

SUPERSTAR CEOs AND INNOVATION

by

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A DISSERTATION

Presented to the Department of Finance
and the Graduate School of the University of Oregon
in partial fulfillment of the requirements
for the degree of
Doctor of Philosophy

June 2015

DISSERTATION APPROVAL PAGE

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Title: Superstar CEOs and Innovation

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Degree awarded June 2015

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DISSERTATION ABSTRACT

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Doctor of Philosophy

Department of Finance

June 2015

Title: Superstar CEOs and Innovation

I empirically evaluate three theoretical views of whether and how winning a high-profile CEO award affects innovation decisions. The agency theory predicts that receiving an award will increase managerial entrenchment and reduce managers' efforts to create valuable innovations because they will either pursue value-decreasing pet projects or simply enjoy the quiet life (agency hypothesis). Conversely, the managerial myopia theory predicts that these awards may increase managerial job security and allow the CEO to focus on long-term innovative projects rather than on boosting the stock price through current earnings. Finally, the overconfidence theory predicts that these awards increase managerial incentives to innovate if they make CEOs overconfident. In my first set of tests, I find evidence that is consistent with the managerial myopia and overconfidence theories: award-winning CEOs innovate more than otherwise similar CEOs who do not win awards, both in terms of the number of patents and the number of citations per patent during the period 1992–2002. After further examination, the evidence continues to be consistent with the managerial myopia theory: there is a clear increase in CEO power and job security after winning a prestigious award and no such increase in overconfidence. I also document that the positive effect of CEO awards on innovation is weaker for firms with high institutional ownership. Overall, the evidence suggests that

winning a prestigious award relieves managerial myopia and brings positive long-term benefits for the firm.

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ACKNOWLEDGMENTS

First and foremost, I would like to thank God for giving me the power and wisdom to pursue my dreams. I could never have done this without the faith in You, the Almighty. I wish to express the deepest appreciation to my committee chair, Dr. Julian Atanassov, for excellent guidance and support throughout this process. I would also like to thank Dr. Diane Del Guercio, Dr. Bhagwat, and Dr. Waddell for serving on the committee. Additionally, I am grateful to John Becker-Blease, Ro Gutierrez, Xiaoding Liu, Stephen McKeon, Donna Paul, Hai Tran, Jay Wang, and Jonathan Witmer for helpful comments.

Special thanks go to my parents who have encouraged and supported for my education for the past 20 years. Lastly, I would like to thank my wife, Jakyong Kim. Without her constant encouragement, sacrifices, patience, and unwavering love, I undeniably would not have been able to do this.

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CHAPTER I

INTRODUCTION

Fast-growing compensations and perks given to celebrity CEOs are subject of debate among practitioners and academics. The value consequences of a CEO's superstar status is ambiguous because it is unclear whether larger compensations and greater perks are designed by shareholders as incentive schemes for CEOs or are extracted by powerful CEOs due to their heightened status in the public media. Malmendier and Tate (2009) show that superstar CEOs tend to extract rents from shareholders using their heightened status and power and are often distracted from their core operational responsibilities, which leads to underperformance relative to their peers. In this paper I investigate whether there might be a bright side to superstar CEOs that has not been uncovered in the extant literature. Specifically, rather than focusing on short-term accounting and stock performance, I examine whether superstar CEOs achieve greater long-term success than their benchmarks. I use prestigious awards conferred by major national magazines in the U.S. to identify a shock in which CEOs achieve superstar status. I use innovative output as a measure of the long-term performance.¹

Achieving superstar CEO status by receiving a high-profile CEO award can affect CEOs' long-term incentives via greater power (and in turn, greater job security) as a result of winning the award. Hermalin and Weisbach (1998) argue that the effectiveness of monitoring a CEO depends on her perceived ability relative to a replacement. Winning

¹ Innovation is considered one of the most important determinants of long-term economic growth and value creation for a firm (Hall, Jaffe, and Trajtenberg, 2005). The innovation literature also suggests that innovation is a strong indicator of a firm's long-term performance (Cohen, Diether, and Malloy, 2013; Hirshleifer, Hsu, and Li, 2013).

such an award conveys additional information to the boards that their CEO is of exceptionally good quality, resulting in less effective monitoring of the CEO. In addition, if a CEO wins a prestigious award, the perception by the shareholders of the CEO's quality (justified or not) improves. If the board fires such a superstar CEO, it may suffer a backlash from shareholders since boards are often susceptible to the voice of shareholders (Fisman, Khurana, and Rhodes-Kropf, 2013) or the public opinion, more generally.

Given the argument that award-winning CEOs achieve greater power and job security, two strands of research make contradictory predictions about the effect of winning a prestigious award on innovation. The agency theory presented by Jensen (1988) argues that more powerful managers are also more entrenched. They will waste corporate resources in pursuing value-destroying pet projects or will just enjoy the quiet life (Bertrand and Mullainathan, 2003). Managers will spend less time, effort, and resources for technologically innovative projects that maximize shareholder wealth and help the firm thrive in the long-run. They will also be slow in responding to technological changes, and as a result the firm will lag behind its competitors. Therefore, the agency hypothesis predicts that winning an award will lead to less innovation.

On the other hand, Stein (1988, 1989) suggests that, due to asymmetric information, the stock market may undervalue the stocks of firms that invest in long-term innovative projects. Consequently, to protect current shareholders and themselves from dismissal due to perceived poor performance, managers are more likely to focus on boosting current earnings at the expense of novel projects. Under this managerial myopia view, managers tend to invest in long-term and innovative projects if they have more power and face a lower threat of job dismissal. Manso (2011) analytically demonstrates

that greater job security may allow managers greater leeway to experiment with new technologies and, as a result, to pursue more novel projects. Therefore, based on the managerial myopia hypothesis, receiving a high-profile award can spur innovation.

It is important to note that winning a high-profile award may not only affect CEO power but may change aspects of the CEO's psychology after the award. Receiving a high-profile award, conferred by reliable outside authorities such as *Business Week*, *Forbes*, etc., can affect CEOs' beliefs in their own abilities and future outcomes, causing them to become overconfident. Hirshleifer, Low, and Teoh (2012) find that overconfident managers achieve greater success in patenting activities. Based on the overconfidence hypothesis, therefore, I expect that award-winning CEOs innovate more.

I use data on prestigious CEO awards as an external shock to the CEO status in the firm, and examine the effect of winning such a prestigious award on innovation. I argue that winning an award shifts a CEO's status permanently (for the rest of his tenure). Since the counterfactual is not observable (i.e., the innovation outputs if the same CEO at the same firm had not won an award), and award-winners and non-winners are different across many dimensions, I perform a propensity score matching as a main identification strategy.² Using the number of patents and the number of citations per patent as a measure of the quantity and quality of innovation output, I find that CEOs who win high-profile awards during the period 1992-2002 are more innovative after the awards than similar CEOs who do not win awards (predicted winners). Specifically, in the four-year period following the award, the average actual winner produces 28.13% more patents

² A propensity score matching, unlike a conventional regression model, matches award-winning CEOs with otherwise similar CEOs who do not receive an award. The matching procedure is performed based on observable firm/CEO characteristics including their past innovation levels. Furthermore it helps track changes in CEO behavior after winning an award.

than the average predicted winner. Furthermore, the number of citations per patent for the average actual award-winner is 25.97% greater than the average predicted winner.

I perform several robustness tests of my inference that superstar CEOs become better innovators. First, I test whether winning a prestigious award has an impact on innovation if I assume that the effect of winning an award is temporary (just for the year of the award) rather than permanent.³ Second, I investigate whether the positive award effects exist outside of the sample period (the period prior to 1992) to check if the effects are driven by period-specific factors that are correlated with winning an award and innovation decisions in the firm. Third, instead of relying on a propensity score matching, I implement a Heckman selection model, which mitigates the endogeneity problem that arises from a potential omitted-variable bias. In all robustness tests, I find similar results - the award has positive effects on innovation.

The positive relationship between winning a prestigious award and a firm's innovation is subject to potential endogeneity problems. First, CEO unobservable skills might drive the positive effect of winning an award on innovation. To address this concern, I control for CEO past performance in the matching procedure to capture much of their unobservable skill. To eliminate potential omitted variable bias arising from any unobservable firm characteristics, I employ firm fixed effects, in the Heckman selection model. Second, rather than winning an award positively affecting CEOs' innovation decisions, it is possible that more innovative CEOs are more likely to receive a prestigious award and continue to achieve greater success in innovation. I alleviate this problem by controlling for CEOs' innovation achievements prior to the award.

³ The finding remains robust regardless of whether I use only the first lifetime awards of the award-winners or all lifetime awards to the same CEO.

In further tests I evaluate the managerial myopia vs. the overconfidence theories. Specifically, I examine the possible mechanisms through which winning an award affects innovation. Consistent with the managerial power hypothesis, I show that there is a clear increase in CEO power and job security after winning a prestigious award. First, I determine that award-winning CEOs' level of compensation increases significantly more than the benchmark CEOs' compensation after the award during the period 1992-2011.⁴ In addition, I find similar results for CEO excess compensation, which I estimate here using Core, Guay, and Larcker's (2008) method. This evidence suggests that award-winning CEOs tend to extract rent using their enhanced power in the firm.

The results also show that award-winners have lower turnover-performance sensitivity than non-winners in the two years following the award. In other words, winning a prestigious award shifts power towards the CEOs and they are less likely to be fired by the board than otherwise similar CEOs, even when they underperform. These two findings provide clear evidence that award-winning CEOs become more powerful and achieve a greater job security.

I fail to find evidence consistent with the overconfidence hypothesis. Using an option-based measure of overconfidence (Campbell et al., 2011; Hirshleifer et al., 2012), I fail to find evidence that winning an award has a significant effect on CEO overconfidence. This finding indicates that overconfidence might not be the main source of the positive effect of winning a prestigious award on innovation. I also show that the award effect on innovation remains statistically and economically significant even after

⁴ This finding is consistent with Malmendier and Tate (2009) who conduct their analysis over the period 1992-2002.

controlling for managerial overconfidence. The evidence suggests that the shift in power towards award-winning CEOs and the resulting managerial entrenchment and job security is a key determinant of the positive relationship between receiving a prestigious award and innovation.

The magnitude of the award-winning effects on innovation may be heterogeneous across firms. I further explore whether the positive effect of award-winning on innovation is stronger or weaker for firms that have higher institutional ownership. Edmans (2009) and Aghion, Van Reenen, and Zingales (2013) document that institutional investors encourage managers to make decisions to maximize the long-term value of the firm rather than its short-term value. Manso (2011) contends that high institutional ownership is characterized with greater CEO job security and greater focus on long-term goals. This in turn encourages managers to innovate. I find that the positive award-winning effect on innovation is weaker for firms with high institutional ownership than for firms with low ownership. This result suggests that award winning and institutional ownership are substitutes – once the CEO is provided with long-term incentives by high institutional ownership, the additional impact of award-winning will be smaller than for firms with low institutional ownership.

This paper contributes to the extant literature in several ways. First, the recent innovation literature has explored how managerial entrenchment (CEO power) affects corporate innovation. One segment of these studies finds support for the agency view (e.g., Atanassov, 2013), while the other for the managerial myopia view (Becker-Blease,

2011; Acharya, Baghai, and Subramanian, 2012).⁵ The evidence in this paper is consistent with the managerial myopia view in that managers who become more powerful after winning a high-profile award innovate more.

Furthermore, the previous literature shows that powerful CEOs, on average, expropriate shareholders and make value-decreasing decisions such as implementing inefficient pet projects (Jensen, 1988), overpaying the target firm in the takeover market (Masulis, Wang, and Xie, 2007), engaging in a quiet-life (Bertrand and Mullainathan, 2003), designing their own suboptimal compensation schemes (Yermack, 1997; Bebchuk and Fried 2003), or underperforming in a short-run (Malmendier and Tate, 2009). However, most of the existing literature frequently uses protection from hostile takeovers as a proxy for managerial entrenchment, despite the fact that hostile takeovers have largely disappeared over the past two decades. Using a prestigious award, rather than the threat from hostile takeovers, helps researchers identify a more recent shock that in turn illustrates the extent to which managers achieve job security.

Moreover, in employing innovation measures, this study complements the previous literature by providing evidence for a positive aspect of CEO entrenchment: greater job security as a result of winning a high-profile CEO award relieves managerial myopia, resulting in more innovation.⁶ Additionally, the evidence in this paper helps

⁵ Sepra, Subramanian, and Subramania (2013) show that the agency view and the managerial myopia view are only “locally” correct. They argue that a relation between governance mechanisms and innovation is non- monotonic due to the tradeoff decision between expected takeover premiums and expected managerial private benefits of control.

⁶ This study differs in several ways from Malmendier and Tate’s (2009) paper, which was the first to address the effects of winning a prestigious award. First, they investigate how superstar CEOs perform in the three years following the award while I focus on the effects of winning an award on longer term measures of performance, namely innovation outputs. The evidence in this paper, therefore, can be reconciled with Malmendier and Tate’s finding of underperformance by superstar CEOs in that, after winning an award, they achieve greater leeway to maximize the long-term value of the company at the cost

resolve the current puzzling issue of why many firms have actively chosen to weaken shareholders' power while giving power to their CEOs despite the findings in previous literature that managerial power (entrenchment) leads to negative consequences for the firm.⁷

The structure of the rest of this paper is as follows. In Chapter II, I review previous literature related to managerial entrenchment, managerial overconfidence, and corporate innovation, and develop empirical predictions on the effects of winning a prestigious award on innovation. Chapter III describes the data and variable constructions. I report the empirical results and robustness tests in Chapter IV. Conclusions are presented in Chapter V.

of short-term profits. Secondly, Malmendier and Tate see winning a prestigious award as a shock that shifts CEO power temporarily, whereas I consider both possibilities; the power shift as a result of winning a high-profile award can be either permanent or temporary. Lastly, in my robustness check, I use a sample period that extends back to 1976 and test whether the effects of winning an award is time-specific, expanding Malmendier and Tate's sample period by 16 years.

⁷ Facebook, Google, and LinkedIn went public with dual class shares to allow their CEOs to maintain their decision-making power. For example, as of 2014, Mark Zuckerberg controls Facebook personally despite the fact that he owns only about 20 percent of the company due to supervoting "class B" shares. Google issued "class B" and "class C" shares to give a majority of votes to Larry Page and Sergey Brin. In this way, those CEOs can retain their control over their firms without allowing any potential conflicts with other shareholders over the firms' directions.

CHAPTER II

THEORETICAL MOTIVATION

In this study I investigate whether winning a prestigious business award affects a CEO's innovation decision. In this chapter, I review previous literature and develop empirical predictions about the relationship between prestigious CEO awards and innovation in this chapter.

2.1. Theoretical Background and Empirical Prediction

2.1.1. Shift in CEO Power (Entrenchment)

Hermalin and Weisbach (1998) maintain that the effectiveness of monitoring a CEO depends on the CEO's bargaining power over the board and that this bargaining power comes from the board's assessment of the CEO's ability. Winning a prestigious award may convey the additional information that the quality of the CEO is exceptional among potential CEOs in the managerial labor market. Thus, an enhanced perception of the CEO's ability as a result of winning an award leads to less effective monitoring by the board.⁸ Malmendier and Tate (2009) support this argument by providing evidence that by using their increased power, award-winning CEOs tend to extract more rent than non-winners after winning an award, even though they underperform the benchmarks in the three years subsequent to the award. Moreover, the boards allow award-winning CEOs to

⁸ One might argue that the effect of winning a prestigious award on the perceived ability of a CEO is negligible because a prestigious award is given based on publicly available information that boards and shareholders also have. However, Hermalin and Weisbach (1998) argue that the effectiveness of monitoring CEOs depends on CEOs' "relative ability" in comparison to other potential successors and that it is costly for the board to search and evaluate the quality of all potential CEOs outside the firm before their CEO receives the award. Therefore, winning an award delivers the information that the CEO is of exceptionally good quality compared to other CEOs (potential successors), resulting in a positive shift in the CEO's bargaining power over the board.

do non-operational, outside-company activities such as writing books, sitting on more outside boards, and playing more golf. They argue that the increase in compensation and outside activities, despite the underperformance of superstar CEOs, indicate that there is a clear shift in CEO power after winning an award.

Award-winning CEOs are also likely to achieve greater job security after their awards. Fisman, Khurana, and Rhodes-Kropf (2013) argue that if boards are susceptible to biased shareholders' voice (i.e., boards are not insulated from the shareholders), the board cannot often make CEO firing or retaining decisions in a way that maximizes the long-term value of the firm. If a board fires an award-winning CEO, the board may then suffer from shareholder backlash because shareholder assessment of their CEO's quality improves (justified or not) and the shareholders see their CEO as the public face of the firm after the award.

There have been several theoretical and empirical studies about the relationship between CEO entrenchment and innovation. Jensen's (1988) agency view contends that managers have fewer incentives to maximize shareholder value in the absence of a threat of disciplinary takeovers. Powerful CEOs who are not well-monitored or who are not pressured by internal (e.g., a board of directors) and external (e.g., hostile takeovers) governance mechanisms are more likely to exhibit self-dealing behaviors and to engage in value-destroying activities. Thus, the agency view predicts that the threat of dismissal mitigates the agency problem by forcing the CEO to invest in the most innovative and valuable projects. Another version of the agency view is the "quiet life" story. Bertrand and Mullainathan (2003) find that managers protected by state anti-takeover laws are more likely to avoid difficult and risky investments (such as innovative and valuable

projects), and entrenched managers might prefer a quiet life over empire-building. The agency view expects that a power shift towards a CEO leads to either self-dealing behaviors or quiet-life behaviors and that CEOs do not exert themselves on innovative projects since such projects require investment in human capital.

In support of the agency view, Atanassov (2013) examines whether changes in the quality of corporate governance due to shifts in the threat of a hostile takeover (as an exogenous shock to the quality of governance) affect corporate innovation. He concludes that firms incorporated in states that have passed anti-takeover laws innovate less than those incorporated in states that have not passed such laws. Atanassov's study shows that managers who have greater job security because of the passage of these anti-takeover laws are reluctant to invest their human capital in innovative projects, resulting in lower innovation outputs and lower firm values. Based on the agency view, I predict that CEOs who win high-profile awards will innovate less.

Hypothesis 1a: Based on the agency hypothesis, superstar CEOs will innovate less than benchmark CEOs.

Conversely, the managerial myopia theory makes a different prediction on the effect of award-winning on innovation. It suggests that CEOs who face a threat of dismissal have fewer incentives to invest their effort and human capital in innovative projects. Innovative projects can take several years to be realized as profits, and if an incumbent manager is dismissed as a result of a hostile takeover, a new manager could take most of the profits from the innovative products that the previous manager began (Shleifer and Summers, 1988). Stein (1988) and Shleifer and Vishny (1989) also argue

that, because of the threat of dismissal through a hostile takeover, managers are often not willing to invest in long-term innovative projects because the market undervalues those innovative projects and managers may be replaced due to poor stock market performance. Acharya et al. (2012b) show that a decreased threat of dismissal through stringent labor laws leads to more innovation by employees. Manso (2011) contends that innovation typically has a high chance of failure and therefore managers who have an increased threat of job termination are unlikely to choose innovative projects; early failure of such risky innovative projects may cause a board to fire a poor performing CEO. He demonstrates that, under his theoretical framework, managers innovate more if their jobs are secure. Overall, the managerial short-termism view predicts that job security fosters corporate innovation because it encourages managers to invest in long-term, risky, and innovative projects. Therefore, based on the managerial myopia theory, I expect that CEOs who win a prestigious award will innovate more since such a high-profile award enhances the status of CEOs inside the firm and creates job security for them.

Hypothesis 1b: Based on the managerial myopia hypothesis, superstar CEOs will innovate more than benchmark CEOs.

2.1.2. Shift in CEO Overconfidence

Winning a prestigious award can change not only the managerial investment decision horizon corresponding to a shift in managerial power, but also aspects of the psychology of a manager after the award. Thus, it is possible that a change in the psychological traits of the manager as a result of winning a prestigious award also affects a firm's innovation decisions. The most relevant psychological trait (among many

psychological biases) to winning an award might be overconfidence. Overconfidence is the tendency of individuals to think that they have better abilities than they really have, causing them to be more optimistic about their future success without rational reasons. Recent corporate finance literature has investigated how managerial overconfidence affects a firm's decisions such as those pertaining to investment (Malmendier and Tate, 2005a), mergers and acquisitions (Malmendier and Tate, 2008), and financing policies (Malmendier and Tate, 2011). In particular, Hirshleifer et al. (2012) indicate that firms with overconfident CEOs (proxied by options- and press-based measures) invest more in innovation, obtain more patents and patent citations, and achieve greater innovative success for given R&D expenditures. Their study provides interesting findings with regard to high-profile CEO awards. For example, CEOs might become overconfident after they win such prestigious awards; they are likely to overestimate their skills and to have a self-attribution bias. Based on this managerial overconfidence view, I predict that CEOs will innovate more after they win an award.

Hypothesis 2a: Based on the overconfidence hypothesis, superstar CEOs will innovate more than benchmark CEOs.

CHAPTER III

DATA AND METHODOLOGY

3.1. Data

I hand-collect a list of the winners of CEO awards conferred by prominent national magazines between 1976 and 2011. Following Malmendier and Tate (2009), I select CEO awards that meet the following conditions: (1) the magazines that grant the awards are popular and circulated nationally; (2) all CEOs are eligible for an award. As a result, only awards that are conferred by the following magazines are included in my sample: *Business Week*, *Financial World*, *Chief Executive*, *Electronic Business Magazine*, *Ernst & Young*, *Forbes*, *Industry Week*, *Marketwatch.com*, *Morningstar.com*, *Time*, and *Time/CNN*. Among the listed magazines, *Business Week* and *Financial World* provide the majority of the award-winners in this sample.⁹

The CEO award data is then matched with CEO and firm characteristics variables. I obtain CEO demographic and compensation information from the Execucomp database. I attain CEO incentive measures (delta and vega) from Lalitha Naveen's website.¹⁰ I collect CEO turnover data from Kuhnen's website.¹¹ As the Execucomp database only provides executive data from 1992, my sample includes only CEO awards winners since 1992.¹² All firm information and characteristics are extracted from Compustat. I exclude non-US firms from the sample because non-US firms are different from US firms across

⁹ Malmendier and Tate (2009) provide details about these awards.

¹⁰ <http://astro.temple.edu/~lnaveen/>. I would also like to thank Steve McKeon for sharing CEO delta and vega measures to fill in missing values in Naveen's data.

¹¹ <http://public.kenan-flagler.unc.edu/faculty/kuhnenc/RESEARCH/research.html>.

¹² In the robustness check section, I include awards granted prior to 1992 in the sample to check whether award-winning effects on innovation vary over time. In Chapter IV, more recent award-winners after 2002 are included in the sample to examine what sources drive the award effect on innovation.

many dimensions such as ownership structure, governance scheme, legal protections to shareholders, business laws, and corporate culture. In addition, CEOs of non-US firms might not have the same chance of winning awards as those of US firms. I obtain stock return data for the sample firms from the Center for Research in Security Prices (CRSP). I calculate risk-adjusted returns by using Carhart's four factor model. The Fama-French return factors ($R_m - R_f$, SMB, and HML) and momentum factors (UMD) for each year are collected from Ken French's online website.¹³ Finally, I merge the sample with the patent data. The patent data is obtained from the National Bureau of Economic Research (NBER) patent database (Hall, Jaffe, and Trajtenberg, 2001). It provides the number of patents and citations for each firm at year t and the mean number of patents and citations at year t across firms and industries. As the patent data is only available up to 2006 and I focus on changes in innovation activity in the four years following a prestigious CEO award, my final sample period is restricted to the years between 1992 and 2002. After I match the CEO award data with Execucomp, Compustat, CRSP, and patent data, a total of 263 awards (163 unique award-winners) are identified.

3.2. Variable Construction for Propensity Score Matching¹⁴

3.2.1. Treatment Variable: Award Dummy

Winning a prestigious award attracts public attention and award-winning CEOs appear more frequently in the media, thereby becoming a public face of their corporation and a nationwide "superstar." The CEOs, then, use this increased status to maintain their superstar standing throughout their tenure. In other words, winning a high-profile award

¹³ http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

¹⁴ More details about the propensity score matching method are described in Appendix B.

is likely to shift an award-winner's status in the firm permanently (until he/she leaves or retires from the company), regardless of whether he/she receives later awards or not. Therefore, as a treatment dummy, I use an award indicator variable equal to one for all the years after the award and zero before the award for all award-winners. An indicator variable equal to zero is used for all years for all non-winners.

3.2.2. Outcome Variables

The outcome variable of interest in the propensity score matching is a firm's innovation outputs. Innovation is considered the key to the long-term success of a firm. In addition, measures of the firm's performance in previous literature might not correctly reflect a firm's intrinsic value. For example, Stein (1988) argues that, due to information asymmetry, investors tend to undervalue stocks of firms that invest in long-term innovative projects. Cohen, Diether, and Malloy (2013) establish that the stock market tends to misvalue the impounded information about innovation and, as a result, current stock prices do not correctly reflect the intrinsic value of stocks. Hirshleifer, Hsu, and Li (2013) assert that information regarding innovation is hard for investors to process due to its intangibility and high uncertainty and therefore the stock market may misprice the fundamental value of the firms. Their finding suggests that innovation efficiency (measured by patents or citations per dollar of research and development) provides information to predict a firm's future return. Therefore, innovation better reflects a firm's fundamental value than the conventional measures of a firm's performance such as stock return performance.

As a quantity measure of innovation, I use the number of patents for each firm at year t . The NBER patent database includes patents only if they are successfully granted. In addition, on average, it takes 2 years for applied patents to be granted. Thus, the most recent applied patents (in 2004 and 2005) may not be included in the database. To control for this truncation bias, I divide the number of patents for each firm-year by the mean number of patents for the same year.

However, the number of patents does not necessarily represent the technological and economic importance of these patents. Patents that are more frequently cited tend to be more valuable economically and technologically. Therefore, I also use the number of citations per patent as a measure of the quality of innovation. Nonetheless, the number of citations per patent may also suffer from a truncation bias. Patents granted in more recent years have fewer chances of being cited than those that were granted in earlier years. To control for this truncation bias, I scale the citation measure by the average number of citations per patent of all patents in the same year. I winsorize the two innovation output variables at the 95th percentile.¹⁵

3.2.3. Matching Variables

A propensity score matching selects predicted winners based on the propensity scores estimated in the logistic regression. As a dependent variable, I use an award dummy variable equal to one if CEOs win their awards at year t and equal to zero

¹⁵ Previous literature uses a firm's R&D expenditure to measure that firm's innovation. However, recent innovation studies (e.g., Hirshleifer et al., 2012; Atanassov, 2013, among others) differentiate an input of innovation from an output of innovation since R&D expenditure may not be used efficiently within firms. In addition, reported R&D expenditure may be at the discretion of the reporting firms and may furthermore be subject to accounting rules.

otherwise. A criteria of selection for matching variables is that they might affect either the likelihood of winning an award, the innovation outcome, or both. The intuition behind the criteria of matching variables is that treatment groups and matched groups must be similar in terms of the propensity to win an award and of future innovation incentives. Following Malmendier and Tate (2009), I use 1-year Carhart's four-factor risk-adjusted stock returns prior to the award, CEO age, and CEO tenure as matching variables to estimate propensity scores in order to predict award-winners. Matching variables to estimate propensity scores for innovation incentives reported in the innovation literature are sales, R&D, cash, leverage, profitability, tangibility, firm age, and CEO incentives (delta and vega).¹⁶ All matching variables are measured at the end of the last fiscal year prior to the award grant month.

Most of the CEO awards in the sample are conferred either at the end of the year or at the beginning of the next year. Thus, I set time t as the month of the award, year $t-1$ denotes the calendar year prior to the award, and year $t+1$ denotes the calendar year after the award. For example, *Business Week* awarded Steve Jobs one of the "Best Managers of 1998" in January 11, 1999. Therefore, year $t-1$ denotes year 1998 and year $t+1$ represents year 1999.

To eliminate any large influence of outliers on the results, I winsorize all continuous variables at the 1st and 99th percentiles. To control for any unobservable time-invariant characteristics of each industry and any macroeconomic shock, I include industry dummies (at the two-digit SIC level) and year dummies in the first stage

¹⁶ More details about variables are described in Appendix A.

regression. The standard errors are clustered at the CEO/firm level. Therefore, the specification of the logit regression is as follows.

$$Award\ Dummy_t = \alpha_t + \beta_t set\ of\ Matching\ variables_{t-1} + \gamma Industry\ effects + \delta Year\ effects + \varepsilon_t$$

CHAPTER IV

RESULTS

4.1. Summary Statistics

If treatment groups are randomly assigned, treatment and control groups are, on average, similar across all firm/CEO characteristics. If this is the case, one can estimate the average treatment effect for treated groups simply by comparing the outcomes between treatment groups and control groups. However, Table 1 (please see APPENDIX C for all tables) shows that this is not the case. Both treatment groups (first-time award-winners and all award-winners) are heterogeneous with non-winners (the non-treatment group) across many dimensions of firm and CEO characteristics. Based on sales, total assets, and market capitalization, award-winners manage significantly larger firms than non-winners' firms. With respect to past stock market performance (1yr-, 2yr-, and 3yr-stock returns prior to an award) and accounting performance, as expected, award-winners' firms are better performers than non-winners' firms. Award-winners' firms have a higher Tobin's Q and their firms belong to more competitive industries than non-winners. Award-winners are compensated more than non-winners and they have a higher pay for performance (delta) and higher risk-taking incentives (vega). These heterogeneous characteristics between the treatment group and the non-treatment group make it difficult to estimate the average treatment effect by directly comparing the outcomes between treated and non-treated groups.

4.2. First Stage Regression Result

Table 2 shows the results of the first-stage propensity score matching procedure (using a logit regression) to estimate propensity scores, based on the sample of 3,092 groups (CEO-firm) and 12,435 CEO-firm-year observations. The dependent variable is a dummy variable equal to one if the CEO wins an award at year t , while explanatory variables are those used as matching variables in the framework of the propensity score matching procedure. The coefficients are presented as odds ratios and standard errors are clustered by firm/CEO groups to control for potential cross-sectional dependence in residuals. I use industry dummies at the two-digit SIC level to control for unobservable heterogeneity across industries, and include year dummies to control for any macroeconomic shocks.¹⁷ The logit regression results are consistent with findings from the summary statistics in Table 1. CEOs who manage larger (in terms of sales), better performing (in terms of stock returns), and cash sufficient firms are more likely to receive awards. In addition, CEOs whose compensation is more tied to performance and CEOs with a shorter tenure are more likely to win awards. Based on the coefficient estimates, I calculate a propensity score for each group at year t to find matched control groups for each treatment group.¹⁸

¹⁷ As a robustness check, I also use Fama-French 48 industries or Fama-French 12 industries dummies instead of two-digit SIC level dummies. The magnitudes and significance of the coefficients for either case are very similar.

¹⁸ Instead of logit regression, I use a probit regression to estimate the propensity score. The coefficients of matching variables in magnitude and significance and the corresponding propensity scores remain similar. This finding is consistent with recent propensity score matching literature that suggests that a choice between a logit and probit regression is not problematic if a treatment indicator variable is binary.

4.3. Second Stage Result: The Effect of Winning an Award on Innovation

The goal of this study is to measure the impact of prestigious CEO awards on a firm's innovation. Since winning a high-profile CEO award might affect that firm's innovation with a time lag, I focus on a firm's innovation for up to 4 years after the CEO wins an award. To improve the quality of the matching procedure, I restrict matched groups (predicted winners) by selecting within the same year groups and the same industry groups (at the two-digit SIC level). Importantly, one might argue that award-winning firms are always more innovative than other firms regardless of whether they receive prestigious awards or not, resulting in inaccurate estimates of the award-winning effect. To mitigate the potential reverse causality problem, I partition the sample firms into two groups based on the level of patenting activities at year $t-1$ and match actual award winners and predicted winners within each group. As a result, predicted winners are selected within the same year, industry, and similar current innovation groups as actual winners. The predicted winners are chosen by a single nearest neighbor, 10-nearest neighbors, and a kernel (Gaussian) matching algorithm.^{19 20}

Figure 1 (please see APPENDIX C for all figures) illustrates the mean number of patents for actual award winners, predicted winners, and non-winners over the four-year period following the awards. Although the numbers of patents for actual winners and predicted winners are similar before the awards (at year $t-1$), the data show that the actual

¹⁹ Further details about each matching algorithms are discussed in the Appendix B.

²⁰ Moreover, in order to reduce bias between actual winners and predicted winners, I set a common support region (Smith and Todd, 2005). In the common support region setting, I exclude treatment groups whose propensity score is higher than the maximum propensity score of the control groups, as well as control groups whose propensity score is lower than the minimum propensity score of the treatment groups. Standard errors are corrected by bootstrapping to improve the accuracy of standard errors.

winners' number of patents increases more than both predicted - and non-winners' over the four years following the awards.

Table 3 presents the results of the impact of CEO awards on innovation using a propensity score matching. For the number of patents (a measure of the quantity of innovation), the matching estimates (the number of patents by actual winners minus those by predicted winners) are significant year $t+1$ to $t+4$ across all three matching procedures. In other words, actual winners consistently and significantly produce more patents than predicted winners from year $t+1$ to year $t+4$, regardless of which matching algorithms are employed to select predicted winners. On average, each year actual award-winners have 20.71% (year $t+1$) to 35.45% (year $t+2$) more patents than predicted winners during the four-year period after their awards.

I find similar results for the number of citations per patent (a measure of the quality of innovation). Regardless of which matching algorithms are used (single-, multiple nearest neighbor, kernel matching), the mean differences in the scaled number of citations per patent between the two groups are significant at the 5% level for year t to year $t+4$. In terms of the magnitude of effects, based on single nearest neighbor matching estimates, the actual winners have 18.87% (year $t+1$) to 32.23% (year $t+4$) more citations per patent than the predicted winners for year t to year $t+4$, suggesting that the actual winners achieve more economically and technologically important innovations than predicted winners.

Since a CEO's award affects a firm's innovation outputs with a lag, one might argue that these innovation outputs are accomplished by that CEO's decisions prior to the award. However, the results show that award-winners still achieve more patents and

citations per patent in later years (year $t+3$ and $t+4$) as well as in the first two years after the award. In sum, the results suggest that CEOs who win awards become better innovators in terms of the number of patents and the number of citations per patent after the awards than matched CEOs who do not win awards.

4.4. Robustness Checks

In this section, I check whether a positive award-winning effect on long-term innovation decisions is robust, regardless of whether there is a different treatment effect model assumption, broader sample periods (periods earlier than 1992), or a different estimation technique (Heckman selection model).

4.1.1. Temporary Shift Model

One might argue that winning a prestigious award affects a CEO's status temporarily. In other words, award-winning CEOs enjoy enhanced status after the award but they lose their status shortly thereafter. In this case, a different specification for an award dummy variable is required. I consider two scenarios: first-time award and multiple awards to the same CEO. I set the award indicator variable to one if a CEO wins an award at year t and zero otherwise.²¹ Actual winners are matched with predicted winners within the same year, industry, and past innovation groups.

Table 4 reports the results of the temporary shift model. Panel A presents the matching estimates of a first-time award. Similar to the results of the permanent shift model in Table 3, actual winners produce more patents than benchmark CEOs from year t

²¹ Further, I convert the award dummy variable to a missing value for award winner-year observations after the award so that they are not selected as predicted winners in the second stage.

to year $t+4$, no matter which matching methods are used. The mean differences in the number of patents between the two groups for year t to year $t+4$ are significant at the 1% significance level. Likewise, based on nearest neighbor matching estimates, the scaled number of citations per patent is larger for the actual award-winners than for the benchmark CEOs by 19% (nearest neighbor matching estimate at year $t+3$) to 47% (nearest neighbor estimate at year $t+4$) and the differences between the two groups are significant at the 5% significance level except for year $t+4$. The matching estimates by a 10-nearest neighbor matching and kernel matching confirm that actual winners have more citations per patent than predicted winners and the differences are all significant at the 5% level.

Panel B gives the matching results of all multiple awards to the same CEO in the temporary shift framework. The matching estimates for both the quantity and quality measure of innovation are all significant at the 5% level regardless of which matching algorithms are employed. This confirms that even when a temporary shift in CEO power as a result of winning a high-profile award is assumed, winning such a prestigious award motivates managers to focus more on long-term investments rather than short-term profits, and produces more economically and technically important patents, regardless of whether the award is a CEO's first award or one of many.

4.2.2. The Effect of Winning an Award over the Broader Sample Period

One might argue that the effects of winning a prestigious award on innovation decisions are time-specific. Period-specific factors that are correlated with CEO status and innovation activities in the firm might be omitted. In this section, I investigate

whether the award effects on innovation persist outside the sample period. I explore the award effects prior to 1992 as well as over a broader sample period (1976 to 2002). It is important to note that CEO delta and vega measures, CEO age, and tenure are omitted in the first stage of the propensity score matching procedure because Execucomp only provides CEO information from 1992. Even though the exclusion of CEO variables in the first stage might affect the propensity score and estimates of a treatment effect, this sub-sample period analysis provides an opportunity to explore whether or not award effects are time-sensitive.

Table 5 reports matching estimates in the permanent shift framework over the period from 1976 to 1991 and over the entire period 1976 to 2002.²² Similar to the findings in previous analyses, award-winning effects are highly significant at the 1% level over the broader sample period (1976 to 2002) and the effects remain significantly persistent even over the early period (periods prior to 1992), regardless of which matching algorithm is used. The results in Table 5 suggest that CEOs who win awards innovate more compared to similar CEOs, even during the earlier period and that the effects, therefore, are not time-specific.²³

4.4.3. Other Robustness Checks

I also perform other robustness checks. First, I exclude award-winners who leave or retire from their company within two years of receiving an award. If a CEO who wins a prestigious award knows that he/she will leave the company soon or if he/she wants to

²² The estimates of the 10-nearest neighbor matching is not reported in the table due to brevity. The results are very similar to other matching methods.

²³ I also implement a propensity score matching in the temporary shift model framework over the broader sample periods. The results are very similar to the permanent shift model.

move to another company, he/she does not have a strong incentive to pursue long-term and innovative projects and could choose to focus on short-term profits. Second, in the propensity score matching procedure, I use a variety of nearest neighbors (e.g., 5, 20, and 50) instead of a 10-multiple nearest neighbor matching. In addition, instead of a Gaussian function I also implement a variety of kernel weighting schemes such as biweight, Epanechnikov, uniform, tricube kernel functions, and local linear weighting scheme. The results for both cases remain very similar in the sense that award-winners innovate more than predicted award-winners.

4.4.4. Heckman Selection Model: Controlling for Endogeneity

In the previous section, I perform a propensity score matching to examine the effect of winning an award on a CEO's innovation decisions. As discussed by Malmendier and Tate (2009), CEO awards are a good application of propensity score matching because those awards are conferred by corporate outsiders who select award-winners based on public information. Nonetheless, the positive effect of winning an award on innovation might be more rigorous if the same result existed in a regression framework. The standard linear regression, however, might be problematic in the case of CEO awards. It suffers from a potential endogeneity problem that arises from an omitted-variable bias because the set of public information that the corporate outsiders rely on is not observable. Therefore, I perform a Heckman selection model to deal with the omitted-variable problem. The model includes two steps:

$$Award = \alpha\Pi + \varepsilon', \tag{1}$$

where $\varepsilon' \sim N(0, \sigma'^2)$

$$Y = \gamma_0 + \gamma_1 X + \gamma_2 Award + \varepsilon, \quad (2)$$

where $\varepsilon \sim N(0, \sigma'^2)$

In selection equation (1), the model estimates the probability of winning an award for each CEO/firm group by regressing the award dummy variable (*Award*) on a set of CEO/firm characteristics (*II*) that predict the likelihood of winning an award. I include 1-year Carhart's four-factor risk-adjusted stock returns prior to an award, log(market capitalization), book-to-market, log(CEO age), and log(1+CEO tenure) as explanatory variables in the first equation. In equation (2), the model regresses innovation outcomes year $t+1$ to year $t+4$ on the estimated probability of winning an award in the selection equation along with a set of variables that affect innovation (*X*). I include log(sales), R&D/assets, leverage, tangibility, profitability, cash/assets, log(1+firm age), log(1+CEO delta), log(1+CEO vega), log(1+CEO tenure), and log(CEO age) in the set of variables that affect innovation. Importantly, to further eliminate a potential omitted variable problem, I include lagged patenting outcomes and run a regression in the firm fixed effects framework. I believe that including lagged patenting outcomes and employing a firm fixed effects approach help control for any remaining firm-level omitted variable bias.²⁴ To control for any macroeconomic shocks, year dummies are also included in the regression.

Table 6 provides estimates of the Heckman selection model. When the quantity of innovation is a dependent variable in the second stage regression, the award variables are all positive during the four years following the award. The award variables are

²⁴ I also implement industry fixed effects instead of firm fixed effects. Both the economic magnitude and statistical significance of the award variable become stronger when industry fixed effects are employed.

statistically significant at the 5% level for the first three years and the award variable in year $t+4$ is close to the cutoff of significance at 10% level ($t=1.58$). When the quality of innovation is examined, the award variables are all significantly positive at the 10% level but the award variable in year $t+4$ is not significant. The results in Table 6 demonstrate that, after dealing with a potential omitted-variable bias, award-winning CEOs, on average, produce more and better quality patents. In other words, winning a high-profile award encourages CEOs to invest in long-term, risky, and innovative projects and helps mitigate any managerial incentives to make myopic investment decisions. The results in Table 6 confirm the finding of a positive effect of winning a high-profile award on innovation and it holds even in the parametric regression framework.

4.5. Sources of the Positive Award-winning Effect on Innovation

The evidence presented in Chapter III suggests that winning a prestigious award helps CEOs focus on long-term growth rather than short-term earnings. In this section, I investigate the channel through which winning a prestigious award fuels innovation. Based on the managerial myopia hypothesis, greater power given to CEOs after a prestigious award incentivizes them to pursue long-term, innovative projects since a shift in CEO power helps insulate them from the risk of job dismissal. On the other hand, the overconfidence hypothesis predicts that CEOs' psychological biases as a result of receiving an award is the driving force for the positive effect.

4.5.1. Do Award-Winning CEOs Become More Powerful?

I explore whether award-winning CEOs become more powerful (and, in turn, more entrenched) in two ways: CEO compensation and CEO turnover-performance

sensitivity. In these analyses, in addition to the award-winners in the sample from 1992 to 2002, I include more recent award winners up to 2011 for the CEO compensation analysis and up to 2006 for the CEO turnover-performance sensitivity analysis.

First, I examine whether CEOs extract rents after winning an award during the sample period 1992-2011.²⁵ Figure 2 plots CEO total compensation between actual award-winners, predicted winners, and non-winners.²⁶ Figure 2 shows that total compensation of award-winning CEOs substantially increases by about 40% over the two years following an award while predicted winners' compensation slightly decreases by about 8% over the same period.

I quantify the increases in CEO compensation and report the results in Panel A of Table 7. Award-winners not only receive higher compensation than similar CEOs who do not win awards, but they also enjoy more increases in compensation after their awards than similar CEOs. The differences in compensation increases around the time of the awards between award-winners and predicted winners are significant at the 1% level. One might argue that award-winners are compensated more because they perform better than similar CEOs or that it might be the optimal decision for a firm to pay its CEO more as a way of incentivizing him/her to maximize firm value. Thus, it is necessary to eliminate potential factors that affect CEO compensation. Core, Guay, and Larcker

²⁵ Malmendier and Tate's (2009) analysis for rent extraction is based on award-winners from the period 1992- 2002 while my analysis covers award-winners up to 2011.

²⁶ Predicted winners are chosen by the propensity score matching technique. I use firm size, returns, CEO gender, CEO age, and CEO tenure as matching variables that might affect one's propensity to win a prestigious award. I also use reported determinants of CEO compensation by prior executive compensation literature as a matching variable: ROA, sales growth, cash, firm risk, and CEO/chairman duality (Core, Guay, and Larcker, 2008; Core, Holthausen, and Larcker, 1999; Murphy, 1999; Rose and Shepard, 1997). Award winners and predicted winners are matched within the same year and same industry group at the two-digit SIC level. To further eliminate heterogeneity for CEO total compensation between actual winners and predicted winners at year $t-1$, I sort the sample CEOs into deciles of total compensation and then I force actual award-winners and predicted winners to match within the same decile.

(2008) estimate excess compensation using a two-stage method. First, they estimate expected compensation by regressing $\log(\text{compensation})$ on $\log(\text{sales})$, contemporaneous and lagged returns and ROA, book-to-market, S&P 500 indicator variable, and $\log(\text{tenure})$ along with year- and industry-fixed effects. Second, they compute excess compensation by adjusting estimated expected compensation. The results for Panel A also suggest that award-winners receive significantly more increased compensation than benchmark CEOs during the period between year $t-1$ and year $t+2$.

The evidence of an immediate jump in compensation over the first two years following the award suggests that superstar CEOs extract a higher compensation using their increased power as a result of winning an award, both relative to their own compensation before winning an award and relative to that of predicted winners. In contrast to total compensation, however, in Figure 1, there is no significant difference in cash compensation between award-winners and similar CEOs in the regression (not tabulated). Evidence of a heterogeneous pattern for compensation is consistent with Malmendier and Tate's finding. They suggest that award-winning CEOs extract rents mostly from equity compensation to avoid potential shareholder outrage because equity compensations are less transparent to shareholders and it is not easy for shareholders to monitor compensation due to a lack of information.

Award-winning CEOs are also likely to have lower CEO performance-turnover sensitivity after winning an award because they become more visible to the public and, as a result, the boards are more likely to be susceptible to shareholder voice (Fisman et al., 2013). I use CEO turnover data from the period 1992-2006 from Camelia Kuhnen's

website.²⁷ I implement a multinomial logistic regression to examine whether winning an award affects CEO turnover.²⁸ The dependent variable is CEO turnover which is equal to one for exogenous turnover (e.g., scheduled retirement, death, etc.), equal to two for unclassified turnover, equal to three for forced turnover, and equal to zero for no turnover events. Thus, the reference category in the regression is no turnover events. Since I am interested in the question of whether award-winning CEOs are fired when they underperform less frequently than similar CEOs who do not win awards, I include a poor performance dummy, which is equal to one if a firm is in the bottom 25% of the sample firms based on ROA in a given year and zero otherwise. The interest variable in the regression is an interaction term between the award dummy and the poor performance dummy. All other variables in Panel B of Table 7 are described in Appendix A.

I find evidence that award-winning CEOs are less likely to be fired by boards (and are even less likely to leave the firm for unclassified reasons) relative to non-winning CEOs, even though they underperform. The interaction term between the award dummy and the poor-performance dummy is significantly negative at the 1% level for forced turnover during the first two years following the award. In terms of the economic magnitude of the effect of winning an award on CEO turnover, award-winning CEOs are 10 times less likely to be fired than similar CEOs when they underperform. The evidence

²⁷ I would like to thank Camelia Kuhnen for making the CEO turnover data publicly available.

²⁸ I implement a multinomial logit regression, rather than a propensity score matching for two reasons. First, CEO turnover is a very rare event. In my sample, only two award-winning CEOs were fired by boards in the year of their award. Therefore, a small change in the number of forced turnover events in the predicted winner group will substantially swing the estimates of the difference in forced turnover rate between award-winners and predicted winners. Second, due to the small number of award-winners, I cannot perform a CEO turnover-performance sensitivity analysis. There are very few awards winners in the poor performance category.

in Panel B demonstrates that boards are reluctant to fire award-winning CEOs even though they underperform.

In sum, the evidence in Table 7 suggests that there is a clear shift in CEO power in the firm after a CEO wins a prestigious award and that the CEO tends to extract rent (consistent with Malmendier and Tate, 2009) and to enjoy greater job security. In other words, CEOs become more powerful and face a lower threat of dismissal after receiving an award, and this job security might drive CEOs to pursue long-term growth opportunities rather than short-term profits. Therefore, the evidence from Table 7 is consistent with the managerial myopia hypothesis.

4.5.2. Do Award-Winning CEOs Become Overconfident?

It is possible that winning a high-profile award not only shifts power towards CEOs but may also change aspects of their psychology. Recent corporate finance literature has focused on the effect of managerial overconfidence on firm decisions and its corresponding consequences. Overconfidence is the tendency of individuals to overestimate their abilities and forecast future outcomes unreasonably optimistically. CEO awards are conferred by corporate outsiders such as prominent nation-wide magazines which are considered more reliable institutions than individuals. Thus, winning such a prestigious award might bias CEOs' beliefs about their skills and abilities and affect the extent to which they are optimistic about their future outcomes on investments.

Related to CEO overconfidence and innovation, Hirshleifer et al. (2012) show that firms with overconfident CEOs (proxied by options- and press-based measures)

invest more in innovation, obtain more patents and patent citations, and achieve greater innovative success for given R&D expenditures. As winning an award can make CEOs overconfident and because managerial overconfidence is positively associated with patenting activities, one might argue that being overconfident after winning an award drives the positive effects of the award on innovation. Therefore, it is important to determine how winning a prestigious award changes CEO overconfidence and how this change in biased beliefs in turn affects innovation decisions.

I estimate a CEO overconfidence measure based on managerial options following the previous literature (Campbell, Gallmeyer, Johnson, Rutherford, and Stanley, 2011; Hirshleifer, Low, and Teoh, 2012). The overconfidence variable is an indicator variable which is equal to one if a CEO does not exercise stock options that are more than 67% in the money and zero otherwise. I first examine whether receiving a prestigious award affects a CEO's overconfidence. Among the award-winners in the sample between 1992 and 2011 (218 unique award-winners with a non-missing overconfidence variable), only about 3% of winners (6 winners) become overconfident during their tenures after the awards.²⁹ Winning a prestigious award does not change an overconfidence trait for the majority of the award-winners in the sample. To quantify the effect of winning an award on overconfidence, I run a regression in which the dependent variable is an indicator variable of whether a CEO becomes overconfident within the next four years in a given year t . For award-winners, the dependent variable is one if a CEO becomes overconfident within the four years following the award. A key independent variable is the award

²⁹ 160 award-winners (73.4% of the winners in the sample) are already overconfident before winning an award while 52 award-winners (23.9% of the winners) remain less confident regardless of winning an award.

dummy which is equal to one if a CEO receives an award at year t and zero otherwise. I also employ several control variables which are reported to affect CEO option exercise: return_{t-1} , return_{t-2} , $\log(\text{asset})_{t-1}$, ROA_{t-1} , ROA_{t-2} , sale growth_{t-1} , cash_{t-1} , volatility_{t-1} , $\log(1+\text{CEO age})_{t-1}$, female dummy, and CEO/chairman duality, along with year fixed effects and industry fixed effects.³⁰

Panel A of Table 8 provides the results. As expected, the award variable is positive but statistically insignificant. In other words, winning a prestigious award does not have a meaningful effect on managerial overconfidence, suggesting that overconfidence is not the main source of the positive effect on innovation.

I further investigate whether the effect of the award on innovation still remains significant after eliminating the effects of pre-existing managerial overconfidence prior to receiving an award. To determine this, I employ both a propensity score matching and a Heckman two-stage regression approach during the sample period 1992-2002. In the propensity score matching, I partition the sample into two groups (firms with vs. firms without overconfident CEOs) and I rematch actual award-winners with non-winners within each group. The results of the propensity score matching analysis (not tabulated) suggests that even after controlling for the CEO overconfidence effect, award-winners still produce more and better quality patents than the predicted winners, and the estimates of the difference between the two groups are significant at the 1% level. In a Heckman selection model, I include an overconfidence variable as an additional explanatory variable. The result of the two-stage regression (Panel B of Table 8) shows that there are still significantly positive effects of winning an award on patenting activities for the first

³⁰ Descriptions of the variables are in Appendix A.

three years following the award, even after controlling for the CEO overconfidence effect. The economic magnitude and statistical significance are quite similar to previous results without controlling for overconfidence. The evidence in Table 8 suggests that the positive effects of receiving a prestigious award on innovation outcomes are not mainly driven by CEO overconfidence, and the effects still exist even after controlling for the effect of overconfidence on innovation.

4.6. The Award Effect on Innovation and Institutional Ownership

The evidence from this study, thus far, suggests that superstar CEOs who win awards are better innovators in terms of both the quantity and the quality of their innovation. In this section, I examine whether the magnitude and significance of the positive effect of CEO awards on innovation differ across a measure of managerial long-term incentives: institutional ownership.

The innovation literature has also explored the relationship between effective monitoring of CEOs and innovation. In this study, I focus on institutional holdings as a proxy for a firm's level of effective monitoring. Edmans (2009), in his theoretical model, contends that blockholders have strong incentives to collect costly information about the fundamental value of the firm and, in turn, their trades help stock prices reflect the fundamental value of the firm rather than short-term earnings. Thus, he demonstrates that blockholders encourage managers to focus on the long-term value of the firm rather than its short-term value. Aghion et al. (2013) examine whether institutional ownership affects a firm's innovation decisions and show that there is a positive relationship between institutional holdings and innovation. Further, they propose two plausible hypotheses to

explain the source of the positive effect of institutional holdings on innovation: managerial slack (institutional investors push lazy CEOs to innovate more) and career concerns (institutional investors monitor CEOs more effectively using better information and abilities). Using the relationship between institutional holdings and product market competition for managerial innovation incentives, they conclude that the positive effect of institutional ownership on innovation is stronger in more competitive markets, which suggests that product market competition and institutional holdings complement each other. In other words, institutional investors encourage CEOs to innovate more, not by forcing lazy CEOs to innovate, but by protecting them from bad luck that happens for purely stochastic reasons. Manso (2011), in his principal-agent theoretical model, also posits that timely feedback by the principal (e.g., blockholders) on performance motivates the agent (managers) to innovate. The existing research discussed above suggests that institutional ownership provides more job security to managers and relieves managerial short-termism.

Based on the literature discussed above, I expect the effect of winning a high-profile award on innovation to vary across firms with different levels of institutional ownership. However, it is not clear whether the positive effect of winning an award is stronger or weaker for firms with more effective monitoring by institutional investors, as this depends on whether winning an award and institutional ownership are substitutes or complements for managerial long-term incentives. If they are substitutes, the additional effect of winning an award should be smaller for CEOs who already have sufficient long-term incentives by high institutional ownership. If they are complements, the more relief from managerial short-termism there is, the more long-term incentives managers will

have. In other words, the additional effect of winning an award should be larger because high institutional ownership boosts the impact of award-winning on the CEOs' long-term incentives.

I collect institutional ownership data from Thomson Reuters Ownership Database. Since the database provides quarterly institutional holdings, I use the institutional holdings for a quarter prior to the CEO awards. I partition the sample into two groups (low institutional ownership and high institutional ownership) at the median of institutional holdings. I rematch actual award-winners with predicted award-winners within each group. Table 9 reports the matching estimates by high- and low-institutional ownership groups. For all of the matching algorithms (10-neighbor matching is not tabulated), the effects of awards on both a quantity and quality measure of innovation are significant during the four years following the award for both groups at the 10% level, except for the effect at year $t+4$ for the high institutional ownership group. However, the effect of winning an award on innovation is significantly larger for the low institutional ownership group than it is for the high institutional ownership group at the 1% level (for single-nearest neighbor matching) during the four years following the award, indicating that winning an award and institutional ownership are a substitute for managerial long-term incentives. In other words, CEOs who are, *ex ante*, provided with long-term incentives by high institutional ownership will have a small additional impact of winning an award on innovation than CEOs in firms with low institutional ownership.

In sum, the evidence presented here is consistent with prior literature on the role of institutional investors on corporate decisions; institutional investors play an important role in motivating managers so that they do not make myopic decisions. Furthermore, the

heterogeneous effect of winning a high-profile award on innovation across firms with different levels of institutional ownership suggests that institutional ownership and winning an award are substitutes for managerial long-term incentives: institutional ownership mitigates the effect of winning a high-profile award on innovation.

CHAPTER V

CONCLUSION

In this paper, I examine how a shift in CEO status as a result of winning a high-profile award affects a firm's innovation decisions. Two opposing views in the context of CEO power (greater job security) predict different consequences of winning such prestigious awards on a firm's innovation. The agency view predicts that CEOs who win awards (superstar CEOs) innovate less due to self-dealing behaviors and because they use their heightened power within the firms to take private benefits of control at the cost of the shareholders. In contrast, the managerial myopia view suggests that superstar CEOs innovate more. A decline in the threat of job termination enables a superstar CEO to take on more long-term and innovative projects with less pressure on their short-term performance. In addition to the managerial myopia hypothesis, the managerial overconfidence view (Hirshleifer et al., 2012), also predicts a positive effect of winning a prestigious award on innovation if award-winning CEOs become overconfident after the award.

Using a propensity score matching as the main identification strategy, I find that CEOs who win high-profile awards, on average, innovate more, in terms of the number of patents and citations per patent, than their benchmarks. The finding that superstar CEOs are better innovators is robust using a different treatment effect model assumption (temporary shift model), broader sample periods, and a different estimation technique (a Heckman selection model).

I then explore a potential source for the positive award effect on innovation. I determine that there is a clear shift in CEO power after CEOs win an award and that they

tend to extract rents and are less likely to be fired by the boards even when they underperform. However, I fail to find evidence that winning a prestigious award drives CEOs to become more overconfident. I also confirm that the positive effects of winning an award on innovation remain similar, even after controlling for the effect of CEO overconfidence.

Lastly, I explore whether the effects of awards on innovation are heterogeneous by institutional ownership. I find that the positive award-winning effect on innovation is weaker for firms with high institutional ownership, concluding that winning a prestigious award and institutional ownership are substitutes for managerial incentives for long-term growth.

The results given in this paper is consistent with the managerial myopia view that a CEO who achieves greater job security (and, in turn, reduced managerial myopia) as a result of winning a high-profile award promotes more innovation.³¹ This study contributes to the extant literature by using a unique and more recent measure of CEO entrenchment (i.e. prestigious CEO awards) and reliable long-term performance measures (i.e. innovation).

The evidence here sheds light on the positive role of managerial entrenchment and superstar status – seeking long-term growth and success by engaging in more innovative projects – in contrast to the findings in previous literature, and it helps resolve the current

³¹ The evidence in this paper can be reconciled with Atanassov's (2013) study in that the shock used in this study is an example of an internal governance mechanism that affects CEO behavior through the board of directors, while hostile takeovers are an example of an external governance mechanism. In addition, winning prestigious CEO awards causes greater investor attention (and, in turn, increases monitoring), which incentivizes award-winning CEOs to maximize the long-term value of their firms. In contrast, enacting anti-takeover state-level laws might be seen as "a windfall" by investors so they do not pay much attention to monitor the CEOs' behaviors.

puzzle of why many firms have actively chosen to weaken shareholder rights and given excessive power to their CEOs over their boards.

APPENDIX A
VARIABLE DESCRIPTIONS

Variables	Description
First-award dummy (permanent model)	Indicator variable: 1 for all the years after a CEO wins a first award at t and 0 for all non-winners
First-award dummy (temporary model)	Indicator variable: 1 if a CEO wins a first award at t and 0 otherwise
Multiple-award dummy	Indicator variable: 1 if a CEO wins any award at t and 0 otherwise
Patent $_t$	Number of patents for each firm at year t , scaled by the total number of patents for all firms at year t
Citation/patent $_t$	Number of citations per patent for each firm at year t , scaled by the citation measure by the average number of citations per patent at year t
Sales	Firm sales are in logarithmic
Stock return	Total compound returns prior to the award month adjusted by Carhart's four-factors ($R_m - R_f$, SMB, HML, and UMD) for each year which are collected from the French's online website
R&D expense	Reported R&D spending scaled by total assets
Leverage	Total long-term debt over total assets
Profitability	Earnings before interest depreciation taxes and amortization (EBITDA) divided by total assets
Tangibility	Net property, plant, and equipment over total assets
Herfindahl index	Sum of squared shares of the sales for all companies within the same 4 digit SIC level
Firm age	1) Number of years since the firm's initial public offering or 2) number of years elapsed since a firm first appears in the CRSP database (if the initial public offering date is not available)
Market capitalization	Price multiplied by shares outstanding measured at the end of the last fiscal year prior to the award month
Book-to-market	Stockholders' equity over market equity
Tobin's Q	Total assets plus market equity minus book equity, divided by total assets

Asset growth	$(\text{Total asset at } t - \text{total asset at } t-1) / \text{total asset at } t-1$
Firm risk	Standard deviation of most recent 3 years of monthly stock returns
G-index	Governance index which is constructed by Gompers, Ishii, and Metrick (2003)
CEO delta	Sensitivity of a CEO's stock and option value (\$ thousands) to a 1% change in stock price
CEO vega	Sensitivity of a CEO's stock and option value (\$ thousands) to a 1% change in stock return volatility
CEO total compensation	Sum of salary, bonus, other annual compensation, restricted stock grants, LTIP payouts, options grants, and all other total compensation
CEO cash compensation	Salary plus bonus, presented in \$K
CEO age	Measured in years as reported by Execucomp database
CEO tenure	Number of years that a given CEO has held the position
CEO/Chairman duality	Indicator variable: 1 if a CEO is also a chairman of a board and 0 otherwise
Female	Indicator variable: 1 if a CEO is female and 0 for male
CEO turnover	Categorical variable: 1 for exogenous turnover (scheduled retirement, death, etc.), 2 for unclassified turnover, 3 for forced turnover (clearly stated in the Factiva that a CEO was fired, forced to leave, or left following a policy disagreement), and 0 for no turnover events.
Poor performance	Indicator variable: 1 if a firm belongs to the bottom 25% group based on ROA and 0 otherwise

APPENDIX B

PROPENSITY SCORE MATCHING

In this study, I examine whether a shift in CEO status as a result of winning a high-profile award affects innovation decisions. In the analytical framework, the treatment effect (effect of winning an award) is the difference between potential outcomes (innovation outputs) with and without treatment for group i :

$$\text{treatment effect} = Y_i^1 - Y_i^0$$

where Y represents potential outcomes and 0 and 1 denotes non-treatment and treatment group respectively.

Each group is identified as a combination of a CEO and a firm.³² The goal of this study is to examine the average treatment effect on the treated groups (ATT):

$$ATT = E(Y_1 - Y_0 | T = 1)$$

where $T=1$ refers to the treatment.

In my study, I compare post-award innovation outputs of an award winner's firm ($E(Y_1) | T = 1$) to the counterfactual firm (i.e., the same firm had the CEO not received the award) ($E(Y_0) | T = 1$). However, because the counterfactual firm's innovation outputs are not observable, appropriate benchmark groups corresponding to each treatment group should be selected by an empirical specification. Thus, I employ a propensity score matching technique (Rosenbaum and Rubin, 1983) to pick benchmark groups similar to treatment groups. A propensity score matching technique is preferred over parametric

³² For example, if a firm has three CEOs in its history, I identify the three CEOs as separate groups since each CEO has heterogeneous innovation decisions, given his/her firm's characteristics and operational environment. Likewise, if a CEO has served for three firms in his/her career, that CEO belongs to three different groups since he or she might make different innovation decisions, given that each firm has different characteristics and a different operational environment.

regressions for the following reasons: A propensity score matching procedure, which is a non-parametric technique, does not need to impose a functional form on outcomes which would be required in a multivariate regression framework. In addition, explanatory variables in a regression are usually correlated with an error term, resulting in an inconsistent and biased estimate on treatment effects.

The propensity score matching procedure has two stages. In the first stage, a propensity score for each group is estimated by running a logit (or probit) regression where the dependent variable is a treatment dummy (whether a CEO wins an award or not at year t) and independent variables are matching variables by which the treatment and control groups are matched. In the second stage, a treatment effect (award-winning effect) on outcome variables (innovation outputs) is estimated after treatment groups are matched with control groups based on the propensity scores.

A variety of algorithms in the propensity score matching technique have been developed in the econometric literature in order to choose the best similar control groups based on propensity scores. Among these algorithms, I choose a single nearest neighbor matching, N -neighbor matching, and a kernel matching algorithm for my analysis. The single nearest neighbor matching selects a benchmark whose propensity score is the closest to the treatment group. The N -neighbor matching chooses multiple benchmark groups after it ranks all control groups based on the distance of their propensity scores from that of the treatment group. Thus, it provides multiple benchmark groups per treatment group. The kernel matching is a non-parametric matching procedure that provides the weighted average of the counterfactual outcomes of all control groups based on the distance of propensity scores between treatment and control groups. Thus, the

kernel matching algorithm uses more information from all control groups than a single or an N -neighbor matching method and, as a result, it reduces the variance of estimates. However, the single nearest neighbor matching algorithm and the N -neighbor matching algorithm have a lower bias than the kernel matching algorithm since kernel matching might use many bad matches. Therefore, in this paper, I employ all three matching algorithms (a single nearest neighbor, N -nearest neighbor, and a kernel matching) to estimate the effects of awards on post innovation activities.

APPENDIX C

FIGURES AND TABLES

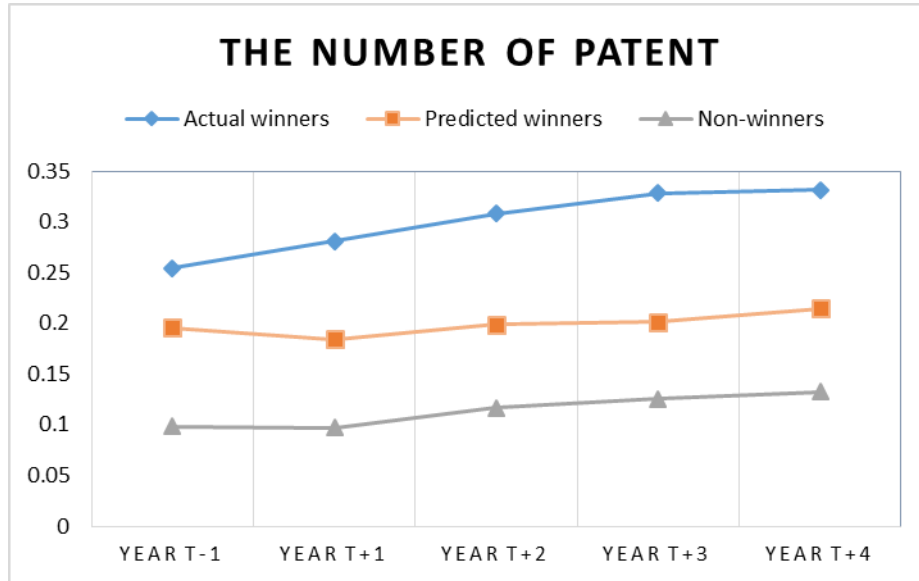


Figure 1: Mean number of patents

The graph plots the mean number of patents for first-time award-winners, predicted winners, and non-winners during the four-year period following the awards from 1992 to 2002. The number of patents for each firm at year t is divided by the mean number of patents of all firms for the same year, to account for a potential truncation bias.

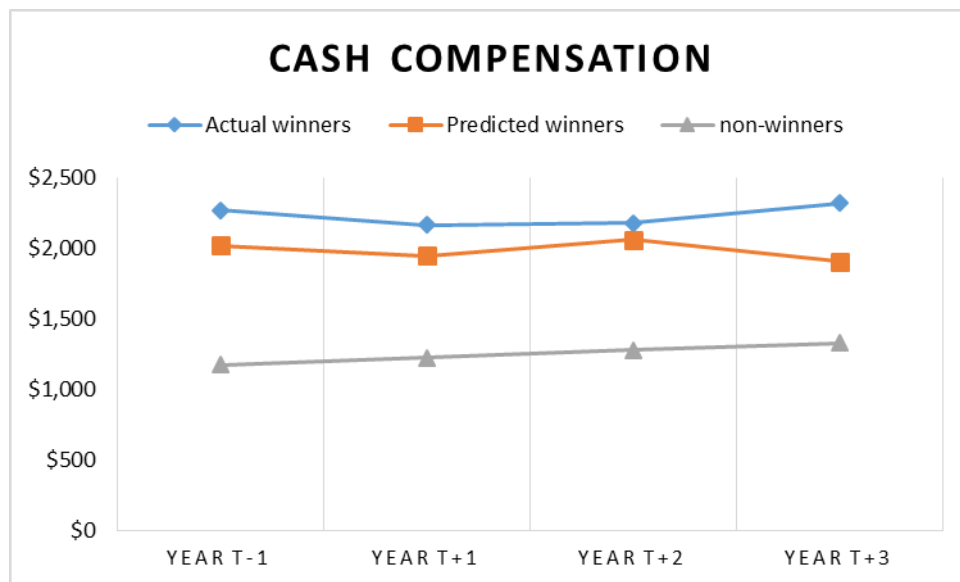
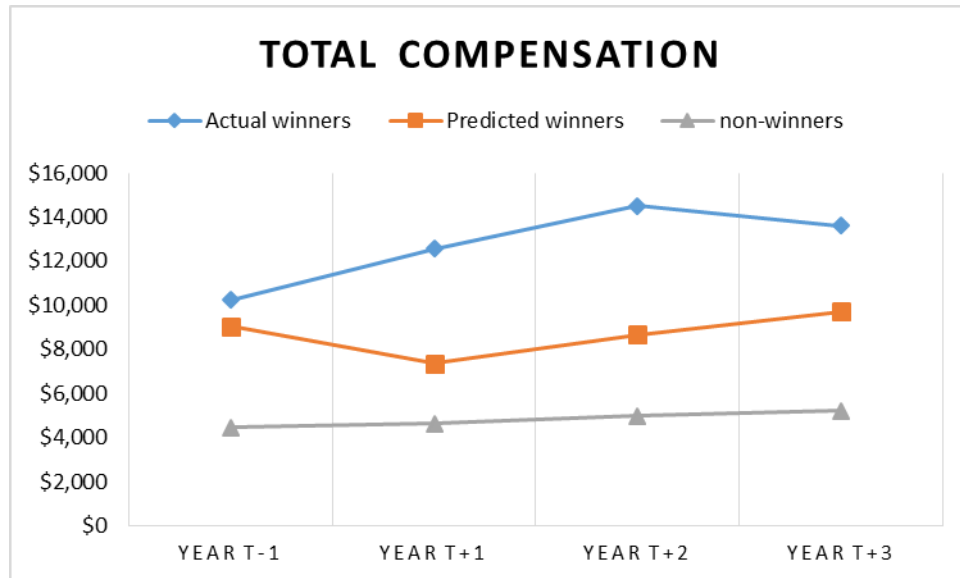


Figure 2: Mean CEO total and cash compensation

The graph plots mean CEO total and cash compensation for first-time award-winners, predicted winners, and non-winners from 1992 to 2011. CEO total compensation (tdc1 from Execucomp) is the sum of salary, bonus, other annual compensation, restricted stock grants, LTIP payouts, options grants, and all other total compensation. The total compensation is reported in increments of \$1000.

Table 1
Summary Statistics

The table reports summary statistics for first-time award-winners, all award-winners, and all non-winners in the sample. The CEO and firm variables are described in Appendix A. All variables are measured at *year t-1* where awards are granted at *t*.

Variables	First-time winners (N=163)			All winners (N=263)			Non-winners (N=23,441)		
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
<i>Matching variables</i>									
Sales (\$ in thousands)	14,780	5,454	30,353	18,739	7,191	32,316	3,880	963	11,854
Past 1-year return (%)	57.62	23.49	217.92	50.26	24.88	175.56	21.11	11.93	66.69
R&D expense/assets	0.032	0.004	0.048	0.035	0.007	0.049	0.031	0.000	0.073
Leverage	0.23	0.19	0.17	0.22	0.19	0.18	0.23	0.21	0.20
Profitability	0.15	0.15	0.10	0.16	0.16	0.10	0.13	0.13	0.13
Tangibility	0.31	0.27	0.23	0.29	0.24	0.23	0.29	0.22	0.24
Cash/assets	0.08	0.05	0.08	0.08	0.05	0.09	0.09	0.04	0.11
Firm age (years)	28.73	23	22.72	29.66	23	23.27	21.35	16	18.31
CEO delta (\$)	3,945	520	16,729	8,118	790	29,969	1,111	196	11,625
CEO vega (\$)	196.54	77.84	332.45	263.71	88.00	530.00	113.05	37.89	269.10
CEO age (years)	54.34	55	7.14	54.79	55	8.15	55.17	55	7.58
CEO tenure (years)	5.89	4	5.97	7.72	5	7.34	7.13	5	7.34
<i>Other firm and CEO characteristics</i>									
Market cap.	26,525	10,471	54,278	37,880	13,631	65,387	5,397	1,127	18,529
Total assets	27,089	5,712	66,094	41,614	9,861	113,709	10,010	1,195	52,291
Past 2-year return (%)	141.05	57.31	420.08	134.80	57.58	374.00	50.15	25.96	157.33
Past 3-year return (%)	204.65	80.82	538.38	244.84	86.01	1,037.13	81.57	39.76	235.17
Book-to-market ratio	0.33	0.31	0.22	0.31	0.28	0.21	0.50	0.44	0.76
Tobin's Q	3.74	1.95	8.83	3.89	2.02	8.56	2.08	1.51	2.25
G index	9.35	9	2.78	8.97	9	2.70	9.26	9	2.69
CEO total compensation(\$)	8,492	3,877	13,897	12,440	4,357	29,961	4,148	1,957	9,955
CEO cash compensation (\$)	2,017	1,530	1,957	2,432	1,690	2,702	1,228	845	1,691

Table 2
First Stage: Logit Regression

This table reports logit regression results. The dependent variable is an indicator variable of whether a CEO wins an award at year t . The explanatory variables are those used as matching variables for a propensity score matching. The selection criteria for the matching variables are those which affect either likelihood to win awards (participation in treatment groups) or innovation activities (outcomes). The variables used in the first stage regression are described in the Appendix. Standard errors are clustered by groups (combination of a CEO and a firm) and are shown in parentheses. ***, **, and * represent significance at 1%, 5%, and 10% levels, respectively.

$$Award\ Dummy_t = \alpha_t + \beta_t set\ of\ Matching\ variables_{t-1} + \gamma Industry\ effects + \delta Year\ effects + \varepsilon_t$$

Variables	Coefficient (Robust SEs)
Ln(sales)	0.885*** (0.089)
Prior 1-Year Return	1.000*** (0.117)
R&D Expense/Assets	0.924 (2.300)
Leverage	-1.329 (0.914)
Profitability	-0.501 (1.410)
Tangibility	0.984 (0.734)
Cash/assets	2.127* (1.182)
Ln(1+firm age)	-0.148 (0.094)
Ln(1+CEO delta)	0.529*** (0.082)
Ln(1+CEO vega)	-0.029 (0.061)
Ln(1+CEO age)	-0.083 (0.101)
Ln(1+CEO tenure)	-1.841** (0.835)
Industry dummies	YES
Year dummies	YES
Pseudo R2	0.29
Observations	12,435
Groups	3,092

Table 3
Post Innovation to CEO Awards

This table shows innovation outputs between actual award-winners and predicted winners in the permanent shift model framework. An award indicator variable is set to one for all CEO-year observations after year t when a CEO wins a first award and set to zero for all non-winners. Matching variables and a matching procedure are described in the Appendix. Predicted winners are selected by a single nearest neighbor, multiple nearest neighbors, and a kernel propensity score matching procedure. The outcome variables are the scaled number of patents and the scaled number of citations per patent. The matching estimates represent differences in the innovation outputs between actual winners and predicted winners. The number of observations in this table only include groups which lie within a common support region. The standard errors are estimated by bootstrapping and are reported in parentheses. ***, **, and * represent significance at 1%, 5%, and 10% levels, respectively.

Outcome Variables	N (On Support)	Single Nearest Neighbor	10 - Neighbors	Kernel (Gaussian)
		Matching Estimate	Matching Estimate	Matching Estimate
Patent $t+1$	759	0.0968*** (0.0172)	0.0956*** (0.0111)	0.0992*** (0.0104)
Patent $t+2$	739	0.1087*** (0.0185)	0.1180*** (0.0124)	0.1135*** (0.0117)
Patent $t+3$	719	0.1267*** (0.0206)	0.1261*** (0.0139)	0.1242*** (0.0131)
Patent $t+4$	702	0.1173*** (0.0225)	0.1378*** (0.0151)	0.1332*** (0.0144)
Citation/Patent $t+1$	759	0.1484*** (0.0447)	0.1436*** (0.0278)	0.1330*** (0.0257)
Citation/Patent $t+2$	739	0.1688*** (0.0423)	0.1314*** (0.0269)	0.1348*** (0.0248)
Citation/Patent $t+3$	719	0.1559*** (0.0421)	0.1270*** (0.0261)	0.1297*** (0.0242)
Citation/Patent $t+4$	702	0.1531*** (0.0366)	0.1227*** (0.0243)	0.1082*** (0.0227)

Table 4
Robustness Check 1: Temporary Shift Model

This table presents the results of innovation outputs around actual winners and predicted winners when CEOs' first awards are considered (Panel A) and all multiple awards to the same CEOs (Panel B) are included in the sample in the temporary shift model framework. Predicted winners (P) are selected by a single nearest neighbor, multiple nearest neighbor, and a kernel propensity score matching procedure. The matching estimates represent differences in the innovation outputs between actual winners and predicted winners. The number of observations in this table only include groups which lie within a common support region. The standard errors are estimated by bootstrapping and are reported in parentheses. ***, **, and * represent significance at 1%, 5%, and 10% levels, respectively.

Panel A: First Award				
Outcome Variables	N (On Support)	Single Nearest Neighbor	10- Neighbors	Kernel (Gaussian)
		Matching Estimate	Matching Estimate	Matching Estimate
Patent $t+1$	154	0.0836*** (0.0323)	0.0927*** (0.0237)	0.0880*** (0.0229)
Patent $t+2$	149	0.1397*** (0.0349)	0.1169*** (0.0265)	0.1176*** (0.0255)
Patent $t+3$	142	0.1321*** (0.0387)	0.1140*** (0.0300)	0.1082*** (0.0289)
Patent $t+4$	137	0.1305*** (0.0425)	0.1015*** (0.0328)	0.1091*** (0.0316)
Citation/Patent $t+1$	154	0.1797*** (0.0801)	0.1393*** (0.0597)	0.1192*** (0.0427)
Citation/Patent $t+2$	149	0.1753*** (0.0816)	0.2009*** (0.0585)	0.1775*** (0.0560)
Citation/Patent $t+3$	142	0.1712*** (0.0813)	0.1545*** (0.0608)	0.1651*** (0.0585)
Citation/Patent $t+4$	137	0.0305 (0.0812)	0.1300*** (0.0548)	0.0983** (0.0445)

Panel B: Multiple Awards				
Outcome Variables	N (On Support)	Single Nearest Neighbor	10 - Neighbors	Kernel (Gaussian)
		Matching Estimate	Matching Estimate	Matching Estimate
Patent $t+1$	243	0.1005*** (0.0135)	0.1104*** (0.0114)	0.1068*** (0.0116)
Patent $t+2$	236	0.1523*** (0.0317)	0.1339*** (0.0142)	0.1309*** (0.0109)
Patent $t+3$	229	0.1163*** (0.0206)	0.1323*** (0.0174)	0.1352*** (0.0080)
Patent $t+4$	222	0.1029*** (0.0246)	0.1451*** (0.0240)	0.1454*** (0.0137)
Citation/Patent $t+1$	243	0.1347** (0.0568)	0.1728*** (0.0354)	0.1711*** (0.0322)
Citation/Patent $t+2$	236	0.1243** (0.0609)	0.1614*** (0.0365)	0.1978*** (0.0293)
Citation/Patent $t+3$	229	0.1808*** (0.0659)	0.1847*** (0.0319)	0.1874*** (0.0314)
Citation/Patent $t+4$	222	0.1562*** (0.0527)	0.1017*** (0.0272)	0.1171*** (0.0254)

Table 5
Robustness Check 2: Subsample Periods Analysis

This table presents award-winning treatment effects on long-run innovation decisions over the periods beginning in 1976. Panel A shows treatment effects, in the permanent shift model, over the period 1976-1991 and the period 1976-2002. Panel B reports award-winning effects on innovation over the two periods when the temporary effects on winning an award are assumed. The division of the sample periods is based on availability of CEO information from Execucomp database. Matched groups for each treatment group are selected by a single nearest neighbor, 10-nearest neighbors (not reported), and kernel propensity score matching procedure (with Gaussian kernel function). Matching procedures are similar to the previous analyses. The outcome variables are the number of patents (scaled by the average number of patents in the same year) and the number of citations per patent. The matching estimates represent differences in the innovation outputs between actual winners and predicted winners. The number of observations in this table only include groups which lie within a common support region. The standard errors are estimated by bootstrapping and are reported in parentheses. ***, **, and * represent significance at 1%, 5%,

Outcome Variables	Period: 1976 ~ 1991			Period: 1976 ~ 2002		
	N	Single Nearest Neighbor	Kernel (Gaussian)	N	Single Nearest Neighbor	Kernel (Gaussian)
	(On Support)	Matching Estimate	Matching Estimate	(On Support)	Matching Estimate	Matching Estimate
Patent $t+1$	632	0.0993*** (0.0137)	0.1063*** (0.0078)	2187	0.1106*** (0.0102)	0.1176*** (0.0059)
Patent $t+2$	623	0.1017*** (0.0141)	0.1211*** (0.0056)	2131	0.1291*** (0.0114)	0.1343*** (0.0066)
Patent $t+3$	613	0.1254*** (0.0112)	0.1421*** (0.0075)	2075	0.1436*** (0.0124)	0.1504*** (0.0074)
Patent $t+4$	600	0.1647*** (0.0198)	0.1617*** (0.0080)	2020	0.1563*** (0.0138)	0.1630*** (0.0082)
Citation/Patent $t+1$	632	0.1017*** (0.0359)	0.1214*** (0.0140)	2188	0.1244*** (0.0248)	0.1238*** (0.0077)
Citation/Patent $t+2$	624	0.1211*** (0.0276)	0.1204*** (0.0134)	2134	0.1158*** (0.0243)	0.1296*** (0.0084)
Citation/Patent $t+3$	615	0.1581*** (0.0307)	0.1210*** (0.0160)	2079	0.1441*** (0.0233)	0.1281*** (0.0076)
Citation/Patent $t+4$	602	0.1091*** (0.0358)	0.1371*** (0.0145)	2025	0.1563*** (0.0231)	0.1271*** (0.01030)

and 10% levels, respectively.

Table 6
Robustness Check 3: Heckman Selection Model

This table reports estimates of the effects of winning an award on innovation outcomes in the Heckman selection model. This regression model includes two steps. In the first step, it runs a probit regression in which the dependent variable is an award dummy in the permanent shift model and the independent variables are 1-year Carhart's four-factor risk-adjusted stock returns prior to an award, log(market capitalization), book-to-market, log(CEO age), log(1+CEO tenure). The estimated probability of winning an award for each observation is included in the second stage as a key independent variable (Award) where the dependent variable is innovation outcomes year $t+1$ to year $t+4$. I also include control variables that affect a firm's innovation decisions in the second stage. To further control an omitted variable bias problem, I include lagged patenting activities and firm dummies in the regression. All continuous variables are winsorized at the 1% level. Standard errors are reported in parentheses. ***, **, and * represent significance at 1%, 5%, and 10% levels, respectively.

Variable	Ln(1+Pat _{t+1})	Ln(1+Pat _{t+2})	Ln(1+Pat _{t+3})	Ln(1+Pat _{t+4})	Ln(1+ $\frac{Cit}{Pat}$ _{t+1})	Ln(1+ $\frac{Cit}{Pat}$ _{t+2})	Ln(1+ $\frac{Cit}{Pat}$ _{t+3})	Ln(1+ $\frac{Cit}{Pat}$ _{t+4})
Award	0.0846*** (0.0275)	0.108*** (0.0295)	0.0774** (0.0317)	0.0526 (0.0333)	0.0664* (0.0344)	0.0894*** (0.0344)	0.0625* (0.0350)	-0.0151 (0.0361)
Ln(1+Pat _{t-1})	0.751*** (0.0252)	0.555*** (0.0297)	0.266*** (0.0338)	0.0107 (0.0378)				
Ln(1+Cit/Pat _{t-1})					0.586*** (0.0284)	0.346*** (0.0288)	-0.0118 (0.0327)	-0.234*** (0.0367)
Ln(Sales)	0.0362*** (0.00484)	0.0237*** (0.00548)	0.0174*** (0.00634)	0.0162** (0.00713)	0.0116** (0.00583)	0.0137** (0.00595)	0.0172*** (0.00637)	0.0260*** (0.00690)
R&D	0.0680 (0.0814)	0.150 (0.0916)	0.326*** (0.103)	0.294** (0.116)	0.602*** (0.0995)	0.818*** (0.102)	0.848*** (0.108)	0.435*** (0.117)
Leverage	-0.0639*** (0.0191)	-0.0649*** (0.0216)	-0.0609** (0.0250)	-0.0644** (0.0284)	-0.0413* (0.0231)	-0.0500** (0.0236)	-0.0725*** (0.0254)	-0.0482* (0.0275)
Tangibility	0.0788*** (0.0292)	0.0774** (0.0326)	0.0792** (0.0369)	0.0908** (0.0411)	0.0906** (0.0356)	0.123*** (0.0360)	0.101*** (0.0380)	0.0954** (0.0408)
Profitability	-0.0761*** (0.0295)	0.00899 (0.0328)	0.0990*** (0.0372)	0.145*** (0.0417)	0.112*** (0.0361)	0.228*** (0.0369)	0.328*** (0.0390)	0.351*** (0.0418)
Cash	-0.0123 (0.0268)	0.00312 (0.0303)	0.0326 (0.0354)	0.00471 (0.0401)	0.0225 (0.0325)	0.0195 (0.0330)	-0.0226 (0.0354)	0.00583 (0.0387)
Ln(1+Firm age)	0.0551*** (0.00780)	0.0560*** (0.00890)	0.0565*** (0.0104)	0.0467*** (0.0116)	-0.0187** (0.00930)	-0.0226** (0.00938)	-0.0153 (0.0101)	-0.0147 (0.0111)
Ln(1+CEO delta)	0.00684*** (0.00241)	0.00450* (0.00271)	-9.67e-05 (0.00310)	-0.00173 (0.00342)	0.00983*** (0.00292)	0.00933*** (0.00296)	0.00113 (0.00316)	-0.00145 (0.00341)
Ln(1+CEO vega)	0.00411** (0.00203)	0.00469** (0.00230)	0.00503* (0.00264)	0.00189 (0.00290)	-0.000761 (0.00244)	-0.00302 (0.00247)	0.00388 (0.00266)	0.00333 (0.00288)
Ln(1+CEO	0.000604	-0.00210	0.00131	0.00409	-0.00448	-0.0102**	-0.00221	0.00231

tenure)	(0.00324)	(0.00363)	(0.00412)	(0.00460)	(0.00395)	(0.00401)	(0.00424)	(0.00455)
Ln(1+CEO age)	-0.0438	-0.0758**	-0.0795**	-0.0800*	-0.0336	-0.00354	0.0119	0.0272
	(0.0266)	(0.0306)	(0.0357)	(0.0413)	(0.0321)	(0.0327)	(0.0350)	(0.0385)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	17,796	15,622	13,513	11,545	18,974	18,015	15,963	13,934

Table 7
CEO Award, CEO Power, and Job Security

This table presents how a shift in CEO power as a result of winning a prestigious award affects CEO total compensation and CEO turnover. Panel A reports a propensity score matching result on a change in CEO total compensation between first-time award-winners and predicted winners. In the first stage, I estimate a propensity score in which a dependent variable is a first-award indicator variable (one for all CEO-year observations after year t when CEOs win their first-time award and zero otherwise). The independent variables used as a matching variable are $\log(\text{asset})$, return_{t-1} , return_t , ROA_{t-1} , ROA_t , sales growth, cash, firm risk, $\log(\text{CEO age})$, $\log(1+\text{CEO tenure})$, CEO gender, and CEO/chairman duality (along with year dummies and industry dummies at the two-digit SIC level). In the second stage, the predicted award-winners are selected in the same year and same industry group at two-digit SIC level with award-winners by using a single nearest neighbor and a kernel propensity score matching algorithm. To further eliminate heterogeneity of total compensation between actual winners and predicted winners, I sort the sample CEOs into deciles of compensation, and then I force actual winners and predicted winners to match within the same decile group. The outcome variables are (excess) total compensation (tdc1 measure from Execucomp). I estimate excess compensation following the estimation method by Core, Guay, and Larcker (2008). The number of observations in this table only include groups which lie within a common support region. The standard errors are estimated by bootstrapping and are reported in parentheses. Panel B presents multinomial logistic regression results on how winning an award affects CEO turnover. The dependent variable is a CEO turnover equal to one for exogenous turnover (scheduled retirement, death, etc.), equal to two for unclassified turnover, equal to three for forced turnover (fired by the board), and equal to zero for no turnover events. Thus, the reference category is no turnover events. The poor performance dummy is equal to one if a firm belongs to the bottom 25% group based on ROA and zero otherwise. The interest variable in the regression is an interaction term between the first award dummy and poor performance dummy. All other variables in Table I are described in the Appendix. The standard errors are clustered at the group (CEO/firm) level. ***, **, and * represent significance at 1%, 5%, and 10% levels, respectively.

Panel A: Changes in compensation

Outcome variables	N (on support)	Nearest-neighbor matching			Kernel matching		
		Award winners (W)	Predicted winners (P)	Difference (W-P)	Award winners (W)	Predicted winners (P)	Difference (W-P)
Δ total compensation [$t-1, t+1$]	165	\$2,175.92	-\$2,413.69	\$4,589.54*** (\$1,654.89)	\$2,175.92	-\$1,745.10	\$3,921.02*** (\$1,480.58)
Δ total compensation [$t-1, t+2$]	138	\$3,534.47	-\$1,490.99	\$5,025.46*** (\$2,268.85)	\$3,534.47	-\$1,438.82	\$4,973.29*** (\$1,650.46)
Δ excess compensation [$t-1, t+1$]	192	\$1,705.46	-\$1,839.61	\$3,545.37* (\$2,000.71)	\$1,705.46	-\$1,950.78	\$3,656.54*** (\$1,667.55)
Δ excess compensation [$t-1, t+2$]	178	\$2,251.53	-\$5,096.51	\$7,321.04*** (\$1,946.46)	\$2,251.53	-\$2,204.70	\$4,456.22*** (\$1,431.50)

Panel B: Multinomial logit regression: Post-CEO turnover after awards

Variable	Year $t+1$			Year $t+2$		
	Exogenous	Unclassified	Forced	Exogenous	Unclassified	Forced
First award dummy	-0.627 (0.633)	0.132 (0.384)	-0.196 (0.728)	-0.0838 (0.476)	-0.447 (0.527)	-1.057 (1.001)
Poor performance dummy	-0.399** (0.177)	0.0946 (0.114)	0.541*** (0.186)	0.121 (0.182)	0.218* (0.129)	-0.144 (0.250)
(First award)*(Poor performance)	1.872* (0.996)	-0.405 (1.161)	-11.38*** (0.829)	0.704 (1.072)	-10.60*** (0.634)	-9.887*** (1.118)
Industry-adjusted Return	-0.396 (0.617)	0.123 (0.448)	-1.740** (0.813)	0.590 (0.626)	0.307 (0.465)	0.776 (0.964)
Industry Return	0.151 (0.894)	-0.328 (0.572)	-1.602 (1.066)	0.688 (0.875)	-0.465 (0.616)	2.248* (1.237)
Industry-adjusted ROA	-0.937 (1.108)	-0.569 (0.587)	-1.005 (0.986)	0.897 (1.145)	-0.630 (0.597)	-1.751* (0.952)
Industry ROA	-0.341 (1.252)	-0.334 (0.712)	-1.301 (1.261)	0.314 (1.301)	-0.473 (0.780)	-1.364 (1.392)
Log(Asset)	0.184*** (0.0413)	0.0740** (0.0298)	0.324*** (0.0544)	0.171*** (0.0434)	0.0950*** (0.0326)	0.308*** (0.0593)
Log(CEO age)	8.246*** (0.642)	3.740*** (0.420)	-1.076 (0.683)	8.141*** (0.692)	4.116*** (0.468)	-1.218 (0.795)
Log (Tenure)	0.1000 (0.0613)	0.0688 (0.0445)	-0.0272 (0.0803)	0.123* (0.0691)	0.0557 (0.0513)	-0.0940 (0.0968)
CEO/Chairman duality	-2.253*** (0.223)	-2.748*** (0.223)	-4.601*** (1.003)	-2.383*** (0.241)	-2.789*** (0.236)	-4.579*** (1.002)
Industry fixed effects		Yes			Yes	
Year fixed effects		Yes			Yes	
Pseudo R2		15.26%			16.18%	
Observations		14,165			11,909	

Table 8**Post Innovation to CEO Awards after Controlling for CEO Overconfidence**

This table shows results of the role that managerial overconfidence plays in explaining the observed results in Chapter IV. Panel A presents a logit regression examining whether receiving a prestigious award affects managerial overconfidence. The dependent variable is an indicator variable of whether a CEO becomes overconfident within four years in a given year t . For award-winners, the dependent variable is one if a CEO becomes overconfident within four years following the award. A key independent variable is the award dummy which is equal to one if a CEO receives an award at year t and zero otherwise. I also employ several control variables which are reported to affect CEO option exercise: return $t-1$, return $t-2$, log (asset) $t-1$, ROA $t-1$, ROA $t-2$, sale growth $t-1$, cash $t-1$, volatility $t-1$, log (1+CEO age) $t-1$, female dummy, and CEO/chairman duality along with year fixed effects and industry fixed effects. Panel B reports estimates of the effects of winning an award on innovation after controlling for CEO overconfidence in the Heckman selection model. The procedure of the two-stage regression is similar to Table 7. All continuous variables are winsorized at the 1% level. Variables are described in more detail in Appendix A. The standard errors are estimated by bootstrapping and are reported in parentheses. ***, **, and * represent

Panel A: CEO award and overconfidence

Variables	Overconfidence
Award dummy	0.837 (0.627)
Return $t-1$	-0.520 (0.674)
Return $t-2$	-0.440 (0.707)
Ln (Asset) $t-1$	-0.235*** (0.0674)
ROA $t-1$	1.804** (0.894)
ROA $t-2$	-2.062** (0.941)
Sale growth $t-1$	-0.666* (0.356)
Cash $t-1$	-0.283* (0.170)
Volatility $t-1$	5.260*** (1.940)
Ln (1+CEO age) $t-1$	-0.958 (0.675)
Female	-0.952 (1.022)
Duality	-0.00216 (0.181)
Year fixed effects	Yes
Industry fixed effects	Yes
No. of obs.	6,805

significance at 1%, 5%, and 10% levels, respectively.

Panel B: Heckman selection model: The effect of the award on innovation after controlling for CEO overconfidence

Variable	$\text{Ln}(1+\text{Pat}_{t+1})$	$\text{Ln}(1+\text{Pat}_{t+2})$	$\text{Ln}(1+\text{Pat}_{t+3})$	$\text{Ln}(1+\text{Pat}_{t+4})$	$\text{Ln}(1+\frac{\text{Cit}}{\text{Pat}}_{t+1})$	$\text{Ln}(1+\frac{\text{Cit}}{\text{Pat}}_{t+2})$	$\text{Ln}(1+\frac{\text{Cit}}{\text{Pat}}_{t+3})$	$\text{Ln}(1+\frac{\text{Cit}}{\text{Pat}}_{t+4})$
Award	0.0841*** (0.0275)	0.1075*** (0.0295)	0.0760** (0.0317)	0.0515 (0.0333)	0.0652* (0.0344)	0.0881** (0.0344)	0.0606* (0.0350)	-0.0161 (0.0361)
Overconfidence	0.0090 (0.0059)	0.0116* (0.0066)	0.0236*** (0.0075)	0.0355*** (0.0085)	0.0133* (0.0072)	0.0209*** (0.0072)	0.0264*** (0.0076)	0.0186** (0.0082)
$\text{Ln}(1+\text{Pat}_t)$	0.7507*** (0.0252)	0.5549*** (0.0297)	0.2656*** (0.0339)	0.0110 (0.0378)				
$\text{Ln}(1+\text{Cit}/\text{Pat}_t)$					0.5855*** (0.0284)	0.3449*** (0.0288)	-0.0121 (0.0327)	-0.2343*** (0.0367)
$\text{Ln}(\text{Sales})$	0.0366*** (0.0048)	0.0241*** (0.0055)	0.0182*** (0.0063)	0.0169** (0.0071)	0.0122** (0.0058)	0.0147** (0.0060)	0.0185*** (0.0064)	0.0268** (0.0069)
R&D	0.0673 (0.0814)	0.1499 (0.0916)	0.3247*** (0.1033)	0.2907** (0.1161)	0.6014*** (0.0995)	0.8177*** (0.1022)	0.8459*** (0.1077)	0.4340*** (0.1168)
Leverage	-0.0641*** (0.0191)	-0.0653*** (0.0216)	-0.0612** (0.0250)	-0.0640** (0.0284)	-0.0416* (0.0231)	-0.0507** (0.0236)	-0.0734*** (0.0254)	-0.0490* (0.0275)
Tangibility	0.0796*** (0.0292)	0.0781*** (0.0326)	0.0803** (0.0369)	0.0927** (0.0410)	0.0917*** (0.0356)	0.1250*** (0.0360)	0.1033*** (0.0380)	0.0964** (0.0408)
Profitability	-0.0772*** (0.0295)	0.0074 (0.0328)	0.0965*** (0.0372)	0.1419*** (0.0417)	0.1099*** (0.0362)	0.2241*** (0.0369)	0.3245*** (0.0390)	0.3487*** (0.0418)
Cash	-0.0133 (0.0268)	0.0017 (0.0304)	0.0292 (0.0354)	-0.0005 (0.0401)	0.0215 (0.0325)	0.0183 (0.0330)	-0.0250 (0.0353)	0.0035 (0.0387)
$\text{Ln}(1+\text{Firm age})$	0.0551*** (0.0078)	0.0558*** (0.0089)	0.0558*** (0.0104)	0.0455*** (0.0116)	-0.0185** (0.0093)	-0.0225** (0.0094)	-0.0157 (0.0101)	-0.0153* (0.0111)
$\text{Ln}(1+\text{CEO delta})$	0.0068*** (0.0024)	0.0045* (0.0027)	-0.0001 (0.0031)	-0.0017 (0.0034)	0.0097*** (0.0029)	0.0092*** (0.0030)	0.0010 (0.0032)	-0.0015 (0.0034)
$\text{Ln}(1+\text{CEO vega})$	0.0038* (0.0020)	0.0042* (0.0023)	0.0039 (0.0027)	0.0002 (0.0029)	-0.0012 (0.0025)	-0.0038 (0.0025)	0.0028 (0.0027)	0.0025 (0.0029)
$\text{Ln}(1+\text{CEO tenure})$	-0.0007 (0.0034)	-0.0039 (0.0038)	-0.0024 (0.0043)	-0.0015 (0.0048)	-0.0065 (0.0040)	-0.0135*** (0.0041)	-0.0063 (0.0044)	-0.0007 (0.0047)
$\text{Ln}(1+\text{CEO age})$	-0.0456* (0.0267)	-0.0778** (0.0306)	-0.0833** (0.0357)	-0.0863** (0.0413)	-0.0364 (0.0321)	-0.0073 (0.0327)	0.0076 (0.0350)	0.0250 (0.0385)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	17,796	15,622	13,513	11,545	18,974	18,015	15,963	13,934

Table 9
Institutional Ownership, CEO Awards, and Innovation

This table presents cross-sectional variation in the effects of prestigious awards on innovation by institutional holdings. I obtain quarterly institutional holdings from Thomson Reuters Ownership Data and aggregate them into annual holdings. Based on the median of the institutional holdings across groups, I partition the sample into two groups: groups with high institutional holdings and groups with low institutional holdings. I then rematch actual award-winners with benchmark CEOs within each category. Predicted winners (P) are selected by a single nearest neighbor, multiple nearest neighbor (not reported), and a kernel propensity score matching procedure (with Gaussian kernel function). I describe more details about matching procedure in Appendix B. The last column represents t-statistics of the differences in treatment effects between groups with high and low institutional holdings. The standard errors are estimated by bootstrapping and are reported in parentheses. ***, **, and * represent significance at 1%, 5%, and 10% levels, respectively.

Outcomes	Low Institutional Ownership (N=462)		High Institutional Ownership (N=307)		Difference (Low-High)	
	Single Nearest	Kernel	Single Nearest	Kernel	Single Nearest	Kernel
	Matching Estimate	Matching Estimate	Matching Estimate	Matching Estimate		
Patent $t+1$	0.0941*** (0.0134)	0.1173*** (0.0071)	0.0734*** (0.0213)	0.0711*** (0.0137)	0.0207*** (0.0170)	0.0462*** (0.0103)
Patent $t+2$	0.1268*** (0.0141)	0.1342*** (0.0071)	0.0694*** (0.0287)	0.0830*** (0.0114)	0.0574*** (0.0212)	0.0512*** (0.0091)
Patent $t+3$	0.1201*** (0.0233)	0.1412*** (0.0111)	0.1067*** (0.0306)	0.0996*** (0.0132)	0.0134*** (0.0265)	0.0416*** (0.0120)
Patent $t+4$	0.1419*** (0.0166)	0.1396*** (0.0165)	0.1312*** (0.0275)	0.1189*** (0.0128)	0.0107*** (0.0216)	0.0207*** (0.0151)
Citation $t+1$	0.1509*** (0.0575)	0.1413*** (0.0223)	0.1234** (0.0538)	0.1165*** (0.0321)	0.0275*** (0.0561)	0.0248*** (0.0267)
Citation $t+2$	0.1501*** (0.0433)	0.1380*** (0.0227)	0.0942* (0.0553)	0.1357*** (0.0279)	0.0599*** (0.0484)	0.0023 (0.0249)
Citation $t+3$	0.2009*** (0.0457)	0.1358*** (0.0232)	0.1302** (0.0582)	0.1115*** (0.0220)	0.0707*** (0.0511)	0.0243*** (0.0227)
Citation $t+4$	0.1598*** (0.0408)	0.1154*** (0.0207)	0.0596 (0.0485)	0.0906*** (0.0253)	0.1002*** (0.0440)	0.0248*** (0.0227)

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