CEOs with Innovative Ability

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August 10, 2018 draft

Abstract

This paper studies if and how CEOs with innovative ability affect a firm's innovation, corporate policies and firm value. Using a sample of 2,134 U.S. public firms and 3,952 CEOs from 1992 to 2008 for all industries, I find that innovator CEOs who have at least one patent can spur firm innovation but pose agency problems to the firm. Specifically, firms with innovator CEOs spend more on R&D projects but with lower efficiency compared to firms with non-innovator CEOs, suggesting that innovator CEOs have overinvestment problems. These overinvestment problems are recognized by the stock market. A CEO's innovative ability has a negative impact on the announcement date stock return of hiring a new innovator CEO. Also, firms with innovator CEOs hold more cash compared to firms with non-innovator CEOs but the cash value is lower.

1. Introduction

In the last 50 years, many successful businesses have been led by creative genius entrepreneurs. For example, Bill Gates, the co-founder and former CEO of Microsoft, has nine patents to his name and recently filed a patent application.[1] Steve Jobs founded Apple in 1976 and filed his first patent in 1980, titled simply "Personal Computer." His last patent was the design of the iconic glass cube at the entrance to Apple's store on Manhattan Fifth Avenue.[2] When Steve Jobs died in 2011, Tim Cook became the CEO of Apple. Since Cook does not have any patents, some Apple investors and journalist, Yukari Iwatani Kane, have questioned if Apple will still be successful.[3] Yet, since Jobs' death, Apple's stock has increased approximately 200%. This example begs the question, does CEO innovation and creativity influence the innovation and performance of the company? Further, how do such effects ultimately impact corporate policies and firm value? This paper examines these questions.

Innovation has long been recognized as important because innovation plays a critical role in promoting economic growth (Solow, 1957) and increases the probability of a firm's survival (Cefis and Marsili, 2006). Since the CEO is the most important person in an organization (Ireland and Hitt, 1999) and research and development (R&D) spending is one of the most fundamental investment decisions made by firms (Barker and Mueller, 2002), it follows that motivating the CEO to pursue firm innovation is an important area of research. Literature shows that extrinsic motivations of a CEO pursuing firm innovation, such as standard pay-for-performance contracts, do not encourage innovation in a firm (Manso, 2011), and performance-contingent financial incentives can even inhibit innovation (Ariely, Gneezy and Loewenstein, 2009; Hellmann and Thiele, 2011; Ederer and Manso, 2013). However, intrinsic motivations of CEOs pursuing firm innovation, such as their age, education and tenure, can foster innovation in a firm (Barker and Mueller, 2002; Wu, Levitas and Priem, 2005). A large literature in

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[1] https://www.geekwire.com/2017/bill-gates-intellectual-ventures-attempt-patent-high-tech-football-helmet/
[2] https://www.technologyreview.com/s/532841/steve-jobs-lives-on-at-the-patent-office/
[3] Yukari Iwatani Kane questioned if Apple will still be successful in her book: Haunted Empire: Apple after Steve Jobs.

economics of science shows that people are attracted to pursue innovation by the explicit economic incentives, but by their intrinsic motivation, such the personal taste for science and the intellectual challenge associated with scientific work (e.g., Sauermann and Cohen, 2010). Sunder, Sunder and Zhang (2017) examine the intrinsic motivations by looking at the role of the CEO's personality traits of sensation-seeking on firm's innovation. They find that CEOs with pilot licenses are associated with more firm innovation.

To examine the effects of a CEO's innovative ability on a firm's innovation, I use patents and citations to measure a CEO's innovative ability. Using a sample of 2,134 U.S. public firms and 3,952 CEOs from 1992 to 2008 from all industries, I find that firms with innovator CEOs who have at least one patent experience more innovation compared to firms with non-innovator CEOs, and that CEOs with greater innovative ability spur more innovation to firms. Further, innovator CEOs generate greater firm innovation in innovative industries relative to non-innovative industries. However, innovator CEOs spur firm innovation only when CEOs' innovation is useful for the firm. That is, a CEO's innovative ability impacts firm's innovation only when the CEO's patent and the firm belong to the same industry classification.

However, such characteristics that benefit corporate innovation may not be without a cost. Prior research finds that a CEO's personal characteristics can lead to distortions in corporate investment policies (Malmendier and Tate, 2005a; Malmendier and Tate, 2005b), overinvestment problems (Campbell, Gallmeyer, Johnson, Rutherford and Stanley, 2011) or value-destroying investments (Goel and Thakor, 2008). If CEOs with innovative ability have passion and interests in investing in innovation, they might pursue their own interests and overinvest in R&D projects. Agency theory also suggests that CEOs may overinvest to build excessive empires (Jensen and Meckling, 1976; Jensen 1986) and entrench themselves (Shleifer and Vishny, 1989) if they pursue their own interests. Bebchuk and Stole (1993) build a theoretical model and assume that the market has incomplete information about the investment returns. They find that since the investors can observe the level of investments when managers signal the market,

overinvestment will occur in the firms. Therefore, CEOs with innovative ability may be more likely to signal investment opportunities to the market, and firms led by innovative CEOs are more likely to have overinvestment problems.

I further study the overinvestment problems that are brought by innovator CEOs. First, I find that firms with innovator CEOs spend more on R&D projects, but this R&D funding is used less efficiently than firms with non-innovator CEOs. Second, I examine the abnormal return around the announcement of a new CEO to examine the market's net assessment of CEOs with innovative experience. I find that, at the announcement date of hiring a new innovator CEO, the CEO's innovative ability has a negative impact on the stock market reaction. These results are consistent with agency theory that innovator CEOs have overinvestment problems. To examine how these agency conflicts are manifested in other corporate policies, I further examine the level of cash holding and the value of cash holdings for firms with innovator CEOs.[4] Here, I find that firms led by innovator CEOs hold more cash than firms led by non-innovator CEOs but the cash value is lower. Overall, the results suggest that while innovator CEOs spur greater firm innovation, they also tend to overinvest in innovation. My results are robust to the alternative firm innovation measure, and alternative CEO ability measures, such as CEO's past industry working experience and CEO's general ability index.

One significant concern with looking at CEOs with innovative ability is that innovative firms are more likely to hire CEOs with greater innovative ability, which begs the question of whether the results are driven not by CEOs' innovative ability itself, but other omitted characteristics that are associated with innovative firms themselves. To deal with this endogeneity, I employ three methods. First, I use two-stage least square (2SLS) regression with the CEO coauthors' ability as an instrumental variable. The CEO coauthors' ability is a valid instrumental variable since the CEO coauthors' ability is related to a CEO's innovative ability and affects firm's innovation only through the CEO's innovative ability. Second, I

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[4] Cash value captures the value that shareholders place on an extra dollar of cash held by firms.

apply a difference-in-difference methodology using CEO exogenous turnover as a shock. Third, I use the propensity score matching method. Regardless of the methodology used, results indicate that a CEO's innovative ability has a positive impact on firm's innovation.

This paper is related to two other papers: Makri and Scandura (2010) and Islam and Zein (2018). Makri and Scandura focus on 77 high-technology firms and test the effects of creative CEO leadership on innovation. They find that creative leadership has a positive impact on the quality and quantity of firm innovation. My paper differs from Makri and Scandura in two ways. First, my sample includes all the industries. Second, Makri and Scandura use CEO interviews and code information pertaining to leadership style, emphasizing developing social and human capital, as a proxy for CEO creative characteristics. This paper uses the number of patents and citations to directly quantify CEOs' innovative ability. Islam and Zein (2018) also define innovation using CEO patents. They emphasize the first-hand innovation experience of inventor CEOs and define "an inventor CEO" as one that has been awarded at least one patent. As well as defining innovator CEO in that way, I also focus on measuring the innovation ability of CEOs by counting patents and citations in each year, up to a given year or in the sample period. Further, like Makri and Scandura (2010), Islam and Zein (2018) only examine CEOs in the high-tech industry. Given that this paper samples all industries, I can examine if the effect of CEOs with innovation ability on firm's innovation is greater when the firms are in the industries that need innovation the most. Most importantly, Islam and Zein only study the effects of innovator CEOs on firm innovation. I add to their study by examining whether CEOs with innovative ability induce overinvestment problems in the firms and whether the stock market recognizes these problems.

This paper contributes to the literature in mainly three ways. First, this paper is complementary to a growing body of literature that explores the effects of CEOs on corporate innovation. Barker and Mueller (2002) study the impact of CEO characteristics on firm's R&D spending; Custodio, Ferreira and Matos (2017) investigate whether general managerial skills spur innovation; Galasso and Simcoe (2011) study CEO overconfidence and firm innovation; and Sunder, Sunder and Zhang (2017) examine the effect

of CEO sensation seeking on firm innovation. I add to this literature by showing that CEOs' innovative ability is a significant driver of corporate innovation, albeit at the cost of overinvestment, reduced innovative efficiency, and excessive cash holdings.

Second, this paper also complements the literature that studies the impact of CEO characteristics on the distortions in corporate investment decisions (Malmendier and Tate, 2005a; Malmendier and Tate, 2005b; Campbell, Gallmeyer, Johnson, Rutherford and Stanley, 2011; Goel and Thakor, 2008). Weisbach (1995) examines the impact of CEO turnover on firm's investment decisions; Bebchuk and Stole (1993) study CEO investment decisions in the presence of imperfect information; and Malmendier and Tate (2005a) investigate the effect of CEO overconfidence on corporate investment. I show that CEOs' innovative ability and intrinsic incentives for innovation can also distort corporate investments. Third, this paper uses a new proxy of CEO's ability that can affect firm's innovation: CEO patents and citations. This new proxy is a more direct and effective measure of a CEO's innovative ability compared to the current proxies (e.g. CEO's education and general ability index (Custodio, Ferreira and Matos, 2017)).

2. Hypotheses development

Ever since Schumpeter (1911), one of the most influential economists of the 20th century, proposed that technological innovation is the cause of economic growth, the effect of innovation on firms' performance has been studied extensively (Pakes, 1985; Austin, 1993; Nicholas, 2008; Kogan, Papanikolaou, Seru and Stoffman, 2017). For example, Hall, Jaffe and Trajtenberg (2005) find that innovation, measured by patents and citations, significantly positively affects the firm's market value and one extra citation of a patent increases the firm market value by three percent.

In addition to the importance of innovation on the firm's performance, researchers document that innovation is affected by stock liquidity (Fang, Tian and Tice, 2014), shareholder protection laws (Brown, Martinsson and Petersen, 2013), antitakeover laws (Atanassov, 2013), banking competition (Cornaggia, Mao, Tian and Wolfe, 2015), corporate venture capital (Chemmanur, Loutskina and Tian, 2014), analyst

coverage (He and Tian, 2013) and institutional ownership (Aghion, Van Reenen and Zingales, 2013). However, innovative work is person centered (Mumford, Scott, Gaddis and Strange, 2002). Innovative people, the most direct influence of firm's innovation, are seldom studied. Moreover, innovative work often needs collaboration among people (Abra, 1994; Cagliano, Chiesa and Manzini, 2000) and interaction between employees and leaders (Pelz, 1963; Tierney, Farmer and Graen, 1999).[5] Furthermore, Mumford, Marks, Connelly, Zaccaro and Reiter-Palmon (2000) point out that organizational leaders must appraise the works of innovative people. It would be difficult to evaluate the innovative ideas if the leader lacks expertise or creative skills (Mumford, Scott, Gaddis and Strange, 2002). Therefore, the CEO, the leader of the organization and in charged with motivating employees and driving changes within the organization, with innovative ability will improve a firm's innovation.

Hypothesis 1: A CEO's innovative ability has a positive effect on the firm's innovation.

Mumford (2000) and Redmond, Mumford and Teach (1993) find that CEOs play a key role on helping innovative people in the firm meet organizational needs and goals, and further CEO expertise and innovative skills are more important when the firm's tasks become more complex (Mumford, Scott, Gaddis and Strange, 2002). Thus, the effect of CEOs with innovative ability on firm's innovation and performance should be larger on firms that need CEOs with innovative ability the most. Moreover, Brown, Fazzari and Peterson (2009) document that the young high-tech industry accounts for about 75% of the entire U.S. R&D boom, indicating the importance of innovation to high-tech industry.

Hypothesis 2: The effect of a CEO's innovative ability is larger on the innovative industry compared to the less innovative industry.

According to agency theories, when CEOs pursue their own interests, the CEOs will overinvest to build excessive empires (Jensen and Meckling, 1976; Jensen 1986). Also, CEOs are interested in

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[5] Specifically, Tierney, Farmer and Graen (1999), focusing on 191 R&D employees of a large chemical company, find that the interactions between employee intrinsic motivation and leader intrinsic motive is related to employee creative performance.

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investments that require their own specific skills, and making such investments can entrench them since it is costly for shareholders to replace them (Shleifer and Vishny, 1989). Xuan (2009) also finds that firms with specialist CEOs have a lower investment efficiency.[6] Therefore, firms with innovator CEOs might have a lower innovation efficiency.

Hypothesis 3: Firms led by innovator CEOs have a lower innovation efficiency.

Innovation is a factor that drives a firm's stock price (Pakes, 1985; Austin, 1993; Nicholas, 2008; Hall, Jaffe, and Trajtenberg, 2005). Useche (2014) focuses on the European and US software industry and finds a positive relation between patent applications before IPO and IPO performance. Patel and Ward (2011) find that firms experience positive abnormal stock returns when patents are granted. If a CEO with innovative ability can increase the firm's innovation, the firm should have a positive stock return when the firm hires a new CEO with innovative ability. However, if the market recognizes the innovator CEO might have overinvestment problems (Jensen and Meckling, 1976; Jensen 1986), the stock return on announcing hiring a new innovator CEO might be negative.

Hypothesis 4a: CEOs with innovative ability positively impact the stock abnormal return on the announcement date of hiring a new innovator CEO.

Hypothesis 4b: CEOs with innovative ability negatively impact the stock abnormal return on the announcement date of hiring a new innovator CEO.

The value of holding cash is to allow a firm to undertake valuable projects when they are available (Almeida, Campello, and Weisbach, 2004; Han and Qiu, 2007). Since firms with innovator CEOs are more likely to invest in R&D projects (Makri and Scandura, 2010), I expect firms led by innovator CEOs to hold more cash compared to firms led by non-innovator CEOs. Moreover, since holding more cash can allow CEOs to invest in projects that offer non-pecuniary benefits but jeopardize

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[6] Xuan (2009) study the job histories of CEOs and define a specialist CEO as a CEO advanced through the ranks from certain divisions in the firm.

shareholder's value (Jensen and Meckling, 1976), according to agency theory, I expect firms with innovator CEOs to hold more cash but have a lower cash value compared to firms with non-innovator CEOs.

Hypothesis 5: Firms led by innovator CEOs hold more cash compared to firms led by non-innovator CEOs but have a lower cash value.

3. Sample Construction, Variable Measurements and Summary Statistics

3.1 Sample Construction

The data is collected from several difference sources. CEO characteristics are from ExecuComp, which provides names, title, and compensation related information for S&P 1500 firms starting from 1992. Firm financial information is from Compustat, stock returns are from Center for Research in Security Prices (CRSP), and firm patent data is provided by Kogan, Papanikolaou, Seru and Stoffman (2017) from 1975 to 2010. According to Hall, Jaffe, Trajtenberg (2001), there is a 2-year lag on average between a patent's application date and grant date with patents being granted eventually. Since the actual timing of innovation is closer to the date of application, I use the application year as the relevant year to match this patent dataset with other datasets and end my sample period in 2008. As a result, my sample period is from 1992 to 2008.

Following many existing studies on innovation (e.g. Sunder, Sunder and Zhang, 2017), I exclude financial and utilities firms. I then include all the other industries where the average number of patents per firm is at least one. This restriction allows the sample to include firms with zero patents but at the same time excludes industries where innovation is not relevant. The resulting sample includes 2,134 firms and 3,952 CEOs from 1992 to 2008.

3.2 Variable Measurements

This subsection defines the independent variable, dependent variable and control variables. A detailed summary of variable definitions is provided in the Appendix.

3.2.1 Measuring CEOs' Innovative Ability

To identify innovator CEOs, I first obtain a list of CEO names from ExecuComp database, which includes the top paid executives of S&P 1500 firms. Then, I merge CEOs' names with patent inventors' names by their first, middle and last name. The data for patent inventors comes from Harvard Business School (HBS) patenting database constructed by Li, Lai, D'Amour, Doolin, Sun, Torvik, Amy and Fleming (2014). HBS patenting database provides unique identifiers (variable: Invnum_N) for each patent's inventors from 1975 through 2010. Although CEO's name is matched to inventor's name, there is still a possibility that the CEO and the inventor are not the same person but just have the same name. In some cases, the CEO's name can be matched to several unique inventors because of the same name. Therefore, I hand collect biographical information to ensure I am accurately matching CEOs with inventors.

The HBS patenting database contains inventor's patent assignee names, and ExecuComp contains CEO's company name. If the inventor's patent assignee name and CEO's company name are the same, it is a one-to-one match, and I identify the patent inventor and the CEO as the same person. If the inventor's patent assignee name and CEO's company name are not the same, it is not a one-to-one match. In this case, I search for the CEO's biographical information on the internet.[7] If the CEO's past working company name is the same as the inventor's patent assignee name, then I identify the patent inventor and the CEO as the same person. Sometimes, the CEO's biography directly indicates that the CEO invented patents. In that case, I identify the CEO as the patent inventor even though the CEO never worked for the

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[7] I first look up the websites providing the most credible and accurate information about the CEO. The first type of websites is the company website, Bloomberg CEO Biography and Wikipedia. If the CEO's biography cannot be found on those websites, I will go to other website to find CEO biography. For example, Notable Names Data Base, news information, LinkedIn, news information and Forbes website.

patent assignee.[8] Using this process, my sample has 340 CEOs who are patent inventors (innovator

CEOs) and 3,612 CEOs who are not patent inventors.[9]

Since HBS patenting database provides design patents as well as utility patents and each patent's

citations,[10] I construct eight metrics to measure CEOs' innovative ability in order to measure the quantity

and quality of their innovative ability. The first measure (variable: Innovator CEO) is a dummy variable

equal to one if the CEO had any patents during 1975 to 2010.[11] Based on this measure, there are 340

innovator CEOs in the sample. The second measure (variable: CEO patent) counts the number of patents

the CEO applied for in a given year.[12] The third measure (variable: CEO citation) counts the number of

citations subsequently received by the patents applied for in a given year. Patent citations measure the

quality of the patent capturing the technology and economic importance. The fourth measure (variable:

CEO avg. citation) is the ratio of CEO citation to CEO patent in a given year. The second, third and

fourth measurements capture CEO's innovative ability in each year. However, CEOs' innovation ability

is also reflected by their past innovation record. When a new CEO is announced, the stock market valuing

the CEO's innovative ability will be based on the CEO's cumulative innovation record, not just one year.

Therefore, the fifth, sixth and seventh measurements of CEOs' innovation ability are cumulative

measures. The fifth measure (variable: CEO cumulative patent) is the cumulative number of patents up to

that year starting the year the first patent was applied for and the sixth measure (variable: CEO

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[8] This is because the inventor sold the patent to the assignee. Therefore, the patent belongs to the assignee but the inventor never worked for the assignee.

[9] I successfully identified 366 CEOs who are patent inventors, but after merging the CEOs database with other databases, only 340 innovator CEOs were left in the sample.

[10] The NBER patent database and Kogan, Papanikolaou, Seru and Stoffman (2017) dataset only provide utility patents. The NBER patent database provides inventor information only from 1975 to 1999 and does not provide inventor unique identifier. Kogan et al. dataset does not contain the patent inventors' information. According to U.S. Patent and Trademark Office (USPTO), "a utility patent protects the way an article is used and works, while a design patent protects the way an article looks". Specifically, the utility patent is a trademark protection that makes sure a person has full control over his or her invention. A design patent is used when a person creates a new design for an existing product.

[11] Even though my sample period is 1992 to 2008, the HBS patent database has information from 1975 to 2010. So if a CEO had a patent in 1985, I recognize this CEO as an innovator CEO.

[12] Patents applied for are generally granted with a two years lag. Thus, date of application is closer to the actual timing of innovation than the patent grant date (Hall, Jaffe and Trajtenberg, 2001).

cumulative citation) is the cumulative number of citations received by the patents up to that year starting the year the first patent was applied for. The seventh measure (variable: CEO cumulative avg. citation) is the ratio of CEO cumulative citation to CEO cumulative patent. The last measure (variable: CEO total avg. citation) is the ratio of CEO total citation over CEO total patent in the sample period. I only present the results using the first and seventh measures, innovator CEO and CEO cumulative average citation. The results of using the other measures are presented in the internet appendix.

3.2.2 Measuring Firm's Innovation

I measure firm innovation using data from Kogan et al. (2017),[13] which reports all utility patents issued by U.S. Patent and Trademark Office (USPTO). This patent database provides each patent assignee's CRSP unique identifier (variable: PERMNO), the citations received by each patent, the estimated value of the patent in nominal dollars, the patent's class, the application date and the grant date.

I use five metrics measuring the firm's patenting activity as proxies for the firm's innovation productivity. The first measure (variable: Firm patent) is a simple count of the number of patents the firm applied for in a given year. In order to capture the variation of the patent's technology importance, the second measure (variable: Firm citation) counts the number of citations subsequently received by the patents that the firm applied for in a given year. I log the first two measures due to the skewness distribution. The third measure (variable: Firm avg. citation) is the ratio of firm citation over firm patent in a given year.

In order to further capture the variation of the patent's technology importance and adjust for citation truncation lags (Hall, Jaffe, Trajtenberg, 2005), I follow Kogan et al (2017) to construct the fourth measure (variable: Citation-weighted firm innovation) using this metric,

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[13] HBS patent database does not provide patent assignee's CRSP unique identifier (PERMNO).

$$\omega_{i,t} = \sum_{j \in P_{i,t}} \left(1 + \frac{C_j}{\overline{C_j}} \right), \quad (1)$$

where $\overline{C_j}$ is the average number of citations received by the patents that were granted in the same year as patent j, C_j is the number of citation received by patent j, $P_{i,t}$ is the set of patents issued to firm i in year t, and $\omega_{i,t}$ is the sum of the weight of citations on each patent plus one for firm i in time t. Since $\omega_{i,t}$ is increasing in firm size (Kogan et al., 2017), $\omega_{i,t}$ is scaled by book assets,

$$W_{i,t}^{cw} = \frac{\omega_{i,t}}{B_{i,t}}, \quad (2)$$

where $B_{i,t}$ is book assets of firm i in year t, and $W_{i,t}^{cw}$ is the citation-weighted innovation for firm i firm in time t.

Citations value the scientific contribution of the patents but not necessarily the value added by the patents. For example, a firm invents a patent that generates only a few citations, but that patent restricts the development of its competitors. The patent will have a large value impact. Thus, the last measure of firm innovation (variable: Market-value firm innovation) uses the patents' private economic value. Following Kogan at el. (2017), market-value firm innovation is constructed using the stock market response to news about the patents.[14] The total dollar value of innovation produced by firm i in year t is equal to the sum of all the values of patents j granted to that firm,

$$\theta_{i,t} = \sum_{j \in P_{i,t}} x_j, \quad (3)$$

where x_j is the dollar value of patent j, and $\theta_{i,t}$ is the total dollar value of patents applied by firm i in year t. Similar to citation-weighted firm innovation, market-value firm innovation is standardized by book assets,

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[14] Kogan at el. (2017) provides the dollar value of each patent based on the stock market response to news about the patents.

$$W_{i,t}^{mv} = \frac{\theta_{i,t}}{B_{i,t}} \ , (4)$$

where $W_{i,t}^{mv}$ is the market-value firm innovation.

3.2.3 Control Variables

In order to investigate the effect of an innovator CEO on firm's innovation, other factors that would affect a firm's innovation must be controlled. In the regression, I control for time-varying firm characteristics and CEO specific variables. Following the innovation literature, controls include firm size, defined as the nature logarithm of total assets, capital intensity, defined as the nature logarithm of the ratio of net property, plant, and equipment divided by the number of employees, stock return, defined as the firm's buy-and-hold return over the fiscal year, and Tobin's Q, defined as the natural log of the ratio of market value of assets to book value of assets.

CEO specific variables include CEO tenure, defined as the number of months a CEO is in the firm, CEO age in years, the delta of the CEO's stock and option portfolio (a proxy for CEO pay-performance sensitivity) and the vega of the CEO's stock and option portfolio (a proxy for CEO risk taking incentives). The calculation method for delta and vega is proposed by Core and Guay (2002), and the data for delta and vega is provided by Coles, Daniel and Naveen (2006). The delta is defined as the dollar change in CEO stock and option portfolio for 1% change in stock price, and the vega is defined as the dollar change in CEO option holdings for 1% change in stock return volatility. I also control for year fixed effects and industry fixed effects.[15] All control variables are lagged by one year.

3.3 Summary Statistics

Table 1 presents the distribution of innovator CEOs by year and by industry. Panel A displays the percentage of innovator CEOs in the sample by year. On average, 9.9% of CEOs in the sample are patent inventors. The percentage of innovator CEOs ranges from 6.8% (1993) to 11.7% (1999). The percentage

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[15] When I add firm fixed effects into the regression, the results remain the same.

of innovator CEOs is higher during the technology bubble period, suggesting firms in the technology industry are more likely to have innovator CEOs. Panel B tabulates the percentage of innovator CEOs by Fama and French 12 industry groups excluding financial firms and utilities.[16] Business equipment has the highest percentage of innovator CEOs (17.0%), followed by consumer durables (15.0%) and health (14.3%). Panel C shows the percentage of innovator CEOs in the sample by high-tech industry following the categorization in Loughran and Ritter (2004).[17] High-tech industries have 18.0% of innovator CEOs compared to 7.6% in non-high-tech industries.

[Insert Table 1 here]

Table 2 provides summary statistics of dependent variables and independent variables in the regressions. I divide the sample into two subsamples, non-innovator CEOs and innovator CEOs, and report the means, medians, and standard deviations for the variables used in the regressions.[18] T-tests (Wilcoxon-Mann-Whitney tests) are also conducted to test for differences between the means (medians) for firms with innovator CEOs and non-innovator CEOs. As expected, firms with innovator CEOs have more patents, citations, average citations per patent, citation-weighted firm innovation and market-value firm innovation than firms with non-innovator CEOs. The differences on mean and median are both statistically significant. Also, firms with innovator CEOs spend a higher proportion of R&D over total assets than firms with non-innovator CEOs.

Examining innovator CEO's innovative ability, I find that on average, innovator CEOs have 0.82 patents and 12.21 citations per year, and cumulative 9.86 patents and 260.14 citations up to a given year. Comparing the firm characteristics for firms led by innovator CEOs and those led by non-innovator

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[16] The Fama and French indsutries are defined in Fama's website.
http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html#Research
[17] In Loughran and Ritter (2004) appendix D, high-tech stocks are defined as those in SIC codes 3571, 3572, 3575, 3577, 3578 (computer hardware), 3661, 3663, 3669 (communications equipment), 3671,3672, 3674, 3675, 3677, 3678, 3679 (electronics), 3812 (navigation equipment), 3823,3825,3826,3827,3829 (measuring and controlling devices), 3841, 3845 (medical instruments), 4812, 4813 (telephone equipment), 4899 (communications services), and 7371, 7372, 7373, 7374, 7375, 7378, and 7379 (software).
[18] The summary statistics of dependent variables and independent variables in the regressions for the full sample are in the internet appendix Table 1A.

CEOs, I find that firms with innovator CEOs are smaller in size and have less capital intensity and higher Tobin's Q on average. There is no significant difference in stock return for firms with innovator CEOs and firms with non-innovator CEOs. Further, innovator CEOs have longer tenure, and higher delta and vega values in their compensation packages than non-innovator CEOs. There is no significant difference in inventor CEO age and non-inventor CEO age.

[Insert Table 2 here]

4. Innovator CEO and Firm Innovation

In this section, I first examine the effect of CEOs with innovative ability on firm innovation controlling for endogeneity problem. Then, I study the industry innovativeness. Next, I examine how innovator CEOs spur firm innovation and the innovation efficiency in the firm with innovator CEOs.

4.1 Patenting Activity

4.1.1 OLS results

Table 3 presents the effects of innovator CEOs on firm's innovation. The regression model follows:

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\begin{aligned}
Firm\ innovation_{i,t+1} \\
= \alpha_1 + \beta_1 CEO\ innovative\ ability_{i,t} + \beta_2 Log(assets)_{i,t} \\
+ \beta_3 Log\ (capital\ intensity)_{i,t} + \beta_4 Stock\ return_{i,t} + \beta_5 Tobin's\ Q_{i,t} \\
+ \beta_6 Log\ (1 + tenure)_{i,t} + \beta_7 CEO\ age_{i,t} + \beta_8 Log\ (1 + delta)_{i,t} \\
+ \beta_9 Log\ (1 + vega)_{i,t} + \gamma_k + \delta_t + \varepsilon_i, \qquad (5)
\end{aligned}
$$

where, $Firm\ innovation_{i,t+1}$, is measured by the five methods previously described, γ_k and δ_t are year fixed effects and industry fixed effects respectively. All other variables are as previously defined.

In Panel A, $CEO\ innovative\ ability_{i,t}$ is measured by *Innovator CEO,* which is a dummy variable equal to one if the CEOs had any patent between 1975 and 2010. I find that *Innovator CEO* is positively statistically significant related to firm's innovation measured in all five proxies. In Panel B, I find that if CEOs have higher innovative ability based on their previous average citations per patent, firms have a greater number of patents, citations, average citations per patent and citation-weighted firm innovation. The results suggest a positive relationship between CEOs' innovative ability and firm's innovation, supporting hypothesis one that firms led by innovator CEOs tend to have more innovation.[19]

Examining the control variables, I find that higher firm innovation is associated with bigger firms consistent with Sunder, Sunder and Zhang (2017). Furthermore, as in Hirshleifer, Low and Teoh (2012), I find that higher firm innovation is associated with firms with poor stock performance and high Tobin's Q. Vega values is generally positive consistent with Coles, Naveen and Naveen (2006). CEO age is negatively associated with firm innovation, suggesting that younger CEOs are better in innovation.

[Insert Table 3 here]

4.1.2. Endogeneity

If highly innovative firms are more likely to hire an innovator CEO, then β_1 in equation (5) is biased due to endogeneity. I control for endogeneity in two ways: 1) an instrument variable approach, and 2) propensity score matching.[20]

4.1.2.a 2SLS results

2SLS (two-stage least square) requires a selection of instrumental variables (IV). Successful IV candidates must satisfy two criteria. First, the IV must correlate with *CEO innovative ability*, and second,

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[19] The results of using the other six measures of a CEO's innovative ability are presented in internet appendix Table 2A. The results are consistent with hypothesis one.

[20] I also employ the difference-in-difference method by using an exogenous shock of CEO turnover to deal with the endogeneity issue. The results are presented in the internet appendix Table 5A. The results are consistent with hypothesis one.

the IV does not correlate with the error term in equation (5). In another words, the IV affects the firm's innovation only through *CEO innovative ability.* I construct an IV using the coauthor's information. *CEO coauthors' ability* is defined as CEO coauthors' average number of citations over average number of patents.[21] I do not include any patents that the CEO coauthors have with the innovator CEO in the calculation of the IV.[22] I choose *CEO coauthors' ability* as an IV since people with higher innovation ability are more likely to work with other people with higher innovative ability. To implement the IV approach, I estimate the following first-stage regression:

$$CEO\ innovative\ ability_{i,t}$$

$$= \alpha_1 + \beta_1 CEO\ coauthors'\ ability_i + \beta_2 Log(assets)_{i,t}$$

$$+ \beta_3 Log\ (capital\ intensity)_{i,t} + \beta_4 Stock\ return_{i,t} + \beta_5 Tobin's\ Q_{i,t}$$

$$+ \beta_6 Log\ (1 + tenure)_{i,t} + \beta_7 CEO\ age_{i,t} + \beta_8 Log\ (1 + delta)_{i,t}$$

$$+ \beta_9 Log\ (1 + vega)_{i,t} + \gamma_k + \delta_t + \varepsilon_i\ , \hspace{2cm} (6)$$

where $CEO\ coauthors'\ ability_i$ is firm i CEO coauthors' average citation to average patent. All other variables are as previously defined. I drop CEOs that are single authors for all the patents. Table 4 presents the first-stage results. I find that CEO coauthors' ability is significant positively related to CEO's innovative abilities in both Panels A and B.[23] Therefore, *CEO coauthors' ability* is a valid instrumental variable since *CEO coauthors' ability* is positively related to CEOs' innovative ability, and CEO coauthors' ability affects firm's innovation only through the CEO.[24]

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[21] CEO coauthors' average citation is defined as the average citation the coauthor has shared with other authors. CEO coauthors' average patent is defined as the average patent the coauthor shared with other authors.

[22] I also manually check 50 CEOs' coauthors and find that CEO coauthors and CEOs do not work in the same company. Therefore, CEO coauthors and CEOs working in the same company is very rare.

[23] The results of using the other six measures of a CEO's innovative ability are presented in internet appendix Table 3A. The results are consistent with Table 4.

[24] One concern regarding the IV maybe that CEOs' free ride and do not really coauthor the patent. To address with this concern, I calculate the frequency with which CEOs and coauthors collaborate. *Frequently collaborated coauthors* are the coauthors have more than one patent with the innovator CEO. The results using *frequently collaborated coauthors* are qualitatively similar to the results in Table 4 and available upon request.

The second-stage equation estimates the impact of the innovator CEO on the firm's innovation activity:

$Firm\ innovation_{i,t+1}$

$$= \alpha_1 + \beta_1 CEO\ \widehat{innovative\ ability}_{i,t} + \beta_2 Log(assets)_{i,t}$$

$$+ \beta_3 Log\ (capital\ intensity)_{i,t} + \beta_4 Stock\ return_{i,t} + \beta_5 Tobin's\ Q_{i,t}$$

$$+ \beta_6 Log\ (1 + tenure)_{i,t} + \beta_7 CEO\ age_{i,t} + \beta_8 Log\ (1 + delta)_{i,t}$$

$$+ \beta_9 Log\ (1 + vega)_{i,t} + \gamma_k + \delta_t + \varepsilon_i, \tag{7}$$

where $CEO\ \widehat{innovative\ ability}_{i,t}$ is the predicted values from equation (6). All other variables are as previously defined.

Table 4 reports the second stage regression results. The odd numbered columns show the results on the whole sample. The even numbered columns present the results including only innovator CEOs.[25] In Panels A, when a CEO's innovative ability is measured by a dummy variable, there is a significantly positive relation between the firm's innovation and the CEO's innovative ability, suggesting that firms led by innovator CEOs have a greater firm innovation compared to firms led by non-innovator CEOs. In Panel B, a CEO's innovative ability is measured by cumulative average citation. The first-stage results show a positive relation between CEO coauthors' ability and CEOs' innovative ability, consistent with the prediction that people with higher innovation ability are more likely to work with other people with higher innovative ability. The second-stage results show that CEOs' innovative ability has a positive impact on firm innovation for the whole sample and also for the sample only including innovator CEOs. Overall, the results are consistent with hypothesis one that CEOs with innovative ability have a positive effect on the firm's innovation.[26]

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[25] Since only the firms with innovator CEOs have a measured of CEO coauthors' ability, I also run regressions excluding firms led by non-innovator CEOs.

[26] The results of using the other six CEO innovative measures are presented in internet appendix Table 4A.

Consistent with prior literature, Table 4 shows that in general, firm innovation is associated with bigger firms, firms with lower stock return, higher Tobin's Q and younger CEO. I also find that in general lower delta value and higher vega value are associated with higher firm innovation consistent with Coles, Naveen and Naveen (2006).

[Insert Table 4 here]

4.1.2.b Propensity score matched samples

Second, I employ a propensity score matching procedure (Rosenbaum and Rubin, 1983) to deal with the endogeneity issue. This methodology allows me to construct a control sample of firms that are led by non-innovator CEOs and exhibit no observable differences in firm and CEO characteristics relative to the firms that are led by innovator CEOs. Therefore, if firm's innovation is different between the matched firms, the only reason can be due to the fact the innovator CEO.

To implement this methodology, I first calculate the probability (propensity score) from the logit regression to construct a nearest-neighbor matched sample for innovator CEOs using all the control variables in equation (5). In each year, I choose, with replacement, the non-innovator CEOs with propensity scores closest to those of each innovator CEO. After constructing the matched sample, I run OLS regression (equation (5)) controlling firm and CEO characteristics, year fixed effects and firm fixed effects. The results are presented in Table 5.[27] Results indicates that innovator CEOs increase firm innovation when measured by patents, citations, average citations per patent and citation-weighted firm innovation, suggesting that firms led by innovator CEOs experience a greater firm innovation compared to firms led by non-innovator CEOs. The results are the same whether there is one or two nearest matching firms.

[Insert Table 5 here]

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[27] The propensity score matching characteristics are presented in Table 6A.

4.2 Effect of Industry Innovativeness

I expect that the effect of an innovator CEO on firm's innovative outcomes should be larger for industries that need innovation the most. I split the sample into a more innovative industry and a less innovative industry two ways. First, I follow Loughran and Ritter's (2004) definition of high-tech industry and non-high-tech industry. In my sample, the high-tech industry has 717 innovator CEOs, and non-high-tech industry has 1087 innovator CEOs. The results are presented in Table 6 Panels A. I find that innovator CEOs are positively significantly related to firm innovation in both high-tech and non-high-tech industry. Specifically, the coefficients on *innovator CEO* for high-tech industry are smaller than for non-high-tech industry when firm innovation is measured by averaged citations per patent but greater when firm innovation is measured by citation-weighted and patent market-value. The results suggest that innovator CEOs are important for both the high-tech and the non-high-tech industry.[28]

Second, I follow Hirshleifer, Low and Teoh (2012) to identify industry innovativeness. Specifically, I identify an industry as an innovative industry if the average citation per patent for the industry is greater than the median average citation per patent across all industries, where industries are classified at the four-digit SIC level.[29] In my sample, the innovative industries have 1,704 innovator CEOs, and non-innovative industries have only 100 innovator CEOs. The results are presented in Table 6 Panel B. I find that the coefficients on *innovator CEO* for the innovative industry are larger and more significant than for the non-innovative industry. Specifically, when firm innovation is measured by average citation per patent, the coefficients on *innovator CEO* for the innovative industry are greater and more significant than for the non-innovative industry on both OLS and 2SLS regressions. When firm innovation is measured by citation-weighted firm innovation, the coefficients on *innovator CEO* are significant on both OLS and 2SLS regressions for the innovative industry but insignificant on 2SLS regression for the non-innovative industry. When firm innovation is measured by market-value firm

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[28] Islam and Zein (2018) study the effect of innovator CEOs on firm innovation only for high-tech industry.
[29] The results are robust to classify industries at the two-digit SIC level.

innovation, the coefficients on *innovator CEO* are significant for the innovative industry on OLS and 2SLS regressions but insignificant for the non-innovative industry. The results support hypothesis two that the effect of CEOs with innovative ability is greater on innovative industries compared to non-innovative industries.[30]

[Insert Table 6 here]

4.3 The usefulness of a CEO's innovative ability to the firm

Next, I examine why and how innovator CEOs spur firm innovation. Specifically, I ask the question: what kind of innovative ability can spur firm innovation? For example, if a firm led by an innovator CEO is in the high-tech industry and the innovator CEO has a patent in the health care industry, does this innovative ability spur the high-tech firm's innovation? I expect that if the innovator CEO's innovative ability is more useful for the firm, the effect of the innovator CEO on firm's innovation will be greater. In other words, if the CEO's patent technological classification is the same as the firm's, the CEO's innovative ability is useful for the firm and can spur more firm innovation.

I split my sample into two subsamples based on CEO patent classification for the technologies to which the patented inventions belong and the firm industry classification.[31] Patent technological classification is from USPTO and Hall et al. (2001).[32] I use Fama-French 12 industry classification as the firm industry classification. I manually matched patent technological classification and firm industry classification. Table 7 presents the results. I find that when a CEO's patent technological classification is

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[30] I also examine the effect of innovator CEOs on firm's innovation for the Fama-French 12 industry groups separately. Energy, utilities, Financial, Telecom and industries categorized as other industries are not included because of low patenting activities. The results are available upon request. Overall, I find that innovator CEOs have a positive impact on firm's innovation across all the industries.

[31] I also split the sample based on CEO patent technological classification and firm patent technological classification. I define firm's patent technological classification but do not count for the CEO's patent. The results remain the same and are available upon request.

[32] USPTO has developed 400 main patent technologies class and over 120,000 patent subclasses. Hall et al. (2001) have developed a higher-level classification and aggregated the 400 classes into 36 two-digit technological sub-categories. And these in turn further aggregated into 6 main categories: Chemical (excluding Drugs); Computers and Communications; Drugs and Medical; Electrical and Electronics; Mechanical; and Others.

the same as the firm industry classification, CEOs' innovative ability has a positive effect on firm average citation and citation-weighted innovation. However, when CEO patent technological classification is not the same as the firm industry classification, the positive coefficients on CEOs' innovative ability disappears after controlling for endogeneity. Surprisingly, the estimated coefficients on CEO's innovative ability are negatively significant when the firm's innovation is measured by patent market-value, suggesting that a CEO's innovative ability hurts the firm's innovation. This result is also in line with agency theory that innovator CEOs may have overinvestment problem (Jensen and Meckling, 1976) especially when CEOs' innovative ability is not useful for the firm. Overall, the results suggest that innovator CEOs can spur firm innovation only when their patent technological classification is the same as the firm industry classification. In other words, innovator CEOs can spur firm innovation only when the CEO's innovative ability is beneficial for the firm.

[Insert Table 7 here]

4.4 R&D Spending

I further study how innovator CEOs spur firm innovation by examining the R&D spending. If the innovator CEO values innovation for the firm, then they will invest more in innovative projects. Following Sunder et al. (2017), R&D spending is a measure of innovation input. R&D spending is calculated as the ratio of R&D spending to lagged total assets. If R&D spending is missing, the value is set to zero.

Table 8 displays the results from regressing CEOs' innovative ability on R&D spending. When CEOs' innovative ability is measured by a dummy variable, the estimated coefficients on CEOs' innovative ability are positively significant in both OLS and 2SLS regressions, suggesting that innovator CEOs invest more in firm's innovation activities compared to non-innovator CEOs. When CEOs' innovative ability is measured by the cumulative average citation per patent up to a given year, CEOs' innovative ability is positively significantly related to R&D spending in OLS and 2SLS regressions for

the whole sample and the sample excluding firms led by non-innovator CEOs, suggesting that CEOs with higher innovative ability invest more in firm's innovation activities. The results show that innovator CEOs could potentially have overinvestment problems.

[Insert Table 8 here]

4.5 Innovation Efficiency

Thus far, results indicate that innovator CEOs spur more firm innovation and they spend more on these innovative activities. However, it is not clear if a firm's investments in R&D spending are efficient or not. Therefore, I examine the innovation efficiency for innovator CEOs. Specifically, I estimate the following regression:

$Firm\ innovation_{i,t+1}$

$$
\begin{aligned}
= &\ \alpha_1 + \beta_1 CEO\ innovative\ ability_{i,t} \\
&+ \beta_2 CEO\ innovative\ ability * R\&D\ spending_{i,t} + \beta_3 R\&D\ spending_{i,t} \\
&+ \beta_4 Log(assets)_{i,t} + \beta_5 Log\ (capital\ intensity)_{i,t} + \beta_6 Stock\ return_{i,t} \\
&+ \beta_7 Tobin's\ Q_{i,t} + \beta_8 Log\ (1 + tenure)_{i,t} + \beta_9 CEO\ age_{i,t} + \beta_{10} Log\ (1 + delta)_{i,t} \\
&+ \beta_{11} Log\ (1 + vega)_{i,t} + \gamma_k + \delta_t + \varepsilon_i, \qquad\qquad\qquad (9)
\end{aligned}
$$

Controlling for *CEO innovative ability* and *R&D spending*, the estimated coefficients on the interaction term, $CEO\ innovative\ ability * R\&D\ spending_{i,t}$, stand for the innovation efficiency. All other variables are as previously defined. The results are reported in Table 9. In Panel A, I find that innovator CEO and R&D spending are positively related to firm innovation consistent with previous findings. After controlling for innovator CEO and R&D spending, the interaction term is negatively significant associated with all the firm's innovation measurements in both OLS and 2SLS regressions, suggesting that innovator CEOs do not use R&D funding efficiently to spur firm innovation. In Panel B, CEOs' innovative ability is measured by cumulative citation per patent up to a given year. I find that after controlling for CEOs' innovative ability and R&D spending, the interaction term is negatively significant

in both OLS and 2SLS regressions, suggesting that innovator CEOs with greater innovative ability use R&D funding even less efficiently to spur firm innovation. The results are the same for the whole sample and the sample excluding firms led by non-innovator CEOs. The results in Table 9 are consistent with the hypothesis 3 and the agency cost theory that CEOs overinvest in the projects that satisfy their own interests (Jensen and Meckling, 1976; Jensen 1986).

[Insert Table 9 here]

5. Innovator CEO Announcement Day Return

In this section, I examine whether the investors recognize the benefit of innovator CEOs using the stock market returns around the announcement date of hiring a new CEO. Specifically, I estimate the following regressions:

$$CAR_{i,t} = \alpha_1 + \beta_1 CEO\ innovative\ ability_{i,t} + \beta_2 Log(assets)_{i,t} + \beta_3 Log\ (capital\ intensity)_{i,t}$$
$$+\ \beta_4 Tobin's\ Q_{i,t} + \beta_5 Log\ (1 + delta)_{i,t} + \beta_6 Log\ (1 + vega)_{i,t} + \gamma_k + \delta_t$$
$$+\ \varepsilon_i\ , \tag{10}$$

where $CAR_{i,t}$ is the cumulative market-adjusted excess returns for firm i at time t, which is defined as the three-day window [-1,+1] around the announcement dates of hiring a new CEO. All other variables are as previously defined. In the regression, I also control for firm and CEO characteristics that can affect the market value of the company, year fixed effects and firm fixed effects. All control variables are previously defined.

Table 10 reports the results from estimating equation (10). I find that when a CEO's innovative ability is measured by patent, citation, cumulative patent and cumulative citations, the CEO's innovative ability is negative and statistically significant associated with the abnormal stock return around the announcement date of hiring a new CEO. The results support hypothesis 4b, suggesting that the market recognizes that innovator CEOs have inefficient overinvestment problems.

[Insert Table 10 here]

6. Innovator CEO and Firm Cash Holdings

In order to understand the negative relation between a CEO's innovative ability and the stock abnormal return on the announcement date of hiring a new innovator CEO, I further investigate the effect of innovator CEOs on firm cash holdings. Following Qiu and Wan (2015), I estimate the regression as below:

$$
\begin{aligned}
Cash_{i,t+1} = \ &\alpha_1 + \beta_1 Innovator\ CEO_{i,t} + \beta_2 Log(sale)_{i,t} + \beta_3 Stock\ return_{i,t} + \beta_4 Tobin's\ Q_{i,t} \\
&+ \beta_5 ROA_{i,t} + \beta_6 Sales\ growth_{i,t} + \beta_7 Income\ volatility_{i,t} + \beta_8 Log\ (1+delta)_{i,t} \\
&+ \beta_9 Log\ (1+vega)_{i,t} + \gamma_k + \delta_t \\
&+ \varepsilon_i, \hspace{5cm} (11)
\end{aligned}
$$

where $Innovator\ CEO_{i,t}$ is a dummy variable equal to one if the CEO had any patents during 1975-2010, $Cash_{i,t+1}$ is the ratio of cash and marketable securities to total book assets, and all other variable definitions are provided in Appendix. Table 11 presents the results from estimating equation (11). In column (1), I do not control for year and industry fixed effects. In column (2), I control for year fixed effect, in column (3), I control for both year and industry fixed effects. I find the coefficients on innovator CEO are positively significant in all three regressions, suggesting that firms led by innovator CEOs hold more cash compared to firms led by non-innovator CEOs. Control variables are consistent with the literature. For example, small firms, and firms with lower Tobin's Q and high income volatility hold more cash (Qiu and Wan, 2015).

[Insert Table 11 here]

Next, I compare the value of cash for firms with innovator CEOs and firms with non-innovator CEOs. I follow Faulkender and Wang (2006) to measure cash value and estimate the following regression:

$$r_{i,t} - R_{i,t}^B = \alpha_1 + \beta_1 \frac{\Delta C_{i,t}}{MV_{i,t-1}} + \beta_2 \frac{\Delta E_{i,t}}{MV_{i,t-1}} + \beta_3 \frac{\Delta NA_{i,t}}{MV_{i,t-1}} + \beta_4 \frac{\Delta RD_{i,t}}{MV_{i,t-1}} + \beta_5 \frac{\Delta I_{i,t}}{MV_{i,t-1}} + \beta_6 \frac{\Delta D_{i,t}}{MV_{i,t-1}}$$

$$+ \beta_7 \frac{C_{i,t-1}}{MV_{i,t-1}}_{i,t} + \beta_8 L_{i,t} + \beta_9 \frac{NF_{i,t}}{MV_{i,t-1}} + \varepsilon_i, \tag{12}$$

The dependent variable, $r_{i,t} - R_{i,t}^B$, is the excess stock return adjusted for size and book-to-market, where $r_{i,t}$ is the stock return for firm i in year t and $R_{i,t}^B$ is the stock i's benchmark return at year t.[33] The benchmark return is the 25 Fama and French (1993) portfolios returns formed on size and book-to-market. The independent variables, $\Delta X_{i,t}$, stand for a change in variable X for firm i over year t-1 to year t. The independent variables include cash and marketable securities ($C_{i,t}$), earnings before extraordinary items ($E_{i,t}$), net assets ($NA_{i,t}$), research and development expense ($RD_{i,t}$), interest expense ($I_{i,t}$), total dividends ($D_{i,t}$), market leverage ($L_{i,t}$) and the firm's net financing ($NF_{i,t}$). The coefficient of cash and marketable securities ($C_{i,t}$), β_1, reflects the cash value of a firm. The dependent variable and all the independent variables (except leverage) are scaled by, $MV_{i,t-1}$, the market value of firm i in year t-1. Therefore, β_1 measures the dollar change in shareholder value when one dollar cash holding changes in a firm.

Table 12 presents the results of comparing the cash value between firms with innovation CEOs and firms with non-innovator CEOs. In column (1) and (2), I do not control for year and industry fixed effects. In column (3) and (4), I control for year fixed effect. In column (5) and (6), I control for both year and industry fixed effects. I find that the cash value of firms with innovator CEOs is lower than the firms with non-innovator CEOs in all six regressions. For example, after controlling for year and industry fixed effects, one dollar change in cash holdings results 0.347 dollar change in shareholder values for firms with innovator CEOs. However, the cash value is 0.566 in firms with non-innovator CEOs. The results suggest that the stock market values the cash holdings lower in firms with innovator CEOs than firms

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[33] The yearly stock return is computed using monthly returns from CRSP.

with non-innovator CEOs. Although firms with innovator CEOs hold more cash, the cash value is lower, suggesting that firms with innovator CEOs hold excess cash and hurt shareholders' value.

[Insert Table 12 here]

7. Robustness Tests

7.1 Alternative firm innovation measure

All the patents a CEO develops while working for a company belong to that company. Thus, there is a possible false positive relation between innovator CEOs and firm innovation. Therefore, I calculate alternative firm innovation measures defined as the difference between firm innovation and CEO innovation that belongs to the firm. Table 13 presents the results. I still find a positive relation between a CEO's innovative ability and the alternative firm innovation, consistent with hypothesis one.

[Insert Table 13 here]

7.2 CEO past working experience

Another concern is that the CEO's innovative ability is just an alternative measure of the CEO's past industry working experience. To address this, I included past working experience into the regressions. If I can still find a positive relationship between a CEO's innovative ability and the firm innovation, the concern is not valid. Past working experience is calculated as a dummy variable equal to one if the CEO's previous company is in the same industry as his current company industry. Table 14 Panel A show the results, and CEO past working experience is calculated based on a four-digit SIC code.[34] Results indicate that past working experience is negatively related to firm innovation and that a CEO's innovative ability is still positively related to firm innovation. This suggests that the CEO's innovative ability is not an alternative measure of the CEO's past working experience.

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[34] Results are robust to CEO past working experience calculated based on a two-digit SIC code.

7.3 General ability index

Custodio, Ferreira and Matos (2017) construct a CEO general ability index (GAI) and find that firms with CEOs that have a higher GAI produce more firm innovation. Therefore, it could be that my measure of a CEO's innovative ability is just measuring a CEO's general ability. To address this concern, I add GAI in regression equation (5). GAI is defined as[35]:

$$GAI_{i,t} = 0.268X1_{i,t} + 0.312X2_{i,t} + 0.309X3_{i,t} + 0.218X4_{i,t} + 0.153X5_{i,t}, \qquad (13)$$

where X1 is the number of different positions that a CEO has had in his lifetime, X2 is the number of firms where a CEO worked, X3 is the number of industries where a CEO worked, X4 is a dummy variable equal to one if a CEO was a CEO at another firm before the current position, X5 is a dummy variable equal to one if a CEO worked for a multidivisional firm.

Table 14 Panel B presents the results of regression equation (7) adding GAI. I find that GAI is positively related to firm average citation and citation-weighted innovation but negatively related to market-value innovation. After adding GAI into the regression, I still find that a CEO's innovative ability is positively related to firm's innovation, consistent with my hypothesis.

[Insert Table 14 here]

8. Conclusion

In this paper, I use the CEO's patenting activity to quantify and qualify the CEO's innovative ability. I find that firms led by innovator CEOs experience more firm innovation compared to firms led by non-innovator CEOs. I also find that the greater the CEO's innovative ability, the more innovative the firm is. The effects of innovator CEOs on firm innovation are greater in the industries that need innovation the most. I also find that innovator CEOs can spur firm innovation only when the CEO's innovative ability is useful for the firm. However, CEOs' innovative ability that benefit firm innovation

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[35] GAI is based on the CEO lifetime publically traded firm working experience prior to the current CEO position.

may not be without a cost. Although firms with innovator CEOs spend more on R&D projects, the innovative efficiency is lower compared to firms with non-innovator CEOs. Furthermore, a CEO's innovative ability negatively impacts the stock market return on the announcement date of hiring a new innovator CEO. Firms with innovator CEOs hold more cash than firms with non-innovator CEOs but have a lower cash value. Overall, the results suggest that innovator CEOs spur firm innovation but pose agency problems to the firm. The results are also robust to the alternative measurement of firm innovation, the CEO's past working experience and the CEO's general ability.

References

Abra, J., 1994. Collaboration in creative work: An initiative for investigation. Creativity Research Journal, 7(1), pp.1-20.

Aghion, P., Van Reenen, J. and Zingales, L., 2013. Innovation and institutional ownership. The American Economic Review, 103(1), pp.277-304.

Almeida, H., Campello, M. and Weisbach, M.S., 2004. The cash flow sensitivity of cash. The Journal of Finance, 59(4), pp.1777-1804.

Ariely, D., Gneezy, U., Loewenstein, G. and Mazar, N., 2009. Large stakes and big mistakes. The Review of Economic Studies, 76(2), pp.451-469.

Atanassov, J., 2013. Do hostile takeovers stifle innovation? Evidence from antitakeover legislation and corporate patenting. The Journal of Finance, 68(3), pp.1097-1131.

Austin, D.H., 1993. An event-study approach to measuring innovative output: The case of biotechnology. The American Economic Review, 83(2), pp.253-258.

Barker III, V.L. and Mueller, G.C., 2002. CEO characteristics and firm R&D spending. Management Science, 48(6), pp.782-801.

Bebchuk, L.A. and Stole, L.A., 1993. Do Short‐Term Objectives Lead to Under‐or Overinvestment in Long‐Term Projects?. The Journal of Finance, 48(2), pp.719-729.

Brown, J.R., Fazzari, S.M. and Petersen, B.C., 2009. Financing innovation and growth: Cash flow, external equity, and the 1990s R&D boom. The Journal of Finance, 64(1), pp.151-185.

Brown, J.R., Martinsson, G. and Petersen, B.C., 2013. Law, stock markets, and innovation. The Journal of Finance, 68(4), pp.1517-1549.

Cagliano, R., Chiesa, V. and Manzini, R., 2000. Differences and similarities in managing technological collaborations in research, development and manufacturing: a case study. Journal of Engineering and Technology Management, 17(2), pp.193-224.

Campbell, T.C., Gallmeyer, M., Johnson, S.A., Rutherford, J. and Stanley, B.W., 2011. CEO optimism and forced turnover. Journal of Financial Economics, 101(3), pp.695-712.

Cefis, E. and Marsili, O., 2006. Survivor: The role of innovation in firms' survival. Research Policy, 35(5), pp.626-641.

Chemmanur, T.J., Loutskina, E. and Tian, X., 2014. Corporate venture capital, value creation, and innovation. The Review of Financial Studies, 27(8), pp.2434-2473.

Coles, J.L., Daniel, N.D., and Naveen, L., 2006. Managerial Incentives and Risk-Taking. Journal of Financial Economics 79, 431-468

Core, J., Guay, W., 2002. Estimating the value of employee stock option portfolios and their sensitivities to price and volatility. Journal of Accounting Research 40, 613-630.

Cornaggia, J., Mao, Y., Tian, X. and Wolfe, B., 2015. Does banking competition affect innovation?. Journal of Financial Economics, 115(1), pp.189-209.

Custodio, C., Ferreira, M.A. and Matos, P., 2017. Do general managerial skills spur innovation?. Management Science.

Ederer, F. and Manso, G., 2013. Is pay for performance detrimental to innovation?. Management Science, 59(7), pp.1496-1513.

Eisfeldt, A.L. and Kuhnen, C.M., 2013. CEO turnover in a competitive assignment framework. Journal of Financial Economics, 109(2), pp.351-372.

Fama, E.F. and French, K.R., 1993. Common risk factors in the returns on stocks and bonds. Journal of Financial Economics, 33(1), pp.3-56.

Fang, V.W., Tian, X. and Tice, S., 2014. Does stock liquidity enhance or impede firm innovation?. The Journal of Finance, 69(5), pp.2085-2125.

Faulkender, M. and Wang, R., 2006. Corporate financial policy and the value of cash. The Journal of Finance, 61(4), pp.1957-1990.

Galasso, A. and Simcoe, T.S., 2011. CEO overconfidence and innovation. Management Science, 57(8), pp.1469-1484.

Goel, A.M. and Thakor, A.V., 2008. Overconfidence, CEO selection, and corporate governance. The Journal of Finance, 63(6), pp.2737-2784.

Hall, B.H., Jaffe, A.B. and Trajtenberg, M., 2001. The NBER patent citation data file: Lessons, insights and methodological tools (No. w8498). National Bureau of Economic Research.

Hall, B.H., Jaffe, A. and Trajtenberg, M., 2005. Market value and patent citations. RAND Journal of Economics, pp.16-38.

Han, S. and Qiu, J., 2007. Corporate precautionary cash holdings. Journal of Corporate Finance, 13(1), pp.43-57.

He, J.J. and Tian, X., 2013. The dark side of analyst coverage: The case of innovation. Journal of Financial Economics, 109(3), pp.856-878.

Hellmann, T. and Thiele, V., 2011. Incentives and innovation: A multitasking approach. American Economic Journal: Microeconomics, 3(1), pp.78-128.e

Hirshleifer, D., Low, A. and Teoh, S.H., 2012. Are overconfident CEOs better innovators?. The Journal of Finance, 67(4), pp.1457-1498.

Ireland, D., & Hitt, M. A. (1999). Achieving and maintaining strategic competitiveness in the 21st century: The role of strategic leadership. The Academy of Management Executive, 13(1), 43−57.

Islam, E. and Zein, J., 2018. Inventor CEOs. Working paper.

Jensen, M.C. and Meckling, W.H., 1976. Theory of the firm: Managerial behavior, agency costs and ownership structure. Journal of Financial Economics, 3(4), pp.305-360.

Jensen, M.C., 1986. Agency costs of free cash flow, corporate finance, and takeovers. The American Economic Review, 76(2), pp.323-329.

Kogan, L., Papanikolaou, D., Seru, A. and Stoffman, N., 2017. Technological innovation, resource allocation, and growth. The Quarterly Journal of Economics, 132(2), pp.665-712.

Li, G.C., Lai, R., D'Amour, A., Doolin, D.M., Sun, Y., Torvik, V.I., Amy, Z.Y. and Fleming, L., 2014. Disambiguation and co-authorship networks of the US patent inventor database (1975–2010). Research Policy, 43(6), pp.941-955.

Loughran, T. and Ritter, J., 2004. Why has IPO underpricing changed over time?. Financial Management, pp.5-37.

Makri, M. and Scandura, T.A., 2010. Exploring the effects of creative CEO leadership on innovation in high-technology firms. The Leadership Quarterly, 21(1), pp.75-88.

Malmendier, U. and Tate, G., 2005a. CEO overconfidence and corporate investment. The Journal of Finance, 60(6), pp.2661-2700.

Malmendier, U. and Tate, G., 2005b. Does overconfidence affect corporate investment? CEO overconfidence measures revisited. European Financial Management, 11(5), pp.649-659.

Manso, G., 2011. Motivating innovation. The Journal of Finance, 66(5), pp.1823-1860.

Mumford, M.D., Marks, M.A., Connelly, M.S., Zaccaro, S.J. and Reiter-Palmon, R., 2000. Development of leadership skills: Experience and timing. The Leadership Quarterly, 11(1), pp.87-114.

Mumford, M.D., 2000. Managing creative people: Strategies and tactics for innovation. Human Resource Management Review, 10(3), pp.313-351.

Mumford, M.D., Scott, G.M., Gaddis, B. and Strange, J.M., 2002. Leading creative people: Orchestrating expertise and relationships. The Leadership Quarterly, 13(6), pp.705-750.

Nicholas, T., 2008. Does innovation cause stock market runups? Evidence from the great crash. The American Economic Review, 98(4), pp.1370-1396.

Pakes, A., 1985. On patents, R & D, and the stock market rate of return. Journal of Political Economy, 93(2), pp.390-409.

Patel, D. and Ward, M.R., 2011. Using patent citation patterns to infer innovation market competition. Research Policy, 40(6), pp.886-894.

Pelz, D.C., 1963. Relationships between measures of scientific performance and other variables. Scientific Creativity: Its Recognition and Development, pp.302-310.

Qiu, J. and Wan, C., 2015. Technology spillovers and corporate cash holdings. Journal of Financial Economics, 115(3), pp.558-573.

Redmond, M.R., Mumford, M.D. and Teach, R., 1993. Putting creativity to work: Effects of leader behavior on subordinate creativity. Organizational Behavior and Human Decision Processes, 55(1), pp.120-151.

Rosenbaum, P.R. and Rubin, D.B., 1983. The central role of the propensity score in observational studies for causal effects. Biometrika, 70(1), pp.41-55.

Sauermann, H. and Cohen, W.M., 2010. What makes them tick? Employee motives and firm innovation. Management Science, 56(12), pp.2134-2153.

Schumpeter, J. A., 1911. The Theory of Economic Development. Harvard University Press, Cambridge, MA

Shleifer, A. and Vishny, R.W., 1989. Management entrenchment: The case of manager-specific investments. Journal of Financial Economics, 25(1), pp.123-139.

Solow, R. M., 1957, Technical change and the aggregate production function, Review of Economics and Statistics 39, 312–320.

Sunder, J., Sunder, S.V. and Zhang, J., 2017. Pilot CEOs and corporate innovation. Journal of Financial Economics, 123(1), pp.209-224.

Tierney, P., Farmer, S.M. and Graen, G.B., 1999. An examination of leadership and employee creativity: The relevance of traits and relationships. Personnel Psychology, 52(3), pp.591-620.

Useche, D., 2014. Are patents signals for the IPO market? An EU–US comparison for the software industry. Research Policy, 43(8), pp.1299-1311.

Weisbach, M.S., 1995. CEO turnover and the firm's investment decisions. Journal of Financial Economics, 37(2), pp.159-188.

Wu, S., Levitas, E. and Priem, R.L., 2005. CEO tenure and company invention under differing levels of technological dynamism. Academy of Management Journal, 48(5), pp.859-873.

Xuan, Y., 2009. Empire-building or bridge-building? Evidence from new CEOs' internal capital allocation decisions. The Review of Financial Studies, 22(12), pp.4919-4948.

Appendix

Dependent variables

Firm patent	The number of patents the firm applied in a given year.
Firm citation	The number of citations subsequently received by the patents the firm applied in a given year.
Firm avg. citation	The ratio of firm citations over firm patents in a given year.
Citation-weighted firm innovation	The sum of the weight of citations on each patent plus one for firm i in time t divided by book assets of firm i in year t.
Market-value firm innovation	Total dollar value of innovation produced by firm i in year t divided by book assets of firm i in year t.
R&D spending	Research and development expenditures divided by lagged total assets, expressed as a percentage. If R&D spending is missing, R&D spending is equal to zero.

Independent variables

Innovator CEO	A dummy variable equal to one if the CEO had any patents during 1975-2010.
CEO patent	The number of patents the CEO applied in a given year.
CEO citation	The number of citations subsequently received by the patents applied for in a given year.
CEO cumulative patent	The cumulative number of patents up to a given year starting from the year of the first patent applied.
CEO cumulative citation	The cumulative number of citations subsequently received by the patents applied for up to a given year starting from the year of the first patent applied.
CEO avg. citation	The ratio of CEO citations over CEO patents.
CEO cumulative avg. citation	The ratio of CEO cumulative citations over CEO cumulative patents.
CEO total avg. citation	The ratio of CEO total citations over CEO total patents in the sample period.
Assets	Total assets in millions.
Capital intensity	The ratio of net property, plant, and equipment over the number of employees.
Stock return	Firm buy-and-hold return over the fiscal year.
Tobin's Q	The ratio of market value of assets over the book value of assets. Book value of assets equals the book value of assets plus the market value of common equity less the sum of the book value of common equity and balance sheet deferred taxes.
Tenure	CEO tenure in months.
CEO age	CEO age in years.
Delta	Dollar change in CEO stock and option portfolio for 1% change in stock price.
Vega	Dollar change in CEO option holdings for 1% change in stock return volatility.
CEO coauthors' ability	CEO coauthors' average citation over average patent. CEO coauthors' patents do not include the patents cooperated with the CEO.

Exogenous turnover	CEO departures classified as planned retirements or caused by a well-specified health problem (Eisfeldt and Kuhnen, 2013).
Sale	The logarithm of total sales.
ROA	Return on asset (ROA) is the ratio of operating income before depreciation to total assets.
Income volatility	Standard deviation of net earnings before extraordinary items from year t to t-3.

Table 1

Year and Industry Distribution

This table provides the breakdown of the number of non-innovator CEOs, number of innovator CEOs, and the percentage of innovator CEOs in the sample by year (Panel A) and by industry excluding financial firms and utilities (Panel B and C). The sample of CEOs is from ExecuComp for the period of 1992-2008.

Panel A: Distribution by Year

Year	Non-Innovator CEOs (#)	Innovator CEOs (#)	Innovator CEOs (%)
1992	210	17	7.5%
1993	617	45	6.8%
1994	879	91	9.4%
1995	943	102	9.8%
1996	982	114	10.4%
1997	1,022	127	11.1%
1998	1,044	127	10.8%
1999	1,093	145	11.7%
2000	1,086	127	10.5%
2001	1,033	125	10.8%
2002	1,016	121	10.6%
2003	1,024	127	11.0%
2004	1,047	119	10.2%
2005	1,038	104	9.1%
2006	1,070	99	8.5%
2007	1,191	110	8.5%
2008	1,182	104	8.1%
Total	16,477	1,804	9.9%

Panel B: Distribution by Fama-French 12 Industry Groups

Industry	Non-Innovator CEOs (#)	Innovator CEOs (#)	Innovator CEO Patent's Industry = Firm's Industry (#)	Innovator CEOs (%)
Consumer NonDurables	1,319	55	21	4.0%
Consumer Durables	193	34	7	15.0%
Manufacturing	2,869	341	161	10.6%
Enrgy	1,112	19	6	1.7%
Chems	796	82	54	9.3%
Business Equipment	3,233	662	489	17.0%
Shops	2,097	72	0	3.3%
Health	1,564	262	254	14.3%
Other	3,294	277	65	7.8%
Total	16,477	1,804	1,057	9.9%

Panel C: Distribution by High-tech Industry Following Loughran and Ritter (2004)

Industry	Non-Innovator CEOs (#)	Innovator CEOs (#)	Innovator CEO Patent's Industry = Firm's Industry (#)	Innovator CEOs (%)
High-tech	3,264	717	546	18.0%
None high-tech	13,213	1,087	511	7.6%
Total	16,477	1,804	1,057	9.9%

Table 2

Summary Statistics

This table presents summary statistics of the variables used in this study. T-tests (Wilcoxon-Mann-Whitney tests) are conducted to test for differences between the means (medians) for firms with innovator CEOs and non-innovator CEOs. Variable definitions are provided in the Appendix. *, ** and *** denote significance at the 10%, 5%, and 1% level, respectively.

Variable	Non-Innovator CEOs				Innovator CEOs			
	N	Mean	Median	Std. Dev.	N	Mean	Median	Std. Dev.
Dependent variables								
Firm patent	16477	28.44	0.00	151.10	1804	39.91***	4.00***	153.87
Firm citation	16477	299.64	0.00	2171.25	1804	409.99**	15.50***	1786.61
Firm avg. citation	16477	4.51	0.00	11.92	1804	9.97***	2.21***	23.81
Citation-weighted firm innovation	16477	57.86	0.00	321.39	1804	92.51***	8.13***	344.48
Market-value firm innovation	16477	460.47	0.00	2923.97	1804	823.62***	9.69***	4814.34
R&D spending	16477	4.38	0.75	8.84	1804	8.58***	5.92***	11.07
Independent variables								
CEO patent	16477	0	0	0	1804	0.82***	0	4.04
CEO citation	16477	0	0	0	1804	12.21***	0	67.20
CEO avg. citation	16477	0	0	0	1804	4.74***	0	27.03
CEO cumulative patent	16477	0	0	0	1804	9.86***	2.00***	26.59
CEO cumulative citation	16477	0	0	0	1804	260.14***	40.00***	673.71
CEO cumulative avg. citation	16477	0	0	0	1804	26.20***	15.00***	41.44
CEO total cumulative citation	16477	0	0	0	1804	23.75***	14.17***	30.27
Assets (millions)	16475	4862.07	1008.01	18725.46	1804	5490.38	607.74***	45216.52
Capital intensity	16274	172.03	37.10	879.16	1797	60.13***	37.97**	79.52
Stock return (%)	16287	0.80	0.04	21.21	1792	0.57	0.02	12.14
Tobin's Q	14965	2.30	1.68	2.53	1659	2.93***	2.13***	3.45
Tenure (months)	16477	78.35	48.00	85.30	1804	107.05***	72.00***	103.17
CEO age (years)	16422	55.43	56.00	7.63	1802	55.25	55.00	8.31
Delta	13725	1010.61	186.34	10052.47	1629	3651.61***	226.02***	26658.81
Vega	14288	105.01	37.23	235.46	1664	121.05**	33.51**	320.34

Table 3

Innovator CEOs and firm's innovation--OLS results

This table presents the effects of innovator CEOs on firm's innovation from OLS regressions. Panel A presents CEO's innovative ability measured by *Innovator CEO*, which is a dummy variable equal to one if the CEO had any patents during 1975-2010. Panel B presents CEO's innovative ability measured by *CEO cumulative avg. citation*, which is the ratio of CEO cumulative citation over CEO cumulative patent. *Firm patent* is the number of patent the firm applied in a given year. *Firm citation* is the number of citations subsequently received by the patents the firm applied in a given year. *Firm avg. citation* is the ratio of firm citations over firm patents. *Citation-weighted firm innovation* is the sum of the weight of citations on each patent plus one for firm i in time t divided by book assets of firm i in year t. *Market-value firm innovation* is total dollar value of innovation produced by firm i in year t divided by book assets of firm i in year t. All independent variables are lagged by 1 year. Variable definitions are provided in the Appendix. T-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Panel A: CEOs' innovative ability measured by innovator CEO

	Log (1+ firm patent)	Log (1+ firm citation)	Firm avg. citation	Citation-weighted firm innovation	Market-value firm innovation
	(1)	(2)	(3)	(4)	(5)
Innovator CEO	0.560***	0.877***	3.872***	49.01***	325.2***
	(15.58)	(15.94)	(12.06)	(5.49)	(4.34)
Log (assets)	0.452***	0.538***	0.0736	66.63***	671.4***
	(46.89)	(36.39)	(0.85)	(27.78)	(33.37)
Log (capital intensity)	-0.0329**	-0.0555**	-0.0866	0.387	73.06**
	(-2.81)	(-3.09)	(-0.83)	(0.13)	(2.99)
Stock return	-0.00300**	-0.00459**	-0.0178*	-0.183	-6.873**
	(-2.87)	(-2.87)	(-1.91)	(-0.71)	(-3.16)
Tobin's Q	0.104***	0.167***	0.551***	5.973***	171.0***
	(19.74)	(20.56)	(11.65)	(4.54)	(15.50)
Log (1+tenure)	-0.00405	-0.000545	-0.147*	0.214	-28.03
	(-0.45)	(-0.04)	(-1.85)	(0.10)	(-1.50)
CEO age	-0.0118***	-0.0148***	-0.0357**	-2.206***	-6.989**
	(-7.65)	(-6.23)	(-2.58)	(-5.73)	(-2.16)
Log (1+delta)	-0.00819	-0.00807	0.250**	2.940	81.01***
	(-0.90)	(-0.58)	(3.07)	(1.30)	(4.27)
Log(1+vega)	0.107***	0.149***	0.399***	2.083	-37.13**
	(12.77)	(11.63)	(5.35)	(1.00)	(-2.13)
Year fixed effects	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y
Adjusted R-square	0.397	0.373	0.145	0.101	0.161
Observations	13913	13913	13913	13913	13913

Panel B: CEOs' innovative ability measured by CEO cumulative avg. citation

	Log (1+ firm patent)	Log (1+ firm citation)	Firm avg. citation	Citation-weighted firm innovation	Market-value firm innovation
	(1)	(2)	(3)	(4)	(5)
CEO cumulative avg. citation	0.00947***	0.0194***	0.201***	0.582**	2.166
	(12.11)	(16.25)	(29.58)	(3.00)	(1.33)
Log (assets)	0.447***	0.535***	0.183**	65.90***	664.8***
	(46.26)	(36.23)	(2.18)	(27.50)	(33.07)
Log (capital intensity)	-0.0326**	-0.0568**	-0.137	0.509	74.53**
	(-2.78)	(-3.16)	(-1.34)	(0.17)	(3.05)
Stock return	-0.00294**	-0.00447**	-0.0165*	-0.180	-6.862**
	(-2.80)	(-2.80)	(-1.82)	(-0.69)	(-3.15)
Tobin's Q	0.105***	0.166***	0.518***	6.041***	171.9***
	(19.69)	(20.44)	(11.23)	(4.59)	(15.57)
Log (1+tenure)	0.00115	0.00679	-0.136*	0.714	-24.41
	(0.13)	(0.50)	(-1.74)	(0.32)	(-1.31)
CEO age	-0.0115***	-0.0139***	-0.0232*	-2.198***	-7.060**
	(-7.41)	(-5.87)	(-1.72)	(-5.70)	(-2.18)
Log (1+delta)	-0.00587	-0.00820	0.154*	3.348	85.12***
	(-0.64)	(-0.59)	(1.94)	(1.48)	(4.48)
Log(1+vega)	0.108***	0.151***	0.424***	2.140	-36.98**
	(12.85)	(11.80)	(5.83)	(1.03)	(-2.12)
Year fixed effects	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y
Adjusted R-square	0.393	0.373	0.187	0.100	0.160
Observations	13913	13913	13913	13913	13913

Table 4

Innovator CEOs and firm's innovation--2SLS results

This table presents the effects of innovator CEOs on firm's innovation from 2SLS regressions. Instrumental variable is CEO coauthors' ability calculated as CEO coauthors' average citation over average patent. CEO coauthors' patents do not include the patents cooperated with the CEO. The odd number columns show the results on the whole sample. The even number columns present the results only including innovator CEOs. All independent variables are lagged by 1 year. In Panel A, CEOs' innovative ability is measured by a dummy variable equal to one if the CEO had any patents during 1975-2010. In Panel B, CEOs' innovative ability is measured by the ratio of CEO cumulative citations over CEO cumulative patents. Variable definitions are provided in the Appendix. T-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Panel A: CEOs' innovative ability measured by innovator CEO

	First-stage	Log (1+ firm patent)	Log (1+ firm citation)	Firm avg. citation	Citation-weighted firm innovation	Market-value firm innovation
		(1)	(3)	(5)	(7)	(9)
Innovator CEO		0.912***	1.552***	0.698***	91.01***	331.9**
		(14.41)	(16.01)	(14.81)	(5.76)	(2.51)
CEO coauthors' ability	0.0207***					
	(91.09)					
Log (assets)	-0.00925***	0.459***	0.551***	0.108***	68.15***	675.7***
	(-5.47)	(46.77)	(36.67)	(14.81)	(27.83)	(32.89)
Log (capital intensity)	-0.000740	-0.0387**	-0.0630***	-0.0240**	-0.153	73.03**
	(-0.36)	(-3.27)	(-3.48)	(-2.72)	(-0.05)	(2.95)
Stock return	-0.000248	-0.00304**	-0.00463**	-0.00201**	-0.193	-6.962**
	(-1.37)	(-2.90)	(-2.88)	(-2.57)	(-0.74)	(-3.18)
Tobin's Q	0.00219**	0.103***	0.164***	0.0665***	5.949***	172.9***
	(2.36)	(19.38)	(20.04)	(16.72)	(4.47)	(15.47)
Log (1+tenure)	0.00737***	-0.00600	-0.00249	-0.00213	-0.410	-30.25
	(4.71)	(-0.66)	(-0.18)	(-0.32)	(-0.18)	(-1.60)
CEO age	-0.000330	-0.0112***	-0.0134***	-0.00304**	-2.125***	-6.482**
	(-1.21)	(-7.13)	(-5.57)	(-2.60)	(-5.43)	(-1.97)
Log (1+delta)	0.00520**	-0.0153*	-0.0196	-0.00555	2.492	84.56***
	(3.25)	(-1.65)	(-1.38)	(-0.81)	(1.08)	(4.37)
Log(1+vega)	-0.00326**	0.108***	0.149***	0.0569***	2.118	-38.52**
	(-2.21)	(12.73)	(11.49)	(9.00)	(1.00)	(-2.17)
Year fixed effects	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y
Adjusted R-square	0.406	0.393	0.366	0.308	0.101	0.162
Observations	13671	13671	13671	13671	13671	13671

Panel B: CEOs' innovative ability measured by CEO cumulative avg. citation

	First-stage		Log (1+ firm patent)		Log (1+ firm citation)		Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation	
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CEO cumulative avg. citation			0.0203***	0.0142***	0.0346***	0.0293***	0.0156***	0.0125***	2.028***	2.049**	7.394**	-5.795
			(14.28)	(4.92)	(15.97)	(6.11)	(14.87)	(5.22)	(5.75)	(3.14)	(2.50)	(-0.84)
CEO coauthors' ability	0.928***	0.584***										
	(81.00)	(12.72)										
Log (assets)	-0.439***	-2.841***	0.459***	0.591***	0.552***	0.656***	0.109***	0.0669**	68.20***	119.8***	675.9***	1082.3***
	(-5.15)	(-3.54)	(46.38)	(18.65)	(36.60)	(12.47)	(14.91)	(2.55)	(27.77)	(16.75)	(32.85)	(14.31)
Log (capital intensity)	0.0956	-0.912	-0.0413***	0.0603	-0.0674***	0.114	-0.0260**	0.0554	-0.414	-4.169	72.08**	-78.40
	(0.92)	(-0.70)	(-3.46)	(1.27)	(-3.71)	(1.44)	(-2.95)	(1.40)	(-0.14)	(-0.39)	(2.91)	(-0.69)
Stock return	-0.0176*	-0.237**	-0.00291**	-0.00611*	-0.00440**	-0.0141**	-0.00191**	-0.00814**	-0.180	0.0705	-6.915**	-26.10**
	(-1.92)	(-2.42)	(-2.75)	(-1.68)	(-2.74)	(-2.34)	(-2.45)	(-2.71)	(-0.69)	(0.09)	(-3.15)	(-3.01)
Tobin's Q	0.133**	0.898**	0.103***	0.0673***	0.163***	0.112***	0.0660***	0.0473***	5.878***	1.425	172.6***	163.8***
	(2.85)	(1.98)	(19.07)	(4.00)	(19.83)	(4.02)	(16.64)	(3.40)	(4.40)	(0.38)	(15.43)	(4.08)
Log (1+tenure)	-0.0799	-2.148**	0.00234	0.00107	0.0117	-0.0142	0.00427	-0.0312	0.423	-2.113	-27.21	-9.890
	(-1.01)	(-2.73)	(0.26)	(0.04)	(0.85)	(-0.29)	(0.64)	(-1.27)	(0.19)	(-0.32)	(-1.44)	(-0.14)
CEO age	-0.0173	0.00435	-0.0111***	-0.0421***	-0.0133***	-0.0534***	-0.0030**	-0.0121**	-2.120***	-6.533***	-6.463**	-42.20***
	(-1.26)	(0.03)	(-7.03)	(-8.65)	(-5.51)	(-6.61)	(-2.57)	(-3.02)	(-5.40)	(-5.95)	(-1.97)	(-3.63)
Log (1+delta)	0.365***	1.457**	-0.0179*	0.160***	-0.0241*	0.219***	-0.00760	0.0672**	2.225	40.84***	83.58***	594.1***
	(4.53)	(2.01)	(-1.92)	(5.82)	(-1.70)	(4.80)	(-1.11)	(2.96)	(0.96)	(6.59)	(4.31)	(9.07)
Log(1+vega)	-0.226**	-1.163*	0.110***	0.0635**	0.152***	0.137**	0.0581***	0.0803***	2.280	-37.51***	-37.93**	-477.0***
	(-3.04)	(-1.70)	(12.80)	(2.53)	(11.67)	(3.29)	(9.23)	(3.87)	(1.07)	(-6.62)	(-2.13)	(-7.96)
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Adjusted R-square	0.341	0.186	0.382	0.399	0.363	0.305	0.314	0.324	0.097	0.305	0.160	0.387
Observations	13671	1256	13671	1256	13671	1256	13671	1256	13671	1256	13671	1256

Table 5

Innovator CEOs and firm's innovation--Propensity score matching results

This table presents the effects of innovator CEOs on firm's innovation from propensity score matching results. *Firm patent* is the number of patent the firm applied in a given year. *Firm citation* is the number of citations subsequently received by the patents the firm applied in a given year. *Firm avg. citation* is the ratio of firm citations over firm patents. *Citation-weighted firm innovation* is the sum of the weight of citations on each patent plus one for firm i in time t divided by book assets of firm i in year t. *Firm avg. citation* is the ratio of firm citations over firm patents. *Market-value firm innovation* is total dollar value of innovation produced by firm i in year t divided by book assets of firm i in year t. All independent variables are lagged by 1 year. Variable definitions are provided in the Appendix. T-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

	Log (1+ firm patent)		Log (1+ firm citation)		Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Innovator CEO	0.625***	0.646***	0.989***	0.957***	0.470***	0.485***	15.56**	16.43***	-1.831	1.824
	(12.58)	(14.23)	(13.79)	(12.20)	(11.63)	(13.23)	(3.06)	(3.32)	(-0.04)	(0.04)
Nearest matching	1	2	1	2	1	2	1	2	1	2
Other control variables	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	3,006	4,509	3,006	4,509	3,006	4,509	3,006	4,509	3,006	4,509

Table 6

Effect of industry innovativeness

This table presents the effects of innovator CEOs on firm's innovation from 2SLS regressions. Panel A presents the effect of innovator CEO on firm's innovation in high-tech industry and non-high-tech industry. The definition of high-tech industry follows Loughran and Ritter (2004). Panel B presents the effect of innovator CEO on firm's innovation in innovative industry and non-innovative industry. An innovative industry is equal to one if the average citation per patent for the industry is greater than the median average citation per patent across all industries. *Innovator CEO* is a dummy variable equal to one if the CEO had any patents during 1975-2010 *Firm avg. citation* is the ratio of firm citations over firm patents. *Citation-weighted firm innovation* is the sum of the weight of citations on each patent plus one for firm i in time t divided by book assets of firm i in year t. *Market-value firm innovation* is total dollar value of innovation produced by firm i in year t divided by book assets of firm i in year t. All independent variables are lagged by 1 year. Variable definitions are provided in the Appendix. T-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Panel A: High-tech industry vs non-high-tech industry.

	High-tech industry (# of Innovator CEO: 717)						Non-high-tech industry (# of Innovator CEO: 1087)					
	Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation		Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation	
	OLS (1)	2SLS (2)	OLS (3)	2SLS (4)	OLS (5)	2SLS (6)	OLS (1)	2SLS (2)	OLS (3)	2SLS (4)	OLS (5)	2SLS (6)
Innovator CEO	3.066*** (4.53)	6.483*** (6.03)	34.98** (2.03)	89.43** (3.13)	468.6** (2.76)	417.3 (1.49)	3.597*** (10.02)	7.061*** (10.94)	27.76** (2.67)	61.88** (3.21)	100.8 (1.23)	158.6 (1.04)
Log (assets)	-0.0657 (-0.26)	0.145 (0.59)	143.9*** (22.47)	147.1*** (22.49)	1098.6*** (17.44)	1103.4*** (17.18)	0.473*** (5.46)	0.553*** (6.48)	55.02*** (21.95)	56.00*** (21.97)	594.2*** (30.03)	598.6*** (29.75)
Log (capital intensity)	0.750** (2.00)	0.503 (1.37)	90.10*** (9.43)	89.32*** (9.18)	235.2** (2.50)	261.0** (2.73)	-0.229** (-2.29)	-0.212** (-2.16)	-6.158** (-2.13)	-6.373** (-2.17)	71.14** (3.11)	71.11** (3.07)
Stock return	-0.0942** (-3.03)	-0.0995*** (-3.31)	-0.302 (-0.38)	-0.483 (-0.60)	-26.11*** (-3.35)	-26.77*** (-3.41)	-0.00313 (-0.35)	-0.00259 (-0.30)	-0.0484 (-0.19)	-0.0428 (-0.16)	-2.819 (-1.37)	-2.813 (-1.36)
Tobin's Q	0.489*** (4.41)	0.499*** (4.63)	5.075* (1.80)	5.637** (1.97)	171.0*** (6.16)	175.4*** (6.24)	0.615*** (11.66)	0.608*** (11.76)	6.769*** (4.44)	6.702*** (4.34)	177.7*** (14.76)	178.5*** (14.65)
Log (1+tenure)	0.000423 (0.00)	-0.00747 (-0.03)	5.049 (0.90)	2.153 (0.38)	-141.7** (-2.58)	-158.8** (-2.82)	-0.150* (-1.88)	-0.0776 (-0.99)	0.387 (0.17)	0.128 (0.05)	-0.924 (-0.05)	-2.755 (-0.15)
CEO age	-0.00886 (-0.24)	0.0147 (0.41)	-3.826*** (-4.14)	-3.554*** (-3.77)	-4.262 (-0.47)	-2.134 (-0.23)	-0.0200 (-1.42)	-0.0299** (-2.16)	-0.901** (-2.21)	-0.867** (-2.10)	-2.817 (-0.88)	-2.639 (-0.81)
Log (1+delta)	-0.0498 (-0.21)	-0.138 (-0.57)	-4.514 (-0.73)	-4.586 (-0.72)	276.5*** (4.57)	316.7*** (5.06)	0.0681 (0.84)	0.0694 (0.87)	-4.431* (-1.89)	-4.526* (-1.90)	-14.11 (-0.76)	-15.49 (-0.83)
Log(1+vega)	1.070*** (5.33)	1.049*** (5.29)	-30.12*** (-5.88)	-31.72*** (-6.02)	-327.1*** (-6.50)	-359.4*** (-6.94)	0.0733 (0.97)	0.0357 (0.48)	7.434*** (3.41)	7.618*** (3.44)	34.05** (1.98)	36.14** (2.07)
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	3070	2997	3070	2997	3070	2997	10843	10674	10843	10674	10843	10674
Adjusted R-square	0.246	0.244	0.256	0.255	0.194	0.199	0.121	0.119	0.084	0.084	0.170	0.170

Panel B: Innovative industry vs non-innovative industry.

	Innovative industry (# of Innovator CEO: 1704)						Non-innovative industry (# of Innovator CEO: 100)					
	Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation		Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation	
	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Innovator CEO	3.743***	7.569***	47.55***	93.40***	316.3***	355.6**	0.718**	1.186**	4.162***	1.402	21.69	-24.60
	(10.53)	(12.52)	(4.77)	(5.33)	(3.80)	(2.43)	(2.76)	(2.20)	(3.74)	(0.62)	(0.41)	(-0.22)
Log (assets)	0.0653	0.211**	76.38***	78.29***	761.2***	768.2***	0.243***	0.250***	1.769***	1.753***	113.7***	113.3***
	(0.66)	(2.15)	(27.40)	(27.46)	(32.71)	(32.28)	(5.17)	(5.31)	(8.81)	(8.85)	(11.95)	(11.82)
Log (capital intensity)	-0.169	-0.193	0.0879	-0.601	84.15**	84.03**	0.155**	0.152**	0.0617	-0.0208	-25.48**	-25.69**
	(-1.40)	(-1.63)	(0.03)	(-0.18)	(2.98)	(2.93)	(2.70)	(2.64)	(0.25)	(-0.09)	(-2.19)	(-2.20)
Stock return	-0.102***	-0.103***	-1.111*	-1.184*	-37.75***	-38.40***	-0.0005	-0.0004	-0.0020	-0.0021	0.0852	0.0793
	(-4.50)	(-4.68)	(-1.75)	(-1.85)	(-7.13)	(-7.19)	(-0.24)	(-0.19)	(-0.23)	(-0.24)	(0.20)	(0.19)
Tobin's Q	0.608***	0.603***	7.031***	7.119***	207.6***	210.5***	0.0944**	0.0911**	0.761***	0.723***	44.37***	44.54***
	(10.76)	(10.88)	(4.44)	(4.43)	(15.69)	(15.69)	(2.11)	(2.05)	(3.99)	(3.87)	(4.91)	(4.93)
Log (1+tenure)	-0.207**	-0.154*	-0.318	-1.256	-36.55*	-40.73*	-0.0499	-0.0558	-0.310*	-0.393**	-9.941	-10.13
	(-2.23)	(-1.68)	(-0.12)	(-0.47)	(-1.68)	(-1.84)	(-1.23)	(-1.37)	(-1.79)	(-2.30)	(-1.21)	(-1.23)
CEO age	-0.0387**	-0.0360**	-2.447***	-2.322***	-6.363*	-5.625	0.0126*	0.0114	-0.0014	0.0002	-1.815	-1.72
	(-2.42)	(-2.28)	(-5.45)	(-5.07)	(-1.70)	(-1.47)	(1.72)	(1.54)	(-0.05)	(0.01)	(-1.22)	(-1.14)
Log (1+delta)	0.385***	0.321***	3.162	2.485	86.61***	90.63***	-0.0705*	-0.0614	-0.480**	-0.420**	-5.450	-5.622
	(3.99)	(3.37)	(1.17)	(0.90)	(3.83)	(3.93)	(-1.74)	(-1.52)	(-2.78)	(-2.48)	(-0.67)	(-0.69)
Log(1+vega)	0.349***	0.320***	1.980	2.097	-52.01**	-53.67**	0.100**	0.0950**	0.611***	0.518***	16.12**	16.01**
	(3.96)	(3.68)	(0.80)	(0.83)	(-2.52)	(-2.55)	(2.81)	(2.65)	(4.01)	(3.43)	(2.23)	(2.19)
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	11800	11576	11800	11576	11800	11576	2113	2095	2113	2095	2113	2095
Adjusted R-square	0.154	0.150	0.113	0.113	0.178	0.179	0.172	0.168	0.142	0.137	0.124	0.123

Table 7

The usefulness of CEO's innovative ability to the firm

This table presents the usefulness of CEO's innovative ability to the firm. *CEO cumulative avg. citation* is the ratio of CEO cumulative citation over CEO cumulative patent. *Firm avg. citation* is the ratio of firm citations over firm patents. *Citation-weighted firm innovation* is the sum of the weight of citations on each patent plus one for firm i in time t divided by book assets of firm i in year t. *Market-value firm innovation* is total dollar value of innovation produced by firm i in year t divided by book assets of firm i in year t. All independent variables are lagged by 1 year. Variable definitions are provided in the Appendix. T-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

	CEO patent technological classification = firm industry classification						CEO patent technological classification not equal to firm industry classification					
	Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation		Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation	
	OLS (1)	2SLS (2)	OLS (3)	2SLS (4)	OLS (5)	2SLS (6)	OLS (1)	2SLS (2)	OLS (3)	2SLS (4)	OLS (5)	2SLS (6)
CEO cumulative avg. citation	0.232***	0.281***	0.189	3.082***	-1.909	6.332	0.136***	0.0301	0.634*	-2.307	2.114	-45.01**
	(13.25)	(7.10)	(0.90)	(5.50)	(-0.93)	(1.26)	(12.07)	(0.45)	(1.78)	(-1.45)	(0.71)	(-2.30)
Log (assets)	-0.446	-0.0701	73.27***	94.08***	624.9***	704.8***	0.243**	0.118	66.35***	150.4***	675.2***	1552.5***
	(-0.72)	(-0.11)	(9.85)	(10.28)	(8.59)	(8.60)	(3.03)	(0.26)	(26.25)	(13.89)	(32.09)	(11.65)
Log (capital intensity)	0.203	0.372	-4.192	-12.31	-178.7*	-191.1*	-0.158	0.982	1.144	-23.52	81.51**	-180.4
	(0.23)	(0.42)	(-0.40)	(-0.99)	(-1.75)	(-1.72)	(-1.64)	(1.18)	(0.38)	(-1.20)	(3.22)	(-0.75)
Stock return	-0.123**	-0.121**	-0.124	-0.0710	-29.42***	-29.62***	-0.00310	0.416	-0.0706	-26.02	-3.352	-419.7*
	(-2.05)	(-2.09)	(-0.17)	(-0.09)	(-4.19)	(-4.03)	(-0.35)	(0.52)	(-0.25)	(-1.40)	(-1.42)	(-1.83)
Tobin's Q	0.547*	0.633**	1.602	2.953	180.2***	180.8***	0.583***	0.590	6.985***	10.22	183.2***	214.2**
	(1.81)	(2.14)	(0.44)	(0.71)	(5.11)	(4.84)	(12.75)	(1.63)	(4.84)	(1.20)	(15.24)	(2.04)
Log (1+tenure)	-2.157***	-1.620**	-3.196	2.284	15.91	18.47	0.0148	-0.532	0.780	4.660	-28.99	-14.01
	(-3.75)	(-2.71)	(-0.47)	(0.27)	(0.24)	(0.24)	(0.20)	(-1.15)	(0.33)	(0.43)	(-1.49)	(-0.10)
CEO age	0.0225	0.00148	-4.905***	-5.560***	-18.63*	-21.83**	-0.0227*	0.0772	-1.992***	-7.229**	-5.709*	-79.60**
	(0.26)	(0.02)	(-4.81)	(-4.64)	(-1.87)	(-2.03)	(-1.75)	(0.76)	(-4.86)	(-3.03)	(-1.67)	(-2.71)
Log (1+delta)	0.739	1.021*	15.71**	13.79*	324.6***	362.8***	0.0837	0.882*	1.754	86.02***	56.01**	1000.4***
	(1.36)	(1.88)	(2.41)	(1.79)	(5.09)	(5.26)	(1.10)	(1.88)	(0.73)	(7.80)	(2.80)	(7.36)
Log(1+vega)	0.767	0.669	2.657	-1.877	-2.160	-13.22	0.375***	0.0467	2.018	-75.70***	-36.33**	-990.9***
	(1.43)	(1.25)	(0.42)	(-0.25)	(-0.03)	(-0.19)	(5.43)	(0.11)	(0.93)	(-7.64)	(-2.00)	(-8.12)
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Adjusted R-square	0.320	0.348	0.207	0.029	0.256	0.266	0.151	0.172	0.097	0.518	0.158	0.475
Observations	881	784	881	784	881	784	13009	468	13009	468	13009	468

Table 8
Innovator CEOs and firm's R&D spending

This table presents the effects of innovator CEOs on firm's R&D spending. Column (1) and (2) presents CEO's innovative ability measured by *Innovator CEO*, which is a dummy variable equal to one if the CEOs have any patent in their life. Column (3) to (5) presents CEO's innovative ability measured by *CEO cumulative avg. citation*, which is the ratio of CEO cumulative citation over CEO cumulative patent. All independent variables are lagged by 1 year. Variable definitions are provided in the Appendix. T-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Dependent variable: R&D spending	CEO innovative ability measured by: Innovator CEO		CEO innovative ability measured by: CEO cumulative avg. citation		
	OLS	2SLS	OLS	2SLS	2SLS
	(1)	(2)	(3)	(4)	(5)
CEO innovative ability	1.978***	4.172***	0.035***	0.093***	0.065***
	(9.16)	(10.98)	(7.47)	(10.92)	(2.91)
Log (assets)	-1.597***	-1.572***	-1.614***	-1.569***	-2.258***
	(-27.80)	(-26.91)	(-28.10)	(-26.72)	(-9.30)
Log (capital intensity)	0.581***	0.568***	0.581***	0.554***	1.475***
	(8.35)	(8.08)	(8.33)	(7.84)	(4.10)
Stock return	-0.006	-0.007	-0.006	-0.006	0.143***
	(-1.02)	(-1.10)	(-0.98)	(-1.00)	(5.14)
Tobin's Q	0.379***	1.378***	1.379***	1.375***	0.901***
	(43.58)	(43.19)	(43.54)	(42.86)	(7.00)
Log (1+tenure)	0.087	0.081	0.104**	0.118**	0.708***
	(1.63)	(1.52)	(1.96)	(2.19)	(3.14)
CEO age	-0.069***	-0.063***	-0.068***	-0.062***	-0.254***
	(-7.56)	(-6.75)	(-7.40)	(-6.63)	(-6.85)
Log (1+delta)	-0.262***	-0.310***	-0.255***	-0.321***	-0.032
	(-4.85)	(-5.67)	(-4.72)	(-5.82)	(-0.15)
Log(1+vega)	0.895***	0.928***	0.897***	0.932***	0.834***
	(18.12)	(18.51)	(18.16)	(18.50)	(4.35)
Year fixed effects	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y
Adjusted R-square	0.2801	0.4304	0.2787	0.4245	0.5878
Observations	14356	14114	14356	14114	1261

Table 9

Innovator CEOs and firm's innovation efficiency

This table presents The effects of innovator CEOs on firm's innovation efficiency. Dependent variable *R&D* spending is the ratio of R&D to lagged total assets, expressed as a percentage. Panel A presents CEO's innovative ability measured by *Innovator CEO*, which is a dummy variable equal to one if the CEOs have any patent in their life. Panel B presents CEO's innovative ability measured by *CEO cumulative avg. citation*, which is the ratio of CEO cumulative citation over CEO cumulative patent. *Firm patent* is the number of patent the firm applied in a given year. *Firm citation* is the number of citations subsequently received by the patents the firm applied in a given year. *Citation-weighted firm innovation* is the sum of the weight of citations on each patent plus one for firm i in time t divided by book assets of firm i in year t. *Firm avg. citation* is the ratio of firm citations over firm patents. *Market-value firm innovation* is total dollar value of innovation produced by firm i in year t divided by book assets of firm i in year t. All independent variables are lagged by 1 year. Variable definitions are provided in the Appendix. T-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Panel A: CEOs' innovative ability measured by innovator CEO

	Log (1+ firm patent)		Log (1+ firm citation)		Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation	
	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Innovator CEO	0.698***	1.269***	1.054***	2.170***	4.480***	0.951***	56.17***	118.9***	400.8***	336.5*
	(16.81)	(13.73)	(16.43)	(15.19)	(11.61)	(13.47)	(5.22)	(4.96)	(4.44)	(1.67)
Innovator CEO x R&D spending	-0.0282***	-0.0497***	-0.0373***	-0.0802***	-0.114***	-0.0318***	-1.813**	-3.984***	-16.27**	-11.55
	(-9.79)	(-11.81)	(-8.38)	(-12.31)	(-4.28)	(-9.88)	(-2.43)	(-3.65)	(-2.60)	(-1.26)
R&D spending	0.0490***	0.0513***	0.0682***	0.0730***	0.177***	0.0271***	4.015***	4.280***	30.49***	30.03***
	(36.17)	(36.25)	(32.54)	(33.32)	(14.07)	(25.06)	(11.43)	(11.65)	(10.34)	(9.74)
Log (assets)	0.528***	0.533***	0.643***	0.654***	0.341***	0.146***	72.94***	74.39***	718.6***	723.6***
	(55.80)	(55.40)	(44.02)	(43.94)	(3.89)	(19.86)	(29.78)	(29.77)	(34.94)	(34.51)
Log (capital intensity)	-0.0549***	-0.0588***	-0.0864***	-0.0900***	-0.164	-0.0337***	-1.511	-1.852	59.13**	58.47**
	(-4.90)	(-5.18)	(-4.99)	(-5.13)	(-1.57)	(-3.88)	(-0.52)	(-0.63)	(2.43)	(2.37)
Stock return	-0.000938	-0.00104	-0.00171	-0.00187	-0.0105	-0.000998	-0.0108	-0.0246	-5.583**	-5.643**
	(-0.94)	(-1.04)	(-1.11)	(-1.20)	(-1.13)	(-1.30)	(-0.04)	(-0.09)	(-2.57)	(-2.58)
Tobin's Q	0.0609***	0.0603***	0.106***	0.104***	0.395***	0.0445***	2.331*	2.329*	143.8***	145.3***
	(11.72)	(11.48)	(13.18)	(12.77)	(8.19)	(11.07)	(1.73)	(1.71)	(12.72)	(12.69)
Log (1+tenure)	-0.00636	-0.00763	-0.00389	-0.00428	-0.155*	-0.00269	-0.0104	-0.554	-29.56	-32.15*
	(-0.75)	(-0.88)	(-0.29)	(-0.32)	(-1.95)	(-0.41)	(-0.00)	(-0.25)	(-1.59)	(-1.70)
CEO age	-0.00845***	-0.00829***	-0.00998***	-0.00954***	-0.0240*	-0.00167	-1.908***	-1.879***	-4.828	-4.252
	(-5.69)	(-5.51)	(-4.35)	(-4.10)	(-1.74)	(-1.45)	(-4.96)	(-4.81)	(-1.49)	(-1.30)
Log (1+delta)	-0.00905	-0.0157*	-0.00934	-0.0204	0.247**	-0.00591	2.850	2.456	80.42***	84.63***
	(-1.04)	(-1.78)	(-0.70)	(-1.49)	(3.06)	(-0.87)	(1.27)	(1.07)	(4.25)	(4.39)
Log(1+vega)	0.0637***	0.0640***	0.0889***	0.0878***	0.245**	0.0342***	-1.457	-1.559	-63.83***	-65.96***
	(7.92)	(7.80)	(7.15)	(6.92)	(3.27)	(5.45)	(-0.70)	(-0.73)	(-3.65)	(-3.69)
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Adjusted R-square	0.450	0.444	0.418	0.408	0.157	0.333	0.110	0.109	0.168	0.169
Observations	13913	13671	13913	13671	13913	13671	13913	13671	13913	13671

Panel B: CEOs' innovative ability measured by CEO cumulative avg. citation

	Log (1+ firm patent)			Log (1+ firm citation)			Firm avg. citation			Citation-weighted firm innovation			Market-value firm innovation		
	OLS	2SLS	2SLS	OLS	2SLS	2SLS	OLS	2SLS	2SLS	OLS	2SLS	2SLS	OLS	2SLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
CEO cumulative avg. citation	0.0104***	0.0210***	0.0160***	0.0211***	0.0362***	0.0334***	0.218***	0.0164***	0.0144***	0.608**	2.123***	2.209***	2.361	7.020**	-6.982
	(12.93)	(13.50)	(4.94)	(17.08)	(15.14)	(6.13)	(30.07)	(13.92)	(5.28)	(2.92)	(5.27)	(3.02)	(1.35)	(2.08)	(-0.89)
CEO cumulative avg. citation x R&D spending	-0.0002***	-0.0003***	-0.0002***	-0.0004***	-0.0005***	-0.0004***	-0.002***	-0.0002***	-0.0002***	-0.0158**	-0.0318***	-0.0357***	-0.119**	-0.168**	-0.110
	(-10.08)	(-12.78)	(-5.55)	(-10.07)	(-12.57)	(-5.61)	(-8.98)	(-10.08)	(-4.27)	(-2.61)	(-4.49)	(-3.83)	(-2.34)	(-2.83)	(-1.11)
R&D spending	0.0471***	0.0473***	0.0328***	0.0658***	0.0659***	0.0416***	0.165***	0.0243***	0.0111**	3.937***	4.006***	6.589***	29.57***	30.24***	42.24***
	(36.76)	(36.41)	(7.59)	(33.36)	(33.13)	(5.71)	(14.31)	(24.88)	(3.06)	(11.89)	(11.94)	(6.74)	(10.63)	(10.75)	(4.05)
Log (assets)	0.527***	0.538***	0.656***	0.645***	0.661***	0.734***	0.454***	0.149***	0.0856**	72.57***	74.83***	133.4***	714.9***	726.2***	1175.4***
	(55.55)	(55.38)	(19.62)	(44.25)	(44.37)	(13.03)	(5.31)	(20.34)	(3.04)	(29.62)	(29.81)	(17.66)	(34.76)	(34.51)	(14.56)
Log (capital intensity)	-0.0579***	-0.0657***	0.0277	-0.0919***	-0.101***	0.0700	-0.221**	-0.0385***	0.0424	-1.616	-2.477	-10.44	58.57**	56.33**	-115.5
	(-5.15)	(-5.76)	(0.59)	(-5.31)	(-5.79)	(0.88)	(-2.18)	(-4.47)	(1.07)	(-0.56)	(-0.84)	(-0.98)	(2.40)	(2.28)	(-1.02)
Stock return	-0.000829	-0.000825	-0.00111	-0.00154	-0.00151	-0.00880	-0.00950	-0.000843	-0.00717**	-0.00238	-0.00362	1.178	-5.527**	-5.562**	-17.78**
	(-0.83)	(-0.82)	(-0.30)	(-1.00)	(-0.97)	(-1.43)	(-1.05)	(-1.11)	(-2.33)	(-0.01)	(-0.01)	(1.42)	(-2.54)	(-2.54)	(-2.01)
Tobin's Q	0.0603***	0.0592***	0.0393**	0.104***	0.102***	0.0827**	0.370***	0.0437***	0.0420**	2.319*	2.204	-4.798	144.0***	144.4***	116.9**
	(11.57)	(11.20)	(2.30)	(12.98)	(12.60)	(2.86)	(7.86)	(10.97)	(2.91)	(1.72)	(1.61)	(-1.24)	(12.73)	(12.60)	(2.83)
Log (1+tenure)	-0.00355	-0.00296	-0.0174	0.000260	0.00438	-0.0367	-0.151*	0.00158	-0.0368	0.317	-0.0228	-5.913	-27.39	-30.69	-35.35
	(-0.42)	(-0.34)	(-0.60)	(0.02)	(0.33)	(-0.75)	(-1.96)	(0.24)	(-1.51)	(0.14)	(-0.01)	(-0.90)	(-1.48)	(-1.63)	(-0.50)
CEO age	-0.00751***	-0.00741***	-0.0354***	-0.00836***	-0.00813***	-0.0456***	-0.0103	-0.00110	-0.0103**	-1.858***	-1.806***	-5.122***	-4.506	-4.027	-32.37**
	(-5.05)	(-4.89)	(-7.24)	(-3.65)	(-3.50)	(-5.54)	(-0.76)	(-0.97)	(-2.51)	(-4.83)	(-4.62)	(-4.64)	(-1.40)	(-1.23)	(-2.75)
Log (1+delta)	-0.00893	-0.0190**	0.151***	-0.0126	-0.0259*	0.202***	0.138*	-0.00834	0.0603**	3.113	2.118	39.79***	83.35***	83.23***	594.2***
	(-1.02)	(-2.13)	(5.55)	(-0.94)	(-1.89)	(4.40)	(1.75)	(-1.24)	(2.62)	(1.38)	(0.92)	(6.45)	(4.40)	(4.30)	(9.02)
Log(1+vega)	0.0652***	0.0657***	0.0421*	0.0917***	0.0910***	0.114**	0.279***	0.0357***	0.0760***	-1.417	-1.424	-42.23***	-63.70***	-66.21***	-512.2***
	(8.07)	(7.96)	(1.70)	(7.39)	(7.19)	(2.73)	(3.84)	(5.73)	(3.64)	(-0.68)	(-0.67)	(-7.54)	(-3.64)	(-3.70)	(-8.56)
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Adjusted R-square	0.447	0.437	0.420	0.420	0.411	0.310	0.201	0.344	0.324	0.109	0.106	0.329	0.167	0.167	0.396
Observations	13913	13671	1256	13913	13671	1256	13913	13671	1256	13913	13671	1256	13913	13671	1256

Table 10

Stock market returns around CEO announcement date

This table presents the results from OLS regression of cumulative abnormal returns (CARs) around CEO announcement dates. CARs are cumulative market-adjusted excess returns during the three-day window [-1,+1] around CEO announcement date. Variable definitions are provided in the Appendix. T-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

	CARs							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Innovator CEO	-0.007							
	(-1.29)							
CEO patent		-0.002*						
		(-1.69)						
CEO citation			-0.00031**					
			(-2.48)					
CEO cumulative patent				-0.0006***				
				(-3.69)				
CEO cumulative citation					-0.00001***			
					(-3.98)			
CEO avg. citation						-0.0003		
						(-0.74)		
CEO cumulative avg. citation							-0.000004	
							(-0.04)	
CEO total avg. citation								-0.00001
								(-0.12)
Log (assets)	-0.000250	-0.000225	-0.000366	-0.000474	-0.000467	-0.000188	-0.000127	-0.000136
	(-0.21)	(-0.19)	(-0.31)	(-0.40)	(-0.40)	(-0.16)	(-0.11)	(-0.12)
Log (capital intensity)	-0.000003	-0.000003	-0.000003	-0.000003	-0.000003	-0.000003	-0.000003	-0.000003
	(-1.20)	(-1.18)	(-1.19)	(-1.22)	(-1.22)	(-1.17)	(-1.17)	(-1.17)
Tobin's Q	-0.000489	-0.000540	-0.000572	-0.000592	-0.000598	-0.000555	-0.000548	-0.000547
	(-0.84)	(-0.93)	(-0.98)	(-1.02)	(-1.03)	(-0.95)	(-0.94)	(-0.94)
Log (1+delta)	-0.0000379	-0.000124	-0.0000310	0.000133	0.000158	-0.000141	-0.000161	-0.000154
	(-0.03)	(-0.11)	(-0.03)	(0.12)	(0.14)	(-0.12)	(-0.14)	(-0.13)
Log(1+vega)	-0.000778	-0.000712	-0.000545	-0.000552	-0.000481	-0.000724	-0.000778	-0.000779
	(-0.66)	(-0.60)	(-0.46)	(-0.47)	(-0.41)	(-0.61)	(-0.66)	(-0.66)
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Observations	1615	1615	1615	1615	1615	1615	1615	1615

Table 11

Innovator CEO and firm cash holdings

This table presents the results from OLS regression of innovator CEO and firm cash holdings. Innovator CEO is a dummy variable equal to one if the CEO has any patents during 1975-2010. The dependent variable is the ratio of cash and marketable securities to total book assets. All other variable definitions are provided in the Appendix. T-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

	(1)	(2)	(3)
Innovator CEO	0.0437***	0.0450***	0.0378***
	(10.01)	(10.47)	(8.82)
Log(sale)	-0.0513***	-0.0500***	-0.0496***
	(-49.32)	(-48.36)	(-47.80)
Tobin's Q	0.0197***	0.0209***	0.0194***
	(25.34)	(26.95)	(25.29)
Stock return	-0.00134	-0.00211*	-0.00190
	(-1.07)	(-1.70)	(-1.56)
Log(ROA)	-0.0761***	-0.0673***	-0.0631***
	(-9.24)	(-8.26)	(-7.85)
Sale growth	-0.0001	-0.0001	-0.0001
	(-0.40)	(-0.46)	(-0.54)
Income volatility	0.0001***	0.0001***	0.0001***
	(13.20)	(12.73)	(12.73)
Log (1+delta)	0.0118***	0.0109***	0.0104***
	(11.31)	(10.61)	(10.10)
Log(1+vega)	0.0134***	0.00839***	0.00840***
	(14.11)	(8.57)	(8.68)
Year fixed effects	N	Y	Y
Industry fixed effects	N	Y	Y
Adjusted R-square	0.308	0.328	0.350
Observations	12003	12003	12003

Table 12

Innovator CEO and cash value

This table presents the results from OLS regression of innovator CEO and cash value. The dependent variable is the excess stock return adjusted for size and book-to-market calculated as the stock return for firm i in year t subtracts the stock i's benchmark return at year t. The benchmark return is the 25 Fama and French (1993) portfolios returns formed on size and book-to-market. The independent variables include cash and marketable securities, earnings before extraordinary items, net assets, research and development expense, interest expense, total dividends, market leverage and the firm's net financing. All the independent variables (except leverage) are scaled by the market value of firm i in year t-1. T-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

	Firms with innovator CEOs	Firms with non-innovator CEOs	Firms with innovator CEOs	Firms with non-innovator CEOs	Firms with innovator CEOs	Firms with non-innovator CEOs
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta C_{i,t}$	0.319***	0.560***	0.332***	0.559***	0.347***	0.566***
	(3.87)	(17.29)	(3.87)	(17.03)	(4.04)	(17.16)
$\Delta E_{i,t}$	-0.00864	0.0179***	-0.0108	0.0179***	-0.0176	0.0183***
	(-0.08)	(3.68)	(-0.10)	(3.67)	(-0.16)	(3.74)
$\Delta NA_{i,t}$	0.239***	0.0132**	0.244***	0.0128**	0.247***	0.0118**
	(5.90)	(2.28)	(5.92)	(2.19)	(5.97)	(2.01)
$\Delta RD_{i,t}$	-0.220	0.968***	-0.220	0.962***	-0.306	0.991***
	(-1.14)	(11.50)	(-1.12)	(11.35)	(-1.54)	(11.42)
$\Delta I_{i,t}$	-4.282***	-0.0781**	-4.427***	-0.0760**	-4.328***	-0.0728**
	(-5.96)	(-2.63)	(-6.00)	(-2.55)	(-5.87)	(-2.43)
$\Delta D_{i,t}$	-0.901	0.0239	-1.122	0.0458	-1.175	0.0578
	(-0.87)	(0.09)	(-1.05)	(0.17)	(-1.10)	(0.22)
$C_{i,t-1}$	0.225***	0.579***	0.245***	0.578***	0.255***	0.584***
	(3.99)	(18.50)	(4.22)	(18.24)	(4.39)	(18.34)
$L_{i,t}$	-0.180**	-0.251***	-0.193**	-0.261***	-0.212**	-0.263***
	(-2.46)	(-7.73)	(-2.61)	(-7.94)	(-2.81)	(-7.92)
$NF_{i,t}$	0.0166	-0.0220	-0.00234	-0.0171	0.0137	-0.0122
	(0.14)	(-0.70)	(-0.02)	(-0.54)	(0.11)	(-0.38)
Year fixed effects	N	N	Y	Y	Y	Y
Industry fixed effects	N	N	N	N	Y	Y
Adjusted R-square	692	6524	692	6524	692	6524
Observations	0.089	0.080	0.095	0.081	0.099	0.082

Table 13

Alternative firm innovation measure

This table presents the effects of innovator CEOs on alternative firm innovation measure. Column (1) and (2) present dependent variable measured as firm patent subtract CEO patent. Column (3) and (4) present dependent variable measured as firm citation subtract CEO citation. Column (5) and (6) present dependent variable measured as firm average citation subtract CEO average citation. All independent variables are lagged by 1 year. Variable definitions are provided in the Appendix. T-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

	(Frim patent - CEO patent)		(Firm citation - CEO citation)		(Firm avg. citation - CEO avg. citation)	
	OLS (1)	2SLS (2)	OLS (3)	2SLS (4)	OLS (5)	2SLS (6)
Innovator CEO	17.38***	24.77***	108.0*	349.0***	3.241***	7.061***
	(4.22)	(3.40)	(1.87)	(3.42)	(10.45)	(13.37)
Log (assets)	32.23***	32.70***	299.3***	309.2***	0.150*	0.285***
	(29.15)	(28.98)	(19.29)	(19.53)	(1.80)	(3.48)
Log (capital intensity)	0.532	0.315	6.691	2.202	-0.187*	-0.228**
	(0.40)	(0.23)	(0.36)	(0.12)	(-1.85)	(-2.31)
Stock return	-0.0990	-0.103	-0.833	-0.892	-0.0172*	-0.0172**
	(-0.83)	(-0.86)	(-0.50)	(-0.53)	(-1.90)	(-1.97)
Tobin's Q	3.447***	3.497***	34.21***	34.20***	0.542***	0.529***
	(5.69)	(5.70)	(4.02)	(3.97)	(11.86)	(11.87)
Log (1+tenure)	0.571	0.372	20.32	16.78	-0.0719	-0.0223
	(0.56)	(0.36)	(1.41)	(1.15)	(-0.93)	(-0.29)
CEO age	-0.998***	-0.981***	-10.47***	-10.17***	-0.0365**	-0.0340**
	(-5.63)	(-5.44)	(-4.21)	(-4.02)	(-2.73)	(-2.59)
Log (1+delta)	1.696	1.618	5.930	1.344	0.230**	0.184**
	(1.63)	(1.52)	(0.41)	(0.09)	(2.92)	(2.38)
Log(1+vega)	-0.221	-0.272	12.77	12.38	0.351***	0.318***
	(-0.23)	(-0.28)	(0.95)	(0.90)	(4.87)	(4.49)
Year fixed effects	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y
Adjusted R-square	0.111	0.112	0.059	0.058	0.145	0.141
Observations	13913	13671	13913	13671	13913	13671

Table 14

Innovator CEO, CEO past working experience and general ability index

This table presents the effects of innovator CEOs, CEO past working experience and general ability index on firm's innovation. *Past working experience* is equal to one if the CEO worked in the same industry in the past. Panel A presents the results that CEO past working experience based on four-digit SIC code. Panel B presents the effects of innovator CEOs and general ability index on firm's innovation. *General ability index* is from Custodio, Ferreira and Matos (2017). *Firm avg. citation* is the ratio of firm citations over firm patents. *Citation-weighted firm innovation* is the sum of the weight of citations on each patent plus one for firm i in time t divided by book assets of firm i in year t. *Market-value firm innovation* is total dollar value of innovation produced by firm i in year t divided by book assets of firm i in year t. All other independent variables are lagged by 1 year. Variable definitions are provided in the Appendix. T-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Panel A: CEO past working experience based on four-digit SIC code.

	Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation	
	OLS (1)	2SLS (2)	OLS (3)	2SLS (4)	OLS (5)	2SLS (6)
Innovator CEO	3.879***	7.691***	49.64***	92.60***	332.8***	349.2**
	(12.08)	(13.99)	(5.56)	(5.85)	(4.44)	(2.63)
Past working experience	-0.487	-0.747	-40.23**	-44.69**	-477.3**	-488.3**
	(-0.75)	(-1.17)	(-2.22)	(-2.44)	(-3.14)	(-3.18)
Log (assets)	0.0741	0.208**	66.66***	68.21***	671.9***	676.3***
	(0.86)	(2.45)	(27.80)	(27.85)	(33.40)	(32.93)
Log (capital intensity)	-0.0807	-0.110	0.871	0.389	78.81**	78.95**
	(-0.77)	(-1.07)	(0.30)	(0.13)	(3.22)	(3.18)
Stock return	-0.0178*	-0.0179**	-0.184	-0.193	-6.877**	-6.967**
	(-1.91)	(-1.97)	(-0.71)	(-0.74)	(-3.16)	(-3.18)
Tobin's Q	0.551***	0.537***	5.969***	5.941***	171.0***	172.8***
	(11.65)	(11.61)	(4.54)	(4.46)	(15.50)	(15.47)
Log (1+tenure)	-0.151*	-0.104	-0.0508	-0.715	-31.17*	-33.59*
	(-1.88)	(-1.33)	(-0.02)	(-0.32)	(-1.67)	(-1.77)
CEO age	-0.0357**	-0.0333**	-2.208***	-2.124***	-7.006**	-6.471**
	(-2.58)	(-2.45)	(-5.74)	(-5.43)	(-2.17)	(-1.97)
Log (1+delta)	0.249**	0.209**	2.866	2.401	80.13***	83.56***
	(3.06)	(2.60)	(1.27)	(1.04)	(4.22)	(4.32)
Log(1+vega)	0.400***	0.363***	2.201	2.258	-35.74**	-36.99**
	(5.37)	(4.94)	(1.06)	(1.07)	(-2.05)	(-2.08)
Year fixed effects	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y
Adjusted R-square	45	0.140	0.101	0.102	0.162	0.163
Observations	13913	13671	13913	13671	13913	13671

Panel B: CEO general ability index.

	Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
	(1)	(2)	(4)	(5)	(7)	(8)
Innovator CEO	4.128***	8.102***	52.27***	95.79***	341.9***	400.8**
	(11.57)	(13.34)	(5.04)	(5.21)	(3.97)	(2.62)
General ability index	0.165	0.207*	2.827	3.237	-56.13*	-61.38**
	(1.35)	(1.72)	(0.80)	(0.89)	(-1.91)	(-2.03)
Log (assets)	-0.0734	0.0571	72.75***	74.29***	725.8***	733.3***
	(-0.75)	(0.60)	(25.63)	(25.64)	(30.79)	(30.48)
Log (capital intensity)	-0.0704	-0.106	0.241	-0.295	69.97**	69.83**
	(-0.60)	(-0.93)	(0.07)	(-0.09)	(2.47)	(2.43)
Stock return	-0.0642	-0.0571	-1.637	-1.639	-58.64***	-59.58***
	(-1.56)	(-1.43)	(-1.37)	(-1.36)	(-5.90)	(-5.94)
Tobin's Q	0.611***	0.600***	6.828***	6.868***	213.0***	216.0***
	(11.13)	(11.22)	(4.28)	(4.24)	(16.09)	(16.07)
Log (1+tenure)	-0.228**	-0.161*	-0.713	-1.397	-43.28**	-46.82**
	(-2.56)	(-1.86)	(-0.28)	(-0.53)	(-2.01)	(-2.14)
CEO age	-0.0315**	-0.0295*	-2.695***	-2.593***	-5.190	-4.264
	(-1.98)	(-1.90)	(-5.85)	(-5.52)	(-1.36)	(-1.09)
Log (1+delta)	0.268**	0.247**	4.319	4.169	96.54***	101.1***
	(2.91)	(2.73)	(1.61)	(1.53)	(4.34)	(4.46)
Log(1+vega)	0.385***	0.331***	-0.623	-0.735	-46.53**	-48.36**
	(4.53)	(3.95)	(-0.25)	(-0.29)	(-2.27)	(-2.30)
Year fixed effects	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y
Adjusted R-square	0.149	0.145	0.107	0.108	0.173	0.174
Observations	11489	11262	11489	11262	11489	11262

Internet Appendix

1. The summary statistics of dependent variables and independent variables for the full sample.

Table 1A

Summary Statistics

This table presents summary statistics of the variables used in this study. Variable definitions are provided in the Appendix.

Variable	N	Mean	Median	Std. Dev.	P25	P75
Dependent variables						
Firm patent	18281	29.57	1.00	151.41	0.00	9.00
Firm citation	18281	310.53	0.00	2137.01	0.00	44.00
Firm avg. citation	18281	5.05	0.00	13.65	0.00	5.00
Citation-weighted firm innovation	18281	61.28	0.00	323.89	0.00	17.71
Market-value firm innovation	18281	496.31	0.00	3162.86	0.00	38.44
R&D spending	18281	4.79	1.10	9.17	0.00	6.28
Independent variables						
CEO patent	18281	0.08	0.00	1.29	0.00	0.00
CEO citation	18281	1.20	0.00	21.42	0.00	0.00
CEO avg. citation	18281	0.47	0.00	8.61	0.00	0.00
CEO cumulative patent	18281	0.97	0.00	8.85	0.00	0.00
CEO cumulative citation	18281	25.67	0.00	225.36	0.00	0.00
CEO avg. cumulative citation	18281	2.59	0.00	15.18	0.00	0.00
CEO total cumulative citation	18281	2.34	0.00	11.85	0.00	0.00
Assets (millions)	18279	4924.08	957.50	22754.11	370.68	2916.80
Capital intensity	18071	160.90	37.22	835.35	21.09	77.52
Stock return (%)	18079	0.78	0.04	20.49	-0.20	0.32
Tobin's Q	16624	2.37	1.71	2.64	1.27	2.60
Tenure (months)	18281	81.18	48.00	87.64	24.00	108.00
CEO age (years)	18224	55.41	55.00	7.70	50.00	60.00
Delta	15354	1290.81	190.37	12897.75	73.46	519.47
Vega	15952	106.68	36.76	245.72	11.75	101.21

2. The effects of innovator CEOs on firm's innovation from OLS regressions using the other six measures of CEOs' innovative ability.

Table 2A

Innovator CEOs and firm's innovation--OLS results

This table presents the effects of innovator CEOs on firm's innovation from OLS regressions. Panel A presents CEO's innovative ability measured by CEO patent, which is the number of patents the CEO applied in a given year. Panel B presents CEO's innovative ability measured by CEO citation, which is the number of citations subsequently received by the patents applied for in a given year. Panel C presents CEO's innovative ability measured by CEO avg. citation, which is the ratio of CEO citation over CEO patent in a given year. Panel D presents CEO's innovative ability measured by CEO cumulative patent, which is the cumulative number of patents in each year starting from the year of the first patent applied. Panel E presents CEO's innovative ability measured by CEO cumulative citation, which is the cumulative number of citations subsequently received by the patents applied for in a given year starting from the year of the first patent applied. Panel F presents CEO's innovative ability measured by CEO total avg. citation, which is the ratio of CEO total citation over CEO total patent. All independent variables are lagged by 1 year. Variable definitions are provided in the Appendix. T-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Panel A: CEOs' innovative ability measured by CEO patent

	Log (1+ firm patent)	Log (1+ firm citation)	Firm avg. citation	Citation-weighted firm innovation	Market-value firm innovation
	(1)	(2)	(3)	(4)	(5)
CEO patent	0.0827***	0.126***	0.367***	2.896	68.11***
	(10.21)	(10.18)	(5.07)	(1.44)	(4.05)
Log (assets)	0.440***	0.518***	-0.0217	65.37***	664.6***
	(45.56)	(35.01)	(-0.25)	(27.36)	(33.19)
Log (capital intensity)	-0.0311**	-0.0525**	-0.0686	0.659	73.61**
	(-2.64)	(-2.91)	(-0.65)	(0.23)	(3.01)
Stock return	-0.00296**	-0.00453**	-0.0177*	-0.182	-6.840**
	(-2.82)	(-2.82)	(-1.89)	(-0.70)	(-3.14)
Tobin's Q	0.106***	0.169***	0.563***	6.151***	171.7***
	(19.93)	(20.74)	(11.86)	(4.67)	(15.56)
Log (1+tenure)	0.00392	0.0119	-0.0949	0.856	-23.14
	(0.44)	(0.87)	(-1.18)	(0.39)	(-1.24)
CEO age	-0.0118***	-0.0147***	-0.0363**	-2.225***	-6.822**
	(-7.55)	(-6.14)	(-2.61)	(-5.77)	(-2.11)
Log (1+delta)	-0.00189	0.00196	0.303***	3.695	83.74***
	(-0.21)	(0.14)	(3.72)	(1.63)	(4.42)
Log(1+vega)	0.107***	0.150***	0.401***	2.096	-36.50**
	(12.79)	(11.65)	(5.36)	(1.01)	(-2.10)
Year fixed effects	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y
Adjusted R-square	0.391	0.366	0.138	0.099	0.161
Observations	13913	13913	13913	13913	13913

Panel B: CEOs' innovative ability measured by CEO citation

	Log (1+ firm patent)	Log (1+ firm citation)	Firm avg. citation	Citation-weighted firm innovation	Market-value firm innovation
	(1)	(2)	(3)	(4)	(5)
CEO citation	0.00412***	0.00993***	0.116***	0.164	-0.312
	(7.42)	(11.71)	(23.81)	(1.20)	(-0.27)
Log (assets)	0.441***	0.523***	0.0725	65.43***	662.2***
	(45.56)	(35.36)	(0.86)	(27.36)	(33.02)
Log (capital intensity)	-0.0300**	-0.0517**	-0.0875	0.693	75.44**
	(-2.54)	(-2.87)	(-0.85)	(0.24)	(3.09)
Stock return	-0.00296**	-0.00451**	-0.0168*	-0.182	-6.879**
	(-2.82)	(-2.81)	(-1.83)	(-0.70)	(-3.16)
Tobin's Q	0.106***	0.168***	0.538***	6.143***	172.5***
	(19.87)	(20.63)	(11.55)	(4.67)	(15.63)
Log (1+tenure)	0.00475	0.0149	-0.0462	0.894	-24.17
	(0.53)	(1.08)	(-0.59)	(0.40)	(-1.30)
CEO age	-0.0122***	-0.0153***	-0.0367**	-2.239***	-7.231**
	(-7.82)	(-6.40)	(-2.69)	(-5.81)	(-2.24)
Log (1+delta)	-0.000509	0.00188	0.251**	3.731*	87.10***
	(-0.06)	(0.13)	(3.13)	(1.65)	(4.59)
Log(1+vega)	0.105***	0.145***	0.361***	2.013	-37.17**
	(12.51)	(11.31)	(4.92)	(0.97)	(-2.14)
Year fixed effects	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y
Adjusted R-square	0.389	0.367	0.170	0.099	0.160
Observations	13913	13913	13913	13913	13913

Panel C: CEOs' innovative ability measured by CEO avg. citation

	Log (1+ firm patent)	Log (1+ firm citation)	Firm avg. citation	Citation-weighted firm innovation	Market-value firm innovation
	(1)	(2)	(3)	(4)	(5)
CEO avg. citation	0.00689***	0.0231***	0.392***	0.295	0.616
	(4.18)	(9.17)	(27.41)	(0.72)	(0.18)
Log (assets)	0.439***	0.521***	0.0987	65.38***	662.7***
	(45.33)	(35.20)	(1.17)	(27.33)	(33.04)
Log (capital intensity)	-0.0300**	-0.0529**	-0.120	0.688	75.27**
	(-2.54)	(-2.93)	(-1.18)	(0.24)	(3.08)
Stock return	-0.00298**	-0.00453**	-0.0166*	-0.183	-6.874**
	(-2.83)	(-2.81)	(-1.82)	(-0.70)	(-3.15)
Tobin's Q	0.106***	0.169***	0.537***	6.162***	172.4***
	(19.94)	(20.69)	(11.61)	(4.68)	(15.62)
Log (1+tenure)	0.00362	0.0129	-0.0554	0.851	-23.95
	(0.40)	(0.94)	(-0.71)	(0.38)	(-1.29)
CEO age	-0.0122***	-0.0152***	-0.0346**	-2.239***	-7.219**
	(-7.80)	(-6.36)	(-2.55)	(-5.81)	(-2.23)
Log (1+delta)	0.000750	0.00376	0.251**	3.778*	86.81***
	(0.08)	(0.27)	(3.15)	(1.67)	(4.58)
Log(1+vega)	0.106***	0.146***	0.358***	2.034	-37.33**
	(12.56)	(11.34)	(4.90)	(0.98)	(-2.14)
Year fixed effects	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y
Adjusted R-square	0.387	0.365	0.180	0.099	0.160
Observations	13913	13913	13913	13913	13913

Panel D: CEOs' innovative ability measured by CEO cumulative patent

	Log (1+ firm patent)	Log (1+ firm citation)	Firm avg. citation	Citation-weighted firm innovation	Market-value firm innovation
	(1)	(2)	(3)	(4)	(5)
CEO cumulative patent	0.0150***	0.0223***	0.0527***	0.684**	7.152**
	(12.66)	(12.28)	(4.98)	(2.33)	(2.90)
Log (assets)	0.447***	0.528***	0.00142	65.72***	667.1***
	(46.27)	(35.68)	(0.02)	(27.43)	(33.22)
Log (capital intensity)	-0.0341**	-0.0569**	-0.0773	0.499	72.91**
	(-2.90)	(-3.16)	(-0.74)	(0.17)	(2.98)
Stock return	-0.00296**	-0.00453**	-0.0177*	-0.182	-6.855**
	(-2.82)	(-2.82)	(-1.89)	(-0.70)	(-3.15)
Tobin's Q	0.106***	0.170***	0.565***	6.160***	172.2***
	(20.05)	(20.86)	(11.91)	(4.68)	(15.61)
Log (1+tenure)	0.00174	0.00863	-0.104	0.768	-24.55
	(0.19)	(0.63)	(-1.29)	(0.35)	(-1.32)
CEO age	-0.0120***	-0.0150***	-0.0375**	-2.229***	-7.093**
	(-7.71)	(-6.30)	(-2.70)	(-5.79)	(-2.20)
Log (1+delta)	-0.00392	-0.000897	0.299***	3.561	84.10***
	(-0.43)	(-0.06)	(3.67)	(1.57)	(4.43)
Log(1+vega)	0.105***	0.146***	0.393***	2.010	-37.82**
	(12.57)	(11.42)	(5.25)	(0.97)	(-2.17)
Year fixed effects	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y
Adjusted R-square	0.393	0.368	0.138	0.100	0.161
Observations	13913	13913	13913	13913	13913

Panel E: CEOs' innovative ability measured by CEO cumulative citation

	Log (1+ firm patent)	Log (1+ firm citation)	Firm avg. citation	Citation-weighted firm innovation	Market-value firm innovation
	(1)	(2)	(3)	(4)	(5)
CEO cumulative citation	0.000526***	0.000964***	0.00570***	0.0253**	0.00714
	(11.86)	(14.22)	(14.48)	(2.30)	(0.08)
Log (assets)	0.447***	0.532***	0.0780	65.77***	662.6***
	(46.25)	(36.01)	(0.91)	(27.43)	(32.95)
Log (capital intensity)	-0.0329**	-0.0565**	-0.102	0.545	75.31**
	(-2.80)	(-3.14)	(-0.97)	(0.19)	(3.08)
Stock return	-0.00296**	-0.00453**	-0.0175*	-0.182	-6.875**
	(-2.83)	(-2.83)	(-1.88)	(-0.70)	(-3.16)
Tobin's Q	0.106***	0.169***	0.560***	6.151***	172.4***
	(20.00)	(20.84)	(11.87)	(4.67)	(15.63)
Log (1+tenure)	0.00346	0.0114	-0.0931	0.847	-24.01
	(0.39)	(0.83)	(-1.17)	(0.38)	(-1.29)
CEO age	-0.0120***	-0.0150***	-0.0362**	-2.232***	-7.223**
	(-7.74)	(-6.32)	(-2.62)	(-5.79)	(-2.24)
Log (1+delta)	-0.00518	-0.00526	0.243**	3.486	86.82***
	(-0.57)	(-0.38)	(2.99)	(1.54)	(4.57)
Log(1+vega)	0.104***	0.145***	0.377***	1.975	-37.29**
	(12.48)	(11.31)	(5.07)	(0.95)	(-2.14)
Year fixed effects	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y
Adjusted R-square	0.393	0.370	0.149	0.100	0.160
Observations	13913	13913	13913	13913	13913

Panel F: CEOs' innovative ability measured by CEO total avg. citation

	Log (1+ firm patent)	Log (1+ firm citation)	Firm avg. citation	Citation-weighted firm innovation	Market-value firm innovation
	(1)	(2)	(3)	(4)	(5)
CEO total avg. citation	0.0117***	0.0222***	0.179***	0.768***	3.435*
	(12.56)	(15.64)	(21.85)	(3.33)	(1.77)
Log (assets)	0.449***	0.537***	0.151*	66.07***	666.0***
	(46.42)	(36.31)	(1.77)	(27.54)	(33.10)
Log (capital intensity)	-0.0333**	-0.0576**	-0.126	0.447	74.08**
	(-2.84)	(-3.21)	(-1.22)	(0.15)	(3.03)
Stock return	-0.00298**	-0.00455**	-0.0175*	-0.182	-6.869**
	(-2.84)	(-2.85)	(-1.90)	(-0.70)	(-3.15)
Tobin's Q	0.106***	0.168***	0.547***	6.096***	172.0***
	(19.89)	(20.71)	(11.70)	(4.63)	(15.59)
Log (1+tenure)	0.000307	0.00544	-0.139*	0.651	-24.77
	(0.03)	(0.40)	(-1.76)	(0.29)	(-1.33)
CEO age	-0.0116***	-0.0142***	-0.0285**	-2.199***	-7.033**
	(-7.46)	(-5.96)	(-2.08)	(-5.70)	(-2.18)
Log (1+delta)	-0.00583	-0.00698	0.201**	3.317	84.62***
	(-0.64)	(-0.50)	(2.50)	(1.46)	(4.46)
Log(1+vega)	0.106***	0.148***	0.396***	2.059	-37.28**
	(12.70)	(11.58)	(5.38)	(0.99)	(-2.14)
Year fixed effects	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y
Adjusted R-square	0.393	0.372	0.165	0.100	0.160
Observations	13913	13913	13913	13913	13913

3. The first-stage results of the effects of innovator CEOs on firm's innovation from 2SLS using the other six measures of CEOs' innovative ability.

Table 3A

Innovator CEOs and firm's innovation--2SLS first-stage results

This table presents the first-stage results of the effects of innovator CEOs on firm's innovation from 2SLS. Column (1) and (2) presents CEO's innovative ability measured by CEO patent, which is the number of patents the CEO applied in a given year. Column (3) and (4) presents CEO's innovative ability measured by *CEO citation*, which is the number of citations subsequently received by the patents applied for in a given year. Column (5) and (6) presents CEO's innovative ability measured by *CEO cumulative patent*, which is the cumulative number of patents in each year starting from the year of the first patent applied. Column (7) and (8) presents CEO's innovative ability measured by *CEO cumulative citation*, which is the cumulative number of citations subsequently received by the patents applied for in a given year starting from the year of the first patent applied. Column (9) and (10) presents CEO's innovative ability measured by *CEO avg. citation*, which is the ratio of CEO citation over CEO patent. Column (11) and (12) presents CEO's innovative ability measured by *CEO total avg. citation*, which is the ratio of CEO total citation over CEO total patent. *CEO coauthors' ability is calculated as* CEO coauthors' average citation over average patent. CEO coauthors' patents do not include the patents cooperated with the CEO. The odd number columns show the results on the whole sample. The even number columns present the results only including innovator CEOs. Variable definitions are provided in the Appendix. T-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

	CEO patent		CEO citation		CEO cumulative patent		CEO cumulative citation		CEO avg. citation		CEO total avg. citation	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
CEO coauthors' ability	0.0173***	-0.00628	0.476***	0.264**	0.271***	0.0242	10.51***	6.023***	0.184***	0.117***	0.815***	0.465***
	(12.58)	(-1.08)	(23.99)	(3.16)	(29.51)	(0.65)	(44.48)	(6.06)	(27.99)	(4.21)	(88.03)	(12.74)
Log (assets)	-0.0186*	-0.0583	-0.604***	-3.433**	-0.473***	-3.333***	-12.57***	-90.48***	-0.214***	-1.331**	-0.462***	-3.025***
	(-1.82)	(-0.57)	(-4.09)	(-2.35)	(-6.93)	(-5.10)	(-7.15)	(-5.21)	(-4.36)	(-2.75)	(-6.70)	(-4.75)
Log (capital intensity)	0.0192	0.293*	0.0685	-0.140	0.255**	4.643***	3.857*	56.42**	0.0803	0.858	0.126	-0.278
	(1.54)	(1.78)	(0.38)	(-0.06)	(3.07)	(4.38)	(1.81)	(2.01)	(1.35)	(1.09)	(1.51)	(-0.27)
Stock return	-0.000760	-0.0144	-0.0148	-0.453**	-0.00631	-0.0169	-0.202	-1.919	-0.00495	-0.126**	-0.0117	-0.0615
	(-0.69)	(-1.15)	(-0.93)	(-2.54)	(-0.86)	(-0.21)	(-1.07)	(-0.91)	(-0.94)	(-2.13)	(-1.57)	(-0.79)
Tobin's Q	0.00996*	0.0845	0.195**	2.277**	0.00734	0.0340	0.212	5.130	0.0456*	0.543**	0.0152	-0.182
	(1.78)	(1.47)	(2.42)	(2.75)	(0.20)	(0.09)	(0.22)	(0.52)	(1.70)	(1.98)	(0.40)	(-0.50)
Log (1+tenure)	-0.0169*	-0.264**	-0.561***	-6.198***	0.0191	-0.401	-3.257**	-38.95**	-0.153***	-1.740***	-0.000730	-1.149*
	(-1.78)	(-2.64)	(-4.10)	(-4.32)	(0.30)	(-0.62)	(-2.00)	(-2.29)	(-3.38)	(-3.66)	(-0.01)	(-1.84)
CEO age	-0.00493**	-0.0447**	0.0150	0.221	-0.00276	-0.0293	0.276	2.806	0.00279	0.0648	-0.00187	0.106
	(-2.99)	(-2.66)	(0.63)	(0.92)	(-0.25)	(-0.27)	(0.97)	(0.98)	(0.35)	(0.81)	(-0.17)	(1.01)
Log (1+delta)	0.0401***	0.316***	0.414**	2.353*	0.290***	2.364***	9.367***	70.48***	0.103**	0.472	0.251***	0.644
	(4.14)	(3.43)	(2.97)	(1.78)	(4.49)	(3.99)	(5.63)	(4.48)	(2.22)	(1.07)	(3.85)	(1.12)
Log(1+vega)	-0.0136	-0.104	0.267**	2.721**	0.0525	0.373	2.568*	25.40*	0.0813*	0.803*	-0.0693	0.0839
	(-1.53)	(-1.20)	(2.08)	(2.19)	(0.88)	(0.67)	(1.68)	(1.72)	(1.91)	(1.95)	(-1.15)	(0.15)
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Adjusted R-square	0.016	0.014	0.049	0.058	0.073	0.048	0.140	0.062	0.063	0.065	0.378	0.177
Observations	13671	1256	13671	1256	13671	1256	13671	1256	13671	1256	13671	1256

4. The effects of innovator CEOs on firm's innovation from 2SLS regressions using the other six measures of CEOs' innovative ability.

Table 4A
Innovator CEOs and firm's innovation--2SLS results

This table presents the effects of innovator CEOs on firm's innovation from 2SLS regressions. Panel A presents CEO's innovative ability measured by CEO patent, which is the number of patents the CEO applied in a given year. Panel B presents CEO's innovative ability measured by CEO citation, which is the number of citations subsequently received by the patents applied for in a given year. Panel C presents CEO's innovative ability measured by CEO cumulative patent, which is the cumulative number of patents in each year starting from the year of the first patent applied. Panel D presents CEO's innovative ability measured by CEO cumulative citation, which is the cumulative number of citations subsequently received by the patents applied for in a given year starting from the year of the first patent applied. Panel E presents CEO's innovative ability measured by CEO avg. citation, which is the ratio of CEO citation over CEO patent. Panel F presents CEO's innovative ability measured by CEO cumulative avg. citation, which is the ratio of CEO cumulative citation over CEO cumulative patent. Panel H presents CEO's innovative ability measured by CEO total avg. citation, which is the ratio of CEO total citation over CEO total patent. *Firm patent* is the number of patent the firm applied in a given year. *Firm citation* is the number of citations subsequently received by the patents the firm applied in a given year. *Firm avg. citation* is the ratio of firm citations over firm patents. *Citation-weighted firm innovation* is the sum of the weight of citations on each patent plus one for firm i in time t divided by book assets of firm i in year t. *Market-value firm innovation* is total dollar value of innovation produced by firm i in year t divided by book assets of firm i in year t. Instrumental variable is *CEO coauthors' ability* calculated as CEO coauthors' average citation over average patent. CEO coauthors' patents do not include the patents cooperated with the CEO. The odd number columns show the results on the whole sample. The even number columns present the results only including innovator CEOs. All independent variables are lagged by 1 year. Variable definitions are provided in the Appendix. T-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Panel A: CEOs' innovative ability measured by CEO patent

	Log (1+ firm patent)		Log (1+ firm citation)		Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CEO patent	1.089***	-1.324	1.853***	-2.731	0.834***	-1.161	108.7***	-190.8	396.4**	539.5
	(9.86)	(-1.03)	(10.29)	(-1.05)	(9.85)	(-1.05)	(5.26)	(-1.04)	(2.47)	(0.69)
Log (assets)	0.471***	0.473**	0.571***	0.414	0.117***	-0.0362	69.34***	102.9***	680.0***	1130.2***
	(32.31)	(3.14)	(24.04)	(1.35)	(10.51)	(-0.28)	(25.41)	(4.79)	(32.14)	(12.27)
Log (capital intensity)	-0.0602***	0.436	-0.0996***	0.889	-0.0405**	0.385	-2.304	49.93	65.19**	-231.4
	(-3.44)	(1.02)	(-3.49)	(1.03)	(-3.01)	(1.05)	(-0.70)	(0.82)	(2.56)	(-0.89)
Stock return	-0.00244	-0.0285	-0.00360	-0.0603	-0.00155	-0.0278	-0.133	-3.153	-6.743**	-16.98
	(-1.59)	(-1.10)	(-1.44)	(-1.15)	(-1.32)	(-1.24)	(-0.46)	(-0.85)	(-3.03)	(-1.07)
Tobin's Q	0.0946***	0.192	0.149***	0.369	0.0597***	0.157	5.065***	19.39	169.7***	113.0
	(11.97)	(1.40)	(11.55)	(1.32)	(9.86)	(1.32)	(3.42)	(0.99)	(14.79)	(1.35)
Log (1+tenure)	0.0191	-0.379	0.0403*	-0.798	0.0171*	-0.364	2.097	-56.84	-21.11	144.9
	(1.44)	(-1.03)	(1.86)	(-1.07)	(1.68)	(-1.15)	(0.84)	(-1.09)	(-1.09)	(0.65)
CEO age	-0.00612**	-0.101*	-0.00476	-0.175	0.000843	-0.0640	-1.620***	-15.05*	-4.639	-18.11
	(-2.57)	(-1.68)	(-1.23)	(-1.44)	(0.46)	(-1.23)	(-3.63)	(-1.75)	(-1.34)	(-0.49)
Log (1+delta)	-0.0542***	0.599	-0.0858***	1.124	-0.0354**	0.452	-1.393	104.1*	70.39***	415.2
	(-3.75)	(1.44)	(-3.65)	(1.33)	(-3.19)	(1.26)	(-0.52)	(1.76)	(3.36)	(1.64)
Log(1+vega)	0.120***	-0.0907	0.169***	-0.181	0.0660***	-0.0549	3.305	-59.71**	-34.19*	-414.2***
	(9.61)	(-0.49)	(8.34)	(-0.48)	(6.91)	(-0.34)	(1.42)	(-2.24)	(-1.89)	(-3.63)
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Adjusted R-square	.	.	.	.	.	.	.	.	0.139	0.082
Observations	13671	1256	13671	1256	13671	1256	13671	1256	13671	1256

Panel B: CEOs' innovative ability measured by CEO citation

	Log (1+ firm patent)		Log (1+ firm citation)		Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CEO citation	0.0396***	0.0315**	0.0675***	0.0649**	0.0304***	0.0276**	3.957***	4.535**	14.43**	-12.82
	(12.58)	(2.91)	(13.84)	(3.13)	(13.20)	(3.04)	(5.61)	(2.30)	(2.49)	(-0.81)
Log (assets)	0.474***	0.658***	0.577***	0.796***	0.120***	0.126**	69.70***	129.6***	681.3***	1054.7***
	(41.30)	(9.98)	(32.49)	(6.29)	(14.33)	(2.28)	(27.08)	(10.75)	(32.23)	(10.95)
Log (capital intensity)	-0.0421**	0.0518	-0.0687**	0.0964	-0.0266**	0.0478	-0.491	-5.403	71.80**	-74.91
	(-3.11)	(0.64)	(-3.28)	(0.62)	(-2.68)	(0.71)	(-0.16)	(-0.37)	(2.88)	(-0.64)
Stock return	-0.00268**	0.00477	-0.00402**	0.00832	-0.00173**	0.00140	-0.157	1.637	-6.832**	-30.53**
	(-2.24)	(0.63)	(-2.16)	(0.57)	(-1.98)	(0.22)	(-0.58)	(1.18)	(-3.09)	(-2.75)
Tobin's Q	0.0977***	0.00840	0.154***	-0.00928	0.0621***	-0.00433	5.376***	-7.062	170.8***	187.8***
	(15.88)	(0.23)	(16.18)	(-0.13)	(13.83)	(-0.14)	(3.90)	(-1.05)	(15.08)	(3.50)
Log (1+tenure)	0.0230**	0.166**	0.0468**	0.325**	0.0201**	0.113	2.482	21.59	-19.70	-76.92
	(2.20)	(2.00)	(2.90)	(2.04)	(2.63)	(1.62)	(1.06)	(1.42)	(-1.03)	(-0.63)
CEO age	-0.0121***	-0.0490***	-0.0149***	-0.0676***	-0.00372**	-0.0182**	-2.215***	-7.528***	-6.807**	-39.38**
	(-6.74)	(-5.87)	(-5.37)	(-4.22)	(-2.84)	(-2.59)	(-5.51)	(-4.93)	(-2.06)	(-3.23)
Log (1+delta)	-0.0269**	0.106**	-0.0394**	0.109	-0.0145*	0.0204	1.328	33.16***	80.31***	615.8***
	(-2.51)	(1.98)	(-2.38)	(1.05)	(-1.85)	(0.45)	(0.55)	(3.38)	(4.07)	(7.84)
Log(1+vega)	0.0944***	-0.0387	0.126***	-0.0737	0.0465***	-0.00933	0.765	-52.23***	-43.45**	-435.3***
	(9.67)	(-0.72)	(8.36)	(-0.72)	(6.53)	(-0.21)	(0.35)	(-5.35)	(-2.42)	(-5.58)
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Adjusted R-square	0.204	.	0.152	.	0.130	.	0.050	.	0.151	0.346
Observations	13671	1256	13671	1256	13671	1256	13671	1256	13671	1256

Panel C: CEOs' innovative ability measured by CEO cumulative patent

	Log (1+ firm patent)		Log (1+ firm citation)		Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CEO cumulative patent	0.0696***	0.344	0.119***	0.709	0.0533***	0.302	6.952***	49.54	25.35**	-140.1
	(13.39)	(0.66)	(14.58)	(0.66)	(13.54)	(0.66)	(5.67)	(0.64)	(2.50)	(-0.50)
Log (assets)	0.483***	1.697	0.593***	2.937	0.127***	1.037	70.60***	279.1	684.6***	631.8
	(44.01)	(0.96)	(34.53)	(0.80)	(15.27)	(0.66)	(27.25)	(1.06)	(31.95)	(0.66)
Log (capital intensity)	-0.0571***	-1.550	-0.0943***	-3.206	-0.0381***	-1.357	-1.990	-236.1	66.33**	577.4
	(-4.44)	(-0.63)	(-4.70)	(-0.63)	(-3.91)	(-0.62)	(-0.66)	(-0.64)	(2.65)	(0.44)
Stock return	-0.00283**	-0.00367	-0.00426**	-0.00908	-0.00185**	-0.00600	-0.171	0.422	-6.885**	-27.09*
	(-2.51)	(-0.13)	(-2.42)	(-0.16)	(-2.16)	(-0.24)	(-0.65)	(0.10)	(-3.13)	(-1.82)
Tobin's Q	0.105***	0.0684	0.166***	0.114	0.0677***	0.0483	6.097***	1.582	173.4***	163.4**
	(18.28)	(0.55)	(18.55)	(0.44)	(15.56)	(0.44)	(4.50)	(0.09)	(15.49)	(2.44)
Log (1+tenure)	-0.000612	0.108	0.00669	0.207	0.00200	0.0630	0.128	13.34	-28.29	-53.60
	(-0.06)	(0.36)	(0.44)	(0.33)	(0.27)	(0.24)	(0.06)	(0.30)	(-1.49)	(-0.33)
CEO age	-0.0113***	-0.0319	-0.0136***	-0.0325	-0.00312**	-0.00325	-2.136***	-5.074	-6.521**	-46.32**
	(-6.69)	(-0.79)	(-5.14)	(-0.39)	(-2.44)	(-0.09)	(-5.37)	(-0.85)	(-1.98)	(-2.14)
Log (1+delta)	-0.0307**	-0.633	-0.0459**	-1.416	-0.0174**	-0.628	0.950	-73.31	78.93***	916.9
	(-3.03)	(-0.50)	(-2.90)	(-0.54)	(-2.27)	(-0.56)	(0.40)	(-0.39)	(4.00)	(1.36)
Log(1+vega)	0.101***	-0.0812	0.138***	-0.161	0.0518***	-0.0466	1.457	-58.35	-40.93**	-418.0**
	(11.09)	(-0.29)	(9.67)	(-0.28)	(7.49)	(-0.19)	(0.68)	(-1.41)	(-2.30)	(-2.80)
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Adjusted R-square	0.297	.	0.236	.	0.172	.	0.070	.	0.158	.
Observations	13671	1256	13671	1256	13671	1256	13671	1256	13671	1256

Panel D: CEOs' innovative ability measured by CEO cumulative citation

	Log (1+ firm patent)		Log (1+ firm citation)		Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CEO cumulative citation	0.00179***	0.00138***	0.00305***	0.00285***	0.00137***	0.00121***	0.179***	0.199**	0.653**	-0.562
	(13.97)	(4.34)	(15.51)	(4.97)	(14.42)	(4.36)	(5.72)	(2.89)	(2.50)	(-0.83)
Log (assets)	0.473***	0.675***	0.575***	0.830***	0.119***	0.141***	69.56***	132.0***	680.8***	1047.9***
	(45.83)	(14.38)	(36.34)	(9.82)	(15.55)	(3.44)	(27.64)	(12.99)	(32.41)	(10.52)
Log (capital intensity)	-0.0463***	-0.0305	-0.0759***	-0.0733	-0.0298**	-0.0243	-0.911	-17.26	70.27**	-41.39
	(-3.78)	(-0.52)	(-4.05)	(-0.70)	(-3.28)	(-0.48)	(-0.31)	(-1.37)	(2.82)	(-0.33)
Stock return	-0.00290**	-0.00683*	-0.00439**	-0.0156**	-0.00190**	-0.00878**	-0.179	-0.0341	-6.913**	-25.80**
	(-2.69)	(-1.67)	(-2.65)	(-2.11)	(-2.38)	(-2.46)	(-0.68)	(-0.04)	(-3.15)	(-2.97)
Tobin's Q	0.105***	0.0730***	0.167***	0.124***	0.0678***	0.0523**	6.110***	2.245	173.5***	161.5***
	(19.10)	(3.85)	(19.75)	(3.63)	(16.60)	(3.16)	(4.56)	(0.55)	(15.50)	(4.01)
Log (1+tenure)	0.00656	0.0243	0.0189	0.0336	0.00750	-0.0108	0.844	1.229	-25.68	-19.34
	(0.70)	(0.69)	(1.32)	(0.53)	(1.09)	(-0.35)	(0.37)	(0.16)	(-1.36)	(-0.26)
CEO age	-0.0120***	-0.0459***	-0.0147***	-0.0612***	-0.00364**	-0.0155**	-2.205***	-7.082***	-6.771**	-40.64***
	(-7.41)	(-8.33)	(-5.95)	(-6.17)	(-3.04)	(-3.22)	(-5.60)	(-5.94)	(-2.06)	(-3.48)
Log (1+delta)	-0.0273**	0.0831**	-0.0401**	0.0608	-0.0148**	0.0000316	1.288	29.81***	80.17***	625.3***
	(-2.83)	(2.12)	(-2.71)	(0.86)	(-2.06)	(0.00)	(0.55)	(3.51)	(4.08)	(7.51)
Log(1+vega)	0.100***	0.0119	0.136***	0.0306	0.0511***	0.0351	1.362	-44.94***	-41.27**	-455.9***
	(11.46)	(0.39)	(10.16)	(0.56)	(7.86)	(1.33)	(0.64)	(-6.88)	(-2.32)	(-7.12)
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Adjusted R-square	0.354	0.228	0.324	.	0.271	0.034	0.087	0.180	0.158	0.379
Observations	13671	1256	13671	1256	13671	1256	13671	1256	13671	1256

Panel E: CEOs' innovative ability measured by CEO avg. citation

	Log (1+ firm patent)		Log (1+ firm citation)		Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CEO avg. citation	0.102***	0.0712***	0.174***	0.147***	0.0785***	0.0625***	10.23***	10.26**	37.28**	-29.01
	(12.85)	(3.34)	(14.23)	(3.76)	(13.63)	(3.67)	(5.64)	(2.58)	(2.49)	(-0.82)
Log (assets)	0.472***	0.645***	0.574***	0.768***	0.119***	0.115**	69.50***	127.7***	680.6***	1060.1***
	(42.16)	(11.74)	(33.32)	(7.62)	(14.65)	(2.61)	(27.27)	(12.46)	(32.37)	(11.64)
Log (capital intensity)	-0.0476***	-0.0137	-0.0781***	-0.0387	-0.0308**	-0.00961	-1.041	-14.84	69.79**	-48.23
	(-3.58)	(-0.19)	(-3.82)	(-0.29)	(-3.20)	(-0.16)	(-0.34)	(-1.08)	(2.80)	(-0.39)
Stock return	-0.00276**	-0.000488	-0.00415**	-0.00252	-0.00179**	-0.00321	-0.165	0.880	-6.860**	-28.39**
	(-2.35)	(-0.08)	(-2.30)	(-0.24)	(-2.11)	(-0.69)	(-0.62)	(0.81)	(-3.11)	(-2.94)
Tobin's Q	0.101***	0.0414	0.159***	0.0589	0.0645***	0.0246	5.682***	-2.304	171.9***	174.4***
	(16.80)	(1.55)	(17.28)	(1.20)	(14.88)	(1.15)	(4.16)	(-0.46)	(15.28)	(3.93)
Log (1+tenure)	0.0164	0.0945*	0.0357**	0.178*	0.0151**	0.0508	1.830	11.34	-22.08	-47.93
	(1.62)	(1.67)	(2.29)	(1.72)	(2.05)	(1.12)	(0.79)	(1.08)	(-1.16)	(-0.51)
CEO age	-0.0118***	-0.0466***	-0.0144***	-0.0628***	-0.00348**	-0.0161**	-2.184***	-7.188***	-6.695**	-40.34***
	(-6.70)	(-6.50)	(-5.32)	(-4.77)	(-2.75)	(-2.82)	(-5.47)	(-5.38)	(-2.03)	(-3.39)
Log (1+delta)	-0.0211**	0.147***	-0.0294*	0.192**	-0.00999	0.0559*	1.914	38.99***	82.45***	599.3***
	(-2.02)	(3.54)	(-1.84)	(2.53)	(-1.33)	(1.69)	(0.81)	(5.04)	(4.22)	(8.72)
Log(1+vega)	0.0966***	-0.0103	0.130***	-0.0151	0.0482***	0.0156	0.990	-48.13***	-42.63**	-446.9***
	(10.13)	(-0.24)	(8.87)	(-0.20)	(7.00)	(0.47)	(0.46)	(-6.16)	(-2.38)	(-6.43)
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Adjusted R-square	0.237	.	0.198	.	0.183	.	0.062	.	0.154	0.361
Observations	13671	1256	13671	1256	13671	1256	13671	1256	13671	1256

Panel F: CEOs' innovative ability measured by CEO total avg. citation

	Log (1+ firm patent)		Log (1+ firm citation)		Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CEO total avg. citation	0.0231***	0.0179***	0.0394***	0.0369***	0.0177***	0.0157***	2.309***	2.577**	8.420**	-7.287
	(14.31)	(4.92)	(15.96)	(6.00)	(14.82)	(5.05)	(5.75)	(3.15)	(2.50)	(-0.84)
Log (assets)	0.461***	0.604***	0.555***	0.684***	0.110***	0.0789**	68.38***	121.8***	676.5***	1076.7***
	(46.56)	(18.40)	(36.71)	(12.32)	(15.02)	(2.81)	(27.80)	(16.50)	(32.82)	(13.72)
Log (capital intensity)	-0.0423***	0.0523	-0.0691***	0.0975	-0.0267**	0.0483	-0.512	-5.322	71.72**	-75.14
	(-3.55)	(1.10)	(-3.80)	(1.21)	(-3.03)	(1.19)	(-0.17)	(-0.50)	(2.89)	(-0.66)
Stock return	-0.00300**	-0.00838**	-0.00455**	-0.0188**	-0.00198**	-0.0101***	-0.188	-0.257	-6.947**	-25.17**
	(-2.84)	(-2.33)	(-2.83)	(-3.09)	(-2.53)	(-3.30)	(-0.72)	(-0.32)	(-3.17)	(-2.93)
Tobin's Q	0.105***	0.0834***	0.167***	0.145***	0.0678***	0.0614***	6.113***	3.735	173.5***	157.3***
	(19.57)	(4.97)	(20.34)	(5.13)	(17.06)	(4.29)	(4.58)	(0.99)	(15.53)	(3.93)
Log (1+tenure)	0.000733	-0.00894	0.00898	-0.0349	0.00303	-0.0399	0.263	-3.554	-27.80	-5.815
	(0.08)	(-0.31)	(0.65)	(-0.70)	(0.45)	(-1.60)	(0.12)	(-0.54)	(-1.47)	(-0.08)
CEO age	-0.0114***	-0.0439***	-0.0138***	-0.0572***	-0.00323**	-0.0137***	-2.151***	-6.797***	-6.575**	-41.45***
	(-7.25)	(-9.06)	(-5.74)	(-6.98)	(-2.77)	(-3.32)	(-5.49)	(-6.24)	(-2.00)	(-3.58)
Log (1+delta)	-0.0163*	0.169***	-0.0214	0.238***	-0.00636	0.0753**	2.387	42.17***	84.17***	590.3***
	(-1.75)	(6.24)	(-1.51)	(5.20)	(-0.92)	(3.26)	(1.03)	(6.94)	(4.34)	(9.14)
Log(1+vega)	0.107***	0.0455*	0.147***	0.0998**	0.0558***	0.0645**	1.982	-40.11***	-39.01**	-469.6***
	(12.48)	(1.81)	(11.28)	(2.35)	(8.84)	(3.00)	(0.93)	(-7.09)	(-2.20)	(-7.81)
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Adjusted R-square	0.385	0.399	0.362	0.279	0.309	0.279	0.098	0.312	0.161	0.386
Observations	13671	1256	13671	1256	13671	1256	13671	1256	13671	1256

5. CEO exogenous turnover

Another way that I deal with the endogeneity problem is to use an exogenous shock, CEO exogenous turnover. CEO turnover data is from Eisfeldt and Kuhnen (2013). Eisfeldt and Kuhnen (2013) classify CEO turnovers during 1992 to 2006 as exogenous turnover (29.25%), forced turnover (15.52%) and unclassified departures (55.23%). They define CEO exogenous turnover as planned retirements announced at least six months before the succession retirements, or caused by a well-specified health problem.

I identify firms in which an innovator CEO was replaced by a non-innovator CEO as treated firms. In order to have a cleaner test, I exclude firms that have a non-innovator CEO replaced by an innovator CEO, and an innovator CEO replaced by another innovator CEO. Then, I merge the treated firms with CEO exogenous turnover data. In my sample, there are a total of 385 exogenous turnover events, including 30 innovator CEO exogenous turnover events and 355 non-innovator CEO exogenous turnover events. I successfully matched the 30 innovator CEO exogenous turnover events with 59 non-innovator CEO exogenous turnover events based on turnover year, firm size and industry. Using the 89 exogenous turnover events, I examine a difference-in-difference model using firm-year observations three years before and after CEO turnover events. Specifically, the difference-in-difference model is defined in equation (8).

$$Firm\ innovation_{i,t+n}$$
$$= \alpha_1 + \beta_1 Treated\ firm * exogenous\ turnover + \beta_2 Treated\ firm$$
$$+ \beta_3 Exogenous\ turnvoer + Other\ control\ variables + \varepsilon_i , (8)$$

where $Treated\ firm$ is a dummy variable equal to 1 if a firm's CEO changes from innovator CEO to non-innovator CEO, and $Exogenous\ turnover$ is a dummy variable equal to 1 if the year is after CEO exogenous turnover year. All other variables are as previously defined. The coefficient β_1 on the interaction term, $Treated\ firm * exogenous\ turnover$, is the results of difference-in-difference method. I expect β_1 to be negatively significant when a firm experiences an innovator CEO replaced by a non-innovator CEO, a firm's innovation should decline significantly.

Table 5A presents the difference-in-difference results. The odd number columns report the difference-in-difference results without any controls. The even number columns show the difference-in-difference results with firm characteristics and CEO characteristics controls, year fixed effects and firm fixed effects. As expected, the interaction term, $Treated\ firm * exogenous\ turnover$, is negatively significant related to firm's innovation as measured by firm citation and the firm average citation per patent, suggesting that the decreased firm's innovation is caused by the depart of innovator CEOs. The results support my first hypothesis that an innovator CEO increases a firm's innovation.

Table 5A
Innovator CEOs and firm's innovation--Difference in difference results

This table presents the effects of innovator CEOs on firm's innovation from difference in difference results. *Exogenous turnover* is defined as CEO departures classified as planned retirements or caused by a well-specified health problem (Eisfeldt and Kuhnen, 2013) and is a dummy variable equal to 1 if the year is after CEO exogenous turnover year. Treated firm is a dummy variable equal to 1 if a firm's CEO changes from innovator CEO to non-innovator CEO. *Firm patent* is the number of patent the firm applied in a given year. *Firm citation* is the number of citations subsequently received by the patents the firm applied in a given year. *Firm avg. citation* is the ratio of firm citations over firm patents. *Citation-weighted firm innovation* is the sum of the weight of citations on each patent plus one for firm i in time t divided by book assets of firm i in year t. *Market-value firm innovation* is total dollar value of innovation produced by firm i in year t divided by book assets of firm i in year t. All independent variables are lagged by 1 year. Variable definitions are provided in the Appendix. T-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

	Log (1+ firm patent)		Log (1+ firm citation)		Firm avg. citation		Citation-weighted firm innovation		Market-value firm innovation	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Exogenous turnover * Treated firm	0.119	-0.310	-0.340	-0.942*	-4.722**	-6.414**	8.880	-1.558	260.0	197.9
	(0.37)	(-1.01)	(-0.66)	(-1.76)	(-2.04)	(-2.88)	(0.35)	(-0.08)	(0.86)	(1.27)
Treated firm	0.258	0.503**	0.505	0.854**	1.896	3.719*	10.63	38.15**	74.69	208.8**
	(1.31)	(2.94)	(1.60)	(2.74)	(1.33)	(1.82)	(0.68)	(3.22)	(0.40)	(2.91)
Exogenous turnover	0.138	0.0368	0.189	0.154	0.124	1.755	8.157	-6.194	219.2	-37.16
	(0.64)	(0.19)	(0.55)	(0.45)	(0.08)	(1.18)	(0.47)	(-0.86)	(1.07)	(-0.80)
Log (assets)		0.531***		0.607***		-0.833		23.49***		216.2***
		(9.51)		(5.93)		(-1.53)		(5.81)		(5.14)
Log (capital intensity)		0.0633		0.0466		-0.293		3.084		47.61**
		(0.99)		(0.41)		(-0.62)		(1.19)		(2.06)
Stock return		-0.0606		-0.168**		-0.634**		0.557		-6.563
		(-1.55)		(-2.28)		(-2.03)		(0.25)		(-0.24)
Tobin's Q		0.0106		0.0124		-0.0824		-2.937**		11.21
		(0.30)		(0.19)		(-0.33)		(-2.06)		(0.66)
Log (1+tenure)		-0.109**		-0.0690		0.421		-9.512**		-55.74
		(-2.12)		(-0.76)		(1.08)		(-2.37)		(-1.32)
CEO age		-0.0241**		-0.0408**		0.0470		-0.0524		2.064
		(-2.25)		(-2.11)		(0.38)		(-0.12)		(0.50)
Log (1+delta)		0.140**		0.155*		-0.556		4.528*		62.29**
		(2.86)		(1.74)		(-1.04)		(1.73)		(2.32)
Log(1+vega)		0.0388		0.0638		0.758**		3.082		-12.54
		(0.81)		(0.77)		(2.39)		(1.36)		(-0.59)
Constant	1.633***	-1.367**	2.878***	-0.0543	8.194***	8.958	36.38***	-136.9***	158.5	-1777.2***
	(13.94)	(-1.98)	(15.31)	(-0.04)	(9.64)	(1.25)	(3.89)	(-3.64)	(1.43)	(-4.04)
Year fixed effects	N	Y	N	Y	N	Y	N	Y	N	Y
Industry fixed effects	N	Y	N	Y	N	Y	N	Y	N	Y
R-square	0.014	0.360	0.006	0.194	0.016	0.046	0.006	0.322	0.018	0.287
Observations	443	360	443	360	443	360	443	360	443	360

6. Propensity score matching characteristics.

Table 6A

Innovator CEOs and firm's innovation--Propensity score matching characteristics

This table presents the matching characteristics for propensity score matching procedures. All the variables are defined in the Appendix. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Matching variables	Innovator CEO	Non-innovator CEO	Differences
Log (assets)	6.16	6.34	-0.18***
Log (capital intensity)	3.69	3.68	0.009
Stock return	0.13	0.09	0.04
Tobin's Q	2.19	2.04	0.15*
Log (1+tenure)	3.78	3.81	-0.03
CEO age	55.80	56.28	0.39
Log (1+delta)	4.78	4.84	-0.063
Log(1+vega)	3.11	3.14	-0.03