e.g., Graham, Hancock, Marco, and Myers, 2013; Myers, 2013). As shown in Panel A, the number of new trademarks increases in the first three years of our sample period (1993-1995), after which it fluctuates over a narrow range, encompassing approximately 5% to 7% of our sample every year. The two rightmost columns present the number of firms in the sample in each year, which peaks in 1996 and then generally declines. Thus, the average number of new trademarks per firm-year is generally increasing over the sample period. We include year fixed effects in our main tests to adjust for this time trend. Next, as presented in Panel B, the new trademarks span all 48 industry groups. While the distribution of new trademarks across the 48 industries is not even, there is little evidence of industry clustering. The most represented industry in the new product trademark sample is Recreational Products (including Mattel Inc. and Hasbro Inc.), which only represents 8.8% of the sample. The next most represented industries are Retail, Consumer Goods, Business Services, and Telecommunications. The most represented industry in the new marketing trademark sample is Retail (including Wal-Mart Stores

Inc. and Target Corp.), which only represents 7.9% of the sample, followed by Telecommunications, Pharmaceutical Products, Business Services, and Banking. Moreover, our evidence shows a substantial representation of service industries.[17] Panel C reports that an average of 5.5 (3.5) new product (marketing) trademarks are registered per firm-year in the new product (marketing) trademark sample. Also, the standard deviation of 14.2 (6.0) in the new product (marketing) trademark sample indicates a substantial amount of variation in trademark creation across firm-years.

Table 1, Panel D, reports selected descriptive statistics for the new product trademark firm-year observations (15,595 firm-year observations from 2,354 distinct firms) and the full sample of Execucomp firm-year observations (43,013 firm-year observations from 3,276 distinct firms), with comparisons and results of *t*-tests (Wilcoxon rank-sum tests) of mean (median) differences for each variable.[18] While new product trademark firms differ from the average Execucomp firm in many dimensions, including investment opportunities (Tobin's Q), profitability (ROA), and R&D intensity, the magnitudes of the differences are economically small. For example, the average Tobin's Q for new product trademark firms is 5.7% higher than for the average Execucomp firm. The primary difference between firms with and without new product trademarks appears to be firm size (captured by assets), sales, and market value of equity. However, the size relation is not monotonic as many large firms have no trademarks. For example, 50.2% of our sample Execucomp firms have average market capitalization over one billion dollars, and of these, 22.2% have no new product trademarks during our sample period. Nevertheless, we include size as a control in our regression. Moreover, the CEOs of new product trademark firms receive higher annual compensation and have greater portions of their total compensation in the form of stock options,

[17] These descriptive statistics are generally consistent with Myers (2013), which describes USPTO trademark data for 1985 through 2011.
[18] The Execucomp firm-year observations include the new product trademark firm-year observations.

with a mean (median) of 31% (27%) of total compensation for new product trademark firms versus 28% (22%) for Execucomp firms in general. Finally, the CEOs of new product trademark firms have greater risk-taking incentives in the form of higher convexity of incentives (i.e., Vega), as well as greater pay-performance sensitivity (i.e., Delta).

Table 1, Panel E, shows the average numbers of trademarks and patents produced by firms in different groups of industries.[19] We label the top patent-producing industries, those producing an average of 20 or more patents per firm-year, as "high-tech," and this category includes industries such as Electronic Equipment, Computers, and Pharmaceutical Products. Similarly, we label the bottom patent-producing industries, those producing fewer than one patent every 3 firm-years, as "low-tech," and we label those in between as "mid-tech." The table shows the low level of overlap between the distributions of trademark-intensive and patent-intensive industries. Several of the most patent-intensive industries, such as Machinery, Computers, and Electronic Equipment, produce few trademarks, while many high-trademark industries, such as Recreational Products, and Alcoholic Beverages, produce low numbers of patents. Overall, the ranking by new patent intensity differs substantially from the ranking by new product or marketing trademark intensity. We exploit this variation to examine the relation between CEO incentives and trademark creation within low-, mid-, and high-tech industries separately, in Section 4.2.

Lastly, Table 2 presents descriptive statistics and correlation coefficients for the main variables used in our analyses. In Panel A, the average (median) fraction of CEO total compensation in the form of stock option is 28% (22%), consistent with Datta, Iskandar-Datta, and Raman (2001). The distributions of *Log(Vega)*, *Log(UnvestedOptions)*, and *Log(Delta)* are also in line with prior studies (e.g., Coles, Daniel, and Naveen, 2006; Devers, McNamara, Wiseman, and

[19] We use USPTO patent data collected by Kogan, Papanikolaou, Seru, and Stoffman (2012). Our patent data consists of 554,778 patents filed during 1993-2008, covering 11,839 firm-years and 1,619 distinct firms. Section 4.2 provides additional details on this patent data.

Arrfel, 2008; Chava and Purnanandam, 2010; Armstrong and Vashishtha, 2012; Kim, 2014). Panel B reports positive correlations between each of our CEO incentive measures (e.g., *OptionComp*, *Log(Vega)*, *Log(Delta)*, and *Log(UnvestedOptions)*) and the number of new product trademarks.

3.2. Trademark Creation and Firm Volatility

To provide insights on whether product development innovation, as measured by new trademarks, is a risky activity, we examine the relation between trademark creation and firm volatility. We conjecture that, if new trademarks measure risky development innovation, they should be associated with more volatile firm performance. Specifically, we estimate the following model for firm *i* in year *t*, where we predict a positive coefficient estimate for β_1:

$$\begin{aligned} Volatility_{i,t+1} = \alpha + \beta_1 Log(NbTrademarks)_{i,t} + \beta_2 Log(NbMktgTrademarks)_{i,t} \\ + \beta_3 Volatility_{i,t} + \beta_4 Age_{i,t} + \beta_5 Size_{i,t} + \sum \chi_j Year_j + \varepsilon_{i,t+1} \end{aligned} \quad (1)$$

where *Volatility* represents *RetVol*, *ChSalesVol* or *ChEarnVol* depending on the model specification. The variables in Equation (1) are defined as follows:

Volatility	Annualized stock return volatility, measured as the annualized standard deviation of daily stock returns over a year.
ChSalesVol (ChEarnVol)	Sales (Earnings) volatility, measured as the standard deviation of seasonal changes in sales (earnings) scaled by average total assets, estimated over two years.[20]
Log(NbTrademarks)	Natural logarithm of one plus the number of new product trademarks registered during the year.[21]
Log(NbMktgTrademarks)	Natural logarithm of one plus the number of new marketing trademarks registered during the year.

[20] We measure *ChSalesVol* (*ChEarnVol*) as the standard deviation of seasonal changes of scaled sales (earnings) in line with prior studies (e.g., Jayaraman, 2008; Hirshleifer, Lim, and Teoh, 2009; Drake, Roulstone, and Thornock, 2012).

[21] We replicate our results using the number of trademarks filed (rather than registered) during the year. The results are qualitatively similar. However, little cost or requirement is involved when filing a trademark, whereas the trademark registration process has strict requirements. Therefore, trademark registration is a cleaner indication that: i) a product/service has been created and ii) the trademark associated with the product/service is being used in commerce.

Age Natural logarithm of one plus the number of months since the firm first appeared on CRSP.

Size Natural logarithm of market value of equity.

Each regression is estimated using Newey-West (1987) standard errors corrected for autocorrelation using four lags (following Green, 2012). We include firm characteristics, age and size, and expect each to be negatively associated with firm volatility. We also estimate a model focusing on volatility before trademark registration, which is more likely to capture uncertainty during the development phase, controlling for prior-period volatility.

Table 3 Panel A presents results for the relation between subsequent firm volatility (measured using stock return, sales and earnings volatility) and the total number of new product and new marketing trademarks produced by a firm, after controlling for current firm volatility. As presented in Model I, and as predicted, we find a significant positive relation (p-value < 0.01) between new product trademarks and future stock return volatility, controlling for current stock return volatility. The coefficients on the control variables have the predicted signs. Return volatility is persistent, and older and larger firms are less volatile. The coefficient on new marketing trademarks is small and statistically insignificant.[22] Models II and III present results for the volatility of sales and earnings, respectively. Results are similar. New product trademarks are positively related to future sales and earnings volatility while new marketing trademarks are not. It is important to note that in all of these regressions, firm volatility in the year of the new trademark

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[22] In untabulated analyses, we also estimate the model including only the number of new product trademarks or only the number of new marketing trademarks. We find a significant positive relation (p-value < 0.01) between each new product trademarks and new marketing trademarks, and future stock return volatility, with similar magnitudes and significance. However, the number of new product and new marketing trademarks are highly positively correlated, with a correlation of 0.62. When a company sells a new product or service, they will often initiate a new marketing campaign as well. When we include both in the regression, as shown in Table 3, we find a significantly positive relation between new product trademarks and future stock return volatility, but an insignificant relation for new marketing trademarks. This suggests that the positive coefficient on *Log(NbMktgTrademarks)* in the model without new product trademarks is driven more strongly by the portion of new marketing trademarks related to new products than the portion of new marketing trademarks related to previously established products.

is included as a control variable. Therefore, these results are not driven by more volatile firms producing a larger number of trademarks. They provide evidence of a relation between trademark creation and future volatility.

In Panel B, we examine firm volatility prior to the new trademark registration year. The pre-registration period likely captures the period when the firm is developing the new products or services, and success of these innovations is not yet known. Firms with a high number of trademarks are likely to have been more actively engaged in development innovation in the preceding period, and therefore have higher firm risk in this development phase. The results in Panel B are largely consistent with this view. There is a significant positive relation between the number of new product trademarks and pre-registration stock return and earnings volatility, though not sales volatility.

In sum, the results in Table 3 are consistent with our premise that new product trademarks are a measure of risky innovation. We do not suggest that these findings imply causality. The purpose of these tests is to document that firms that create more new product trademarks experience higher risk, consistent with trademark creation being a risky venture. The results also suggest that marketing development innovation by itself is not as risky as new product development innovation. Given the high correlation between the two, and the riskiness of product development innovation, we focus on new product trademarks in subsequent analyses.

4. CEO Incentives and Product Development Innovation

4.1. CEO Incentives and Trademark Creation

Our primary research question is whether the use of option-based pay and the convexity of incentives motivate CEOs toward more product development innovation, as measured by the creation of new product trademarks. In this section, we first explore the general relation between the structure of CEO incentives and future product trademark creation. Second, to ensure that our results are not driven by high-tech industries, we repeat our main tests by subsets of low-tech, mid-tech, and high-tech industries. Finally, to address endogeneity concerns, we conduct a changes analysis focusing on stock option compensation, using SFAS 123(R) as an event which drove an exogenous change in stock option compensation.

To provide evidence on the effect of incentive structures on firm innovation, we examine the relation between stock option compensation, incentive convexity, and pay-performance sensitivity, and future product trademark creation, as a measure of product development innovation. Given that stock option compensation and incentive convexity each increase incentives to pursue risky innovation, we predict that each is associated with more product trademark creation in the future. To test this prediction, we first focus on testing H1. Focusing on option compensation, we estimate the following model for firm *i* in year *t*:

$$\begin{aligned} Log(NbTrademarks)_{i,t} = \alpha &+ \beta_1 OptionComp_{i,t-1} + \beta_2 Log(TotalComp)_{i,t-1} + \beta_3 Log(Sales)_{i,t-1} \\ &+ \beta_4 R\&D_{i,t-1} + \beta_5 ROA_{i,t-1} + \beta_6 TobinQ_{i,t-1} + \beta_7 Leverage_{i,t-1} \\ &+ \sum \chi_j Year_j + \sum \delta_k Industry_k + \varepsilon_{i,t} \end{aligned} \quad (2)$$

where the variables are defined as follows:

Log(NbTrademarks)	Natural logarithm of one plus the number of new product trademarks registered during the year.
OptionComp	CEO's annual stock option compensation, measured as the value of new stock options granted as a fraction of total compensation.
Log(TotalComp)	Natural logarithm of the CEO's annual total compensation, measured as the sum of salary, bonus, other annual compensation, value of restricted stock granted, value of new stock options granted during the year, long-term incentive payouts, and all other compensation.
Log(Sales)	Natural logarithm of total sales.
R&D	R&D expense divided by total sales.

ROA	Return on assets, measured as earnings before extraordinary items and discontinued operations scaled by average total assets.
TobinQ	Market value of total assets divided by the book value of total assets.
Leverage	Total liabilities divided by total assets.

Our variable of interest in testing H1a is *OptionComp*, the proportion of CEO compensation in the form of stock options. To test H1b, we estimate Equation (2) after substituting *OptionComp* with *Log(Vega)*, the natural logarithm of one plus the CEO's sensitivity to stock return volatility, measured as the dollar change in the CEO's option portfolio for a 0.01 change in annualized standard deviation of stock returns. Finally, to test H1c, we substitute *OptionComp* with *Log(UnvestedOptions)*, the natural logarithm of one plus the CEO's unvested stock option holdings. We predict a positive and significant value for β_1 in all three models. Finally, solely for comparison purposes, we estimate Equation (2) after substituting *OptionComp* with *Log(Delta)*, the CEO's sensitivity to stock price, measured as the dollar change in the CEO's stock and option portfolio for a one-percent change in stock price, and we do not predict a significant coefficient on *Log(Delta)*. We include independent variables to control for factors that potentially impact future product development innovation, including: CEO total compensation (*Log(TotalComp)*), sales (*Log(Sales)*), R&D intensity (*R&D*), profitability (*ROA*), investment opportunities (*TobinQ*), and leverage (*Leverage*).

Table 4 presents the results. Model I presents the results for a benchmark model excluding the structure of CEO compensation. *Log(Sales)*, *R&D*, and *TobinQ* are significantly positively related to future product trademark creation, while *Leverage* is significantly negatively related and *ROA* is not significantly related to future product trademark creation. The coefficient on CEO total compensation (*Log(TotalComp)*) is marginally positively significant. Thus, larger firms, firms that spend proportionally more on R&D, and firms with more growth opportunities and less leverage tend to produce larger numbers of new product trademarks.

Model II presents the results including CEO stock option compensation, *OptionComp*, testing H1a. As predicted, we find a significantly positive relation between *OptionComp* in year *t*-1 and product trademark registration in year *t*, controlling for year and industry fixed effects (*p*-value < 0.01). Greater incentive compensation via the use of option compensation, holding constant total compensation, increases trademark creation. The coefficient on *OptionComp*, 0.0959, implies that increasing option-based pay from the first to the third quartile, 48 percentage points, results in an increase in *Log(NbTrademarks)* of 0.047. For a company producing one trademark a year, this is a 7% increase in product trademark creation, controlling for total compensation, sales, R&D spending, ROA, Tobin's Q, and leverage. While this may not sound like a dramatic change, it is significant when compared to the effects from the control variables. For example, increasing from the first to third quartile for *OptionComp* has almost two hundred times the impact of increasing R&D from the first to third quartile, three times the impact of increasing leverage from the first to third quartile, 1.4 times the impact of increasing investment opportunities as measured by Tobin's Q from the first to third quartile, and 9% of the effect of increasing sales from the first to third quartile, which amounts to growing sales by over a factor of eight. While R&D spending can be adjusted from year to year, it may be difficult for a firm's management or owners to directly and quickly change investment opportunities, firm size or leverage. Thus, *OptionComp* presents a controllable factor with an economically significant relation with future new product trademarks. The coefficient for *Log(TotalComp)* is no longer significant, suggesting that the option compensation component of *TotalComp* likely contributed to its marginal significance in Model I.

Model III presents the results including *Log(Vega)*, testing H1b. Similarly, we find a significantly positive relation between *Log(Vega)*, the convexity of the relation between CEO wealth and stock price, in year *t*-1 and product trademark registration in year *t* (*p*-value < 0.01).

The magnitude of the effect is roughly twice that of *OptionComp* in Model II. The magnitude of the coefficient estimate suggests that, holding all else equal, moving from the first to third quartile of *Log(Vega)* has 1.9 times the effect of moving from the first to third quartile of *OptionComp*, increasing product trademark creation by 13% for a firm producing one product trademark per year. Model IV presents the results including *Log(UnvestedOptions)*, testing H1c. We find a similar significantly positive coefficient on *Log(UnvestedOptions)* (p-value < 0.01), though the economic magnitude is slightly smaller – the coefficient estimate implies that an increase from the first to third quartile of unvested option holdings has 78% of the effect of an increase from the first to third quartile of *OptionComp*. Given that unvested option holdings include some options that will vest in the near future, and thus with less of a long-term incentive component than new option compensation, and given that it is also an imperfect proxy for the overall convexity of the CEO's incentives, this is not surprising. Finally, as expected, we find that CEO pay-performance sensitivity (*Log(Delta)* in Model V) is not related to future trademark creation, with a small and statistically insignificant coefficient estimate.[23]

Overall, the findings in Table 4 support H1. They suggest that when firms pay their CEOs a greater fraction of their compensation in the form of stock options, or when firms provide risk incentives in the form of higher convexity of incentives, the firm creates more product development innovation, as measured by new product trademarks in the following year, controlling for other firm factors that may drive product trademark creation. Furthermore, boards of directors interested in motivating CEOs to engage in product development innovation are likely to have a stronger impact if they structure CEO pay to be based more on stock options or with

[23] These results are robust to several alternative specifications. In particular, the results for Model III (V) is similar if we substitute *Log(Vega)* (*Log(Delta)*) with *Vega* (*Delta*), or if we scale *Vega* (*Delta*) by CEO wealth. Results for all five models are also robust if we measure development innovation using the total number of new product and marketing trademarks, instead of only the number of new product trademarks.

stronger risk incentives, rather than simply increasing total compensation.

4.2. *CEO Incentives and Trademark Creation for Subsets of Low-Tech, Mid-Tech, and High-Tech Industries*

One of the primary advantages of using trademarks to measure *product development* innovation is that we are able to examine innovation in a segment of the economy, particularly low-tech and mid-tech industries, which engage in low levels of patent innovation. In this section, we build on prior research on the effect of CEO incentives on research innovation using patents as outcomes (e.g., Francis, Hasan, and Sharma, 2011; Baranchuk, Kieschnick, and Moussawi, 2014), and our results in Section 4.1, and examine trademark and patent innovation in subsets of technology-intensive industries. We first gather patent data using the USPTO patent data extracted and compiled by Kogan, Papanikolaou, Seru, and Stoffman (2012). Our patent data consists of 554,778 patents filed during 1993-2008, covering 11,839 firm-years and 1,619 distinct firms. We classify industries as low-tech, mid-tech, or high-tech based on the patent intensity of the firms in the industry.

As reported in Section 3.1, there are significant differences in patent- and trademark-creation across industries. The variation in patent and product trademark creation allows us to estimate Equation (2) separately for three subsets of industries based on their patent production intensity: low-tech (i.e., the bottom ten patent-intensive industries, highlighted in Table 1, Panel E, which have the lowest number of new patents per firm-year), mid-tech (i.e., the middle 28 industries), and high-tech (i.e., the top ten industries). If our results are primarily driven by the relation between CEO incentive structures and new patents, and the translation of patents into trademarked products, then our results would be strongest for firms in high-tech industries. In contrast, if our hypothesized differences in innovation types are correct, our results should be strong and robust in low- and mid-tech industries (with no clear prediction for high-tech industries). In contrast, we expect the relation between CEO incentives and *patent* innovation to be strongest in high-tech industries. Thus, we also estimate Equation (2) for the subsets of low-tech, mid-tech, and high-tech industries replacing *Log(NbTrademarks)* with *Log(NbPatents),* the natural logarithm of one plus the number of new patents filed during the year, to provide a comparison.

Table 5 reports the results. Models I through III cover firms in low-tech industries. This subset of firms produces approximately 0.1 patent per year on average, in contrast to an average of over 51 patents per year for firms in high-tech industries. Focusing first on Table 5, Panel A, which examines trademark creation, consistent with our results in Table 4, the coefficients on *OptionComp* in Model I, *Log(Vega)* in Model II, and *Log(UnvestedOptions)* in Model III remain positive and statistically significant for the subset of low patent-intensity industries. Models IV-VI estimate Equation (2) for the subset of firms in mid-tech industries. Similarly, the coefficients on *OptionComp* in Model IV, *Log(Vega)* in Model V, and *Log(UnvestedOptions)* in Model VI remain positive and statistically significant for this subset. In Models VII-IX, we focus on the high-tech sample. It is important to note that the coefficient on *OptionComp* in Model VII is not significant. Thus, we do not see evidence that, in high-tech industries, new stock option grants to CEOs are significantly associated with more product innovation captured by new product trademarks. However, when faced with incentives to increase risky innovation through Vega or unvested stock option holdings, companies in high-tech industries are more likely to increase trademark creation. Finally, for all three incentive measures, the coefficient magnitudes are similar across all industry groups. We find (in untabulated tests) that the coefficient estimates on all three incentive measures do not differ significantly between low-, mid-, and high-tech industries. These results are consistent with *product development* innovation, as measured by new product trademarks, being important for a broad set of industries. In addition, they suggest that CEO incentives for innovation are related to product development innovation even in the subsets of low-tech and mid-tech firms which we may not traditionally consider “innovative.”

Finally, in Table 5, Panel B, we conduct a similar analysis, but focusing on the production of patent innovation. We predict that the relation between CEO innovation incentives and patent production will be concentrated in high-tech industries. We estimate the same models as in Table 5, Panel A, but replace *Log(NbTrademarks)* with *Log(NbPatents)*. We find positive and statistically significant coefficients for all three incentive variables for high-tech industries. For mid-tech industries, only the coefficient on *OptionComp* is significantly positive, and the coefficient estimates on the other two incentive variables are near zero. Finally, we find small and statistically insignificant coefficients on all three incentive measures for low-tech industries. In contrast to trademarks, for which we found no significantly different incentive effects across the three industry groups, we find that the coefficients on *Log(Vega)* and *Log(UnvestedOptions)* are significantly higher for high-tech industries than both low-tech and mid-tech industries, with $p < 0.01$. In addition, the coefficient on *OptionComp* is significantly higher for mid-tech industries than for low-tech industries, with $p = 0.07$. Consistent with prior research, we find that CEO incentives are related to patent innovation in high-tech industries. However, we find no relation in low-tech industries and an inconsistent relation for mid-tech industries depending on which incentive measure we examine.

Overall, these results suggest that the types of innovation that low-tech, mid-tech, and high-tech industries engage in differ. By focusing on only one innovation measure, we may fail to fully understand innovation in the economy. We find that low-tech industries create more trademarks when faced with higher CEO incentives to innovate, suggesting that they innovate through product development. Mid-tech industries create more trademarks, but also show some increase in patent production, particularly for higher option compensation. Finally, high-tech industries produce more patents, and to a lesser extent create more trademarks as well.

4.3. *Changes in CEO Incentives and Trademark Creation around SFAS 123(R)*

Given the persistence in many firm characteristics, our results presented in Tables 4 and 5 could be due to endogenous factors driving both CEO compensation structure and product trademark creation. To address endogeneity concerns, we use the change in the accounting of stock option compensation, introduced by the adoption of SFAS 123(R) in 2005, as an exogenous shock to the use of option-based pay. Prior to SFAS 123(R), firms provided pro forma footnote disclosures of the fair value of stock option grants during the period, but only recognized the "intrinsic value" of these granted options as an expense on their income statement. Because the strike price of stock options is typically set at the current stock price on the grant date, the intrinsic value is typically zero. For fiscal years beginning after June 15, 2005, firms are mandated by SFAS 123(R) to recognize the fair value of stock option grants as compensation expense. Consequently, the financial reporting cost of using stock options increased considerably with the implementation of SFAS 123(R). Prior research documents a noticeable decrease in the use of stock option compensation after the adoption of SFAS 123(R) (Brown and Lee, 2010; Hayes, Lemmon and Qiu, 2012; Skantz, 2012).

To exploit, in our setting, this exogenous shock in the use of option-based compensation, we follow Hayes, Lemmon, and Qiu (2012) and compute three-year averages of our main variables, both pre- and post-SFAS 123(R).[24] Our sample consists of 1,552 distinct firms with non-missing data for our main variables included in Equation (3) below. Out of these 1,552 firms, 1,051 (i.e., 68%) experienced a decrease in *OptionComp* after the adoption of SFAS 123(R) compared to before, whereas 383 (25%) had an increase. Table 6, Panel A, provides univariate statistics of

[24] Hayes, Lemmon and Qiu (2012) define the pre-123(R) period as the 3-year interval of 2002-2004 and the post-123(R) period as the 4-year interval of 2005-2008 to include any firms which respond to 123(R) before the required change in accounting. To reduce noise we exclude the transition year, 2005, and define our post-123(R) period as 2006-2008.

variables pre- and post-SFAS 123(R). In line with findings from prior research, we document that *OptionComp* decreases considerably following the adoption of SFAS 123(R). Indeed, the mean (median) *OptionComp* in our sample firms decreases from 33% (31%) of total compensation to 20% (17%). These decreases are statistically significant. Moreover, in the subsample of firms with a decrease in *OptionComp*, the mean (median) *OptionComp* decreases from 42% (40%) of total compensation to 17% (14%).[25]

To provide evidence on the effect of changes in stock option compensation introduced by SFAS 123(R) on changes in new product trademark creation, we estimate the following model for firm *i*:

$$\begin{aligned} \Delta Log(NbTrademarks)_i = \alpha + \beta_1 \Delta OptionComp_i + \beta_2\ \Delta Log(TotalComp)_i \\ + \beta_3 \Delta Log(Sales)_i + \beta_4 \Delta R\&D_i + \beta_6\ \Delta TobinQ_i \\ + \beta_7\ \Delta Leverage + \varepsilon_i \end{aligned} \quad (3)$$

where the sign *Δ* represents the difference, for each variable, between i) the three-year average in the post-SFAS 123(R) period and ii) the three-year average in the post-SFAS 123(R) period.[26] All variables are defined as in Equation (2). If CEO stock option compensation drives product development innovation, measured by new product trademarks, then we should find that firms which change (e.g., decrease) their option-based pay around SFAS 123(R) also experience a change (e.g., decrease) in product trademark creation. In other words, we should find a positive relation between the change in stock option compensation and the change in product trademark

[25] We focus our analysis on changes in *OptionComp* since we expect SFAS 123(R) to most directly affect the use of option compensation. While SFAS 123(R) may also indirectly reduce the convexity of CEO incentives through the reduction in new option compensation; this effect is likely to be smaller, since the overall convexity of incentives is affected by the entire stock of CEO security holdings, and not just new grants, and will be affected more strongly by factors other than SFAS 123(R). Consistent with this, we find a much smaller reduction in *Vega* than in *OptionComp*. While average (median) *OptionComp* decreases by 40.1% (45.5%), average (median) *Vega* decreases by only 23.5% (12.4%). Similarly, while 67.7% (24.7%) of firms decrease (increase) option compensation around SFAS 123(R), 55.0% (43.7%) decrease (increase) *Vega*.

[26] For the dependent variable, *Log(NbTrademarks)*, the pre(post)-SFAS 123(R) period corresponds to fiscal years 2003-2005 (2007-2009), whereas for all other variables, the pre(post)-SFAS 123(R) period corresponds to fiscal years 2002-2004 (2006-2008).

creation for firms affected by SFAS 123(R). Table 6, Panel B, presents the results. Model I includes all firm observations. The coefficient on *ΔOptionComp* is significantly positive, with $p = 0.03$. The magnitude of the coefficient, 0.1344, is slightly higher than the magnitude of the coefficient on *OptionComp* in Table 4, 0.0959, suggesting that the association between lagged option compensation and product trademark creation documented in Table 4 is largely due to the effect of option compensation on product development innovation. Because we expect the exogenous shock of SFAS 123(R) to decrease the use of option compensation, firms that experience a decrease in option compensation are most likely to have been affected by the exogenous shock. Firms that experience an increase in option compensation over the same time period are most likely affected by other factors. Thus, to better isolate the impact of the exogenous shock, Model II (Model III) includes only the subsample of firm observations with decreases (increases) in *OptionComp* after the adoption of SFAS 123(R). Across both models, we find that changes in stock option compensation are significantly positively associated with subsequent changes in product trademark creation. Overall, these findings confirm that stock option compensation is a significant driver of product development innovation, as measured by new product trademarks.

It is interesting to note that these results also suggest a previously undocumented real effect to the implementation of SFAS 123(R). In addition to somewhat directly impacting the use of option compensation, the accounting standard indirectly impacts product development innovation. The magnitudes of the effects we document suggest the following: given that median *OptionComp* drops from 31% to 17% of total compensation, we would expect a 5.2% decrease in product trademark creation after 123(R) for the median firm. This amounts to 42 fewer new product trademarks per year after 123(R) than before 123(R), across the sample of 1,552 firms included in our analysis. This decrease in product development innovation is a potential cost to the entire economy. Alternatively, this might be a more optimal level of innovation, if pre-123(R) levels included inefficient (excessive) investments in product development innovation.

5. Conclusion

We examine the structure of CEO incentives as a determinant of product development innovation. We introduce a new measure of development innovation: trademark creation. We document that product development innovation, as measured by new product trademarks, is associated with the volatility of firms' sales, earnings, and stock returns, suggesting that product development innovation is in fact a risky activity.

Using this new measure, we find that the structure of CEO incentives, specifically the use of stock option compensation, the convexity of incentives, and the amount of unvested stock options held by a CEO, is associated with higher levels of product development innovation. In addition, we find that the positive relation between CEO incentives and future new product trademarks is consistently significant for firms in low-tech and mid-tech industries, while the relation between two incentive measures, incentive convexity and unvested stock option holdings, and trademark creation are significant for firms in high-tech industries. In contrast, the relation between CEO incentives and *patent* innovation is strongest in high-tech industries, is weaker but somewhat significant for mid-tech industries, and is insignificant for low-tech industries. These findings provide evidence that the structure of CEO incentives affects product development innovation activities, independently of its effect on patents, and that it is particularly important to examine *product development* innovation to understand innovation in low-tech and mid-tech firms. Finally, we exploit SFAS 123(R) as an exogenous shock to the use of stock options and document a significantly positive relation between changes in CEO stock option compensation around SFAS 123(R) and subsequent changes in product trademark creation.

Our study provides valuable insights about innovation and the incentives to engage in innovative activities. We collect and compile a comprehensive sample of new trademarks, as a new measure of product and marketing development innovation. Little is known about what contributes to firms' success in product and marketing development innovation, given the focus of prior research on research-oriented innovation in technology-intensive firms. Our study provides insights into how firms, especially those in non-technology-intensive industries, motivate product development innovation through the design of executive compensation contracts. This is crucial given the broad presence of non-technology-intensive firms and industries in the economy, the potential importance of product development innovation to firm performance, and the substantial differences between research innovation and development innovation.

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Appendix A
Trademarks as a Measure of Product and Marketing Development Innovation

Patents have traditionally been used as a measure of innovation in firms. We make a distinction between *research innovation* and *development innovation.* To illustrate this distinction, consider the following two examples.

First, consider Apple Inc.'s iPhone, launched in 2007. On the one hand, the iPhone was technologically innovative. Prior to 2007, Apple had only 17 patents related to cell phones. By 2012, it had nearly 1,300, almost all filed after the 2007 launch of the initial iPhone (Gaze and Roderick 2012). While some patents may never be related to eventual products, these patents were turned into a product for sale, in the form of the iPhone. The trademark process resulted in a single trademark for the iPhone itself, with additional trademarks over time for variations in the logo, and for related products or marketing phrases, like "Made for iPod, iPad, iPhone" and "Works with iPhone." We were able to find a total of just 15 active trademarks registered by Apple Inc. for the iPhone. Thus the iPhone encompasses both *research innovation* and *product development innovation*, with patents serving as a reasonable proxy for the extent of *research innovation* involved in the product, and trademarks capturing the fact that these translated, through *product development innovation*, into a product for sale.

Second, consider General Mills' Yoplait Pro-Force Greek Yogurt. While this new product was innovative for the company and market – tailoring the relatively new high-protein Greek yogurt product to children and teenagers who have traditionally favored the sweeter traditional yogurts – it was not technologically innovative. Based on our search, General Mills and Yoplait did not file any new patents related specifically to the production of Greek yogurt or high-protein yogurt around the launch of Yoplait's new product. Most likely, they relied on their existing production methods. However the company registered two trademarks, for "Yoplait Pro-Force" and for "Pro-Force," to protect their new product line. The company has also taken on substantial risk in launching this new product. Because of its novelty, they do not know if it will be accepted by its target customers. The company will have to divert certain limited resources, such as the limited shelf space they are allotted by grocery stores, away from more established products. Overall, the company is engaging in a type of risky innovation, which is distinct from the type of *research innovation* which Apple engaged in. One analyst focused on Yoplait's "innovation," in an analysis of this new product:

> "*Through its strategy of innovating new and established brands, the company wants to cater to the increasing global demands for packaged food. Some of these innovations, mainly in yogurt,…*" (Zacks Equity Research, 2013).

We label this type of innovation, which results in a new product available to the market, but which may or may not exploit new technologies from *research innovation*, as *product development innovation.*

The second distinction that we make is between *product development innovation* and *marketing innovation*. While many trademarks represent product names, usually indicating new products, many marketing-related trademarks are related to new marketing campaigns for existing products. For example, the following three images were registered by Coca-Cola Company in 1976, 1992, and 2005 respectively.

1976:	

1992:	
2005:	

While these trademarks represent innovations to the firm's marketing of the Fanta product, they do not represent new product development innovation.[27] Marketing functions are often separated from product development in organizations, and factors that contribute to the pursuit and success of these separate innovations likely also differ. Consequently, for our analyses, separating new trademarks resulting from product development innovation and new trademarks from marketing innovation is appropriate.

We classify all images (20.7% of our sample trademarks) as marketing-related. While companies often trademark logos such as the Fanta logos above, they often also include a "Word mark" for the product name. In the case of Fanta, Coca-Cola Co. has a trademark for the word "Fanta," which was originally registered in 1955 and which is still active, in addition to the changing image marks displayed above. Similarly, we classify "sound marks," such as the MGM

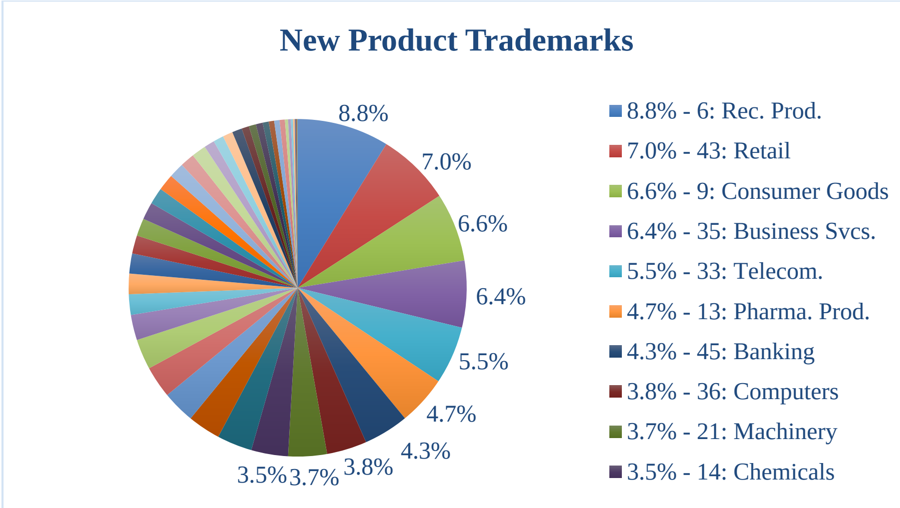
[27] While we were unable to find definitive sources, a reading of dozens of news articles related to Fanta suggests that the 1992 and 2005 logo changes were not associated with any significant changes in the taste, color, or general packaging (e.g., cans, bottles) of the Fanta product. The 1992 logo change corresponded with a significant overseas marketing push of Fanta, particularly in the former Soviet Union and Eastern Bloc countries. The 2005 logo change corresponded to a reintroduction of the Fanta product in the U.S. market in the early 2000's, with a large associated marketing push. We were unable to find significant information regarding the 1976 logo change.

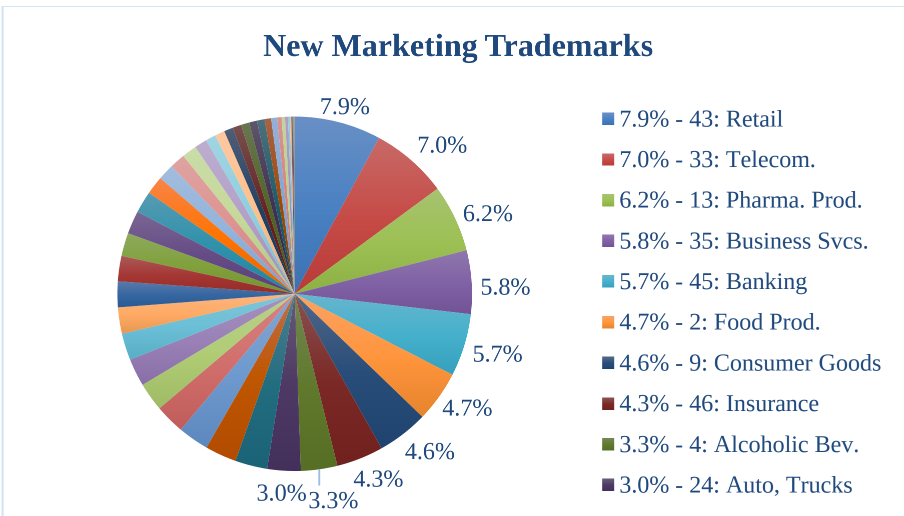
roaring of the lion at the beginning of movies and the THX sound at movies, as marketing-related (0.02% of our sample trademarks). The final category, "word marks," tends to include both product names and slogans used for marketing. Below we provide examples to illustrate this distinction. The following is a table with a few examples of each for well-known companies:

Company	**Example Product Trademarks**	**Example Marketing Trademarks (e.g., Slogans)**
McDonald's Corp.	Big Mac; Big N' Tasty; McDouble	I'm Lovin' It; What We're Made Of
Coca-Cola Co.	Fanta; Sprite; Cherry Coke	The Coca-Cola Side of Life; Coca-Cola Refresh Your Flow
Citigroup Inc.	Citi Retail Services; Citi Treasury Diagnostics; C-Trackss	Citibank Deals About Town; Endless Points. Endless Potential.; Every Step of the Way

In order to categorize word marks as either product or marketing trademarks, we examined 500 randomly chosen trademarks, and hand-coded them as product, marketing, or unclear, trademarks based upon searches for the given words or phrases. As might be expected, longer phrases are more likely to be marketing-focused, while shorter phrases are more likely to represent product names. In particular, we found that for trademarks of four words, slightly more than 50% were related to marketing. The percentage was even higher for longer phrases. For trademarks of three words, the percentage was only 23% by the most conservative measure (including all "unclear" trademarks as marketing-related), and less than 7% (2.5% for two-word (one-word) trademarks. Thus, we use the number of words in the word mark to separate marketing- from product-focused word-based trademarks. While this partition is not error-proof, it provides a reasonable rule for categorizing the large number of trademarks in our sample (123,545 unique trademarks), while minimizing errors. In the examples provided above, only the "I'm Lovin' It" trademark from McDonalds would be misclassified.

Figure 1
Distribution of New Trademarks and Patents by Industry





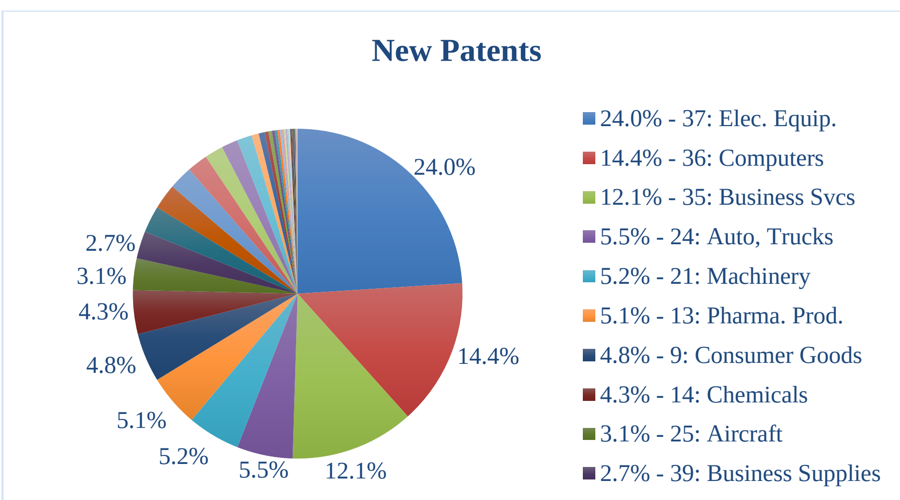


Table 1
Distribution of New Product and Marketing Trademarks and Firm-Year Observations

Panel A: Distribution of New Product and Marketing Trademarks and Firm-Year Observations by Fiscal Year

Year	New Product Trademarks		New Marketing Trademarks		Execucomp Firm-Year Observations	
	N	%	N	%	N	%
1993	2,110	2.48	1,013	2.64	2,247	5.22
1994	2,713	3.18	1,159	3.02	2,348	5.46
1995	3,455	4.06	1,621	4.23	2,532	5.89
1996	4,286	5.03	1,811	4.72	2,600	6.04
1997	4,850	5.69	2,188	5.71	2,569	5.97
1998	4,176	4.90	1,868	4.87	2,555	5.94
1999	3,893	4.57	1,715	4.47	2,490	5.79
2000	4,247	4.98	2,077	5.42	2,392	5.56
2001	4,498	5.28	1,911	4.99	2,323	5.40
2002	5,681	6.67	2,415	6.30	2,323	5.40
2003	5,364	6.30	2,291	5.98	2,315	5.38
2004	4,788	5.62	1,998	5.21	2,287	5.32
2005	4,628	5.43	2,118	5.52	2,227	5.18
2006	5,406	6.34	2,303	6.01	2,153	5.00
2007	5,565	6.53	2,402	6.27	2,056	4.78
2008	5,839	6.85	2,706	7.06	1,977	4.60
2009	4,997	5.86	2,532	6.60	1,936	4.50
2010	4,344	5.10	2,139	5.58	1,878	4.37
2011	4,369	5.13	2,069	5.40	1,805	4.20
All Years	**85,209**	**100.00**	**38,336**	**100.00**	**43,013**	**100.00**

Table 1 (cont'd)

Panel B: Distribution of New Product and Marketing Trademarks and Firm-Years by Industry

Industry	New Product Trademarks		New Marketing Trademarks		Execucomp Firm-Years	
Code and Description	N	%	N	%	N	%
1: Agriculture	230	0.27	122	0.32	139	0.32
2: Food Products	2,659	3.12	1,786	4.66	777	1.81
3: Candy, Soda	62	0.07	40	0.10	96	0.22
4: Alcoholic Beverages	1,345	1.58	1,274	3.32	135	0.31
5: Tobacco Products	495	0.58	517	1.35	71	0.16
6: Recreational Products	7,487	8.79	1,126	2.94	220	0.51
7: Entertainment	1,435	1.68	902	2.35	503	1.17
8: Printing, Publishing	1,676	1.97	1,039	2.71	407	0.95
9: Consumer Goods	5,602	6.57	1,781	4.65	713	1.66
10: Apparel	1,417	1.66	939	2.45	629	1.46
11: Healthcare	439	0.52	342	0.89	843	1.96
12: Medical Equipment	2,669	3.13	536	1.40	1,049	2.44
13: Pharma. Products	4,023	4.72	2,359	6.15	1,543	3.59
14: Chemicals	2,999	3.52	766	2.00	1,021	2.37
15: Rubber, Plastic Products	441	0.52	102	0.27	208	0.48
16: Textiles	602	0.71	153	0.40	236	0.55
17: Construction Materials	845	0.99	314	0.82	739	1.72
18: Construction	429	0.50	356	0.93	527	1.22
19: Steel Works, Etc.	809	0.95	302	0.79	811	1.89
20: Fabricated Products	68	0.08	29	0.08	116	0.27
21: Machinery	3,150	3.70	1,080	2.82	1,490	3.46
22: Electrical Equipment	1,485	1.74	437	1.14	541	1.26
23: Miscellaneous	1,173	1.38	291	0.76	231	0.54
24: Automobiles, Trucks	2,475	2.91	1,164	3.04	726	1.69
25: Aircraft	580	0.68	208	0.54	191	0.44
26: Ship., Railroad Equip.	145	0.17	49	0.13	67	0.16
27: Defense	559	0.66	270	0.70	93	0.22
28: Precious Metals	2	0.00	6	0.02	138	0.32
29: Nonmetallic Mining	80	0.09	22	0.06	146	0.34
30: Coal	9	0.01	9	0.02	84	0.19
31: Petroleum, Natural Gas	1,173	1.38	637	1.66	1,606	3.73
32: Utilities	851	1.00	918	2.39	2,325	5.41
33: Telecommunications	4,724	5.54	2,686	7.01	1,014	2.36
34: Personal Services	251	0.30	273	0.71	420	0.98
35: Business Services	5,448	6.39	2,220	5.79	4,327	10.06
36: Computers	3,271	3.84	887	2.31	1,615	3.75
37: Electronic Equipment	2,864	3.36	966	2.52	2,569	5.97
38: Measure, Control Equip.	1,238	1.45	227	0.59	826	1.92
39: Business Supplies	2,070	2.43	810	2.11	674	1.57
40: Shipping Containers	173	0.20	64	0.17	185	0.43
41: Transportation	817	0.96	566	1.48	1,087	2.53
42: Wholesale	1,670	1.96	804	2.10	1,409	3.28
43: Retail	6,000	7.04	3,023	7.88	2,738	6.37
44: Restaurant, Hotel, Motel	1,353	1.59	1,097	2.86	787	1.83
45: Banking	3,672	4.31	2,191	5.71	2,682	6.23
46: Insurance	2,599	3.05	1,637	4.27	1,923	4.47
47: Real Estate	8	0.01	12	0.03	68	0.16
48: Trading	1,637	1.92	997	2.60	2,268	5.27
All Industries	**85,209**	**100.00**	**38,336**	**100.00**	**43,013**	**100.00**

Table 1 (cont'd)

Panel C: Distribution of New Product and Marketing Trademarks across Firm-Years

	Nb of Firm-Years	Min	Q1	Mean	Median	Q3	P99	Max	Std Dev
New Product Trademarks Per Firm-Year									
Execucomp Sample	43,013	0	0	2.0	0	1	26	705	8.9
New Product Trademark Sample	15,595	1	1	5.5	2	5	44	705	14.2
New Marketing Trademarks Per Firm-Year									
Execucomp Sample	43,013	0	0	0.9	0	1	14	114	3.4
New Marketing Trademark Sample	10,804	1	1	3.5	2	3	28	114	6.0

Panel D: New Product Trademark Firm-Years versus Execucomp Firm-Years

Variable	New Product Trademark Firm-Years N=15,595		Execucomp Firm-Years N=43,013		Trademark vs. Execucomp *p*-value of Difference	
	Mean	Median	Mean	Median	Mean	Median
TotalAssets (in $M)	13,793.9	1,740.0	7,377.5	1,082.1	<0.01	<0.01
MarketValueEquity ($M)	9,209.2	1,820.1	4,614.1	998.4	<0.01	<0.01
Sales (in $M)	6,442.7	1,539.7	3,438.8	813.2	<0.01	<0.01
R&D (in % of *Sales*)	0.0470	0.0033	0.0477	0.0000	0.50	<0.01
ROA	0.0431	0.0489	0.0348	0.0428	<0.01	<0.01
TobinQ	2.0511	1.5591	1.9404	1.4458	<0.01	<0.01
Leverage (in % of TotalAssets)	0.5589	0.5563	0.5584	0.5553	0.80	0.69
NbMonths (in months)	288.5	223.0	245.2	178.0	<0.01	<0.01
Salary (in $K)	728.83	689.51	633.98	582.10	<0.01	<0.01
Bonus (in $K)	634.09	208.88	489.56	158.50	<0.01	<0.01
OptionGrants (in $K)	2,118.13	717.17	1,549.37	420.26	<0.01	<0.01
StockGrants (in $K)	969.88	0.00	752.27	0.00	<0.01	<0.01
TotalComp (in $K)	5,459.04	3,139.83	4,238.73	2,266.83	<0.01	<0.01
OptionComp (in % of *TotalComp*)	0.31	0.27	0.28	0.22	<0.01	<0.01
Vega (in $K)	167.34	65.09	112.38	40.08	<0.01	<0.01
Delta (in $K)	1,007.70	272.30	683.51	196.18	<0.01	<0.01

Table 1 (cont'd)

Panel E: Ranking of High, Mid, and Low Technology Intensive Industries

Industry Code and Description	Nb of Firm-Years	New Patents		New Product Tmarks		New Marketing Tmarks	
		Avg Nb per Firm-Yr	Rank	Avg Nb per Firm-Yr	Rank	Avg Nb per Firm-Yr	Rank
HIGH-TECH INDUSTRIES							
25: Aircraft	191	108.11	1	3.04	12	1.09	17
23: Miscellaneous	231	77.73	2	5.08	6	1.26	14
37: Electronic Equipment	2,569	60.07	3	1.11	33	0.38	40
36: Computers	1,615	56.09	4	2.03	24	0.55	29
27: Defense	93	52.08	5	6.01	5	2.90	4
24: Automobiles, Trucks	726	47.51	6	3.41	10	1.60	10
9: Consumer Goods	713	42.50	7	7.86	3	2.50	7
14: Chemicals	1,021	26.82	8	2.94	13	0.75	22
39: Business Supplies	674	25.19	9	3.07	11	1.20	15
21: Machinery	1,490	21.95	10	2.11	23	0.72	24
22: Electrical Equipment	541	21.79	11	2.74	15	0.81	21
13: Pharma. Products	1,543	20.94	12	2.61	16	1.53	11
MID-TECH INDUSTRIES							
35: Business Services	4,327	17.85	13	1.26	30	0.51	31
38: Measure, Control Equip.	826	15.68	14	1.50	27	0.27	43
12: Medical Equipment	1,049	15.19	15	2.54	18	0.51	32
26: Ship., Railroad Equip.	67	14.55	16	2.16	21	0.73	23
1: Agriculture	139	13.30	17	1.65	26	0.88	18
17: Construction Materials	739	12.63	18	1.14	32	0.42	35
6: Recreational Products	220	10.64	19	34.03	1	5.12	3
33: Telecommunications	1,014	10.16	20	4.66	7	2.65	5
31: Petroleum, Natural Gas	1,606	9.30	21	0.73	38	0.40	38
5: Tobacco Products	71	9.12	22	6.97	4	7.28	2
40: Shipping Containers	185	6.25	23	0.94	35	0.35	42
15: Rubber, Plastic Products	208	4.88	24	2.12	22	0.49	33
19: Steel Works, Etc.	811	4.43	25	1.00	34	0.37	41
4: Alcoholic Beverages	135	4.38	26	9.96	2	9.44	1
18: Construction	527	3.14	27	0.81	36	0.68	25
16: Textiles	236	2.82	28	2.55	17	0.65	27
2: Food Products	777	2.72	29	3.42	9	2.30	8
10: Apparel	629	2.21	30	2.25	19	1.49	12
7: Entertainment	503	1.78	31	2.85	14	1.79	9
29: Nonmetallic Mining	146	1.59	32	0.55	43	0.15	46
20: Fabricated Products	116	1.05	33	0.59	42	0.25	44
42: Wholesale	1,409	0.72	34	1.19	31	0.57	28
48: Trading	2,268	0.67	35	0.72	39	0.44	34
LOW-TECH INDUSTRIES							
41: Transportation	1,087	0.31	36	0.75	37	0.52	30
28: Precious Metals	138	0.31	37	0.01	48	0.04	48
8: Printing, Publishing	407	0.28	38	4.12	8	2.55	6
46: Insurance	1,923	0.26	39	1.35	29	0.85	19
43: Retail	2,738	0.18	40	2.19	20	1.10	16
11: Healthcare	843	0.16	41	0.52	44	0.41	37
45: Banking	2,682	0.15	42	1.37	28	0.82	20
32: Utilities	2,325	0.13	43	0.37	45	0.39	39
34: Personal Services	420	0.05	44	0.60	41	0.65	26
3: Candy, Soda	96	0.04	45	0.65	40	0.42	36
44: Restaurant, Hotel, Motel	787	0.04	46	1.72	25	1.39	13
47: Real Estate	68	0.02	47	0.12	46	0.18	45
30: Coal	84	0.00	48	0.11	47	0.11	47

Table 1 (cont'd)

Notes:

Panel A (Panel B) of this table presents the distribution by year (by industry) of the sample of 85,209 new product trademarks and 38,336 new marketing trademarks registered by 2,354 and 2,189 distinct Execucomp firms, respectively, during fiscal years 1993-2011 as well as the full sample of 43,013 Execucomp firm-year observations (3,276 distinct firms). Industry grouping is based on the Fama-French (1997) 48-industry classification. Panel C presents the distribution of new product (marketing) trademarks registered during a year across firms for the Execucomp Sample and the Execucomp Sample with new product (marketing) trademarks. Panel D of this table presents selected summary statistics for the new product trademark firm-year observations (15,595 firm-year observations from 2,354 distinct firms) and the Execucomp firm-year observations (43,013 firm-year observations from 3,276 distinct firms), which include the new product trademark firm-year observations. Panel D also presents comparisons and results of *t*-tests (Wilcoxon rank-sum tests) of mean (median) differences for each variable. Panel E presents the ranking of high, mid, and low technology intensive industries, where high (low) technology intensive industries are the industries with more (less) than 20 (0.5) patents per firm-year, on average. For each industry, Panel E shows new patent intensity, new product trademark intensity, and new marketing trademark intensity, as well as ranks of these intensities, where intensity is measured at the industry level as the sum of all new patents, new product trademarks, or new marketing trademarks in the industry, divided by the total number of firm-years in the industry. Industry grouping is based on the Fama-French (1997) 48-industry classification. Ranks are from one (highest intensity) to 48 (lowest intensity). In all panels, the sample covers fiscal years 1993-2011, except in Panel E for new patent intensity where the sample covers fiscal years 1993-2008. *TotalAssets* is total assets, in $M. *MarketValueEquity* is market value of common equity, in $M. *Sales* is total sales, in $M. *R&D* is research and development expense divided by total sales (set as zero when R&D expense is missing in Compustat). *ROA* is return on assets, measured as earnings before extraordinary items and discontinued operations scaled by average total assets. *TobinQ* is the market value of total assets divided by the book value of total assets. *Leverage* is total liabilities divided by total assets. *NbMonths* is the number of months since the firm first appeared on CRSP. *Salary* is the CEO's annual base salary, in $K. *Bonus* is the CEO's annual bonus, in $K. *OptionGrants* is the value of new stock options granted to the CEO during the year, in $K. *StockGrants* is the value of the stock-related awards (e.g., restricted stock, restricted stock units, phantom stock, phantom stock units, common stock equivalent units, etc.) granted to the CEO during the year, in $K. *TotalComp* is the CEO's annual total compensation, in $K, measured as the sum of salary, bonus, other annual compensation, value of restricted stock granted, value of new stock options granted during the year, long-term incentive payouts, and all other compensation. *OptionComp* is the CEO's annual stock option compensation, defined as the value of new stock options granted as a fraction of total compensation. *Vega* is the CEO's sensitivity to stock return volatility, measured as the dollar change in the CEO's option portfolio for a 0.01 change in standard deviation of stock returns. *Delta* is the CEO's pay-performance sensitivity, measured as the dollar change in the CEO's wealth for a one-percent change in stock price. To mitigate the influence of outliers, all variables except *NbMonths* are winsorized at the 1st and 99th percentiles.

Table 2
Descriptive Statistics and Correlation Coefficients

Panel A: Descriptive Statistics

Variable	Q1	Mean	Median	Q3	Std Dev
Log(NbTrademarks)	0.0000	0.5127	0.0000	0.6931	0.8258
Log(NbMktgTrademarks)	0.0000	0.3031	0.0000	0.6931	0.6141
RetVol	0.2855	0.4588	0.3976	0.5648	0.2499
ChSalesVol	0.0109	0.0501	0.0239	0.0477	1.4349
ChEarnVol	0.0039	0.0478	0.0094	0.0242	3.1895
OptionComp	0.0000	0.2774	0.2214	0.4781	0.2802
Log(Vega)	2.5353	3.5460	3.7155	4.7772	1.7642
Log(UnvestedOptions)	5.5946	6.4144	7.4103	8.6053	3.2537
Log(Delta)	4.2898	5.2912	5.2841	6.3017	1.6155
Log(TotalComp)	6.9796	7.7517	7.7286	8.5269	1.1771
Log(Sales)	5.5749	6.7059	6.7009	7.8866	1.8307
R&D	0.0000	0.1541	0.0000	0.0304	4.6007
ROA	0.0110	0.0326	0.0428	0.0860	0.2260
TobinQ	1.1037	2.0000	1.4458	2.1624	2.2631
Leverage	0.3774	0.5713	0.5554	0.7192	1.0124
Age	4.4427	5.0357	5.1874	5.8464	1.1246
Size	5.8673	6.9738	6.9061	8.0727	1.7545

Table 2 (cont'd)

Panel B: Pearson (Spearman) Correlation Coefficients in the Lower Left (Upper Right) Diagonal

	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)
A: Log(NbTrademarks)	–	0.59	-0.08	-0.02	-0.01	0.10	0.27	0.21	0.21	0.25	0.31	0.17	0.07	0.10	0.02	0.18	0.30
B:Log(NbMktgTrademarks)	0.69	–	-0.11	-0.06	-0.06	0.07	0.23	0.17	0.20	0.24	0.31	0.02	0.05	0.05	0.07	0.16	0.29
C: RetVol	-0.10	-0.11	–	0.41	0.50	0.11	-0.16	-0.04	-0.16	-0.15	-0.37	0.25	-0.17	0.07	-0.23	-0.35	-0.43
D: ChSalesVol	-0.01	-0.01	0.18	–	0.54	0.09	-0.13	0.00	-0.10	-0.13	-0.16	0.21	0.11	0.23	-0.28	-0.17	-0.31
E: ChEarnVol	-0.01	0.00	0.32	0.99	–	0.10	-0.05	0.01	-0.15	-0.07	-0.25	0.38	-0.14	0.18	-0.24	-0.18	-0.28
F: OptionComp	0.09	0.06	0.13	0.01	0.01	–	0.44	0.60	0.18	0.37	0.04	0.19	0.04	0.19	-0.09	-0.09	0.14
G: Log(Vega)	0.29	0.25	-0.16	-0.07	-0.05	0.44	–	0.75	0.55	0.67	0.48	0.10	0.08	0.12	0.11	0.16	0.58
H: Log(UnvestedOptions)	0.18	0.14	-0.04	0.03	0.02	0.57	0.73	–	0.52	0.56	0.30	0.15	0.16	0.31	0.00	-0.03	0.46
I: Log(Delta)	0.23	0.22	-0.19	-0.03	-0.11	0.20	0.49	0.35	–	0.48	0.37	0.02	0.29	0.36	-0.02	0.00	0.59
J: Log(TotalComp)	0.26	0.24	-0.12	-0.01	-0.01	0.36	0.61	0.41	0.43	–	0.60	0.01	0.08	0.06	0.19	0.18	0.65
K: Log(Sales)	0.37	0.35	-0.36	-0.03	-0.03	0.00	0.44	0.20	0.37	0.55	–	-0.22	0.04	-0.17	0.38	0.45	0.77
L: R&D	-0.01	-0.01	0.05	0.00	0.00	0.01	-0.01	0.01	-0.03	-0.03	-0.12	–	0.03	0.37	-0.34	-0.06	-0.05
M: ROA	0.04	0.03	-0.35	-0.02	-0.02	-0.01	0.08	0.07	0.25	0.06	0.14	-0.09	–	0.53	-0.38	-0.01	0.20
N: TobinQ	0.02	0.01	0.14	0.01	0.01	0.15	0.05	0.16	0.27	0.00	-0.20	0.05	-0.10	–	-0.40	-0.19	0.18
O: Leverage	0.01	0.01	-0.12	0.01	0.01	-0.04	0.08	0.00	-0.04	0.02	0.04	0.02	-0.29	0.31	–	0.22	0.18
P: Age	0.20	0.17	-0.29	-0.14	-0.10	-0.13	0.15	-0.03	0.00	0.15	0.42	-0.01	0.03	-0.18	0.06	–	0.33
Q: Size	0.36	0.35	-0.42	-0.02	-0.02	0.14	0.53	0.31	0.60	0.58	0.76	-0.03	0.15	0.09	0.00	0.30	–

Notes:

This table presents selected descriptive statistics (Panel A) and correlation coefficients (Panel B) of the variables included in Tables 3 through 5 for the Execucomp sample (43,013 firm-year observations from 3,276 distinct firms). The sample covers fiscal years 1993-2011. In Panel B, pearson (spearman) correlation coefficients are provided in the lower (upper right) diagonal. *Log(NbTrademarks)* is the natural logarithm of one plus the number of new product trademarks registered during the year. *Log(NbMktgTrademarks)* is the natural logarithm of one plus the number of new marketing trademarks registered during the year. *RetVol* is the annualized stock return volatility, measured as the annualized standard deviation of daily stock returns over the year. *ChSalesVol* (*ChEarnVol*) is sales (earnings) volatility, measured as the standard deviation of seasonal sales (earnings) changes estimated over the most recent three years. *OptionComp* is the CEO's annual stock option compensation, measured as the value of new stock options granted as a fraction of total compensation. *Log(Vega)* is the natural logarithm of one plus the CEO's sensitivity to stock return volatility, measured as the dollar change in the CEO's option portfolio for a 0.01 change in annualized standard deviation of stock returns. *Log(UnvestedOptions)* is the natural logarithm of one plus the CEO's unvested stock option holdings (in $K). *Log(Delta)* is the natural logarithm of one plus the CEO's sensitivity to stock price, measured as the dollar change in the CEO's stock and option portfolio for a one-percent change in stock price. *Log(TotalComp)* is the natural logarithm of the CEO's annual total compensation, measured as the sum of salary, bonus, other annual compensation, value of restricted stock granted, value of new stock options granted during the year, long-term incentive payouts, and all other compensation. *Log(Sales)* is the natural logarithm of total sales. *R&D* is research and development expense divided by total sales (set as zero when R&D expense is missing in Compustat). *ROA* is return on assets, measured as earnings before extraordinary items and discontinued operations scaled by average total assets. *TobinQ* is the market value of total assets divided by the book value of total assets. *Leverage* is total liabilities divided by total assets. *Age* is the natural logarithm of one plus the number of months since the firm first appeared on CRSP. *Size* is the natural logarithm of market value of equity. Industry grouping is based on the Fama-French (1997) 48-industry classification. To mitigate the influence of outliers, all variables are winsorized by year and industry at the 1st and 99th percentiles.

Table 3
Relation between New Product and Marketing Trademarks and Firm Volatility

Panel A: Relation between New Product and Marketing Trademarks and Future Firm Volatility

$$Volatility_{i,t+1} = \alpha + \beta_1 Log(NbTrademarks)_{i,t} + \beta_2 Log(NbMktgTrademarks)_{i,t} + \beta_3 Volatility_{i,t} + \beta_4 Age_{i,t} + \beta_5 Size_{i,t} + \sum \chi_j Year_j + \varepsilon_{i,t+1}$$

Variable	Expected Sign	Coefficient *(t-statistic)*		
		$RetVol_{t+1}$	*$ChSalesVol_{[t+1;t+2]}$*	*$ChEarnVol_{[t+1;t+2]}$*
		Model I	Model II	Model III
$Log(NbTrademarks)_t$	+	**0.0037**	**0.0007**	**0.0006**
		(3.25)	***(2.71)***	***(2.30)***
$Log(NbMktgTrademarks)_t$	?	0.0002	0.0003	0.0004
		(0.13)	*(0.75)*	*(1.12)*
$RetVol_t$	+	**0.7343**		
		(112.51)		
$ChSalesVol_{[t-1;t]}$	+		**0.4518**	
			(47.89)	
$ChEarnVol_{[t-1;t]}$	+			**0.5048**
				(40.78)
Age_t	–	**-0.0094**	0.0001	**-0.0015**
		(-11.13)	*(0.54)*	***(-6.97)***
$Size_t$	–	**-0.0127**	**-0.0033**	**-0.0027**
		(-18.79)	***(-23.36)***	***(-17.33)***
Year Effects		Included	Included	Included
Nb of Observations		39,144	37,827	37,826
Adj. R^2 (%)		68.66	30.96	31.14

Table 3 (cont'd)

Panel B: Relation between New Product and Marketing Trademarks and Past Firm Volatility

$$Volatility_{i,t-1} = \alpha + \beta_1 Log(NbTrademarks)_{i,t} + \beta_2 Log(NbMktgTrademarks)_{i,t} + \beta_3 Volatility_{i,t-2} + \beta_4 Age_{i,t} + \beta_5 Size_{i,t} + \sum \chi_j Year_j + \varepsilon_{i,t-1}$$

Variable	Expected Sign	Coefficient (*t-statistic*)		
		$RetVol_{t-1}$	$ChSalesVol_{[t-2;t-1]}$	$ChEarnVol_{[t-2;t-1]}$
		Model I	Model II	Model III
$Log(NbTrademarks)_t$	+	**0.0062**	0.0000	**0.0014**
		(5.87)	*(-0.03)*	***(5.41)***
$Log(NbMktgTrademarks)_t$	?	0.0003	0.0004	-0.0001
		(0.20)	*(1.08)*	*(-0.21)*
$RetVol_{t-2}$	+	**0.7044**		
		(113.87)		
$ChSalesVol_{[t-4;t-3]}$	+		**0.5173**	
			(52.15)	
$ChEarnVol_{[t-4;t-3]}$	+			**0.5904**
				(43.08)
Age_t	–	**-0.0133**	**-0.0008**	**-0.0026**
		(-13.71)	***(-3.01)***	***(-10.50)***
$Size_t$	–	**-0.0168**	**-0.0023**	**-0.0027**
		(-27.80)	***(-15.32)***	***(-20.40)***
Year Effects		Included	Included	Included
Nb of Observations		36,786	35,550	35,559
Adj. R^2 (%)		71.68	35.79	36.54

Notes:
This table (Panels A and B) presents the results from the regressions presented above and estimated using Newey-West (1987) standard errors corrected for autocorrelation using four lags. The sample covers fiscal years 1993-2011. *t*-statistics are in parenthesis below coefficient estimates. Bolded coefficient estimates and *t*-statistics are statistically significant (two-tailed p-values < 0.10). Year effects are included but not reported for brevity. In Model I of both panels, the dependent variable *RetVol* is the annualized stock return volatility, measured as the annualized standard deviation of daily stock returns over the year. In Model II (Model III) of both panels, the dependent variable *ChSalesVol* (*ChEarnVol*) is sales (earnings) volatility, measured as the standard deviation of seasonal sales (earnings) changes estimated over the two years. *Log(NbTrademarks)* is the natural logarithm of one plus the number of new product trademarks registered during the year. *Log(NbMktgTrademarks)* is the natural logarithm of one plus the number of new marketing trademarks registered during the year. *Age* is the natural logarithm of one plus the number of months since the firm first appeared on CRSP. *Size* is the natural logarithm of market value of equity. To mitigate the influence of outliers, all variables are winsorized by year at the 1st and 99th percentiles.

Table 4
Relation between CEO Incentives and New Product Trademarks

$$Log(NbTrademarks)_{i,t} = \alpha + \beta_1 OptionComp_{i,t-1} + \beta_2 Log(TotalComp)_{i,t-1} + \beta_3 Log(Sales)_{i,t-1} + \beta_4 R\&D_{i,t-1} + \beta_5 ROA_{i,t-1} + \beta_6 TobinQ_{i,t-1} + \beta_7 Leverage_{i,t-1} + \sum \chi_j Year_j + \sum \delta_k Industry_k + \varepsilon_{i,t}$$

Variable	Expected Sign	Coefficient *(t-statistic)* Model I	Model II	Model III	Model IV	Model V
OptionComp$_{t-1}$	+		**0.0959**			
			(2.97)			
Log(Vega)$_{t-1}$	+			**0.0405**		
				(6.14)		
Log(UnvestedOptions)$_{t-1}$	+				**0.0124**	
					(4.60)	
Log(Delta)$_{t-1}$	?					0.0096
						(1.21)
Log(TotalComp)$_{t-1}$	?	**0.0185**	0.0055	-0.0041	0.0103	**0.0246**
		(1.73)	*(0.47)*	*(-0.43)*	*(1.04)*	***(2.36)***
Log(Sales)$_{t-1}$	+	**0.2311**	**0.2348**	**0.2327**	**0.2419**	**0.2403**
		(20.44)	***(20.80)***	***(19.83)***	***(20.74)***	***(19.78)***
R&D$_{t-1}$	+	**0.0084**	**0.0085**	**0.0146**	**0.0149**	**0.0151**
		(4.07)	***(4.14)***	***(3.53)***	***(3.42)***	***(3.41)***
ROA$_{t-1}$	+	-0.0596	-0.0542	**-0.1634**	**-0.1688**	**-0.1752**
		(-1.24)	*(-1.13)*	***(-2.57)***	***(-2.64)***	***(-2.59)***
TobinQ$_{t-1}$	+	**0.0327**	**0.0319**	**0.0399**	**0.0385**	**0.0401**
		(6.13)	***(6.07)***	***(6.30)***	***(6.19)***	***(5.90)***
Leverage$_{t-1}$	–	**-0.0471**	**-0.0447**	**-0.1542**	**-0.1617**	**-0.1642**
		(-2.08)	***(-2.05)***	***(-2.97)***	***(-3.13)***	***(-3.13)***
Year Effects				Included		
Industry Effects				Included		
Nb of Observations		32,524	32,524	30,541	30,607	29,459
Adj. R^2 (%)		26.79	26.85	28.19	27.82	27.77

Notes:
This table presents the results from the regression presented above and estimated using Huber-White robust standard errors clustered by firm. The sample covers fiscal years 1993-2011. *t*-statistics are in parenthesis below coefficient estimates. Bolded coefficient estimates and *t*-statistics are statistically significant (two-tailed p-values < 0.10). Year and industry effects are included but not reported for brevity. The dependent variable *Log(NbTrademarks)* is the natural logarithm of one plus the number of new product trademarks registered during the year. *OptionComp* is the CEO's annual stock option compensation, measured as the value of new stock options granted as a fraction of total compensation. *Log(Vega)* is the natural logarithm of one plus the CEO's sensitivity to stock return volatility, measured as the dollar change in the CEO's option portfolio for a 0.01 change in annualized standard deviation of stock returns. *Log(UnvestedOptions)* is the natural logarithm of one plus the CEO's unvested stock option holdings (in $K). *Log(Delta)* is the natural logarithm of one plus the CEO's sensitivity to stock price, measured as the dollar change in the CEO's stock and option portfolio for a one-percent change in stock price. *Log(TotalComp)* is the natural logarithm of the CEO's annual total compensation, measured as the sum of salary, bonus, other annual compensation, value of restricted stock granted, value of new stock options granted during the year, long-term incentive payouts, and all other compensation. *Log(Sales)*

is the natural logarithm of total sales. *R&D* is research and development expense divided by total sales (set as zero when R&D expense is missing in Compustat). *ROA* is return on assets, measured as earnings before extraordinary items and discontinued operations scaled by average total assets. *TobinQ* is the market value of total assets divided by the book value of total assets. *Leverage* is total liabilities divided by total assets. Industry grouping is based on the Fama-French (1997) 48-industry classification. To mitigate the influence of outliers, all variables are winsorized by year and industry at the 1st and 99th percentiles.

Table 5
CEO Incentives, New Product Trademarks and New Patents, by Subsets of Technology Intensive Industries

Panel A: CEO Incentives and New Product Trademarks, by Subsets of Technology Intensive Industries

$$Log(NbTrademarks)_{i,t} = \alpha + \beta_1 OptionComp_{i,t-1} + \beta_2 Log(TotalComp)_{i,t-1} + \beta_3 Log(Sales)_{i,t-1} + \beta_4 R\&D_{i,t-1} + \beta_5 ROA_{i,t-1} + \beta_6 TobinQ_{i,t-1} + \beta_7 Leverage_{i,t-1} + \sum \chi_j Year_j + \sum \delta_k Industry_k + \varepsilon_{i,t}$$

Variable	Expected Sign	Coefficient *(t-statistic)* Low-Tech Model I	Low-Tech Model II	Low-Tech Model III	Mid-Tech Model IV	Mid-Tech Model V	Mid-Tech Model VI	High-Tech Model VII	High-Tech Model VIII	High-Tech Model IX
$OptionComp_{t-1}$	+	**0.0810**			**0.1420**			0.0106		
		(1.72)			***(2.87)***			*(0.15)*		
$Log(Vega)_{t-1}$	+		**0.0277**			**0.0478**			**0.0501**	
			(2.99)			***(4.40)***			***(3.42)***	
$Log(UnvestedOptions)_{t-1}$				**0.0072**			**0.0158**			**0.0159**
				(1.82)			***(3.57)***			***(2.78)***
$Log(TotalComp)_{t-1}$	?	-0.0017	-0.0101	0.0017	0.0098	0.0048	0.0208	0.0169	-0.0077	0.0074
		(-0.10)	*(-0.69)*	*(0.11)*	*(0.56)*	*(0.33)*	*(1.40)*	*(0.60)*	*(-0.41)*	*(0.37)*
$Log(Sales)_{t-1}$	+	**0.2256**	**0.2218**	**0.2272**	**0.2255**	**0.2102**	**0.2218**	**0.2703**	**0.2697**	**0.2818**
		(11.90)	***(11.53)***	***(11.85)***	***(13.10)***	***(11.59)***	***(12.40)***	***(12.14)***	***(11.99)***	***(12.54)***
$R\&D_{t-1}$	+	**8.2141**	**7.6015**	**7.8577**	0.0841	0.0720	0.0759	**0.0088**	**0.0175**	**0.0178**
		(5.29)	***(5.57)***	***(5.92)***	*(1.58)*	*(1.60)*	*(1.61)*	***(3.98)***	***(3.49)***	***(3.38)***
ROA_{t-1}	+	-0.1550	-0.1777	-0.1397	-0.0789	-0.1704	-0.1802	**-0.1718**	**-0.2053**	**-0.2164**
		(-0.95)	*(-0.96)*	*(-0.75)*	*(-1.19)*	*(-1.57)*	*(-1.65)*	***(-2.30)***	***(-2.13)***	***(-2.22)***
$TobinQ_{t-1}$	+	**0.0592**	**0.0614**	**0.0562**	**0.0325**	**0.0444**	**0.0426**	**0.0208**	**0.0270**	**0.0267**
		(4.65)	***(4.68)***	***(4.30)***	***(4.19)***	***(3.75)***	***(3.70)***	***(3.12)***	***(3.36)***	***(3.30)***
$Leverage_{t-1}$	–	-0.0850	-0.0708	-0.0727	**-0.2260**	**-0.2414**	**-0.2519**	-0.0160	-0.0957	-0.1076
		(-0.90)	*(-0.66)*	*(-0.68)*	***(-3.53)***	***(-2.77)***	***(-2.89)***	*(-1.45)*	*(-1.13)*	*(-1.28)*
Year Effects						Included				
Industry Effects						Included				
Nb of Observations		10,745	10,105	10,125	12,800	11,953	11,983	8,979	8,483	8,499
Adj. R^2 (%)		24.75	25.44	25.18	24.60	25.77	25.56	28.63	29.58	29.49

Table 5 (cont'd)

Panel B: CEO Incentives and New Patents, by Subsets of Technology Intensive Industries

$$Log(NbPatents)_{i,t} = \alpha + \beta_1 OptionComp_{i,t-1} + \beta_2 Log(TotalComp)_{i,t-1} + \beta_3 Log(Sales)_{i,t-1} + \beta_4 R\&D_{i,t-1} + \beta_5 ROA_{i,t-1} + \beta_6 TobinQ_{i,t-1} + \beta_7 Leverage_{i,t-1} + \sum \chi_j Year_j + \sum \delta_k Industry_k + \varepsilon_{i,t}$$

Variable	Expected Sign	Coefficient (*t-statistic*)								
		Low-Tech			Mid-Tech			High-Tech		
		Model I	Model II	Model III	Model IV	Model V	Model VI	Model VII	Model VIII	Model IX
OptionComp$_{t-1}$	+	0.0108 *(0.47)*			**0.1513** ***(2.08)***			**0.2179** ***(1.66)***		
Log(Vega)$_{t-1}$	+		0.0041 *(1.02)*			0.0238 *(1.30)*			**0.1776** ***(5.88)***	
Log(UnvestedOptions)$_{t-1}$				0.0026 *(1.53)*			-0.0083 *(-1.09)*			**0.0516** ***(4.14)***
Log(TotalComp)$_{t-1}$	?	-0.0125 *(-1.47)*	**-0.0150** ***(-2.14)***	**-0.0155** ***(-2.00)***	-0.0142 *(-0.51)*	-0.0082 *(-0.36)*	0.0241 *(1.00)*	**0.2305** ***(4.20)***	**0.1256** ***(3.09)***	**0.1992** ***(4.59)***
Log(Sales)$_{t-1}$	+	**0.0500** ***(6.01)***	**0.0497** ***(5.96)***	**0.0503** ***(6.06)***	**0.4144** ***(13.15)***	**0.4114** ***(12.18)***	**0.4156** ***(12.83)***	**0.7305** ***(17.45)***	**0.7048** ***(17.61)***	**0.7404** ***(18.91)***
R&D$_{t-1}$	+	**18.4673** ***(3.16)***	**19.3507** ***(2.96)***	**19.4181** ***(2.96)***	**4.1445** ***(6.95)***	**4.2507** ***(6.19)***	**4.3181** ***(6.26)***	**0.4908** ***(5.93)***	**0.4846** ***(5.70)***	**0.4941** ***(5.60)***
ROA$_{t-1}$	+	-0.1251 *(-0.99)*	-0.1404 *(-1.04)*	-0.1386 *(-1.03)*	0.1829 *(0.93)*	-0.1371 *(-0.69)*	-0.1228 *(-0.62)*	**-1.4762** ***(-6.24)***	**-1.6390** ***(-6.58)***	**-1.6652** ***(-6.58)***
TobinQ$_{t-1}$	+	0.0148 *(1.19)*	0.0145 *(1.18)*	0.0133 *(1.08)*	**0.0737** ***(5.33)***	**0.1044** ***(6.40)***	**0.1045** ***(6.39)***	**0.0808** ***(5.57)***	**0.0882** ***(5.33)***	**0.0854** ***(5.11)***
Leverage$_{t-1}$	–	-0.0763 *(-1.63)*	-0.0753 *(-1.46)*	-0.0766 *(-1.49)*	**-0.5895** ***(-5.15)***	**-0.5762** ***(-4.52)***	**-0.5762** ***(-4.56)***	**-0.9961** ***(-5.71)***	**-1.0025** ***(-5.28)***	**-1.0453** ***(-5.45)***
Year Effects						Included				
Industry Effects						Included				
Nb of Observations		9,069	8,529	8,546	10,547	9,850	9,876	7,542	7,145	7,158
Adj. R^2 (%)		9.05	9.07	9.07	39.14	40.09	40.07	50.24	52.11	51.52

Table 5 (cont'd)

Notes:

This table presents the results from the regression presented above and estimated using Huber-White robust standard errors clustered by firm. The sample covers fiscal years 1993-2011 in Panel A and 1993-2008 in Panel B. *t*-statistics are in parenthesis below coefficient estimates. Bolded coefficient estimates and *t*-statistics are statistically significant (two-tailed p-values < 0.10). Year and industry effects are included but not reported for brevity. In both panels, Models I to III (Models VII to IX) present the results for a subset of firm-year observations in low-tech (high-tech) industries, and Models IV to VI present the results for a subset of firm-year observations in the remaining industries. Low-tech (high-tech) technology intensive industries are the industries with less (more) than 0.5 (20) patents per firm-year, on average. In Panel A, the dependent variable *Log(NbTrademarks)* is the natural logarithm of one plus the number of new product trademarks registered during the year. In Panel B, the dependent variable *Log(NbPatents)* is the natural logarithm of one plus the number of new patents filed during the year. *OptionComp* is the CEO's annual stock option compensation, measured as the value of new stock options granted as a fraction of total compensation. *Log(Vega)* is the natural logarithm of one plus the CEO's sensitivity to stock return volatility, measured as the dollar change in the CEO's option portfolio for a 0.01 change in annualized standard deviation of stock returns. *Log(UnvestedOptions)* is the natural logarithm of one plus the CEO's unvested stock option holdings (in $K). *Log(TotalComp)* is the natural logarithm of the CEO's annual total compensation, measured as the sum of salary, bonus, other annual compensation, value of restricted stock granted, value of new stock options granted during the year, long-term incentive payouts, and all other compensation. *Log(Sales)* is the natural logarithm of total sales. *R&D* is research and development expense divided by total sales (set as zero when R&D expense is missing in Compustat). *ROA* is return on assets, measured as earnings before extraordinary items and discontinued operations scaled by average total assets. *TobinQ* is the market value of total assets divided by the book value of total assets. *Leverage* is total liabilities divided by total assets. Industry grouping is based on the Fama-French (1997) 48-industry classification. To mitigate the influence of outliers, all variables are winsorized by year and industry at the 1st and 99th percentiles.

Table 6
Changes in CEO Stock Option Compensation
and Changes in New Product Trademarks around SFAS 123(R)

Panel A: Univariate Analysis

	Three-Year Average Pre-SFAS 123(R)		Three-Year Average Post-SFAS 123(R)		Post vs. Pre *p*-value of Difference	
Variable	Mean	Median	Mean	Median	Mean	Median
All (N=1,552)						
Log(NbTrademarks)	0.6660	0.3662	0.7006	0.3662	0.26	0.73
OptionComp	0.3325	0.3114	0.1993	0.1696	<0.01	<0.01
Log(TotalComp)$_t$	7.8909	7.8780	8.0840	8.1273	<0.01	<0.01
Log(Sales)	7.1486	7.0569	7.5389	7.4826	<0.01	<0.01
R&D	0.1363	0.0000	0.0641	0.0000	0.30	0.89
ROA	0.0377	0.0388	0.0313	0.0390	0.21	0.73
TobinQ	1.8736	1.4519	1.7450	1.4149	<0.01	<0.01
Leverage	0.5618	0.5475	0.6011	0.5745	0.09	0.01
OptionComp Decrease (N=1,051)						
Log(NbTrademarks)	0.6978	0.3662	0.7278	0.3662	0.44	0.54
OptionComp	0.4151	0.3953	0.1654	0.1398	<0.01	<0.01
Log(TotalComp)$_t$	8.0286	8.0047	8.1042	8.1440	0.08	0.01
Log(Sales)	7.1434	7.0672	7.5375	7.4599	<0.01	<0.01
R&D	0.1840	0.0000	0.0632	0.0000	0.24	0.83
ROA	0.0359	0.0365	0.0291	0.0389	0.32	0.98
TobinQ	1.9107	1.4762	1.7622	1.4476	0.01	<0.01
Leverage	0.5527	0.5417	0.6076	0.5705	0.10	0.01
OptionComp Increase (N=383)						
Log(NbTrademarks)	0.6626	0.3662	0.7197	0.3662	0.35	0.97
OptionComp	0.2082	0.1803	0.3536	0.3409	<0.01	<0.01
Log(TotalComp)$_t$	7.7687	7.7430	8.2575	8.2629	<0.01	<0.01
Log(Sales)	7.2769	7.2131	7.6659	7.6225	<0.01	<0.01
R&D	0.0425	0.0000	0.0823	0.0000	0.35	0.94
ROA	0.0407	0.0427	0.0340	0.0386	0.38	0.69
TobinQ	1.8185	1.4322	1.7375	1.3967	0.28	0.27
Leverage	0.5976	0.5718	0.6022	0.5920	0.79	0.63

Table 6 (cont'd)

Panel B: Regression Analysis

$$\Delta Log(NbTrademarks)_i = \alpha + \beta_1 \Delta OptionComp_i + \beta_2 \Delta Log(TotalComp)_i + \beta_3 \Delta Log(Sales)_i + \beta_4 \Delta R\&D_i + \beta_5\ \Delta ROA_i + \beta_6\ \Delta TobinQ_i + \beta_7\ \Delta Leverage_i + \varepsilon_i$$

Variable	Expected Sign	Coefficient (*t-statistic*)		
		All	*OptionComp* Decrease	*OptionComp* Increase
		Model I	Model II	Model III
Intercept	?	-0.0040	0.0258	**-0.1162**
		(-0.19)	*(0.75)*	***(-2.03)***
ΔOptionComp	+	**0.1344**	**0.1629**	**0.4207**
		(2.24)	***(1.70)***	***(1.97)***
ΔLog(TotalComp)	?	-0.0151	-0.0175	-0.0159
		(-0.80)	*(-0.79)*	*(-0.32)*
ΔLog(Sales)	+	**0.1475**	**0.1170**	**0.2977**
		(4.99)	***(3.18)***	***(4.53)***
ΔR&D	+	0.0102	0.0100	**0.0353**
		(1.01)	*(0.78)*	***(1.80)***
ΔROA	+	-0.0876	-0.0783	-0.1310
		(-1.38)	*(-1.19)*	*(-0.56)*
ΔTobinQ	+	-0.0110	-0.0018	-0.0138
		(-0.68)	*(-0.09)*	*(-0.41)*
ΔLeverage	–	0.0355	0.0244	0.0755
		(0.86)	*(0.46)*	*(0.55)*
Nb of Observations		1,552	1,051	383
Adj. R^2 (%)		1.78	1.17	5.35

Notes:
This table presents univariate results (Panel A) and regression results (Panel B) of changes in CEO stock option compensation and changes in trademark registration around the adoption of SFAS 123(R). The sample consists of 1,552 distinct firms. For each variable, we calculate i) the three-year average pre-SFAS 123(R) and ii) the three-year average post-SFAS 123(R). For *Log(NbTrademarks)*, the pre(post)-SFAS 123(R) period corresponds to fiscal years 2003-2005 (2007-2009), whereas for all other variables, the pre(post)-SFAS 123(R) period corresponds to fiscal years 2002-2004 (2006-2008). Panel A presents univariate results, with comparisons and results of *t*-tests (Wilcoxon rank-sum tests) of mean (median) differences for each variable. For Panel B, we calculate the difference between ii) and i). *t*-statistics are in parenthesis below coefficient estimates. Bolded coefficient estimates and *t*-statistics are statistically significant (two-tailed p-values < 0.10). Model II (III) includes only firm observations with decreases (increases) in *OptionComp* around the adoption of SFAS 123(R). *Log(NbTrademarks)* is the natural logarithm of one plus the number of product trademarks registered during the year. *OptionComp* is the CEO's annual stock option compensation, measured as the value of new stock options granted as a fraction of total compensation. *Log(TotalComp)* is the natural logarithm of the CEO's annual total compensation, measured as the sum of salary, bonus, other annual compensation, value of restricted stock granted, value of new stock options granted during the year, long-term incentive payouts, and all other compensation. *Log(Sales)* is the natural logarithm of total sales. *R&D* is research and development expense divided by total sales (set as zero when R&D expense is missing in Compustat). *ROA* is return on assets, measured as earnings before extraordinary items and discontinued operations scaled by average total assets. *TobinQ* is the market value of total assets divided by the book value of total assets. *Leverage* is total liabilities divided by total assets. Industry grouping is based on the Fama-French (1997) 48-industry classification. To mitigate the influence of outliers, all variables are winsorized by industry at the 1st and 99th percentiles.