Overconfident CEOs as Outside Directors: Are They Better Facilitators for Innovation?

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Abstract

This paper examines the relation between director overconfidence and innovation. We find that firms with a higher proportion of overconfident directors on the board invest more in innovation, obtain more patents and patent citations, and achieve greater innovation efficiency. These firms also have higher firm value as measured by Tobin's Q and better operating performance. The results are robust to alternative measures of innovation and are not driven by firm-director matching, suggesting the relation is causal. In the cross-section, we find the effect on innovation output is concentrated in the firms with overconfident CEO and in innovative industries. Overall, our results show that overconfident directors facilitate more innovation.

Keywords: CEO Overconfidence, Board of Directors, Corporate Innovation, Board Advising

JEL Classification: G34

1 INTRODUCTION

There is growing evidence that managers' psychological biases affect corporate decisions such as acquisitions, investments, and risk-taking (Malmendier and Tate, 2005, 2008; Hirshleifer, Low, and Teoh, 2012, Ben-David, Graham and Harvey, 2013). However, researchers have so far paid little attention to the psychological biases of directors and how they interact with those of the managers in affecting corporate decisions. Since major corporate decisions need the approval of the board before they can be implemented and directors also provide valuable advices to the management in these decisions, a complete picture of psychological biases on decision making in firms should apparently take into account both managers and directors. In this paper, we fill in this gap in the literature by examining one particular psychological bias of directors, overconfidence, and its effect on one important driver of firm value, innovation.

Overconfidence is the tendency of individuals to overestimate their ability, judgement or the probability of favorable outcomes. Psychological and other research finds that people differ substantially in their degree of overconfidence and such differences are persistent over time. Overconfidence of decision makers can have a particularly strong impact on corporate innovation because innovative projects, which develop new technologies, apply new business methods, or offer new products or services, are risky, challenging and have ambiguous and delayed feedbacks. Hirshleifer, Low, and Teoh (2012) find that overconfident CEOs invest more in R&D and achieve greater innovation. However, corporate innovation is also likely to be significantly affected by the board of directors because any major decisions and strategic plans of the CEO need to obtain the board's approval. The board also sets the CEO incentive through compensation and monitoring. At the same time, they provide advice to the CEO. The presence of overconfident directors on the board could affect the innovation of firms in several ways. First,

CEOs are more likely to get support for innovative projects from overconfident directors because they are enthusiastic about risky and challenging projects and likely to overestimate the return on the investments and probability of success. Second, overconfident directors are likely to encourage the CEO to take on risky innovation projects through their authority to evaluate the CEO performance and set CEO compensation. Hence, it is expected that overconfident directors are associated with not only more innovation inputs (R&D expenses), but also more innovation outputs (patent counts and citations). However, the overconfidence argument itself does not give a clear prediction on whether firms with overconfident directors produce more innovation output at any given level of R&D input. On the one hand, overconfident directors may overestimate the expected return on innovative projects and thus are more likely to approve projects with low expected returns. One the other hand, overconfident directors may push a rational CEO to take on more risky projects than she is willing to on her own due to her concentrated wealth in the firm, but from the shareholders' perspective are good risky projects. Thus, firms with overconfident directors may achieve higher innovative productivity. In addition, when overconfident directors are CEOs of other firms, they are able to provide valuable advice on innovation projects and thus help the firm to achieve higher innovative efficiency because they tend to invest more in innovative projects in their own firms and thus have acquired valuable experience in innovation (Hirshleifer, Low, and Teoh (2012)).

To measure the degree of overconfidence of the directors, we use the option measure proposed by Malmendier and Tate (2005) that is widely used in the CEO overconfidence literature. This measure builds on the idea that, if a manager persistently fails to reduce her personal exposure to firm-specific risk by retaining vested deep-in-the-money options in her own firms, then that is a strong indication that she is overconfident in the prospects of the firm or her

ability to manage the firm. Using executive compensation data on the ExecuComp database, we are able to calculate the overconfidence measure for all directors who served as top executives in S&P 1500 firms. Since overconfidence is a persistent personal trait, we define a director as overconfident if she exhibited overconfidence as a top executive in her current firm or another firm. One advantage of our approach is that overconfidence is measured in a different firm than the one we examine its effect on corporate decisions. This avoids the endogeneity concern that managers' decision to expose themselves to idiosyncratic risk of their firm is endogenously linked to the corporate decisions they make. The disadvantage is that the option measure cannot be calculated for directors who never served as a top executive in S&P 1500 firms and we classify all of them as not overconfident. At the firm level, three variables are then created that measure (1) the presence of overconfident CEO directors, (2) the number of overconfident CEO directors and (3) the percentage of overconfident CEO directors relative to board size.

We evaluate corporate innovation by examining both innovation input and output. In particular, as is standard in the literature, we use R&D intensity to measure the innovation investments. However, as greater innovation input does not necessarily lead to greater innovation output, we further use the quantity and quality of patents created by the firm to capture innovation performance. In terms of quantity, we use the number of patents applied for (and eventually granted) by a firm in a given year. In terms of quality, we use the number of citations accumulated by the firm's patents from subsequent patents. In robustness checks, we also use the patent index (Bena and Li, 2012), innovation efficiency (Amanda, Hsu and Li, 2013) and citations per patent (Hirshleifer, Low, and Teoh, 2012) as alternative measures for innovation output.

Our sample consists of S&P 1500 firms from 1998 to 2006. We find a significantly positive relation between overconfident CEO directors and corporate innovation. Specifically, the presence, number and proportion of overconfident directors on the board are all positively related to higher R&D expenditure, more patents and more patent citations. The relations are all statistically significant at conventional levels. To test whether overconfident directors simply invest more in innovation or actually achieve greater innovation efficiency (Aghion, Van Reenen, and Zingales, 2013), we control for R&D intensity in the patent and citation regressions and find that the coefficient on our overconfident directors remain positive and statistically significant, suggesting they generate more innovation output at any given level of R&D input.

These results are robust to several alternative measures of innovation. To adjust for differences across technology classes and time periods, we replace the simple measure of patent counts by the patent index (Bena and Li, 2012). To differentiate whether a high citation count is achieved by means of more patents or by patents with higher impact (Hirshleifer, Low, and Teoh, 2012), we replace the simple measure of citation counts by citations per patent. To measure innovative efficiency, we scale the patent counts and citations by R&D (Almeida, Hsu, and Li, 2013). With all these changes, our main results remain hold.

We also explore the cross-sectional variations in the degree of director overconfidence. The main tests use the cut-off moneyness of 67% to identify overconfidence (Malmendier and Tate, 2005; Campbell et al., 2011) and treat the overconfident directors as a homogenous group. However, the results may be driven by CEO directors with certain degrees of overconfidence. To allow for nonlinearity in the relation, we further divide overconfident CEO directors into three groups based on their degree of overconfidence. Following Hirshleifer, Low, and Teoh (2012), low overconfidence, moderate overconfidence and high overconfidence are defined if the

confidence measures are in the range of [67%, 130%), (130%, 250), and [250%, $+\infty$), respectively. The results are largely consistent with those in the main tests, while CEOs with a high overconfidence level are associated with the most pronounced effects on corporate innovation.

The strong association between overconfident directors and corporate innovation is consistent with two very different interpretations. The first interpretation is that it represents a causal effect of directors on innovation. Alternatively, it can be solely driven by firm-director matching, where firms that have greater innovation opportunities tend to attract or hire overconfident directors to their boards. To prove a causal relation, we take two approaches to rule out the firm-director matching explanation. First, we exploit the fact that while a firm's innovative opportunities vary significantly over time, director overconfidence is persistent. Hence, the matching effect is expected to be the strongest when the overconfident directors are newly appointed to the firm. We thus re-estimate our regressions in the subsample of firm-years where the tenure of the overconfident directors is greater than three years. The results remain the same. Second, we take an instrumental variable approach. The number of overconfident directors in the State of the firm's headquarter should be positively correlated with the appointment of overconfident directors to the board but not so with the innovative activities in the firm. Hence, we use the number of overconfident directors in the State as the instrument and estimate two-stage least square regressions. Again, our main findings do not change. Hence, we conclude that director overconfidence has a causal effect on corporate innovation.

Next, we examine under what scenarios overconfident CEO directors are more or less likely to affect corporate innovation. Results show that in terms of innovation input as measured by R&D intensity, overconfident CEO directors play the role of innovation facilitator no matter

whether the CEO of the firm is overconfident, or whether the firm is in an innovative industry. However, when it comes to innovation output as measured by patents and patent citations, overconfident CEO directors play the role of innovation facilitator only when the CEO of the firm is overconfident, or when the firm is in an innovative industry. Further, to investigate whether board memberships matter, we follow Faleye, Hoitash, and Hoitash (2011) to define intense monitors and find that overconfident CEO directors play a bigger role if they sit on advising committees relative to those who are intense monitors. These results suggest that the board's influence on innovation is mainly through its approval power for major investments and advising role. Although it could approve more R&D projects, the quality of the innovative projects crucially depends on the choices made by the CEO. If the CEO is overconfident, then an overconfident board facilitates the CEO's ambition to take on risky innovative projects. However, if the CEO is not overconfident, the approved R&D spending does not lead to significantly more innovation output as measured by patents.

Next, we examine whether overconfident CEO directors are associated with enhanced corporate performance, as measured by Tobin's Q and return on assets (ROA). To alleviate the endogeneity concern, we perform the 2SLS regressions using the IV. Evidence consistently shows that overconfident CEO directors are associated with greater firm value as measured by Tobin's Q and better operating performance as measured by ROA. Further, the causality runs from overconfident CEO directors to firm performance—not the other way around. We conclude that by facilitating corporate innovation, overconfident CEO directors help promote value creation.

While CEO directors are a distinct group on the board, it is interesting and important to ask: Does the overconfidence of non-CEO outside directors have any impact on corporate

innovation and performance? We determine the confidence level of each non-CEO outside director as long as there are data available in ExecuComp and create variables at the firm level indicating the presence, number and percentage of overconfident non-CEO outside directors on the board. Unsurprisingly, we find that overconfident non-CEO outside directors have similar (although sometimes weaker) effects to overconfident CEO directors on corporate innovation and performance.

Overall, the findings suggest that overconfident outside CEO directors are better facilitators for corporate innovation than those who are not overconfident. They are associated not only with greater innovation input, but also better innovation output. Further, such directors are associated with increased firm value and improved operating performance. The evidence supports the view that overconfident CEO directors are better advisors to incumbent CEOs.

Our paper contributes to the literature on boards of directors by examining a new dimension of director characteristics, the psychologic biases of directors, and its impact on firm decisions. Agrawal and Knoeber (2001) argue that outside directors who have experience in politics or government play a political role by providing advice and insight into the workings of government and by acting to influence the government directly. Adams and Ferreira (2007) show that a management-friendly board could be value-enhancing due to better advising, as CEOs would be more willing to share information with a board that monitors them less intensively. Faleye (2011) finds that CEO directors can play important advisory roles as acquisition returns increase with CEO directors, especially for firms with limited internal growth opportunities. Masulis, Wang, and Xie (2012) examine foreign independent directors (FID) and find that firms with such directors make better cross-border acquisitions when the targets are from the home regions of FIDs. Field, Lowry, and Mkrtchyan (2013) argue that busy directors offer advantages

for many firms, as their experience and contacts arguably make them excellent advisors. Faleye, Hoitash, and Hoitash (2013) examine independent directors' experience in the same industry and find that board industry expertise is associated with a significant increase in firm value and corporate innovation. None of these studies look at the psychological biases of directors. We argue that psychological biases of directors can affect firm decisions through the board's authority to approve major decisions and monitor the CEOs and its function to provide advice to CEOs and find evidence that overconfidence of directors increases firms' innovation input, output and innovative efficiency.

Our paper extends a recent literature on CEO overconfidence to overconfidence of directors. Prior studies have examined the effect of CEO overconfidence on various corporate aspects, such as investment decisions (Dittrich, Güth, and Maciejovsky, 2005; Malmendier and Tate, 2005), M&A decisions (Ferris, Jayaraman, and Sabherwal, 2013; Kolasinski and Li, 2012; Malmendier and Tate, 2008), financial policies (Malmendier, Tate, and Yan, 2011), innovative activities (Galasso and Simcoe, 2011; Hirshleifer, Low, and Teoh, 2012), dividend policies (Deshmukh, Goel, and Howe, 2013), accounting conservatism (Ahmed and Duellman, 2013), earnings management (Burg, Pierk, and Scheinert, 2013; Yu, 2013), financial misreporting (Schrand and Zechman, 2012) and forced CEO turnovers (Campell et al., 2011). While most of them document evidence on the adverse consequences of overconfident CEOs, both Galasso and Simcoe (2011) and Hirshleifer, Low, and Teoh (2012) find that overconfident CEOs are associated with better corporate innovation. However, all these papers ignore the psychological biases of directors. We complete the picture of decision making in firms by taking into account the overconfidence of directors and show that it too has a significant impact on corporate innovation. In addition, in CEO overconfidence studies, CEO overconfidence is measured in the

same firm where the corporate decisions are studied. In contrast, in our study, the overconfidence of directors is measured in one firm and its impact on innovation is studied in another firm. This avoids the endogenous link between the overconfidence measure and the corporate decisions being studied.

We also contribute to the literature on corporate governance and innovation. Francis and Smith (1995) find diffusely held firms are less innovative than firms with concentrated ownership by the management or outside blockholders because concentrated ownership is more effective at alleviating the high monitoring costs associated with innovation. Aghion, Van Reenen and Zingales (2013) find that higher institutional ownership leads to more innovation in publicly listed U.S. firms because institutional investors are more tolerant of failure than other investors. Focusing on external governance, Chemmanur and Tian (2015) find that more anti-takeover provisions help to insulate managers from the market for corporate control and promote more innovation. Sapra, Subramanian and Subramanian (2015) find a U-shaped relation between innovation and external takeover pressure. They find that firms innovate more either when there is unimpeded takeover pressure or whey anti-takeover laws are server enough to effectively deter takeovers. However, there is little research on the board characteristics that are associated with innovation. We show that the presence and percentage of overconfident directors on the board is an important determinant of a firm's ability to innovate.

The remainder of this paper is organized as follows. Section 2 describes the data and variable construction, and it presents summary statistics for the sample. Section 3 examines the effect of overconfident CEO directors on corporate innovation. Section 4 presents several robustness tests. Section 5 conducts several cross-sectional analyses and discusses further

extensions on the effect of overconfident CEO directors on firm performance and the effect of the overconfidence among other outside directors. Section 6 concludes.

2 DATA AND SAMPLE

We utilize several databases to construct the sample. We start with all S&P 1500 firms from RiskMetrics (formerly IRRC) database, over the 1998–2006 period.[1] As is standard in the literature, we exclude firms in financial (with two-digit SIC code 60–69) and utility (with two-digit SIC code 49) industries, because firms in these industries are subject to regulatory constraints. The RiskMetrics database contains information on whether each director has a current 'CEO' title. Together with the information on directors' independence status and name of their primary employer, we identify outside directors who are active CEOs of other firms. We then match the directors' names in RiskMetrics to those in ExecuComp, which contains information on annual compensation for up to five top executives in firms in the S&P 1500 index from 1992 onwards. We match the names by the full name (i.e. first name, middle name and last name). As there are minor spelling mistakes and inconsistencies within and across the databases, we use regular expression to standardize the names first within a database and then across the databases. Finally, to ensure the accuracy of the matching, we further check the consistency of the age of each person.

We use information in ExecuComp relating to the CEOs' option compensation to compute the confidence measure based on the average moneyness of the CEOs' option holdings. We compute the confidence measure for all CEOs in our sample. Further, as an extension, we compute the confidence measure for non-CEO outside directors if data for them are available in ExecuComp.

[1] Although RiskMetrics provides data starting from 1996, coverage of directors' principal occupations began in 1998.

Data on the characteristics of the boards are obtained from RiskMetrics, including board size, board independence and CEO–chairman duality. We also obtain the GIM index from RiskMetrics. Data on blockholders are from Thomson Reuters Institutional Holdings (13F) Database. Firm financial data are obtained from Compustat. Patent data are obtained from the 2006 edition of the National Bureau of Economic Research (NBER) patent databases.

After excluding firms with missing data on the variables used in the regressions, the final sample consists of 8,593 firm-year observations over the 1998–2006 period.

2.1 Variable Construction

2.1A Measure of Overconfidence

We measure whether an outside CEO director is overconfident or not by examining his or her option holdings and exercise decisions in his or her own firm. Prior studies argue that overconfidence is a personal trait that is persistent and long-lasting (e.g. Malmendier and Tate, 2005, 2008). Hence, we expect overconfident CEO will bring this trait with them to the firms they serve as outside directors, therefore potentially affecting the firm policy at the appointing firm.

We use the overconfidence measure developed by Malmendier and Tate (2005) and define a CEO as overconfident if he or she holds stock options that are more than 67% in the money for at least twice in their career history. The choice of the 67% cutoff is derived from calibrating Hall and Murphy's (2002) model using a detailed dataset on executive stock option holding and exercise decisions. The rationale for measuring CEO overconfidence using stock option holdings is as follows. CEOs typically have overexposure to the idiosyncratic risk of their firms. They usually receive large grants of options and restricted stocks as compensation and they are not allowed to trade their options/stocks for a given period of time or hedge the risk by

short-selling the company stock. Further, the value of their human capital is intimately linked to the firms' performance. Therefore, due to this potentially serious under-diversification, risk-averse CEOs should exercise their options at the earliest opportunity given a sufficiently high stock price (Hall and Murphy, 2002). If CEOs choose to voluntarily expose themselves to firm-specific risk by retaining options that are deep in the money, then they are inferred to be overconfident in their ability to keep the company's stock price rising so they can profit from expected price increases by holding these options. To the extent that overconfident CEOs are willing to keep more of their personal wealth tied to the company, it is reasonable to use the value of their exercisable but not-yet-exercised options as a measure of their overconfidence.

Since we do not have access to detailed data on CEOs' option holdings and exercise prices for each option grant as Malmendier and Tate do, we follow Campbell et al. (2011) and Hirshleifer, Low, and Teoh (2012) and calculate the average moneyness of the CEOs' option portfolio for each year. Specifically, Core and Guay's (2002) approximation method is applied to estimate the average exercise price of the aggregated options. We first compute the per-option realizable value as the total realizable value of the unexercised exercisable options (ExecuComp variable: OPT_UNEX_EXER_EST_VAL) divided by the number of unexercised exercisable options (ExecuComp variable: OPT_UNEX_EXER_NUM). We then subtract the per-option realisable value from the stock price at the fiscal year end (Compustat variable: PRCC_F) to obtain an estimate of the average exercise price of the unexercised exercisable options. The average percent moneyness of the unexercised exercisable options is then calculated as the per-option realisable value divided by the estimated average exercise price.

Outside directors who are current CEOs of other firms are identified as overconfident if their measure of confidence at least twice exceeds 67% in the ExecuComp database (Hirshleifer,

Low, and Teoh, 2012). Three measures are then created at the firm level: (1) an indicator variable which equals 1 if there is at least one overconfident CEO director on the board; (2) the number of overconfident CEO directors on the board; and (3) the proportion of overconfident CEO directors relative to board size.

Since the overconfidence of CEO-directors is measured using the option exercise behavior of these CEOs in their own firms, our confidence measure are not confounded by concerns for it being correlated with past stock performance and private information in the firm they serve as directors, which in turn are likely to be correlated with innovation measures.

2.1B Measures of Corporate Innovation

R&D intensity is a traditional measure of corporate innovation input. Following the literature, we first use R&D intensity as a proxy for a firm's innovation activities. Specifically, we define R&D intensity as the R&D expenditures scaled by total assets. As is common practice in the literature, if Compustat reports R&D as missing, the value of this variable is set to zero.

While R&D intensity quantifies the *input* to innovation activities, it does not necessarily lead to successful innovation or better innovation *output*. As suggested by Jensen (1993), higher R&D intensity may simply reflect the fact that the money is spent in wasteful managerial pet projects. Therefore, we further use two performance-oriented measures that are related to patents to measure corporate innovation activities (Bena and Li, 2012).

First, to capture the quantity of innovation *output*, we count the number of successful patent applications during the year for each firm. However, simple patent counts ignore the huge variations in the technological and economical importance of each patent and do not perfectly measure innovation success. Thus, we also use a second measure of innovation output, patent citations. Trajtenberg (1990) concludes that patent citations are related to the social value created

by the innovation; Hall, Jaffe, and Trajtenberg (2005) show that patent citations are significantly related to firm value as measured by Tobin's Q. Patent citations are calculated as the total number of citations subsequently received by patents a firm applied for during a given year, adjusted by the weighting index of Hall, Jaffe, and Trajtenberg (2005). This adjustment is necessary because a patent will receive accumulated citations once it is created; thus, patents created in later periods will have less time to accumulate citations compared to those created earlier. To address this truncation bias issue, the NBER patent database provides a weighting index, which is constructed using a quasi-structural approach to estimate the shape of the citation-lag distribution econometrically.

2.1C Other Control Variables

In addition, we also create variables to control for CEO and board attributes, as well as firm characteristics that are potentially related to corporate innovation. These include board size, board independence, CEO–chairman duality, firm size, firm age, leverage, ROA, capital expenditures, the number of institutional blockholders and the GIM index. Detailed variable definitions can be found in the Appendix.

2.2 Summary Statistics

The annual distribution of the key variables of interest is reported in Table 1, and summary statistics for all variables are reported in Table 2. We find that all three measures of overconfident CEO directors are quite stable over the sample period. On average, 20% of the sample firms have at least one overconfident CEO director on the board. The average number of overconfident CEO directors on the board is 0.24 and the average proportion of such directors relative to board size is 2.5%, given that many firms do not have such directors at all. However,

if a firm does have overconfident CEO directors, it can have as many as five. Given an average board size of nine, this amounts to 45% of all directors on the board. On average, 73% of the sample firms have an overconfident CEO, consistent with the options-based finding in Hirshleifer, Low, and Teoh (2012). However, the correlation between the existence of overconfidence CEO directors and overconfident CEO is -0.0102, suggesting that they are essentially different board characteristics. This negative correlation also indicates that it's less likely that overconfident CEOs deliberately stack the board with overconfident directors.

Turning to other control variables, we find that they are comparable to prior studies. On average, the Tobin's Q for the sample firms is 2.167, with a median of 1.657. The value of total assets for a mean (median) firm is $5.9 ($1.3) billion, indicating that the sample firms are large. The average firm age is 25 years. Firms earn an average ROA of 9.7%. The average capital expenditure is 7% and the average R&D expenditure is 3.8%. An average board comprises 66.4% independent directors. In 64% of firms, the CEO holds the title of Chairman of the board at the same time. Finally, for firms that are represented in NBER patent database, the average patent number is 54, with a similar patent index of 53. The average number of citations received by the patents of these sample firms is 592, while the number of citations per patent is around 8.

3 OVERCONFIDENT CEO DIRECTORS AND CORPORATE INNOVATION

We hypothesize that overconfident CEO directors on the board will facilitate and enhance corporate innovation in terms of both innovation input and output, as measured by R&D intensity, patents and patent citations. In this section, we empirically test this hypothesis. In each multivariate regression, the dependent variable is the measure of corporate innovation, and the key independent variable is the measure of overconfident CEO directors. All independent variables are lagged by one year, and continuous innovation and accounting variables are

winsorised at the 0.5% level at both tails. Year and industry dummies are included in all regressions in order to control for potential time trend and industry effects, where industry is classified using two-digit SIC codes.

3.1 R&D Intensity

To test whether overconfident CEO directors are associated with increased spending on innovation as measured by R&D intensity, we use R&D expenditures scaled by total assets as the dependent variable and regress it on each of the three measures of overconfident CEO directors separately and an array of control variables. The results are reported in Table 3. We find the coefficient on our measure of overconfidence CEO directors is positive and statistically significant at the 1% level for all three measures of overconfident CEO directors, indicating that firms with overconfident CEO directors on the board spend more on R&D. In terms of economic magnitude, take the percentage measure as an example. Its coefficient is 0.031, indicating that an increase of one standard deviation in this measure (0.057) is associated with an increase of 0.18% in a firm's R&D intensity. With a sample mean R&D intensity of 0.038, this amounts to an economically significant increase of 4.7% in R&D intensity for an average firm.

Turning to the control variables, we find firms with overconfident CEOs are associated with greater investments in R&D. This is consistent with prior studies, which examined the relation between CEO overconfidence and corporate innovation (Galasso and Simcoe, 2011; Hirshleifer, Low, and Teoh, 2012). The fact that our measure of overconfidence CEO directors are statistically significant while controlling for the overconfidence of the CEO of the firm suggests that our results are not driven by any correlation between the overconfidence of directors and the CEO of the firm. Other control variables are also largely consistent with findings in the literature. For example, firms with poorer operating performance as measured by

ROA, smaller boards and fewer institutional blockholders invest less in R&D. In contrast, older firms tend to invest more in innovation. The GIM index, which has been used as an overall measure of corporate governance in some previous studies with higher value indicating weaker corporate governance, is significantly negatively associated with investments in R&D, suggesting that firms with better corporate governance invest more in innovative projects.

3.2 Number of Patents

While R&D intensity captures the *input* to innovation activities, it does not necessarily measure successful innovation *output*. To examine the relation between overconfident CEO directors and the fruits of innovation *input*, this section will discuss the output-oriented measures—namely, the number of patents and the number of patent citations.

In Table 4, the dependent variable is the log value of one plus the number of patents. In columns 1-3, the coefficient on the measure of overconfident CEO directors is positive and statistically significant at the 1% level in all three columns, suggesting that firms with more overconfident CEO directors have higher innovation output. One reason for this could be that these firms invest more in R&D as we showed in Table 3. To see if overconfident CEO directors are associated with greater innovation effectiveness as measured by innovation output for a given level of R&D expenditure, we add R&D expenditure as an additional control variable to the regression models in column 1-3 and re-estimate the models. The results are reported in columns 4-6 of Table 4. As expected, R&D expenditure is significantly positively correlated with innovation output, indicating that more spending on R&D produces more patents. Nevertheless, holding the level of R&D constant, the three measures of overconfident CEO directors are still positively associated with greater number of patents. The coefficient estimates are statistically significantly at the 1% level. Hence, overconfident CEO directors are also associated with

greater innovation effectiveness. In terms of economic magnitude of the effect, in column 4, the coefficient estimate suggests that the presence of overconfident CEO directors is associated with 12.7% higher patent count. Similarly, in column 5, the coefficient estimate on the proportion of overconfident CEO directors is 0.867, indicating that a 10% increase in this measure will increase the number of patents by 8.67%.

Most of our control variables have sign and statistical significance similar to those in prior studies. We note that the overconfidence CEO dummy is statistically indifferent from zero in all columns, which seems to be different from Hirshleifer, Low, and Teoh (2012).[2] We find that this is mainly driven by sample differences. Our sample size is smaller than Hirshleifer et al. (2012) and our sample period is different from theirs, theirs is from 1993 to 2003 while ours is from 1998 to 2006, because we require the availability of RiskMetrics data. When we exclude the outside CEO director measures from our regressions and thus expand our sample, we find similar effect of overconfident CEO on patent count as Hirshleifer et al. (2012). In addition, Hirshleifer et al. (2012) find that when R&D expenditure is included in their regression, the coefficient on overconfident CEO becomes statistically insignificant.[3] They interpret this as indicating that "the question remains open of whether managerial overconfidence increases or decreases the effectiveness of the manager in generating innovation for any given level of R&D expenditure". The ROA has a negative and statistically significant coefficient when R&D expenditure is not controlled for but a positive and statistically significant coefficient when R&D expenditure is controlled for. This is possibly due to the fact that the R&D expenses in innovative firms account for a large proportion of ROA.

[2] Hirshleifer, Low, and Teoh (2012) find a significantly positive effect of overconfident CEOs on both patent counts and patent citations in Table 5 and Table 6 of their paper.

[3] As stated in their footnote number 16, "although the coefficients are positive, the option-based measure is not significant for any of the three dependent variables".

Overall, the results in Table 4 indicate that overconfident CEO directors are consistently associated with a substantially higher number of patent grants. This conclusion is valid even after controlling for spending on innovation, suggesting that overconfident CEO directors are also effective facilitators in generating innovation output for any given level of R&D expenditure.

3.3 Patent Citations

Not every patent is of equal importance, and ground-breaking patents are much more influential than those that are only incremental technologies. Thus, having examined the effect of overconfident CEO directors on patent count, we further examine the effect on the quality of innovation in this section by using the patent citations as the dependent variable.

In Table 5, the dependent variable is the logarithm of one plus the total number of citations received by a firm's patents in a year. As discussed in Section 2.1B, we use the weighting index provided by the NBER patent database to alleviate the truncation bias (Hall, Jaffe, and Trajtenberg, 2005). R&D expenditure is included in all regressions to control for the effect of R&D spending on patent citations. Thus, the coefficient on overconfident CEO directors measures the effect holding R&D spending constant. The regression results confirm our expectation that overconfident CEO directors are associated with a greater number of patent citations. Across different measures of overconfident CEO directors, the coefficient estimates are significantly positive at the 1% level. The presence of overconfident CEO directors is associated with 16% more citations, while a 10% increase in the proportion of overconfident CEO directors is associated with a 13% increase in the number of patent citations. The coefficient estimate on R&D intensity is positive and statistically significant at 1% in all models, suggesting the firms that spend more on R&D in general produces higher quality innovations. But, as our results show,

spending on innovation does not subsume the effect of overconfident CEO directors on innovation quality.

In sum, our results so far clearly show that firms with greater representation of overconfident CEO directors not only spend more on R&D but also produce more and higher quality patents holding R&D expenditure constant.

4. ROBUSTNESS CHECKS

In this section, we perform several robustness checks to ensure that the results survive the use of alternative measures, the potential sample selection bias and some other robustness tests. We take further steps to address the concern of firm-director matching and other endogeneity problems.

4.1 Alternative Measures of Innovation

When measuring the quantity of innovation output, we use the number of patents. However, this measure does not take into account the difference in patenting practices across different technology classes. For example, there are substantially larger amount of patents on average in certain technology classes, and firms specializing in such areas may appear to be more innovative than others if we simply consider overall patent count. Thus, following Bena and Li (2012), we use a patent index to quantify a firm's innovation output that is benchmarked relative to the median quantity of innovation output in each technology class and time period where and when the firm was active in patenting. Specifically, for each technology class *k* and patent application year *t*, the median value of the number of awarded patents across all firms that were awarded at least one patent is calculated. The number of awarded patents is then scaled to the focal firm in technology class *k* with application year *t* by the corresponding median value. This

measure adjusts for technology class-specific factors and thus is more accurate in measuring innovation output and more comparable across firms. We repeat the regressions in Table 3 using this new patent index as the dependent variable. The results are reported in Panel A of Table 6. As we can see, the results remain qualitatively similar.

Second, following Almeida, Hsu, and Li (2013), we define innovation efficiency as the number of patents scaled by R&D expenditure and use this variable as the dependent variable. Results are as follows in Panel B of Table 6. We find that the significantly positive effect of CEO director overconfidence still holds, suggesting that the overconfidence of CEO directors is associated with greater innovation efficiency.

Third, we use the number of patent citations in the previous analysis to capture the quality of innovation output. The citation count is based on the total number of citations received by all of the patents created by a firm in a given year. However, as discussed in Hirshleifer, Low, and Teoh (2012), it is less clear whether greater innovation output is achieved by means of more patents or by patents with higher impact. It is possible that a firm has a high citation count not because the firm has any influential patents, but simply because it has many patents (albeit of less importance). To distinguish between the two possibilities, we follow Hirshleifer, Low, and Teoh (2012) and create another measure of patent citation—namely, average citations *per patent*. We repeat the analysis by using this new measure as the dependent variable. The results are reported in Panel C of Table 6; as in Table 5, they remain unchanged.

4.2 Firm-Years with Zero Patents, Citations or R&D Expenditure

In our sample, there are many firm-years with zero patents or citations. This raises the concern that our main results may be driven by the jump from zero patents (citations) to at least one patent (citation). A similar issue exists for R&D intensity because many firms have zero R&D

expenditure.[4] As a robustness check, we rerun our tests in Tables 3 and 4 while deleting firm-years with zero patents (citations) or R&D expenditure. In unreported results, we find that our conclusions are not affected by deleting these firm-years.

4.3 Degree of Overconfidence

So far, we have treated all CEOs who exhibited late exercise of deep in-the-money options (67% in-the-money) as having the same degree of overconfidence. However, in reality, even within this group, CEOs' degree of overconfidence is likely to differ. To gain further insight into whether outside CEO directors with different degrees of overconfidence have different impacts on corporate innovation, we divide the overconfident CEO directors into three groups based on three cut-offs of in-the-moneyness of their option holdings. Following Hirshleifer, Low, and Teoh (2012), we define an outside CEO director as having low overconfidence if her confidence measure is in the range of [67%, 130%), moderate overconfidence if her confidence measure is in the range of [130%, 250%), and high overconfidence if her confidence measure is greater than 250%. We then create three indicator variables to indicate the presence of overconfident outside CEO directors within each above interval of in-the-moneyness. For example, LOC_CD (dummy) equals to one if there is at least one outside CEO director on the board with low overconfidence. A CEO with a lower level of overconfidence can move up to a higher level of overconfidence but not the other way around.

In Table 7, we report the results on R&D intensity, patent count and patent citations when the three indicators for director overconfidence level are simultaneously included in the regressions. This specification allows for a non-linear effect of director overconfidence on innovation input and output. In the R&D regression, we find that holding other factors constant,

[4] R&D expenditure is missing for many firm-years in the Compustat database. Following previous literature, we code missing R&D expenditure to zero.

low overconfidence is not associated with greater R&D intensity, while moderate and high overconfidence both have significant impacts with the same magnitude. In both the patent count and citation regressions, all three levels of overconfidence are significantly positively associated with innovation output and quality. Consistent with higher degree of overconfidence being associated with a stronger effect on innovation output and quality, the magnitude of the coefficient estimate monotonically decreases from the high overconfidence category to the low overconfidence category.[5] Take the citation counts as an example. The change from having zero to at least one high-overconfidence CEO director is associated with a 26.7% increase in patent citations. For having moderate-confidence outside CEO directors, this number is 16.3%, and for having low-confidence outside CEO directors, this number is 11.3%.

4.4 Endogeneity Problem

Although our results are consistent with a causal effect of director overconfidence on corporate innovation, it can potentially also be explained by firm-director matching. For example, firms anticipating greater innovation opportunities may try to appoint overconfident directors to facilitate the innovation process. Although firm-director matching could be well motivated by a causal effect of overconfidence on innovation, it still makes the interpretation of the association problematic. To mitigate this concern, we perform the following additional tests in this subsection.

First, we follow Hirshleifer, Low, and Teoh (2012) and restrict the sample to a subset of firm-years for which matching is likely to be less important. Specifically, we delete all firm-years where there is an overconfident CEO director on the board whose tenure is less than three years. While CEO overconfidence is considered a persistent trait, a firm's growth and innovation

[5] Further t-tests find no statistical difference among the coefficient estimates on the three overconfident outside CEO director measures though.

opportunities tend to vary over time as its competitive environment changes. Thus, if overconfident CEO directors are appointed only because firms foresee greater innovation opportunities in the near future, then the matching effects should be strongest when such directors are newly appointed. If the effect of overconfident CEO directors on innovation truly exists, then significant coefficient estimates should be found in the sample where the matching effects are less important. We repeat the main analyses in Section 3 using the restricted sample. In unreported results, we continue to find a significantly positive relation between overconfident CEO directors and corporate innovation, suggesting that the relation is not completely driven by the endogenous matching between overconfident CEO directors selection and innovative firms.

Second, we perform a two-stage least squares (2SLS) analysis using the percentage of overconfident CEOs in the state in which the firm's headquarter is located as the instrumental variable (IV). This measure captures the potential local supply of overconfident CEOs, and firms operating in states where there are more overconfident CEOs are more likely to have such people on the board, hence satisfying the relevance requirement for IVs. However, the presence of more overconfident CEOs in the state does not necessarily correlate with a firm's innovation.

The results of the 2SLS regressions are reported in Table 8. In the first stage, the dependent variables are the three measures of overconfident CEO directors, respectively, and the key independent variable is the IV. In the second stage, the dependent variables are the measures of corporate innovation, and the key independent variable is the predicted value obtained in the first stage. All other control variables are the same as in Section 3. As expected, in the first stage, the IV is significantly positively related to the measures of overconfident CEO directors. The findings reveal that the greater the supply of overconfident CEOs in the local state, (1) the more likely that the firm has overconfident CEOs as outside directors on the board, (2) there are more

overconfident CEO directors on the board and (3) there is a greater proportion of outside directors who are overconfident CEOs of other firms. Further, the F-stat for the first-stage regressions is on average 21, with the lowest being 19 and the highest being 26. This is well above the recommended value of 10, suggesting the validity of the IV. In the second stage, overconfident CEO directors are significantly positively associated with R&D and citations. Although the statistical significance vanishes for the patent regressions, for all three panels, the coefficient estimates on predicted values are positive, as expected. However, the p-values are about 0.17. Note that the patent regressions include all firms both with and without patents. Given that many of the sample firms do not have any patents, to increase the precision of the regression, we restrict the sample to firms with non-zero patents and repeat the 2SLS regressions for patents. In unreported tables, for this subsample, the effect of overconfident CEO directors on corporate innovation is significantly positive at the 1% level.

Together, the results in this subsection collectively indicate that the conclusion that overconfident CEO directors have positive effects on corporate innovation is not solely driven by firm-director matching but captures a causal effect.

5 EXTENSIONS

5.1. Interaction with CEO overconfidence

Since major investment decisions are typically initiated by the CEO not the board of directors, the effect of the board may well depends on the degree of overconfidence of the CEO. If the CEO is overconfident, board overconfidence is likely to reinforce the CEO's effect on corporate innovation. However, if the CEO is not overconfident, then the board's effect can be quite limited. In this section, we divide our sample into two sub-samples based on whether the

CEO of the firm is identified as overconfident and repeat our previous analyses on R&D, patents, and patent citations, respectively. The results are reported in Tables 9, 10, and 11.

It's clear from Table 9 that in the R&D regressions, for both sub-samples, the overconfidence effect of CEO directors remains valid. Hence, overconfident directors are associated with high R&D expense regardless of whether the CEO is overconfident or not. However, in terms of the innovation output as measured by the number of patents and the number of patent citations, results in Table 10 and Table 11 show that the significant effect of overconfident CEO directors only survives in the sub-sample where the CEO of the firm is also overconfident. This contrast can be explained by the different role played by the board and the CEO in the innovation process. Boards with overconfident directors are more willing to approve investments in R&D; however, the riskiness and the potential for patenting of the projects are determined by the CEO. If the CEO is not overconfident, most of the proposed projects are low risk projects that are not necessarily associated with significantly higher patent counts or citations. Only when the CEO is overconfident, the proposed projects are likely to be risky and associated with greater patent counts and citations. This suggests that an important channel for director overconfidence to affect innovation is through the approval power of the board.

The board has the power to approve major investment projects but does not have the time and resources to initiate these projects. Boards with overconfident directors are more willing to approve investments in R&D. Hence, we observe higher R&D spending in firms with overconfident director regardless of whether the CEO is overconfident. However, if the CEO is not overconfident, these

5.2. Innovative vs. Non-Innovative Industries

Hirshleifer, Low and Teoh (2012) find that the significant effect of overconfident CEOs on corporate innovation concentrates in innovative industries because these industries have better opportunities to innovate. We expect the same to be true for director overconfidence, especially given our result above that the effect of the board works through the CEO's initiatives. To test this, we split the sample into firm-years in the innovative industries and non-innovative industries. An industry is defined as innovative if the average R&D expenditure intensity in the two-digit SIC code industry is greater than the median of all industries. Results are reported in Tables 12, 13, and 14.

Similar to last section, we find that director overconfidence is associated with higher R&D spending in both types of industries. However, it is only significantly associated with greater patents count and citations in innovative industry.

5.3. Monitoring vs. Advising Committee Membership

Besides approval of the CEO's initiatives, the board can also affect innovation through its advising function. If this is the case, we expect overconfident directors to have a bigger impact on innovation when they serve on advising committees than monitoring committees. To examine this, we define audit, nominating, and compensation committees as monitoring committees, and all other committees including R&D and science and technology committees as advising committees. Outside directors are likely to sit on more than one committee. We define overconfident CEO directors as intense monitors if they sit on at least two monitoring committees, as they are less likely to sit on advising committees (Faleye, Hoitash, and Hoitash, 2011). We include the overconfidence measure, a dummy variable indicating whether the overconfident CEO director is an intense monitor, and an interaction term of them into the

regression with all other control variables. In Table 15, we find that the estimated coefficient on the interaction term is negative at 5% or 1% significance level, suggesting that sitting on monitoring committees weakens the effect of overconfidence on corporate innovation. Therefore, board membership matters and overconfident CEO directors play a bigger role if they sit on advising committee relative to those who are intense monitors.

5.4 Overconfident CEO Directors and Firm Performance

By far, the results suggest that overconfident CEO directors are associated with greater investments in innovation as measured by R&D intensity. Moreover, overconfident CEO directors are better facilitators in helping enhance innovation output as measured by patent counts and citation counts. This section further examines whether enhanced innovation performance is associated with greater firm value as measured by Tobin's Q and improved operating performance as measured by ROA.

In a baseline model, we regress Tobin's Q and ROA on the measures of overconfident CEO directors and all other control variables. The results are reported in Table 16, with Panel A for Tobin's Q and Panel B for ROA. Across the columns and panels, evidence consistently suggests that overconfident CEO directors are associated with greater firm value and better operating performance. For Tobin's Q, all coefficient estimates on the measures of overconfident CEO directors are positive and significant at the 1–5% levels. For ROA, all coefficient estimates are positive and significant at the 1% level.

To address the endogeneity problems, we use the IV approach and perform 2SLS regressions. As in Section 4, we use an IV which measures the percentage of overconfident CEOs in the state in which the firm's headquarter is located. The results are reported in Table 17. The first stage regression results are the same as those in Table 8, where the dependent variables

are the three measures of overconfident CEO directors, respectively, and the key independent variable is the IV. In the second stage, for each of the three measures of overconfident CEO directors, the predicted value obtained from the first stage regression is significantly positively associated with both Tobin's Q and ROA. Overall, overconfident CEO directors are not only better facilitators for corporate innovation, but they are also associated with greater firm performance.

5.5 Overconfidence among Other Outside Directors

The evidence shows that overconfident CEO directors are better facilitators for corporate innovation and firm value creation. While CEO directors are arguably the most powerful directors on the board due to their current day jobs, it is interesting to ask: Do other outside directors have similar effects on corporate innovation and firm value creation?

To answer this question, we first calculate the confidence measure for all other outside directors if they are present in ExecuComp database. We might have under-identified overconfident outside directors if there is no data available for them in ExecuComp. Some outside directors may be overconfident but unable to be identified if they are not among the top five executives in the S&P 1500 firms covered in ExecuComp. Similar to the above analyses, we create three variables measuring the overconfidence of non-CEO outside directors: (1) an indicator variable which equals 1 if there is at least one overconfident non-CEO outside director on the board; (2) the number of such overconfident outside directors on the board; and (3) the proportion of such overconfident outside directors relative to board size. We then use these measures as the key independent variables and repeat the regression analyses. In unreported tables, the overconfidence of non-CEO outside directors is shown to have similar effects on corporate innovation and firm performance, despite weaker statistical significance and smaller

economic magnitude. Thus, the evidence suggests that overconfident non-CEO outside directors also facilitate corporate innovation and value creation. Their advice and counsel to the appointing CEO are also valuable.

Next, we combine all outside directors (both CEOs and non-CEOs) together and examine their effects. Similarly, we repeat all the analyses performed in previous sections by replacing the measures of overconfident CEO directors with the measures of all identifiable overconfident outside directors. The results are qualitatively similar, suggesting that the overconfidence of outside directors as a whole is also an important driver of innovation.

6 CONCLUSION

Although recent research on psychological biases in corporate decision making has paid much attention to CEO overconfidence, little is known about the role of director overconfidence. In this paper, we examine the effect of director overconfidence on one important corporate activity that is mostly like to be affected by overconfidence of decision makers, corporate innovation.

Identifying overconfident directors by their option exercise behaviour in firms they serve as top executives, we find that firms with more overconfident outside directors invest more heavily in R&D, generate more innovation outputs as measured by the number of patent grants and citations, and achieve greater innovative efficiency as measured by patent counts and citations at any given level of R&D expenditure. However, although their effect on innovation input does not vary with different subsamples, their effect on innovation output is only significant in the subsample of firms with overconfident CEOs or in innovative industries. In addition, the effect is stronger when overconfident directors serve on advising committees of the board than on monitoring committees of the board. This suggests that overconfident directors

mainly play the role of facilitators of innovation through their role to approve innovation projects and advise the CEO. Lastly, we find that overconfident directors are also associated with better firm performance as measured by Tobin's Q and ROA

These results survive a series of robustness tests that address concerns for measure of innovation output and endogeneity of the relation between director overconfidence and corporate innovation, consistently suggesting a causal effect of overconfident directors on corporate innovation and firm value.

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Table 1 Board Characteristics over Time, 1998–2006

This table contains sample composition by year for the main variables of interest throughout the sample period 1998–2006. All variables are defined in Appendix.

Year	Firms	OC_CD (dummy)	OC_CD (number)	Max	OC_CD (%)	Max
1998	919	0.21	0.27	4	2.7%	44.4%
1999	940	0.21	0.26	5	2.7%	45.5%
2000	941	0.19	0.24	4	2.4%	33.3%
2001	976	0.18	0.22	4	2.3%	40.0%
2002	967	0.19	0.25	3	2.5%	40.0%
2003	979	0.20	0.25	4	2.6%	42.9%
2004	988	0.19	0.24	3	2.4%	37.5%
2005	962	0.18	0.22	5	2.2%	45.5%
2006	921	0.20	0.25	3	2.5%	40.0%

Table 2 Summary Statistics

This table reports summary statistics for variables used in the paper. The sample consists of S&P 1500 firms excluding those from financial and utility industries over the period 1998–2006. All variables are defined in Appendix. Patent data only cover the period 2000–2006 due to availability.

	Obs	Mean	Std	Min	Median	Max
OC_CD (dummy)	8593	0.193	0.394	0	0	1
OC_CD (number)	8593	0.244	0.551	0	0	5
OC_CD (%)	8593	0.025	0.057	0	0	0.455
LOC_CD (number)	8593	0.065	0.267	0	0	3
MOC_CD (number)	8593	0.071	0.277	0	0	2
HOC_CD (number)	8593	0.107	0.352	0	0	3
OC_C (dummy)	8593	0.734	0.442	0	1	1
R&D	8593	0.038	0.065	0	0.006	0.416
Patents	3454	53.699	159.668	1	8	1379
Patent Index	3454	52.909	157.426	1	8	1378
Citation	3454	592.347	2273.337	0	40	23441
Citations/Patents	3454	8.256	11.692	0	5.110	295.666
Total Assets ($ mil)	8593	5901.048	24613.569	16.767	1304.838	750507.060
Tobin's Q	8591	2.167	1.536	0.707	1.657	11.159
ROA	8593	0.097	0.098	-0.409	0.097	0.435
Leverage	8593	0.573	0.282	0.069	0.562	2.155
CAPEX	8593	0.070	0.330	0	0.046	29.991
Firm Age	8593	25.409	15.957	2	20	56
Board Size	8593	9.035	2.395	3	9	25
Board Independence	8593	0.664	0.168	0	0.667	1
CEO-chairman Duality	8593	0.640	0.480	0	1	1
GIM Index	8593	9.158	2.609	2	9	19
Blockholders (number)	8593	2.181	1.356	0	2	8

Table 3 The Effect of Overconfident CEO Directors on Corporate Innovation: R&D Intensity

This table reports the results on the relation between overconfident CEO directors and R&D intensity, where the dependent variable in each regression is R&D intensity. The sample consists of S&P 1500 firms excluding those from financial and utility industries over the period 1998–2006. All variables are defined in Appendix. Year and industry fixed effects are included in all columns. Robust p-values are reported in the parentheses below the coefficient estimates, with ***, **, and * denoting significance at the 1%, 5%, and 10%, respectively.

	[1]	[2]	[3]
OC_CD (dummy)	0.005***		
	(0.001)		
OC_CD (number)		0.004***	
		(0.000)	
OC_CD (%)			0.031***
			(0.005)
OC_C (dummy)	0.010***	0.010***	0.010***
	(0.000)	(0.000)	(0.000)
Ln(Total assets)	-0.001	-0.001	-0.001
	(0.258)	(0.291)	(0.311)
ROA	-0.111***	-0.111***	-0.111***
	(0.000)	(0.000)	(0.000)
Leverage	0.004	0.004	0.004
	(0.334)	(0.340)	(0.341)
CAPEX	0.002	0.002	0.002
	(0.401)	(0.401)	(0.397)
Board size	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)
Board independence	-0.018***	-0.018***	-0.017***
	(0.000)	(0.000)	(0.000)
Firm age	0.020***	0.020***	0.021***
	(0.000)	(0.000)	(0.000)
CEO-chairman duality	-0.006***	-0.006***	-0.006***
	(0.000)	(0.000)	(0.000)
GIM index	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
Blockholders (number)	-0.002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)
Constant	0.116***	0.116***	0.115***
	(0.000)	(0.000)	(0.000)
Year Dummies	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes
Observations	8,593	8,593	8,593
R-squared	0.377	0.376	0.376

Table 4 The Effect of Overconfident CEO Directors on Corporate Innovation: Patents

This table reports the results on the relation between overconfident CEO directors and the number of patents, where the dependent variable in each regression is the log value of one plus the number of patents. In columns 4-6, R&D is added as an additional control variable. The sample consists of S&P 1500 firms excluding those from financial and utility industries over the period 1998–2006. All variables are defined in Appendix. Year and industry fixed effects are included in all columns. Robust p-values are reported in the parentheses below the coefficient estimates, with ***, **, and * denoting significance at the 1%, 5%, and 10%, respectively.

	[1]	[2]	[3]	[4]	[5]	[6]
OC_CD (dummy)	0.156***			0.127***		
	(0.000)			(0.001)		
OC_CD (number)		0.136***			0.116***	
		(0.000)			(0.000)	
OC_CD (%)			1.035***			0.867***
			(0.000)			(0.001)
OC_C (dummy)	0.009	0.009	0.009	-0.045	-0.045	-0.045
	(0.768)	(0.762)	(0.768)	(0.116)	(0.118)	(0.116)
R&D				5.334***	5.327***	5.339***
				(0.000)	(0.000)	(0.000)
Ln(Total assets)	0.464***	0.464***	0.465***	0.468***	0.468***	0.469***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ROA	-0.350**	-0.369***	-0.359**	0.240*	0.222	0.233*
	(0.013)	(0.009)	(0.011)	(0.085)	(0.111)	(0.095)
Leverage	-0.392***	-0.393***	-0.393***	-0.414***	-0.414***	-0.415***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CAPEX	0.027	0.027	0.028	0.018	0.018	0.018
	(0.269)	(0.269)	(0.261)	(0.215)	(0.216)	(0.206)
Board size	0.004***	0.004***	0.004***	0.007***	0.007***	0.007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Board independence	-0.121**	-0.126**	-0.101*	-0.025	-0.030	-0.008
	(0.045)	(0.037)	(0.094)	(0.669)	(0.610)	(0.887)
Firm age	0.633***	0.618***	0.636***	0.524***	0.509***	0.525***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CEO-chairman duality	0.024	0.022	0.024	0.055**	0.054**	0.055**
	(0.341)	(0.381)	(0.342)	(0.024)	(0.028)	(0.024)
GIM index	-0.023***	-0.023***	-0.023***	-0.017***	-0.017***	-0.017***
	(0.000)	(0.000)	(0.000)	(0.002)	(0.001)	(0.001)
Blockholders (#)	-0.038***	-0.037***	-0.038***	-0.027***	-0.026***	-0.027***
	(0.000)	(0.000)	(0.000)	(0.004)	(0.005)	(0.004)
Constant	-1.610***	-1.583***	-1.654***	-2.231***	-2.203***	-2.266***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,593	8,593	8,593	8,593	8,593	8,593
R-squared	0.503	0.503	0.503	0.533	0.534	0.533

Table 5 The Effect of Overconfident CEO Directors on Corporate Innovation: Patent Citations

This table reports the results on the relation between overconfident CEO directors and patent citations, where the dependent variable in each regression is the log value of one plus the number of patent citations. The sample consists of S&P 1500 firms excluding those from financial and utility industries over the period 1998–2006. All variables are defined in Appendix. Robust p-values are reported in the parentheses below the coefficient estimates, with ***, **, and * denoting significance at the 1%, 5%, and 10%, respectively.

	[1]	[2]	[3]
OC_CD (dummy)	0.160***		
	(0.006)		
OC_CD (number)		0.170***	
		(0.000)	
OC_CD (%)			1.309***
			(0.001)
OC_C (dummy)	-0.053	-0.053	-0.053
	(0.245)	(0.247)	(0.244)
R&D	7.725***	7.707***	7.724***
	(0.000)	(0.000)	(0.000)
Ln(Total assets)	0.582***	0.581***	0.583***
	(0.000)	(0.000)	(0.000)
ROA	0.427*	0.398*	0.412*
	(0.059)	(0.078)	(0.068)
Leverage	-0.555***	-0.555***	-0.556***
	(0.000)	(0.000)	(0.000)
CAPEX	0.010	0.010	0.011
	(0.692)	(0.700)	(0.681)
Board size	0.008***	0.007***	0.008***
	(0.000)	(0.000)	(0.000)
Board independence	-0.115	-0.124	-0.092
	(0.231)	(0.196)	(0.336)
Firm age	0.744***	0.711***	0.733***
	(0.000)	(0.000)	(0.000)
CEO-chairman duality	0.061	0.058	0.061
	(0.124)	(0.143)	(0.127)
GIM index	-0.017**	-0.018**	-0.018**
	(0.041)	(0.035)	(0.034)
Blockholders (number)	-0.035**	-0.034**	-0.035**
	(0.016)	(0.021)	(0.018)
Constant	-2.515***	-2.455***	-2.546***
	(0.000)	(0.000)	(0.000)
Year Dummies	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes
Observations	8,593	8,593	8,593
R-squared	0.488	0.489	0.489

Table 6 Robustness Checks: Alternative Measures of Innovation

This table reports the results on the relation between overconfident CEO directors and corporate innovation using alternative measures of innovation. In Panel A, the dependent variable in each regression is the patent index; in Panel B, the dependent variable in each regression is innovation efficiency; and in Panel C, the dependent variable in each regression is citations per patent. All variables are defined in Appendix. Year and industry fixed effects are included in all columns. Robust p-values are reported in the parentheses below the coefficient estimates, with ***, **, and * denoting significance at the 1%, 5%, and 10%, respectively.

Panel A: The Patent Index

	[1]	[2]	[3]
OC_CD (dummy)	0.126***		
	(0.001)		
OC_CD (number)		0.116***	
		(0.000)	
OC_CD (%)			0.862***
			(0.001)
OC_C (dummy)	-0.044	-0.043	-0.044
	(0.126)	(0.128)	(0.126)
R&D	5.310***	5.302***	5.315***
	(0.000)	(0.000)	(0.000)
Ln(Total assets)	0.465***	0.465***	0.467***
	(0.000)	(0.000)	(0.000)
ROA	0.246*	0.228	0.238*
	(0.076)	(0.101)	(0.086)
Leverage	-0.410***	-0.411***	-0.411***
	(0.000)	(0.000)	(0.000)
CAPEX	0.017	0.017	0.018
	(0.217)	(0.218)	(0.208)
Board size	0.007***	0.007***	0.007***
	(0.000)	(0.000)	(0.000)
Board independence	-0.018	-0.023	-0.001
	(0.758)	(0.695)	(0.983)
Firm age	0.521***	0.505***	0.522***
	(0.000)	(0.000)	(0.000)
CEO-chairman duality	0.056**	0.055**	0.056**
	(0.021)	(0.025)	(0.021)
GIM index	-0.016***	-0.017***	-0.017***
	(0.002)	(0.002)	(0.002)
Blockholders (number)	-0.027***	-0.026***	-0.027***
	(0.003)	(0.004)	(0.003)
Constant	-2.234***	-2.205***	-2.269***
	(0.000)	(0.000)	(0.000)
Year Dummies	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes
Observations	8,593	8,593	8,593
R-squared	0.533	0.533	0.533

Table 6 Robustness Checks: Alternative Measures of Innovation (continued)

Panel B: Innovation Efficiency

	[1]	[2]	[3]
OC_CD (dummy)	0.224***		
	(0.000)		
OC_CD (number)		0.134***	
		(0.000)	
OC_CD (%)			1.153***
			(0.000)
R&D	-5.420***	-5.412***	-5.407***
	(0.000)	(0.000)	(0.000)
OC_C(dummy)	-0.020	-0.019	-0.019
	(0.677)	(0.693)	(0.689)
Ln(Total assets)	-0.191***	-0.187***	-0.187***
	(0.000)	(0.000)	(0.000)
ROA	-0.654***	-0.673***	-0.664***
	(0.005)	(0.004)	(0.005)
Leverage	-0.381***	-0.386***	-0.385***
	(0.000)	(0.000)	(0.000)
CAPEX	1.302**	1.276**	1.288**
	(0.015)	(0.016)	(0.016)
Firm Age	0.003*	0.003*	0.003*
	(0.088)	(0.085)	(0.061)
Board Size	-0.101	-0.110	-0.076
	(0.358)	(0.317)	(0.489)
Board Indep	0.418***	0.427***	0.435***
	(0.004)	(0.004)	(0.003)
Board Duality	-0.003	-0.005	-0.004
	(0.953)	(0.908)	(0.935)
GIM Index	-0.010	-0.010	-0.010
	(0.260)	(0.268)	(0.242)
Blockholders (#)	-0.009	-0.009	-0.010
	(0.608)	(0.618)	(0.578)
Constant	0.994***	0.996***	0.929***
	(0.001)	(0.001)	(0.002)
Year Dummies	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes
Observations	2,980	2,980	2,980
R-squared	0.450	0.449	0.449

Table 6 Robustness Checks: Alternative Measures of Innovation (continued)

Panel C: Citations per Patent

	[1]	[2]	[3]
OC_CD (dummy)	0.061**		
	(0.021)		
OC_CD (number)		0.066***	
		(0.000)	
OC_CD (%)			0.555***
			(0.002)
OC_C (dummy)	-0.033	-0.033	-0.033
	(0.134)	(0.135)	(0.133)
R&D	2.925***	2.918***	2.923***
	(0.000)	(0.000)	(0.000)
Ln(Total assets)	0.143***	0.142***	0.142***
	(0.000)	(0.000)	(0.000)
ROA	0.105	0.094	0.098
	(0.363)	(0.418)	(0.396)
Leverage	-0.159***	-0.159***	-0.159***
	(0.000)	(0.000)	(0.000)
CAPEX	-0.009	-0.009	-0.009
	(0.288)	(0.276)	(0.293)
Board size	0.002***	0.002***	0.002***
	(0.004)	(0.007)	(0.005)
Board independence	-0.056	-0.060	-0.047
	(0.248)	(0.217)	(0.332)
Firm age	0.307***	0.293***	0.299***
	(0.000)	(0.000)	(0.000)
CEO-chairman duality	0.009	0.008	0.009
	(0.656)	(0.696)	(0.663)
GIM index	0.000	0.000	-0.000
	(0.959)	(0.999)	(0.984)
Blockholders (number)	-0.013*	-0.013*	-0.013*
	(0.062)	(0.073)	(0.068)
Constant	-0.321*	-0.296*	-0.329**
	(0.052)	(0.073)	(0.046)
Year Dummies	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes
Observations	8,593	8,593	8,593
R-squared	0.419	0.419	0.419

Table 7 Robustness Checks: Different Degrees of Overconfidence

This table reports the results from regressions of corporate innovation measures on indicators of different levels of overconfidence. All variables are defined in Appendix. Year and industry fixed effects are included in all columns. Robust p-values are reported in the parentheses below the coefficient estimates, with ***, **, and * denoting significance at the 1%, 5%, and 10%, respectively.

	[1]	[2]	[3]
	R&D	ln(Patent)	ln(Citation)
HOC_CD (dummy)	0.005**	0.154***	0.267***
	(0.037)	(0.003)	(0.001)
MOC_CD (dummy)	0.005***	0.112**	0.163**
	(0.008)	(0.042)	(0.049)
LOC_CD (dummy)	0.002	0.093**	0.113*
	(0.115)	(0.029)	(0.080)
OC_C (dummy)	0.010***	-0.046	-0.057
	(0.000)	(0.105)	(0.212)
R&D		5.324***	7.701***
		(0.000)	(0.000)
Ln(Total assets)	-0.001	0.468***	0.581***
	(0.307)	(0.000)	(0.000)
ROA	-0.111***	0.225	0.405*
	(0.000)	(0.106)	(0.073)
Leverage	0.004	-0.413***	-0.551***
	(0.331)	(0.000)	(0.000)
CAPEX	0.002	0.018	0.010
	(0.401)	(0.217)	(0.705)
Board size	-0.000***	0.007***	0.007***
	(0.000)	(0.000)	(0.000)
Board independence	-0.018***	-0.031	-0.126
	(0.000)	(0.600)	(0.189)
Firm age	0.020***	0.510***	0.713***
	(0.000)	(0.000)	(0.000)
CEO-chairman duality	-0.006***	0.054**	0.059
	(0.000)	(0.027)	(0.135)
GIM index	-0.001***	-0.017***	-0.018**
	(0.000)	(0.001)	(0.032)
Blockholders (number)	-0.002***	-0.026***	-0.034**
	(0.000)	(0.005)	(0.022)
Constant	0.117***	-2.200***	-2.448***
	(0.000)	(0.000)	(0.000)
Year Dummies	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes
Observations	8,593	8,593	8,593

R-squared	0.377	0.534	0.489

Table 8 Robustness Checks: 2SLS Regressions Using IV

This table reports the results from 2SLS regressions of corporate innovation measures on overconfident CEO directors. The IV for overconfident CEO directors is the percentage of overconfident CEOs in the state in which the firm's headquarter is located. Panels A, B, and C present the results for the three measures of overconfident CEO directors, respectively. All variables are defined in Appendix. Year and industry fixed effects are included in all columns. Robust p-values are reported in the parentheses below the coefficient estimates, with ***, **, and * denoting significance at the 1%, 5%, and 10%, respectively.

Panel A: OC_CD (dummy)

	[1]	[2]	[3]	[4]	[5]
	IV	R&D	IV	ln(Patent)	ln(Citation)
1st Stage	0.184***		0.169***		
	(0.000)		(0.000)		
2nd Stage		0.315***		1.070	2.692**
		(0.000)		(0.172)	(0.034)
OC_C (dummy)	0.001	0.008***	-0.001	-0.046	-0.057
	(0.924)	(0.000)	(0.899)	(0.110)	(0.218)
R&D			0.251***	5.034***	6.960***
			(0.001)	(0.000)	(0.000)
Ln(Total assets)	0.050***	-0.016***	0.050***	0.419***	0.453***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ROA	0.081**	-0.130***	0.107***	0.160	0.191
	(0.047)	(0.000)	(0.010)	(0.324)	(0.468)
Leverage	-0.022	0.011**	-0.023	-0.388***	-0.483***
	(0.144)	(0.012)	(0.127)	(0.000)	(0.000)
CAPEX	0.002	0.001	0.002	0.017	0.005
	(0.342)	(0.642)	(0.426)	(0.293)	(0.846)
Board size	0.003***	-0.001***	0.003***	0.003	-0.001
	(0.000)	(0.000)	(0.000)	(0.205)	(0.783)
Board independence	0.081***	-0.042***	0.085***	-0.109	-0.334**
	(0.000)	(0.000)	(0.000)	(0.217)	(0.020)
Firm age	0.413***	-0.109***	0.408***	0.114	-0.326
	(0.000)	(0.000)	(0.000)	(0.731)	(0.544)
CEO-chairman duality	0.008	-0.008***	0.009	0.044*	0.034
	(0.353)	(0.000)	(0.266)	(0.091)	(0.417)
GIM index	0.005***	-0.002***	0.005***	-0.020***	-0.027***
	(0.005)	(0.000)	(0.003)	(0.003)	(0.009)
Blockholders (number)	-0.013***	0.002***	-0.012***	-0.015	-0.006
	(0.000)	(0.003)	(0.000)	(0.246)	(0.797)
Constant	-0.787***	0.322***	-0.805***	-1.546**	-0.718
	(0.000)	(0.000)	(0.000)	(0.020)	(0.472)
Year Dummies	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes

Observations	8,528	8,528	8,528	8,528	8,528
R-squared	0.179	0.379	0.180	0.531	0.487

Table 8 Robustness Checks: 2SLS Regressions Using IV (continued)

Panel B: OC_CD (number)

	[1] IV	[2] R&D	[3] IV	[4] ln(Patent)	[5] ln(Citation)
1st Stage	0.291***		0.272***		
	(0.000)		(0.000)		
2nd Stage		0.198***		0.666	1.675**
		(0.000)		(0.172)	(0.034)
OC_C (dummy)	-0.003	0.009***	-0.006	-0.043	-0.050
	(0.823)	(0.000)	(0.662)	(0.129)	(0.273)
R&D			0.337***	5.078***	7.070***
			(0.001)	(0.000)	(0.000)
Ln(Total assets)	0.057***	-0.012***	0.057***	0.434***	0.492***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ROA	0.239***	-0.152***	0.274***	0.092	0.021
	(0.000)	(0.000)	(0.000)	(0.630)	(0.946)
Leverage	-0.018	0.008*	-0.020	-0.399***	-0.511***
	(0.351)	(0.069)	(0.317)	(0.000)	(0.000)
CAPEX	0.003	0.001	0.003	0.016	0.005
	(0.309)	(0.657)	(0.331)	(0.299)	(0.860)
Board size	0.005***	-0.001***	0.005***	0.004	-0.001
	(0.000)	(0.000)	(0.000)	(0.180)	(0.824)
Board independence	0.129***	-0.043***	0.135***	-0.108	-0.331**
	(0.000)	(0.000)	(0.000)	(0.218)	(0.020)
Firm age	0.585***	-0.095***	0.578***	0.165	-0.196
	(0.000)	(0.000)	(0.000)	(0.574)	(0.681)
CEO-chairman duality	0.023**	-0.011***	0.025**	0.037	0.017
	(0.035)	(0.000)	(0.022)	(0.186)	(0.706)
GIM index	0.007***	-0.002***	0.008***	-0.019***	-0.026***
	(0.002)	(0.000)	(0.002)	(0.003)	(0.010)
Blockholders (number)	-0.020***	0.002***	-0.019***	-0.016	-0.007
	(0.000)	(0.004)	(0.000)	(0.221)	(0.746)
Constant	-1.153***	0.303***	-1.178***	-1.624***	-0.912
	(0.000)	(0.000)	(0.000)	(0.009)	(0.319)
Year Dummies	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes
Observations	8,528	8,528	8,528	8,528	8,528
R-squared	0.188	0.379	0.189	0.531	0.487

Table 8 Robustness Checks: 2SLS Regressions Using IV (continued)

Panel C: OC_CD (%)

	[1] IV	[2] R&D	[3] IV	[4] ln(Patent)	[5] ln(Citation)
1st Stage	0.027***		0.026***		
	(0.000)		(0.000)		
2nd Stage		2.107***		7.057	17.758**
		(0.000)		(0.172)	(0.034)
OC_C (dummy)	0.000	0.008***	-0.000	-0.046	-0.057
	(0.963)	(0.000)	(0.887)	(0.110)	(0.220)
R&D			0.031***	5.082***	7.081***
			(0.007)	(0.000)	(0.000)
Ln(Total assets)	0.006***	-0.013***	0.006***	0.430***	0.480***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ROA	0.021***	-0.149***	0.025***	0.101	0.044
	(0.001)	(0.000)	(0.000)	(0.588)	(0.885)
Leverage	-0.002	0.008*	-0.002	-0.400***	-0.511***
	(0.446)	(0.070)	(0.413)	(0.000)	(0.000)
CAPEX	-0.000	0.002	-0.000	0.019	0.012
	(0.871)	(0.410)	(0.737)	(0.223)	(0.673)
Board size	0.000***	-0.001***	0.000***	0.004	-0.001
	(0.000)	(0.000)	(0.000)	(0.141)	(0.901)
Board independence	-0.008**	-0.001	-0.007**	0.032	0.020
	(0.013)	(0.770)	(0.021)	(0.645)	(0.862)
Firm age	0.059***	-0.103***	0.058***	0.138	-0.265
	(0.000)	(0.000)	(0.000)	(0.660)	(0.603)
CEO-chairman duality	0.001	-0.009***	0.001	0.044*	0.034
	(0.317)	(0.000)	(0.245)	(0.090)	(0.413)
GIM index	0.001***	-0.003***	0.001***	-0.022***	-0.032***
	(0.000)	(0.000)	(0.000)	(0.004)	(0.007)
Blockholders (number)	-0.002***	0.002***	-0.002***	-0.015	-0.005
	(0.000)	(0.002)	(0.000)	(0.252)	(0.808)
Constant	-0.075***	0.233***	-0.078***	-1.861***	-1.509**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.027)
Year Dummies	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes
Observations	8,528	8,528	8,528	8,528	8,528
R-squared	0.142	0.379	0.143	0.531	0.487

Table 9 The Effect of Overconfident CEO Directors on R&D Intensity: Does the Overconfidence of CEOs Matter?

This table reports the sub-sample results on the relation between overconfident CEO directors and R&D intensity, where the dependent variable in each regression is R&D intensity. In columns 1, 2, and 3, the CEO of the appointing firm is overconfident, while in columns 4, 5, and 6, the CEO of the appointing firm is not overconfident. The sample consists of S&P 1500 firms excluding those from financial and utility industries over the period 1998–2006. All variables are defined in Appendix. Year and industry fixed effects are included in all columns. Robust p-values are reported in the parentheses below the coefficient estimates, with ***, **, and * denoting significance at the 1%, 5%, and 10%, respectively.

	[1]	[2]	[3]	[4]	[5]	[6]
Overconfident CEO	Yes	Yes	Yes	No	No	No
OC_CD (dummy)	0.005**			0.008***		
	(0.021)			(0.001)		
OC_CD (number)		0.003***			0.006***	
		(0.010)			(0.003)	
OC_CD (%)			0.030**			0.049**
			(0.024)			(0.014)
Ln(Total assets)	0.001	0.001	0.001	-0.003***	-0.003***	-0.003***
	(0.193)	(0.175)	(0.173)	(0.005)	(0.007)	(0.007)
ROA	-0.097***	-0.097***	-0.097***	-0.144***	-0.145***	-0.145***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Leverage	0.004	0.004	0.004	0.008	0.008	0.008
	(0.448)	(0.457)	(0.459)	(0.373)	(0.366)	(0.364)
CAPEX	0.001	0.001	0.001	0.104***	0.104***	0.105***
	(0.450)	(0.449)	(0.445)	(0.002)	(0.002)	(0.002)
Firm Age	-0.001***	-0.001***	-0.001***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Board Size	-0.019***	-0.019***	-0.018***	-0.019***	-0.019***	-0.018***
	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.004)
Board independence	0.031***	0.031***	0.031***	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.966)	(0.964)	(0.981)
Board Duality	-0.009***	-0.009***	-0.009***	0.001	0.001	0.001
	(0.000)	(0.000)	(0.000)	(0.634)	(0.653)	(0.610)
GIM Index	-0.001***	-0.001***	-0.001***	-0.001***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Blockholders (#)	-0.001	-0.001	-0.001	-0.004***	-0.004***	-0.004***
	(0.122)	(0.124)	(0.124)	(0.000)	(0.000)	(0.000)
Constant	0.124***	0.124***	0.123***	0.101***	0.101***	0.098***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,309	6,309	6,309	2,281	2,281	2,281
R-squared	0.394	0.394	0.394	0.409	0.409	0.409

Table 10 The Effect of Overconfident CEO Directors on Patents: Does the Overconfidence of CEOs Matter?

This table reports the sub-sample results on the relation between overconfident CEO directors and the number of patents, where the dependent variable in each regression is the log value of one plus the number of patents. In columns 1, 2, and 3, the CEO of the appointing firm is overconfident, while in columns 4, 5, and 6, the CEO of the appointing firm is not overconfident. The sample consists of S&P 1500 firms excluding those from financial and utility industries over the period 1998–2006. All variables are defined in Appendix. Year and industry fixed effects are included in all columns. Robust p-values are reported in the parentheses below the coefficient estimates, with ***, **, and * denoting significance at the 1%, 5%, and 10%, respectively.

	[1]	[2]	[3]	[4]	[5]	[6]
Overconfident CEO	Yes	Yes	Yes	No	No	No
OC_CD (dummy)	0.154***			-0.003		
	(0.000)			(0.968)		
OC_CD (number)		0.124***			0.060	
		(0.000)			(0.219)	
OC_CD (%)			0.942***			0.375
			(0.002)			(0.417)
R&D	4.972***	4.969***	4.977***	6.482***	6.437***	6.455***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Ln(Total assets)	0.469***	0.470***	0.471***	0.513***	0.510***	0.511***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ROA	0.458***	0.441***	0.451***	-0.413	-0.435	-0.428
	(0.005)	(0.008)	(0.006)	(0.124)	(0.106)	(0.111)
Leverage	-0.482***	-0.484***	-0.485***	-0.260**	-0.257**	-0.257**
	(0.000)	(0.000)	(0.000)	(0.010)	(0.011)	(0.011)
CAPEX	0.019	0.019	0.020	0.394	0.380	0.391
	(0.161)	(0.159)	(0.150)	(0.337)	(0.355)	(0.343)
Firm Age	0.005***	0.005***	0.005***	0.012***	0.012***	0.012***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Board Size	0.020	0.017	0.040	-0.121	-0.130	-0.119
	(0.774)	(0.804)	(0.560)	(0.270)	(0.234)	(0.276)
Board independence	0.511***	0.501***	0.521***	0.427***	0.396***	0.406***
	(0.000)	(0.000)	(0.000)	(0.003)	(0.005)	(0.004)
Board Duality	0.062**	0.061**	0.062**	0.042	0.038	0.040
	(0.030)	(0.035)	(0.032)	(0.388)	(0.432)	(0.407)
GIM Index	-0.013**	-0.013**	-0.013**	-0.030***	-0.031***	-0.031***
	(0.036)	(0.036)	(0.036)	(0.005)	(0.004)	(0.004)
Blockholders (#)	-0.021*	-0.021*	-0.021*	-0.020	-0.019	-0.020
	(0.053)	(0.058)	(0.053)	(0.246)	(0.266)	(0.252)
Constant	-2.119***	-2.100***	-2.166***	-3.166***	-3.085***	-3.128***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes

Observations	6,309	6,309	6,309	2,281	2,281	2,281
R-squared	0.545	0.545	0.544	0.550	0.550	0.550

Table 11 The Effect of Overconfident CEO Directors on Patent Citations: Does the Overconfidence of CEOs Matter?

This table reports the sub-sample results on the relation between overconfident CEO directors and patent citations, where the dependent variable in each regression is the log value of one plus the number of patent citations. In columns 1, 2, and 3, the CEO of the appointing firm is overconfident, while in columns 4, 5, and 6, the CEO of the appointing firm is not overconfident. The sample consists of S&P 1500 firms excluding those from financial and utility industries over the period 1998–2006. All variables are defined in Appendix. Year and industry fixed effects are included in all columns. Robust p-values are reported in the parentheses below the coefficient estimates, with ***, **, and * denoting significance at the 1%, 5%, and 10%, respectively.

	[1]	[2]	[3]	[4]	[5]	[6]
Overconfident CEO	Yes	Yes	Yes	No	No	No
OC_CD (dummy)	0.214***			-0.062		
	(0.002)			(0.567)		
OC_CD (number)		0.199***			0.052	
		(0.000)			(0.500)	
OC_CD (%)			1.585***			0.205
			(0.001)			(0.781)
R&D	7.231***	7.219***	7.229***	9.310***	9.240***	9.264***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Ln(Total assets)	0.590***	0.588***	0.590***	0.628***	0.622***	0.623***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ROA	0.836***	0.807***	0.823***	-0.805*	-0.835*	-0.825*
	(0.001)	(0.002)	(0.002)	(0.081)	(0.070)	(0.074)
Leverage	-0.691***	-0.693***	-0.695***	-0.208	-0.204	-0.205
	(0.000)	(0.000)	(0.000)	(0.212)	(0.220)	(0.217)
CAPEX	0.015	0.015	0.015	0.819	0.800	0.810
	(0.522)	(0.524)	(0.506)	(0.261)	(0.273)	(0.267)
Firm Age	0.005**	0.004**	0.005**	0.015***	0.014***	0.015***
	(0.016)	(0.026)	(0.017)	(0.000)	(0.000)	(0.000)
Board Size	-0.001	-0.007	0.030	-0.358*	-0.372**	-0.362*
	(0.996)	(0.948)	(0.788)	(0.057)	(0.048)	(0.053)
Board independence	0.778***	0.747***	0.774***	0.437*	0.391*	0.405*
	(0.000)	(0.000)	(0.000)	(0.062)	(0.094)	(0.083)
Board Duality	0.064	0.062	0.063	0.076	0.071	0.073
	(0.173)	(0.190)	(0.177)	(0.339)	(0.374)	(0.359)
GIM Index	-0.015	-0.015	-0.016	-0.023	-0.024	-0.024
	(0.115)	(0.109)	(0.106)	(0.179)	(0.162)	(0.168)
Blockholders (#)	-0.028	-0.027	-0.028	-0.020	-0.019	-0.020
	(0.112)	(0.127)	(0.121)	(0.467)	(0.491)	(0.479)
Constant	-2.460***	-2.408***	-2.511***	-3.714***	-3.587***	-3.636***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,309	6,309	6,309	2,281	2,281	2,281
R-squared	0.502	0.503	0.503	0.492	0.492	0.492

Table 12 The Effect of Overconfident CEO Directors on R&D Intensity: Does Industry Innovativeness Matter?

This table reports the sub-sample results on the relation between overconfident CEO directors and R&D intensity, where the dependent variable in each regression is R&D intensity. In columns 1, 2, and 3, the industry in which the appointing firm operates is innovative, while in columns 4, 5, and 6, the industry in which the appointing firm operates is not innovative. The sample consists of S&P 1500 firms excluding those from financial and utility industries over the period 1998–2006. All variables are defined in Appendix. Year and industry fixed effects are included in all columns. Robust p-values are reported in the parentheses below the coefficient estimates, with ***, **, and * denoting significance at the 1%, 5%, and 10%, respectively.

	[1]	[2]	[3]	[4]	[5]	[6]
Innovative Industry	Yes	Yes	Yes	No	No	No
OC_CD (dummy)	0.006***			0.001***		
	(0.008)			(0.000)		
OC_CD (number)		0.004***			0.001***	
		(0.005)			(0.000)	
OC_CD (%)			0.031**			0.010***
			(0.032)			(0.000)
OC_C(dummy)	0.015***	0.015***	0.015***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Ln(Total assets)	-0.001	-0.000	-0.000	-0.001***	-0.001***	-0.001***
	(0.539)	(0.599)	(0.637)	(0.000)	(0.000)	(0.000)
ROA	-0.148***	-0.149***	-0.148***	-0.004*	-0.004*	-0.004*
	(0.000)	(0.000)	(0.000)	(0.087)	(0.075)	(0.084)
Leverage	0.004	0.004	0.004	0.001***	0.001**	0.001***
	(0.431)	(0.432)	(0.439)	(0.009)	(0.011)	(0.010)
CAPEX	0.162***	0.162***	0.162***	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.298)	(0.302)	(0.316)
Firm Age	-0.001***	-0.001***	-0.001***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Board Size	-0.028***	-0.028***	-0.027***	0.001***	0.001***	0.002***
	(0.000)	(0.000)	(0.000)	(0.002)	(0.003)	(0.001)
Board independence	0.031***	0.031***	0.032***	0.003***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Board Duality	-0.008***	-0.009***	-0.008***	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.652)	(0.670)	(0.666)
GIM Index	-0.001***	-0.001***	-0.001***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Blockholders (#)	-0.003***	-0.003***	-0.003***	-0.000**	-0.000**	-0.000**
	(0.000)	(0.000)	(0.000)	(0.044)	(0.043)	(0.047)
Constant	0.132***	0.132***	0.130***	0.002	0.002	0.001
	(0.000)	(0.000)	(0.000)	(0.193)	(0.137)	(0.230)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,471	5,471	5,471	3,119	3,119	3,119
R-squared	0.278	0.278	0.278	0.140	0.142	0.141

Table 13 The Effect of Overconfident CEO Directors on Patents: Does Industry Innovativeness Matter?

This table reports the sub-sample results on the relation between overconfident CEO directors and the number of patents, where the dependent variable is the log value of one plus the number of patents. In columns 1, 2, and 3, the industry in which the appointing firm operates is innovative, while in columns 4, 5, and 6, the industry in which the appointing firm operates is not innovative. The sample consists of S&P 1500 firms excluding those from financial and utility industries over the period 1998–2006. All variables are defined in Appendix. Year and industry fixed effects are included in all columns. Robust p-values are reported in the parentheses below the coefficient estimates, with ***, **, and * denoting significance at the 1%, 5%, and 10%, respectively.

	[1]	[2]	[3]	[4]	[5]	[6]
Innovative Industry	Yes	Yes	Yes	No	No	No
OC_CD (dummy)	0.151***			0.005		
	(0.001)			(0.888)		
OC_CD (number)		0.134***			0.001	
		(0.000)			(0.976)	
OC_CD (%)			0.901***			0.020
			(0.002)			(0.947)
R&D	5.291***	5.284***	5.300***	39.559***	39.584***	39.575***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
OC_C(dummy)	-0.046	-0.046	-0.046	-0.037	-0.037	-0.037
	(0.211)	(0.213)	(0.208)	(0.195)	(0.195)	(0.195)
Ln(Total assets)	0.607***	0.607***	0.609***	0.112***	0.112***	0.112***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ROA	0.023	0.006	0.015	0.429***	0.429***	0.429***
	(0.894)	(0.972)	(0.931)	(0.002)	(0.002)	(0.002)
Leverage	-0.577***	-0.576***	-0.578***	-0.105**	-0.105**	-0.105**
	(0.000)	(0.000)	(0.000)	(0.017)	(0.017)	(0.017)
CAPEX	0.956***	0.941**	0.950***	-0.008	-0.008	-0.008
	(0.010)	(0.011)	(0.010)	(0.482)	(0.483)	(0.483)
Firm Age	0.006***	0.006***	0.006***	0.007***	0.007***	0.007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Board Size	-0.050	-0.053	-0.029	0.110**	0.110**	0.111**
	(0.534)	(0.507)	(0.719)	(0.017)	(0.016)	(0.016)
Board independence	0.757***	0.739***	0.763***	0.126*	0.128*	0.127*
	(0.000)	(0.000)	(0.000)	(0.066)	(0.065)	(0.065)
Board Duality	0.030	0.028	0.030	0.054***	0.054***	0.054***
	(0.374)	(0.412)	(0.376)	(0.006)	(0.006)	(0.006)
GIM Index	-0.009	-0.010	-0.010	-0.019***	-0.019***	-0.019***
	(0.218)	(0.196)	(0.196)	(0.000)	(0.000)	(0.000)
Blockholders (#)	-0.045***	-0.044***	-0.045***	0.025***	0.025***	0.025***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Constant	-3.057***	-3.030***	-3.107***	-0.912***	-0.916***	-0.915***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,471	5,471	5,471	3,119	3,119	3,119
R-squared	0.545	0.546	0.545	0.345	0.345	0.345

Table 14 The Effect of Overconfident CEO Directors on Patent Citations: Does Industry Innovativeness Matter?

This table reports the sub-sample results on the relation between overconfident CEO directors and patent citations, where the dependent variable is the log value of one plus the number of patent citations. In columns 1, 2, and 3, the industry in which the appointing firm operates is innovative, while in columns 4, 5, and 6, the industry in which the appointing firm operates is not innovative. The sample consists of S&P 1500 firms excluding those from financial and utility industries over the period 1998–2006. All variables are defined in Appendix. Year and industry fixed effects are included in all columns. Robust p-values are reported in the parentheses below the coefficient estimates, with ***, **, and * denoting significance at the 1%, 5%, and 10%, respectively.

	[1]	[2]	[3]	[4]	[5]	[6]
Innovative Industry	Yes	Yes	Yes	No	No	No
OC_CD (dummy)	0.180**			0.004		
	(0.014)			(0.949)		
OC_CD (number)		0.191***			0.002	
		(0.000)			(0.967)	
OC_CD (%)			1.326***			-0.031
			(0.004)			(0.953)
R&D	7.185***	7.168***	7.189***	59.709***	59.715***	59.760***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
OC_C(dummy)	-0.052	-0.052	-0.053	-0.053	-0.053	-0.053
	(0.372)	(0.374)	(0.367)	(0.292)	(0.293)	(0.293)
Ln(Total assets)	0.751***	0.749***	0.752***	0.151***	0.151***	0.151***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ROA	0.058	0.030	0.042	0.671***	0.671***	0.672***
	(0.836)	(0.913)	(0.879)	(0.007)	(0.006)	(0.006)
Leverage	-0.783***	-0.780***	-0.784***	-0.167**	-0.167**	-0.167**
	(0.000)	(0.000)	(0.000)	(0.021)	(0.021)	(0.021)
CAPEX	1.568***	1.545**	1.557**	-0.013	-0.013	-0.013
	(0.010)	(0.011)	(0.010)	(0.356)	(0.356)	(0.356)
Firm Age	0.006***	0.005***	0.006***	0.009***	0.009***	0.009***
	(0.004)	(0.008)	(0.004)	(0.000)	(0.000)	(0.000)
Board Size	-0.244*	-0.250*	-0.215	0.223**	0.223***	0.224***
	(0.062)	(0.056)	(0.101)	(0.010)	(0.010)	(0.010)
Board independence	1.056***	1.015***	1.048***	0.195*	0.196*	0.199*
	(0.000)	(0.000)	(0.000)	(0.089)	(0.090)	(0.085)
Board Duality	0.033	0.030	0.033	0.035	0.035	0.035
	(0.536)	(0.577)	(0.538)	(0.348)	(0.347)	(0.345)
GIM Index	-0.005	-0.006	-0.006	-0.020**	-0.020**	-0.020**
	(0.640)	(0.590)	(0.585)	(0.012)	(0.012)	(0.012)
Blockholders (#)	-0.062***	-0.060***	-0.061***	0.042***	0.042***	0.042***
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Constant	-3.009***	-2.949***	-3.057***	-1.099***	-1.100***	-1.107***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,471	5,471	5,471	3,119	3,119	3,119
R-squared	0.519	0.520	0.519	0.274	0.274	0.274

Table 15 The Effect of Overconfident CEO Directors When They are Intense Monitors

This table reports the results on the relation between overconfident CEO directors and R&D intensity, where the dependent variable in each regression is R&D intensity. A director is defined as an intense monitor if she sits on at least two monitoring committees (Faleye, Hoitash, and Hoitash, 2011). The sample consists of S&P 1500 firms excluding those from financial and utility industries over the period 1998–2006. Year and industry fixed effects are included in all columns. Robust p-values are reported in the parentheses below the coefficient estimates, with ***, **, and * denoting significance at the 1%, 5%, and 10%, respectively.

	[1]	[2]	[3]
OC_CD*Intense Monitor	-0.007**	-0.002**	-0.030***
	(0.049)	(0.024)	(0.002)
Intense Monitor	0.005*	0.002	0.004**
	(0.083)	(0.297)	(0.043)
OC_CD (dummy)	0.007***		
	(0.001)		
OC_CD (number)		0.005***	
		(0.001)	
OC_CD (%)			0.044***
			(0.004)
OC_C(dummy)	0.010***	0.010***	0.010***
	(0.000)	(0.000)	(0.000)
Ln(Total assets)	-0.001	-0.001	-0.001
	(0.243)	(0.243)	(0.240)
ROA	-0.110***	-0.111***	-0.110***
	(0.000)	(0.000)	(0.000)
Leverage	0.004	0.004	0.004
	(0.330)	(0.331)	(0.328)
CAPEX	0.002	0.002	0.002
	(0.402)	(0.402)	(0.400)
Firm Age	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)
Board Size	-0.018***	-0.018***	-0.018***
	(0.000)	(0.000)	(0.000)
Board Independence	0.020***	0.020***	0.020***
	(0.000)	(0.000)	(0.000)
Board Duality	-0.006***	-0.006***	-0.006***
	(0.000)	(0.000)	(0.000)
GIM Index	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
Blockholders (#)	-0.002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)
Constant	0.116***	0.117***	0.115***

	(0.000)	(0.000)	(0.000)
Observations	8,590	8,590	8,590
R-squared	0.377	0.377	0.377

Table 16 Overconfident CEO Directors and Firm Performance

This table reports the results on the relation between overconfident CEO directors and corporate performance. In Panel A, the dependent variable in each regression is Tobin's Q and in Panel B, the dependent variable in each regression is ROA. All variables are defined in Appendix. Year and industry fixed effects are included in all columns. Robust p-values are reported in the parentheses below the coefficient estimates, with ***, **, and * denoting significance at the 1%, 5%, and 10%, respectively.

Panel A: Tobin's Q

	[1]	[3]	[5]
OC_CD (dummy)	0.107***		
	(0.001)		
OC_CD (number)		0.086***	
		(0.000)	
OC_CD (%)			0.551**
			(0.011)
OC_C (dummy)	0.207***	0.207***	0.207***
	(0.000)	(0.000)	(0.000)
R&D	10.137***	10.135***	10.147***
	(0.000)	(0.000)	(0.000)
Ln(Total assets)	0.021	0.021	0.023
	(0.141)	(0.130)	(0.104)
ROA	7.348***	7.336***	7.346***
	(0.000)	(0.000)	(0.000)
Leverage	-0.302***	-0.303***	-0.303***
	(0.000)	(0.000)	(0.000)
CAPEX	0.040	0.040	0.040
	(0.293)	(0.293)	(0.290)
Board size	-0.005***	-0.005***	-0.005***
	(0.000)	(0.000)	(0.000)
Board independence	-0.288***	-0.290***	-0.275***
	(0.000)	(0.000)	(0.000)
Firm age	0.039	0.033	0.050
	(0.666)	(0.715)	(0.577)
CEO-chairman duality	0.014	0.013	0.015
	(0.614)	(0.642)	(0.609)
GIM index	-0.029***	-0.029***	-0.029***
	(0.000)	(0.000)	(0.000)
Blockholders (number)	-0.119***	-0.119***	-0.119***
	(0.000)	(0.000)	(0.000)
Constant	2.085***	2.097***	2.044***
	(0.000)	(0.000)	(0.000)
Year Dummies	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes

Observations	8,591	8,591	8,591
R-squared	0.456	0.456	0.456

Table 16 Overconfident CEO Directors and Firm Performance (continued)

Panel B: ROA

	[1]	[2]	[3]
OC_CD (dummy)	0.007***		
	(0.007)		
OC_CD (number)		0.009***	
		(0.000)	
OC_CD (%)			0.070***
			(0.000)
OC_C (dummy)	-0.328***	-0.329***	-0.329***
	(0.000)	(0.000)	(0.000)
R&D	0.035***	0.035***	0.035***
	(0.000)	(0.000)	(0.000)
Ln(Total assets)	0.006***	0.006***	0.006***
	(0.000)	(0.000)	(0.000)
Leverage	-0.015***	-0.015***	-0.015***
	(0.005)	(0.005)	(0.005)
CAPEX	0.009	0.009	0.009
	(0.240)	(0.240)	(0.239)
Board size	-0.000	-0.000*	-0.000
	(0.138)	(0.072)	(0.105)
Board independence	0.007	0.006	0.008
	(0.190)	(0.231)	(0.132)
Firm age	0.002	0.000	0.001
	(0.731)	(0.999)	(0.886)
CEO-chairman duality	-0.004**	-0.005**	-0.004**
	(0.043)	(0.037)	(0.042)
GIM index	0.001*	0.001*	0.001*
	(0.075)	(0.089)	(0.093)
Blockholders (number)	-0.004***	-0.004***	-0.004***
	(0.000)	(0.000)	(0.000)
Constant	0.061***	0.065***	0.060***
	(0.000)	(0.000)	(0.000)
Year Dummies	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes
Observations	8,593	8,593	8,593
R-squared	0.180	0.181	0.181

Table 17 Overconfident CEO Directors and Firm Performance: 2SLS Results

This table reports the results from 2SLS regressions of corporate performance measures on overconfident CEO directors. The IV for overconfident CEO directors is the percentage of overconfident CEOs in the state in which the firm's headquarter is located. Panels A, B, and C present the results for the three measures of overconfident CEO directors, respectively. All variables are defined in Appendix. Year and industry fixed effects are included in all columns. Robust p-values are reported in the parentheses below the coefficient estimates, with ***, **, and * denoting significance at the 1%, 5%, and 10%, respectively.

Panel A: OC_CD (dummy)

	[1] IV	[2] Tobin's Q	[3] ROA
1st Stage	0.169***		
	(0.000)		
2nd Stage		3.668***	2.929***
		(0.000)	(0.000)
OC_C (dummy)	-0.001	0.192***	0.017***
	(0.899)	(0.000)	(0.000)
R&D	0.251***	9.088***	-1.029***
	(0.001)	(0.000)	(0.000)
Ln(Total assets)	0.050***	-0.157***	-0.142***
	(0.000)	(0.000)	(0.000)
ROA	0.107***	7.053***	
	(0.010)	(0.000)	
Leverage	-0.023	-0.216***	0.060***
	(0.127)	(0.006)	(0.000)
CAPEX	0.002	0.035	-0.000
	(0.426)	(0.360)	(0.961)
Board size	0.003***	-0.017***	-0.010***
	(0.000)	(0.000)	(0.000)
Board independence	0.085***	-0.590***	-0.237***
	(0.000)	(0.000)	(0.000)
Firm age	0.408***	-1.426***	-1.200***
	(0.000)	(0.000)	(0.000)
CEO-chairman duality	0.009	-0.021	-0.030***
	(0.266)	(0.492)	(0.000)
GIM index	0.005***	-0.045***	-0.013***
	(0.003)	(0.000)	(0.000)
Blockholders (number)	-0.012***	-0.076***	0.034***
	(0.000)	(0.000)	(0.000)
Constant	-0.805***	4.583***	2.081***
	(0.000)	(0.000)	(0.000)
Year Dummies	Yes	Yes	Yes

Industry Dummies	Yes	Yes	Yes
Observations	8,528	8,526	8,528
R-squared	0.180	0.458	0.425

Table 17 Overconfident CEO Directors and Firm Performance: 2SLS Results (continued)

Panel B: OC_CD (number)

	[1]	[2]	[3]
	IV	Tobin's Q	ROA
1st Stage	0.272***		
	(0.000)		
2nd Stage		2.283***	1.986***
		(0.000)	(0.000)
OC_C (dummy)	-0.006	0.201***	0.016***
	(0.662)	(0.000)	(0.000)
R&D	0.337***	9.238***	-0.899***
	(0.001)	(0.000)	(0.000)
Ln(Total assets)	0.057***	-0.105***	-0.111***
	(0.000)	(0.001)	(0.000)
ROA	0.274***	6.822***	
	(0.000)	(0.000)	
Leverage	-0.020	-0.254***	0.036***
	(0.317)	(0.001)	(0.000)
CAPEX	0.003	0.035	-0.003
	(0.331)	(0.370)	(0.325)
Board size	0.005***	-0.017***	-0.010***
	(0.000)	(0.000)	(0.000)
Board independence	0.135***	-0.586***	-0.257***
	(0.000)	(0.000)	(0.000)
Firm age	0.578***	-1.249***	-1.155***
	(0.000)	(0.000)	(0.000)
CEO-chairman duality	0.025**	-0.044	-0.052***
	(0.022)	(0.172)	(0.000)
GIM index	0.008***	-0.043***	-0.014***
	(0.002)	(0.000)	(0.000)
Blockholders (number)	-0.019***	-0.078***	0.036***
	(0.000)	(0.000)	(0.000)
Constant	-1.178***	4.318***	2.021***
	(0.000)	(0.000)	(0.000)
Year Dummies	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes

Observations	8,528	8,526	8,528
R-squared	0.189	0.458	0.612

Table 17 Overconfident CEO Directors and Firm Performance: 2SLS Results (continued)

Panel C: OC_CD (%)

	[1] IV	[2] Tobin's Q	[3] ROA
1st Stage	0.026***		
	(0.000)		
2nd Stage		24.199***	21.081***
		(0.000)	(0.000)
OC_C (dummy)	-0.000	0.192***	0.009***
	(0.887)	(0.000)	(0.000)
R&D	0.031***	9.252***	-0.896***
	(0.007)	(0.000)	(0.000)
Ln(Total assets)	0.006***	-0.120***	-0.125***
	(0.000)	(0.000)	(0.000)
ROA	0.025***	6.853***	
	(0.000)	(0.000)	
Leverage	-0.002	-0.255***	0.035***
	(0.413)	(0.001)	(0.000)
CAPEX	-0.000	0.044	0.005
	(0.737)	(0.255)	(0.185)
Board size	0.000***	-0.016***	-0.010***
	(0.000)	(0.000)	(0.000)
Board independence	-0.007**	-0.107	0.159***
	(0.021)	(0.134)	(0.000)
Firm age	0.058***	-1.343***	-1.238***
	(0.000)	(0.000)	(0.000)
CEO-chairman duality	0.001	-0.021	-0.032***
	(0.245)	(0.498)	(0.000)
GIM index	0.001***	-0.052***	-0.021***
	(0.000)	(0.000)	(0.000)
Blockholders (number)	-0.002***	-0.075***	0.038***
	(0.000)	(0.000)	(0.000)
Constant	-0.078***	3.505***	1.317***
	(0.000)	(0.000)	(0.000)
Year Dummies	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes
Observations	8,528	8,526	8,528

R-squared	0.143	0.458	0.590

APPENDIX: VARIABLE DEFINITIONS

Variable	*Definition and Source*
Overconfidence Measures	
Confidence	A measure of how in-the-money a CEO's vested stock options are. It is calculated as the per option realizable value of the unexercised exercisable options divided by the estimated average exercise price, where the per option realizable value is calculated as the total realizable value of the unexercised exercisable options (ExecuComp variable: OPT_UNEX_EXER_EST_VAL) divided by the number of unexercised exercisable options (ExecuComp variable: OPT_UNEX_EXER_NUM), and the estimated average exercise price is the difference between the stock price at the fiscal year end and the per option realizable value (Campbell et al. (2011)).
Overconfident	A person is identified to be overconfident if his/her Confidence measure exceeds 67% for more than two times (Campbell et al. (2011)).
OC_CD (dummy)	Overconfident CEO Director (dummy): an indicator which equals one if there is at least one overconfident CEO director on the board.
OC_CD (number)	Overconfident CEO Director (number): the number of overconfident CEO directors on the board.
OC_CD (%)	Overconfident CEO Director (%): the proportion of overconfident CEO directors relative to board size.
LOC_CD (number)	The number of low-overconfidence CEO directors in a firm. A person is identified to have low overconfidence if his/her Confidence measure is in the range of [67%, 130%) (Hirshleifer, Low, and Teoh (2012)).
MOC_CD (number)	The number of moderate-overconfidence CEO directors in a firm. A person is identified to have moderate overconfidence if his/her Confidence measure is in the range [130%, 250%) (Hirshleifer, Low, and Teoh (2012)).
HOC_CD (number)	The number of high-overconfidence CEO directors in a firm. A person is identified to have high overconfidence if his/her Confidence measure exceeds 250% (Hirshleifer, Low, and Teoh (2012)).
OC_C (dummy)	Overconfident CEO (dummy): an indicator which equals one if the CEO of the appointing firm is overconfident, and zero otherwise (Hirshleifer, Low, and Teoh (2012)).
Innovation Measures	
R&D	The firm's R&D expenditures scaled by total assets, which is set to zero if Compustat reports R&D as missing (Compustat).
Patents	The number of patents applied for during the year by the firm (NBER patent database).
Patent Citation	The number of citations summed across all patents applied for during the year. Each patent's number of citations is multiplied by the weighting index from Hall, Jaffe, and Trajtenberg (2005) before aggregating up to the firm-year level (NBER patent database).

Patent Index	Similar to Bena and Li (2012), first, for each technology class k and patent application year t, we compute the median value of the number of awarded patents across all firms that were awarded at least one patent. Second, we scale the number of awarded patents to the focal firm in technology class k with application year t by the corresponding median value from the first step (NBER patent database).
Citation per Patent	The total number of citations divided by the number of patents in a firm for a given year (NBER patent database).
Firm Characteristics	
Total Assets	Natural log of book value of total assets in millions of dollars (Compustat).
Tobin's Q	The book value of assets minus the book value of equity, plus the market value of equity, divided by the book value of assets (Compustat).
ROA	The firm's annual return on assets, calculated as income before interest and taxes (EBIT) divided by the book value of assets at the beginning of the fiscal year (Compustat).
Leverage	Long-term debts divided by total assets (Compustat).
CAPEX	The firm's capital expenditures scaled by total assets (Compustat).
Firm Age	The number of years since the firm first appeared on Compustat (Compustat).
GIM Index	The governance index from Gompers, Ishii, and Metrick (2003) (RiskMetrics).
Blockholders (number)	The number of institutions who own at least 5% of the firm's equity (Thomson 13F).
Board Characteristics	
Board Size	The total number of directors on the board (RiskMetrics).
Outside Director	A director who is neither affiliated nor currently an employee of the firm (RiskMetrics).
Board Independence	The number of independent directors divided by the total number of directors on the board (RiskMetrics).
CEO-chairman Duality	An indicator which equals one if the CEO also holds the title of Chairman of the board, and zero otherwise (RiskMetrics).