
Do New CEOs Really Care about Innovation?

Abstract

This study asks whether new CEOs care about innovation post-turnover. Using a large sample of Chinese listed firms between 2008 and 2019, our identification strategy relies on the exogenous variation in CEO turnovers. Our difference-in-difference estimates indicate that new CEOs improve R&D efficiency and generate more and higher quality patents. We further show that this positive effect is more pronounced when CEOs have longer career horizons and overseas experience. Overall, our findings indicate that CEO turnover represents an effective mechanism for fostering innovation and new CEOs indeed care about innovation. Our results could benefit several groups of stakeholders with respect to CEO selection process.

JEL Classification: G34, J63; O32

Keywords: CEO Turnover, Corporate Innovation, Difference-in-Difference

1. Introduction

Chief executive officers (CEOs) are typically viewed as critical to the success and survival of firms, and CEO turnover has important long-term implications for firms' corporate policies and outcomes. As such, the literature documents significant impacts of CEOs on firm performance (Bandiera *et al.*, 2020; Nourayi & Daroca, 2008; Saidu, 2019); leadership change (Carmeli *et al.*, 2011; Chen *et al.*, 2019) and survival rates (Jenter *et al.*, 2016). Consequently, CEO turnover has attracted considerable attention from academics practitioners, and media. Recent studies also suggest a decline in average CEO tenures (Goyal & Low, 2019), an increase in involuntary dismissals and high performance-turnover sensitivity (Alexandridis *et al.*, 2019) leading to significant changes in the firm performance (Bhagat *et al.*, 2010; Dikolli *et al.*, 2014; Jenter & Kanaan, 2015; Kato & Long, 2006). Previous studies have provided useful insights into the effects of CEO turnover on post-turnover operating and market performance (Jenter & Lewellen, 2020; Kim, 1996; Murphy & Zimmerman, 1993). Yet, empirical evidence on the association between CEO turnover and corporate innovation is scant. Our study attempts to fill this gap.

CEO turnover is a critical event that impacts organisational functions and performance. This is because CEOs are responsible for developing and implementing strategies and oversee operational and functional decisions within an organisation. Therefore, a CEO change could radically affect corporate policies, procedures, and performance (Finkelstein *et al.*, 1996; Hambrick & Quigley, 2014). The extant literature examining CEO turnover-performance nexus suggests that turnovers (particularly forced) are preceded by poor operating and market performance (Denis *et al.*, 1997; Fee & Hadlock, 2004; Jenter & Lewellen, 2020; Warner *et al.*, 1988; Weisbach, 1988). For example, Jenter and Lewellen (2020) document a close link between performance and turnover and find that performance induced turnovers account for between 38% and 55% of all turnovers. These studies also

suggest that firm performance should improve following CEO turnovers. The empirical evidence on the relationship between turnover and performance, however, is mixed. For instance, some studies document improvements in operating earnings and stock returns following turnovers (Denis & Denis, 1995; Huson *et al.*, 2004). This strand of the literature suggests that managerial turnover improves performance by learning from previous organisational mistakes, reversing of past poor investment decisions and resetting strategic directions leading to better performance (Alexandridis *et al.*, 2019; Haveman *et al.*, 2001; Shen & Cho, 2005). On the other hand, another strand of the literature does not find evidence of performance improvements following CEO changes (Cao *et al.*, 2017; Wiersema, 2002). The change in CEO is disruptive and successor CEOs' policies and restructuring could provoke instability and ambiguity for employees leading to poor performance (Ballinger & Marcel, 2010; Schepker *et al.*, 2017).

Investment in research and development (R&D) is one of the key decisions made by CEOs because investment in developing new products, processes and technologies often confers competitive advantages that are vital for future productivity performance (Ettlie, 1998; Scherer, 1984). Corporate innovation is not only an important determinant of firm performance (Baer, 2012; Gunday *et al.*, 2011; Tuan *et al.*, 2016), but also, it is vital for the aggregate national productivity and overall economic development (Porter, 1992). Hence, understanding the determinants of corporate innovation is imperative for academics and policy makers alike. A sizeable body of literature has investigated the determinants of corporate innovation such as the role of equity analysts (Fiorillo *et al.*, 2022), corporate social responsibility (Liu *et al.*, 2021), creation culture (Wang *et al.*, 2021), CEOs and board characteristics (Cao *et al.*, 2016; Chen, 2013; González-Uribe & Groen-Xu, 2017; Mazouz & Zhao, 2019; Sena *et al.*, 2017). Given the key role of CEOs in fostering innovation, the literature documents a significant impact of CEOs characteristics on innovation; for instance,

CEO overconfidence (Galasso & Simcoe, 2011), sensation seeking (Sunder *et al.*, 2017), inventing ability (Islam & Zein, 2020), exploratory mindset (He & Hirshleifer, 2022), general managerial skills (Custódio *et al.*, 2019) and education (Beladi *et al.*, 2022). Although some studies examine changes in R&D spending around CEO turnovers (Dechow & Sloan, 1991; Murphy & Zimmerman, 1993), the impact of CEO changes on overall innovation (input and output) activities is scant, particularly in emerging markets.

Theoretical arguments from the literature predict improvements in innovation performance following CEO changes due to divergent incentives of departing and successor CEOs. The quiet life hypothesis suggests that lazy incumbent managers would underinvest in innovation due to the risks involved in innovation in the absence of incentives or threat of replacement (Aghion *et al.*, 2013). These agency issues are likely to be more severe in firms where managers are close to departing their firms due to retirement or contract expiration (Murphy & Zimmerman, 1993). Dechow and Sloan (1991) find a reduction in R&D spending in firms where CEOs are close to departing their firms. Similarly, Boot (1992) argues that managers are reluctant to divest poorly performing investments due to career concerns. These agency issues are likely to be exacerbated in emerging markets like China due to the lack of robust corporate governance mechanisms, market discipline and political entrenchment (He *et al.*, 2020; Jiang *et al.*, 2010). Managerial turnover provides an opportunity for successor CEOs to “reset” the poor investments decisions of departing managers and the empirical evidence supports this conjecture. For instance, successor CEOs reverse value destroying decisions by divestitures and operational downsizing (Ansari *et al.*, 2014; Conyon & He, 2014; Goel & Thakor, 2008), and successor CEOs add value through superior mergers and acquisitions, reversing prior poor investments through asset disposals and adopting more efficient investment strategies (Alexandridis *et al.*, 2019). Moreover, to showcase their managerial ability, successor CEOs are likely to optimise innovation strategies. Innovation

success also yields career benefits for CEOs; successor CEOs enjoy relatively longer career horizons and the results from the literature shows that firms with longer horizon CEOs invest more in R&D and produce better quality innovations (González-Urbe & Groen-Xu, 2017).

In this study, we investigate CEOs turnover-innovation nexus in a large sample of Chinese listed firms. Our choice of Chinese sample is mainly motivated by two reasons. First, China is the largest emerging market and second largest economy in the world. A large part of China's rapid economic growth is attributable to the innovative capabilities of Chinese firms. In fact, China has emerged as one of the most innovative nations in the world during the past decade.¹ Second, there are significant institutional differences between Chinese and developed markets. For instance, the ownership, control and corporate governance mechanisms of Chinese listed firms are radically different compared to those from developed markets, making China an interesting setting to study the impact of CEO turnover on innovation. Moreover, other factors such as weak legal and institutional environment, underdeveloped investor protection legislation, state control and ownership, and importance of political connections might have significant different implications for causes (and consequences) of CEO changes on Chinese firms' policies compared to their Western counterparts² (Cao *et al.*, 2017; He *et al.*, 2014; Kato & Long, 2006).

We test CEO turnover-innovation relationship on a large sample of CEO replacements in Chinese listed firms from 2008-2019. We manually collect CEO turnover

¹ China filed 1.2 million patents in 2016 more than the combined total of the US, Japan, The Republic of Korea and the European Patent Office. It was ranked among the 20 most innovative economies in the world for the first time in 2018 (WIPO: https://www.wipo.int/pressroom/en/articles/2018/article_0005.html). According to a recently released Global Innovation Index 2022 by WIPO, China ranks 11th among the most innovative nations in the world (https://www.wipo.int/global_innovation_index/en/2022/).

²Unlike the developed markets (e.g., US and UK) that utilise a unitary (one-tier) board, Chinese companies set up a supervision board to monitor the decisions made by the board of directors or CEOs (Frag & Mallin, 2016). Nevertheless, most of the members of the supervision board are the former board of directors, and they have no actual rights to make any strategic decisions (e.g. CEO recruitment), which consequently reduces the efficiency and transparency of the whole internal corporate governance system (Sabbaghi, 2016). In addition, for CEO recruitment in Chinese companies, the nominee must gain over 50% affirmative votes from the shareholders. See (Jiang *et al.*, 2013) for further details.

related data from firms' annual reports, press releases, and online sources and combine this data with demographic information of CEOs in China Stock Market and Accounting Research (CSMAR) database. Given the endogenous nature of CEO turnovers (Sarkar *et al.*, 2019), we exploit variations in CEO changes caused by exogenous reasons for identification: health, retirements and contract expirations (Cao *et al.*, 2017). To test CEO turnover - innovation relationship and to further account for the differences between firms with and without CEO changes, we employ a generalised difference-in-difference (DID) estimation approach. Our primary measures of innovation include input (R&D efficiency), output (patent applications) and quality of the innovation (patent citations).

Our results reveal that CEOs turnovers are positively associated with innovation performance of firms experiencing the CEO changes. We show that successor CEOs increase R&D efficiency, innovation output in both quantity (patent applications) and quality (patent citations) compared with a matched sample of control firms which do not experience a CEO change. Our results are not only statistically significant but are also economically sizeable. For instance, successor CEOs are associated with an increase of 13.31% in invention patents, 6.82% in invention and utility patents, 6.39% in citations and 0.33% in R&D/Invention Patents, respectively. To further verify that the significant changes in innovation are indeed caused by CEO turnover, we conduct placebo tests. We find that results from our main regressions cannot be replicated using a non-turnover control firm as a firm experiencing actual turnover (placebo firm). Overall, these results suggest that it is in fact CEO turnover that triggers improvements in post-turnover innovation. Our results are also robust to several adjustments (instrumental variable, Heckman selection and system GMM) for endogeneity concerns. We further validate our results using a series of additional robustness tests including controls for CEO and board characteristics, alternative model specifications and

different matched samples. Our main results remain insensitive to all the additional robustness tests.

Having established that CEO turnover influences innovation, we next study the mechanisms which drive these observed results. We examine whether the effects of CEO changes on innovation rely on the extent of CEO career horizon and overseas experience. Our univariate tests suggest that successor CEOs have longer career horizons and more overseas experience (work or study) than the departing CEOs. Moreover, as expected, we uncover that the relationship between CEO turnover and innovation is strengthened with longer career horizon and more overseas experience.

Our study contributes to the literature in the following ways: First, we contribute to the growing literature on the effects of CEO turnover on corporate policies (Cao *et al.*, 2017; Denis & Denis, 1995; Huson *et al.*, 2004; Sarkar *et al.*, 2019; Wiersema, 2002). The existing literature examining the turnover effects mainly focuses on firm performance (Conyon & He, 2014; Jenter & Kanaan, 2015), board leadership changes (Goyal & Park, 2002) or corporate risk-taking behaviour (Bushman *et al.*, 2010). Our results regarding the positive association between CEO turnover and post-turnover innovation complement the existing literature showing improvements in investment performance post CEO changes (Bereskin & Hsu, 2014; Huson *et al.*, 2004; Murphy & Zimmerman, 1993). Our results are also related to the strand of literature showing that incoming CEOs increase value by adopting more efficient investment strategies (Aivazian *et al.*, 2011; Alexandridis *et al.*, 2019; Pan *et al.*, 2016; Weisbach, 1995).

Second, our paper complements the literature focusing on human-capital based explanation of innovation and examines the effects of personal characteristics on firms' decisions and innovation (Cronqvist *et al.*, 2012; Graham *et al.*, 2013; Hirshleifer *et al.*, 2012;

Malmendier & Tate, 2005, 2008; Sunder *et al.*, 2017). We uncover that some personal attributes (e.g. career horizon and overseas experience) of successor CEOs are significantly important for innovation and these results are related to studies showing that heterogeneity in CEOs personal dimensions enhances innovation (Barker III & Mueller, 2002; Custódio *et al.*, 2019; Galasso & Simcoe, 2011; Islam & Zein, 2020).

Finally, our paper also contributes to the growing debate in the literature on the determinants of innovation and CEO turnovers in China (Cao *et al.*, 2017; Conyon & He, 2014; He *et al.*, 2014). China has emerged at the forefront of innovation and now ranks 11th in the Global Innovation Index 2022 rankings. A spate of recent studies examining innovation in China show male heir preference (Chen *et al.*, 2021), CEO early life experience (Kong *et al.*, 2021), foreign experience (Yuan & Wen, 2018) and investor site visits (Jiang & Yuan, 2018) as the determinants of firm-level innovation. We contribute to this growing strand of the literature showing that CEO turnover represents an effective mechanism for fostering innovation particularly in the Chinese context.

The remainder of this paper is organized as follow. Section 2 introduces the research design including sample, variables and empirical modelling. Section 3 presents the empirical results, while additional tests for robustness checks have been provided in Section 4. Section 5 provide evidence on the further analysis. Finally, Section 6 concludes the paper.

2. Research Design

2.1 Dataset

Our sample covers all firms listed on both the Shanghai and Shenzhen Stock Exchanges (SHSE, SZSE) between 2008 and 2019. We collect financial data, CEO related information and corporate governance variables from the CSMAR database. We also use company websites and other online sources (news, social media etc.) to complete missing information related to CEO turnover and other CEO characteristics. For innovation related

variables, we use China National Intellectual Property Administration (CNIPA) data and collect patent applications and citations. Due to the absence of a common identifier between CSMAR and CNIPA, we use company names to match firms in both databases. Our sample construction proceeds in the following two steps. First, we obtain all CEO turnovers in our sample from 2008 to 2019. In total, we identify eleven reasons for CEO turnovers. However, following the literature (Cao *et al.*, 2017; Sarkar *et al.*, 2019), we only keep firms with CEO turnovers due to the three strictly exogenous reasons (contract expiration, health, and retirement)³. Further, we only retain incoming CEOs with at least three-year tenure, since corporate innovation is a long-term process and is unlikely to be affected by temporary CEOs⁴ (Cao *et al.*, 2020). We drop firms with multiple CEO turnovers to avoid confounding effects following Berger *et al.* (2014). Following the above steps and excluding financial firms and firms with missing data, we obtain a sample of 309 CEO turnovers (treatment group) due to contract expiration, health, and retirements reasons.

Second, we construct a corresponding sample of firms by matching treatment firms with firms of similar characteristics without CEO turnovers (control group) following Berger *et al.* (2014). More specifically, we use firm size, performance (ROA), year and industry sector as the matching criteria. The size criterion ensures comparing firms with similar operations in terms of scope and scales and business model (Schaeck *et al.*, 2011). In particular, we match firm i (treatment firm) to other firms in the control group whose total assets range between 80%-120% of firm i 's total assets in the same year. The industry sector criterion ensures comparing firms from the same industry sector. Our final matching criteria is based on firm performance. We select control firms whose ROA ranges between 80% and 120% of the ROA of the treated firm in the same year. We follow $1:n$ matching method to have at least one control firm for each firm that experiences a CEO turnover. We do not

³ Detailed explanation of the turnover reasons can be found in Appendix 1.

⁴ In our sample, we find 21 successor CEOs whose tenures are less than three years.

restrict the number of control firms in the sample to exploit the large sample of Chinese firms. Our final sample consists of 309 firms in the treatment group and 1,220 firms in the control group corresponding to 12,855 firm-years.

2.2 Variables Definitions

2.2.1 Corporate Innovation

The measurement of innovative activities is inherently difficult leading to the use of different proxies for innovation (Smith, 2005). R&D spending has been widely used as a proxy of innovation (Chen & Hsu, 2009; David & O'Brien, 2006; Koh *et al.*, 2017; Zhu & Wang, 2012) based on the assumption that firms' R&D engagement and intensity persist over time. However, using R&D as a proxy of innovation is problematic for at least two reasons. First, the lack of mandatory reporting related to R&D spending precludes systematic and consistent data collection. However, Koh and Reeb (2015) show that 10.5% of missing R&D firms in their sample file and eventually receive patents indicating that R&D might not capture the actual innovation efforts. Second, R&D spending is subject to discretionary reporting choices and firms' strategic motives. Firms may engage in real earnings management by temporarily reducing R&D spending to boost short term profitability (Osma, 2008). While R&D is an input measure of innovation, patent-based proxies represent output measures of innovation activities. Prior literature regards raw patent counts as one of the most appropriate indicators of innovative performance of a firm (Bresman *et al.*, 1999; Griliches, 2007). Patent counts are a popular measure of innovation as long time series firm level data exists and it is accepted that patent applications capture firms' outcome of innovative efforts (Hagedoorn & Cloudt, 2003). Although, patent counts generate a quantitative measure of innovation output, simple patent count-based measures do not indicate the quality of innovation. Forward citations to patent imply that the patent is valuable for subsequent innovations. Therefore, the citation count captures the technical impact and quality of the cited patent. Patent counts and citations have been increasingly used as indicators of

innovation in the finance and economics literature (Brav *et al.*, 2018; Deng *et al.*, 2021; Kim & Valentine, 2021; Li *et al.*, 2021; Pu *et al.*, 2022). However, patent-based innovation proxies also suffer from issues such as international and industry differences in patenting behaviours, patenting differences between large and small firms, and lack of patenting for secrecy (Hagedoorn & Cloudt, 2003). Since all innovation proxies suffer from biases and shortcomings to some extent, we use a comprehensive set of input and output-based proxies for innovation. To the best of our knowledge, our study is among the very few (Fang *et al.*, 2018) to use such a comprehensive set of innovation proxies in the Chinese context (Chen *et al.*, 2021; Jiang & Yuan, 2018; Kong *et al.*, 2021; Yuan & Wen, 2018).

We construct innovation variables using data from CNIPA and CSMAR that contains information on patent application date, application identification, grant date, applicant institution and R&D spending. The Chinese patents are classified into three categories: invention patents, utility model patents, and design patents. Invention patents are granted for a new solution to a product or technical process. Utility model patents are for a new technical solution or improvement with lower degree of inventiveness relating to certain features of a product such as shape or structural physical features. Design patents are granted for innovations in external features of a product such as shape, pattern and/or colour which make the product attractive and fit for industrial application. Given the limited technological innovation involved in design patents, we use only invention and utility model patents to construct our innovation measures following Chinese innovation literature (Chen *et al.*, 2019; Fang *et al.*, 2017; Jiang & Yuan, 2018; Tan *et al.*, 2015; Wang *et al.*, 2021). We use application year rather than grant year for our patent counts because application year corresponds more closely to the actual time of the innovation (Fang *et al.*, 2014; Hall *et al.*, 2005; He & Tian, 2013; Jiang & Yuan, 2018; Wang *et al.*, 2021).

Our firm-level innovation measures are constructed in four ways. First, *Invention*, is the raw count of invention patents filed and eventually granted to a firm each year. Second, *Invention+Utility*, is the raw count of invention and utility patents filed and eventually granted to a firm each year. We use natural log of one plus patent counts (*Invention*, *Invention+Utility*) to address the skewness concerns in patent count related variables (Fang *et al.*, 2017; Jiang & Yuan, 2018; Wang *et al.*, 2021). Third, we use the number of forward citations received by a firm's invention patents (*Citation_Adjusted*). In order to account for the truncation bias in citations, we adjust the citations received by each patent by the average citations in the same cohort (year and industry class) following Hall *et al.* (2005). Fourth, we use *R&D/Invention Patents* as our final measure of corporate innovation (Danguy *et al.*, 2014; de Rassenfosse & van Pottelsberghe de la Potterie, 2009) to show innovation efficiency. The use of a comprehensive set of innovation proxies allows us to examine the impact of CEO turnover on the entire innovation process: from input (R&D spending) to output (patent application counts) and the subsequent impact of the innovation (citations).

2.2.2 CEO Turnover

Prior literature suggests that CEO turnovers may not only be endogenously determined by firm performance (Hermalin & Weisbach, 1991) but also by industry and economic performance (Jenter & Kanaan, 2015). This poses a significant challenge in examining any related effect of CEO turnover, for instance, on innovation in our case. An ideal setting to examine the causal effect of CEO turnover in our case is whether CEO turnover is exogenous to firm level innovation. To overcome these identification challenge, we focus on the reasons for CEO turnover in Chinese firms in detail.

We identify eleven different reasons for CEO turnovers in our sample based on the information from firms' annual reports, press releases, online sources, and CSMAR. These reasons include personal, contract expiration, health, retirement, corporate governance

restructuring, job transfer, agent related termination, change of controlling right, dismissal, resignation and case involve. Detailed explanation of each reason can be found in Appendix 1.

We only focus on the plausibly exogenous reasons for CEO turnover in this study namely “Contract Expiration⁵”, “Health” and “Retirement”. These reasons are least likely to be correlated with innovation for the purpose of identification. Our classification is in line with Cao *et al.* (2017) who classify all these three reasons as normal (non-performance related) turnovers. Moreover, Sarkar *et al.* (2019) use retirement age as an exogenous reason for CEO turnover in their sample. We exclude all other reasons treating them as endogenous turnovers⁶.

2.2.3 Control Variables

Following innovation literature, we control for an array of well know firm-level characteristics that may affect a firm’s innovation. We include *Firm Size* (natural log of the total asset) following Shefer and Frenkel (2005), who find a positive effect of firm size on innovation. *Firm Age*, proxied by the number of years since a firm started operations, is included to control for differences in the stage of development across firms following Balasubramanian and Lee (2008). Following David and O'Brien (2006), we use *Leverage* ratio measured as total debt to total assets ratio. We include return on assets (*ROA*) measured as net income divided by total assets to control firms’ profitability following Howell (2018). We also include operating cash flow (*OCF*) and cash holding ratio (*CHR*) to control the growth opportunities following (Amore *et al.*, 2013; Lee, 2020; Wu & Tang, 2016). Finally, we include state ownership (*SOE*) measured as the percentage shares held by the state following Wang and Kafouros (2009). In robustness tests, we also include several board and

⁵ We check company’s official documents to ensure that there is no renewal of contract for the same CEO.

⁶ We carefully checked the firms’ relevant filings (e.g. annual report) but failed to find any further details on personal reasons.

CEO characteristics as additional controls. All variables are defined in Appendix 2 and continuous variables are winsorized at the 1st and 99th percentiles.

2.3 Empirical modelling

To test the effect of CEO turnover on firm innovation, we employ the generalised difference-in-difference (DID) approach. The DID estimator compares a treatment group to a control group before and after the treatment. In our case, the treatment group includes firms that experienced a CEO turnover due to contract expiration, health issues or retirement. For control group, we use a matched sample of non-CEO turnover firms (explained in section 2.1). A similar research approach has been employed recently in several studies (Bertrand & Mullainathan, 2003; Carbó-Valverde *et al.*, 2020; Haselmann *et al.*, 2010; Low, 2009; Sarkar *et al.*, 2019). Our generalised DID specification is as follows:

$$Y_{i,t+1} = \beta_0 + \beta_i + \beta_t + \beta_1 \times New\ CEO\ Post_{i,t} + \gamma X_{i,t} + \varepsilon_{i,t} \quad (1)$$

where i indexes firms and t indexes time. The dependent variable $Y_{i,t}$ is the natural log of one plus invention patents (*Invention*), natural log of one plus invention and utility patents (*Invention+Utility*), and adjusted citations per patent (*Citation_ Adjusted*) and *R&D/Invention Patents* respectively. Our innovation variables account for the input (R&D), quantity (raw patent counts) and quality (citations) of the innovation. *New CEO Post_{i,t}*, our main variable of interest, is a dummy variable equal to 1 when and after a firm i undergoes a CEO turnover event in year t , and 0 otherwise. This variable serves as the DID operator and our estimate of the CEO turnover effect is β_1 . The firm fixed effects β_i take into account the various time-invariant factors across firms that influence the firms' innovation. The year fixed effects β_t control for aggregate fluctuations in innovation over time. In particular, this generalised DID approach essentially compares the change in innovation for a firm before and after the CEO turnover and compares this change with that of a non-CEO turnover firm

(control group) over the same period. $X_{i,t}$ is a vector of control variables including *Firm Size*, *Firm Age*, *Leverage*, *ROA*, *operating cash flows*, *cash holding ratio* and *SOE*, and $\varepsilon_{i,t}$ is error term. We allow for clustering of observations at the firm level to account for the presence of serial correlation in the data.

3. Results and Discussion

3.1 Summary Statistics

Panel A of Table 1 presents annual frequency of exogenous CEO turnovers in our sample firms. We find 309 firms with exogenous CEO turnover events, and the turnover rate is steady across our sample period with 20.21% on average. Regarding turnover reasons, a large proportion (81.22%) of turnovers are due to contract expiration. Panel B presents means and standard deviations for all our variables. Column (1) refers to the treatment group, which includes firm-years experiencing a CEO turnover due to either of the contract expiration, health issues or retirement, while column (2) presents means and standard deviations of matched control firm-years without any CEO change. A comparison of means for treated and control observations shows that all innovation-related variables have higher mean values for treated firms than the control ones. For instance, treated firms have, on average, 4.366 more invention patents compared to the control firms. The invention citations show a considerable difference between the treatment and control groups as well, whereby invention citations in treated firms exceed the control firms by 0.51. In terms of R&D, treated firms spend 0.109 per invention patent more compared to the control group. Overall, these results show that successor CEOs enhance innovation input and output in the post-turnover periods. The mean values for control variables do not show any noticeable differences between treatment and control firms because we use a matched sample.

[INSERT TABLE 1 HERE]

3.2 Correlation Matrix

Table 2 presents correlations for variables used in the study. *New CEO Post* is positively correlated with all the innovation proxies at 5% significance level. The correlations between all control variables are not high to give rise to multicollinearity issues in our regressions.

[INSERT TABLE 2 HERE]

3.3 Main DID results

The DID estimation results are presented in Table 3. All models include firm and year fixed effects. The coefficient on *New CEO Post* is positive and significant (with varying significance levels) across all models. Apart from statistical significance of these results, the economic impact of CEO turnover on firm-level innovation is considerable. For instance, a CEO turnover is associated with an increase of 13.31%⁷ in invention patents, 6.82% in invention and utility patents, 6.39% in adjusted citations and 0.33% in R&D/Invention Patents⁸, respectively. Overall, our results suggest that exogenous CEO turnovers are followed by increase in innovation input (R&D), output (patent counts) and impact (citations). These results also indicate that incoming CEOs are effective in reallocating resources more efficiently from poor-performing projects (Weisbach, 1995) to more promising investment opportunities (Bereskin & Hsu, 2014), resulting in improvements in overall firm-level innovation.

The results for control variables are also consistent with prior literature. *Firm Size* is positive and statistically significant in all models suggesting that larger firms invest more in R&D, resulting in more patents (Mazouz & Zhao, 2019). *Firm Age* is negatively related to innovation proxies in all models. The relation between firm age and innovation is, at best,

⁷ $(\exp^{(0.125)} - 1) \times 100$. The other log transformed variable, *Invention + Utility* is interpreted in the same way.

⁸ For *Adjusted citation* and *R&D/Invention Patents*, we use the equation $\frac{\text{Coff}_{New\ CEO\ Post} * \text{Std.Dev}_{New\ CEO\ Post}}{\text{Std.Dev}_{Adj.Citation\ or\ R\&D/Invention\ Patent}}$ to interpret the economic meanings.

mixed. One could argue that mature firms gain experience and become more effective at innovative activities due to the accumulation of resources, technical knowledge, and ability to survive competition and uncertainty (Coad *et al.*, 2016). Consistent with these arguments, a few studies report a positive relation between the firm age and innovative outcomes (Sørensen & Stuart, 2000). Conversely, mature firms are likely to experience organisational inertia constraining their learning effects and ability to adapt in the face of significant external changes. The inertia may lead to decline in innovative efforts in mature firms and a number of studies have documented a negative relationship between firm age and innovation (Balasubramanian & Lee, 2008; Barker III & Mueller, 2002; Huergo & Jaumandreu, 2004; Navaretti *et al.*, 2014). The younger firms may enjoy greater adaptability to capitalise on the radical innovative ideas. These firms invest more in R&D to gain competitive advantages and survive in the highly competitive business environments (Baer, 2012; Porter, 1992). Our results regarding firm age and innovation augment the dominant evidence regarding the negative relation between firm age and innovation in the prior literature. *Leverage*, *ROA* and *CHR* indicate the positive and statistically significant relationship with innovation. These results are largely consistent with the previous studies (David & O'Brien, 2006; Hull & Rothenberg, 2008; Kemp *et al.*, 2003; Lyandres & Palazzo, 2016; Tian & Wang, 2014). Overall, the above results show a strong association between CEO turnover and firm-level innovation.

[INSERT TABLE 3 HERE]

Although above results clearly show a significant impact of successor CEOs on innovation in the post-turnover periods, there is a concern that the treated and control firms might have been following different trajectories in terms of their innovation performance. To assuage these concerns, we present pre-turnover differences in the means and medians of innovation variables across the treated and control groups following Islam and Zein (2020).

More specifically, we calculate means and medians for 3,2 and 1 prior years relative to the turnover year ($t=0$) for both treated and control firms and test the differences between means and medians of the two groups (treated vs control). The results presented in Appendix 3 show no significant differences between treated and control groups across all innovation proxies in each of the three years prior to the turnover year. These results support our main regression results and provide evidence that the innovation changes in post-turnover periods are a product of CEO turnover.

3.4 Placebo Test

Our results so far show a consistent effect of CEO turnover on firm level innovation. We want to establish that innovation increases in response to actual CEO turnover and not due to confounding factors. To further establish that our earlier results are not driven by omitted variables and spurious correlations, we construct placebo falsification tests.

We apply falsification at the firm-level by randomly choosing a firm from control group (non-CEO turnover firms) and designate it as a treated firm (with a CEO turnover). This constitutes our alternative treatment sample as we assign a false CEO turnover event to these firms according to the actual turnover event year of the original treatment group. For analysis, we remove the original treatment firms from our sample and use the alternative (falsified) treatment group. We then rematch the alternative sample firms with control firms based on firm size, firm performance, year, and industry, and perform estimation using equation (1). If the results of our analysis are driven by unobservable common characteristics or spurious correlations, the placebo test results should closely mirror the results from our main analysis (Table 3). An insignificant estimated coefficient on (*New CEO Post*), would suggest that the increase in innovation is indeed caused by the actual CEO turnover.

Table 4 shows the results of the placebo test using the matched samples. These results show that *New CEO Post* is not statistically significant for any of our innovation proxies. These results suggest that the changes in innovation do not occur in control firms that are falsified as treated firms. Overall, the evidence from placebo test suggests that association between CEO turnover and innovation is not an artefact of the confounding factors.

[INSERT TABLE 4 HERE]

3.5 Endogeneity Issue

Our main model specification uses only exogenous turnovers and employs DID estimation to address the potential endogeneity concerns in our study. However there is a possibility that firms can strategically replace CEOs on the back of exogenous reasons (Cao *et al.*, 2017) leading to bias in our main estimations. Additionally, literature suggests that firms consider various attributes such as personal characteristics (Eisfeldt & Kuhnen, 2013) and past performance (Kato & Long, 2006) before appointing successor CEOs. Under the firm-CEO matching argument, the appointment of the successor CEO might be non-random leading to the selection bias. We use instrumental variable (IV), dynamic GMM (Generalized Method of Moments) panel estimator and the Heckman two-step sample selection model to mitigate these concerns (Bereskin & Hsu, 2014; Yuan & Wen, 2018).

3.5.1 IV Method

We use retirement age as the instrumental variable in our 2SLS regression model following Bereskin and Hsu (2014), since CEOs' retirement age is a vital trigger for CEO turnover (Murphy & Zimmerman, 1993). According to the *Chinese Labour Law*, the retirement age for a male is 60 years- and 55-years- for females. We instrument CEO turnover using the *Retirement Age*, a dummy variable equal to one when a male (female) CEO is aged 58 or 59 (53 or 54) years and zero otherwise

Table 5 reports the IV estimation results. The first-stage regression results (column 1) show that CEO turnover is significantly positively correlated with the IV, consistent with the literature suggesting that older CEOs are more likely to be replaced by the companies (McClelland *et al.*, 2012). The Cargg-Donald Wald F statistics (163.18) is much higher than the Stock-Yogo 10% critical value (19.93) indicating that the instrument variable is not weak (Stock & Yogo, 2005). The second stage results (columns 2-5) are consistent with our main results.

[INSERT TABLE 5 HERE]

We provide further credence to our IV results by using the plausibly exogenous test following Conley *et al.* (2012). Our IV method assumes that the retirement age is correlated with CEO turnover but has no correlation with the unobservables influencing innovation (exclusion restriction). This assumption is debatable and CEO retirement age might be correlated with innovation (He & Hirshleifer, 2022; Li *et al.*, 2020). We assuage these concerns using plausibly exogenous test as in Conley *et al.* (2012). Specifically, we use the union of symmetric method with the corresponding restrictions that $\gamma \in [-2\delta, +2\delta]^3$ and local-to-0 method when γ follows the normal distribution with zero mean and $\delta^2 I$ standard deviation for the plausibly exogenous test, respectively. Following (Xu & Yan, 2014), we set $\delta=0.005$ and corresponding results in Table 6 indicate that our 2SLS coefficients lie between the lower and upper bound under the union of symmetric method (Panel A). Our main independent variable, *New CEO Post*, remains positive and statistically significant with all innovation variables under the local-to-0 method (Panel B)⁹.

[INSERT TABLE 6 HERE]

⁹ Plots of union of symmetric method and local-to-0 method can be found in Appendix 4.

3.5.2 System GMM

Since there is a possibility that unobservable time-invariant and firm-specific characteristics jointly affect the relationship between CEO turnover and corporate innovation, we use two-step system-GMM estimator following Wintoki *et al.* (2012). In addition, the GMM technique can also address the simultaneity bias that arises from the potential endogeneity of the explanatory variables (Farag & Mallin, 2018).

We use values of one-year lagged corporate innovation and control variables as the instruments to control for the endogeneity problem. The lagged levels are treated as instruments for the regression in differences, and the lags of the first-differenced variables are utilized as instruments in the equation in levels (Farag & Mallin, 2018). Table 7 reports the regression results using system GMM. Consistent with our main findings, CEO turnover is significantly related to all innovation proxies. Our models are well specified since Hansen test statistics are all insignificant and the results of AR(2) suggest that there is no serial correlation in the second order.

[INSERT TABLE 7 HERE]

3.5.3 Heckman Selection Model

We correct for selection bias in the CEO turnover-innovation nexus by employing Heckman selection model. We use CEO turnover dummy as the dependent variable and include all control variables from equation (1) as the independent variables in first step regression. The Heckman's estimator requires an exogenous variable correlated with the CEO turnover event but not related to corporate innovation. Following Yuan and Wen (2018), we use average CEO turnover percentage within the same industry and year as the exogenous variable in the first step regression. Since the turnover events can vary across different industries and years, the mean parentage of CEO turnover is likely to impact the CEO

turnover within firms but unlikely to impact the innovation. Our approach is also consistent with the prior literature (Jiang *et al.*, 2017; Yuan & Wen, 2018). The inverse mills ratio (IMR) generated from first step regression is included in the second step to control the potential sample selection bias. The specification of the second step of the model is same as equation (1) and Table 8 presents the Heckman model results.

The results from the first step regression show that both *Leverage* and *Average Percentage of Turnover* are positively related to CEO turnover, while *Firm Size*, *Firm Age* and *ROA* are negative predictors of the CEO turnover. Results from the second stage show our main independent variable, *New CEO Post*, remains positive and significant across all innovation proxies (models 2-5). The IMR coefficient is positive and statistically significant in all models, suggesting that the unobserved factors that make CEO turnover more likely tend to be positively associated with corporate innovation.

[INSERT TABLE 8 HERE]

4. Robustness Tests

In this section we perform several additional tests to check the robustness of our results.

First, although we use a comprehensive set of firm characteristics as control variables in our baseline regression, yet prior literature suggests that both CEO and board characteristics influence corporate innovation (Balsmeier *et al.*, 2017; Bertrand & Mullainathan, 2003; Huang & Kisgen, 2013; Islam & Zein, 2020; Simsek, 2007). Hence, we expand our selection of control variables by taking CEO and board characteristics into account. CEO characteristics contain gender, age, compensation, political connection, education, tenure, tenure for first term (dummy variable) and overconfidence (Barber & Odean, 2001; Chen, 2013; Galasso & Simcoe, 2011; Hirshleifer *et al.*, 2012; Lin *et al.*, 2011).

Board characteristics include board size, board independence, duality and ownership concentration¹⁰. We rerun equation (1) including these additional controls for CEO and board characteristics, and present results in Table 9. Even after controlling for various CEO and board attributes, the coefficient for *New CEO Post* is positive and statistically significant across all innovation variables, indicating that our results are robust to these additional controls.

[INSERT TABLE 9 HERE]

Second, we test the consistency of our results using alternative regression model specifications. In innovation literature, Poisson and Tobit models are often employed to address the count-based nature of patent data (Jiang & Yuan, 2018; Mazouz & Zhao, 2019; Wang *et al.*, 2021). We re-estimate our DID model (equation 1) using Poisson and Tobit models to ensure that our results are not specific to alternative econometric estimation techniques. The results presented in Table 10 are consistent with our main regression results in Table 3 and show that our findings are invariant to alternative estimation techniques.

[INSERT TABLE 10 HERE]

Third, we use 1:1 matching criterion to select control firms for our treated firms¹¹. We re-estimate regression equation (1) and the results are presented in Table 11. Our main results remain robust to this alternative matching strategy.

[INSERT TABLE 11 HERE]

Fourth, we re-estimate our main DID regression specification by treating health and retirement as the only exogenous turnover events (Betzer *et al.*, 2020; Eisfeldt & Kuhnen, 2013; Sarkar *et al.*, 2019). The results presented in Appendix 5 show that our main inferences remain unchanged. All innovation related variables are positively and significantly related to *New CEO Post*. Additionally, we also include “Personal” turnover reason in the treatment group and re-estimate the baseline regression on the matched sample. Results in Appendix 6

¹⁰ Detailed explanation of each variable can be found in Appendix 2.

¹¹ We choose the control firms where the size and ROA is the closest to the treated firms.

suggest that the positive relationship between CEO turnover and corporate innovation remains.

Fifth, we employ propensity score matching (PSM) to create the matched sample. We use all controls variables as the matching criteria in PSM because these firm characteristics (e.g. firm age, leverage, OCF etc.) can also impact the innovation output (Amore *et al.*, 2013; David & O'Brien, 2006; Howell, 2018; Lee, 2020; Wu & Tang, 2016). We manually select the matched control firms and then rerun our baseline DID regression (equation 1). Results in Appendix 7 indicate the existence of the positive impact of CEO turnover on corporate innovation.

Sixth, although we use one period ahead ($t+1$) values for the dependent variable in the baseline regression, still there is a possibility that the innovation outcomes will be delayed since the successor CEOs need time to adjust and integrate into the company. Hence, we use two period ahead ($t+2$) values for the dependent variable as the robustness check and present the results in Appendix 8. Consistent with the baseline regression, we find *New CEO Post* positively and statistically significantly affects all corporate innovation proxies.

Seventh, to ensure that corporate innovation is driven by the CEO turnover and not by matching, we exclude the control group and only use treatment group sample to rerun the main DID estimation and report the results in Appendix 9. We find consistent results showing the positive effect of CEO turnover on corporate innovation.

Finally, we interact the year and firm fixed effect to further check the robustness of the relationship between CEO turnover and corporate innovation. Results in Appendix 10 are in line with the main regression results, suggesting our findings remain robust.

5. Further Analysis

So far, the evidence we have presented suggests that successor CEOs enhance innovation in the post turnover periods. In this section, we investigate the mechanisms

through which CEO turnover influences firm-level innovation. To do so, we focus on CEO career horizon and overseas experience as the main mechanisms.

5.1 CEO Career Horizon

CEOs are the most powerful actors in firms and, as such, have a significant impact on their firms' strategic choices, investments, and subsequent performance (Chatterjee & Hambrick, 2011; Hambrick & Quigley, 2014; Miller, 1991). Not surprisingly, the literature documents a substantial influence of CEO related characteristics on firm performance (Bandiera *et al.*, 2020; Nourayi & Daroca, 2008; Saidu, 2019). More recently, the studies have focused on the impact of CEO career horizon on firms' strategic choices and economic outcomes (Lee *et al.*, 2018; McClelland *et al.*, 2012). The CEO career horizon encompasses the expected time left before a CEO is dismissed or approaches retirement (González-Uribe & Groen-Xu, 2017; Kang, 2016; Matta & Beamish, 2008). These studies argue that the divergence between near-departing CEOs' (short) career horizon and the firms' (long) investment horizon creates and exacerbates agency problems leading to conflicts of interest. The agency perspective suggests that the near-departing CEOs have lower motivations and incentives to engage in long-term risky investments, since the rewards of such investments are not likely to occur until after their departure. A short career horizon is likely to induce CEOs to adopt short-term risk averse strategies that preserve their legacy and reputation and are more conducive to career security (Matta & Beamish, 2008; McClelland *et al.*, 2012). Consistent with these arguments, Ladika and Sautner (2020) suggest that managers value short-term projects more since these projects often have a faster payback period that can quickly enhance managers' reputations in the job market (Narayanan, 1985). Committing to innovation, however, is a long-term and risky strategy that requires immediate costs but leads to uncertain financial returns in the long run. Given the short career horizon of near-departing CEOs, it can be argued that CEOs with short career horizon are less likely to pursue long-

term R&D projects and innovation. The overall findings from the literature provide support to this conjecture: CEOs with short career horizon reduce R&D (Barker III & Mueller, 2002; Heyden *et al.*, 2017), capital expenditures (Dechow & Sloan, 1991) and innovation (Cho & Kim, 2017; González-Uribe & Groen-Xu, 2017). Hence, we argue that CEO career horizon is an important mechanism through which CEO turnover influences innovation.

We follow Lee *et al.* (2018) in quantifying the career horizon. This measure is based on the difference in CEOs' tenures and ages on both the individual and industry levels, which controls the industry effect since CEOs' career horizon varies across different industries (Hambrick *et al.*, 1993; Lucier *et al.*, 2002). The specification to compute CEO career horizon is:

$$Career\ Horizon_{i,t} = [CEO\ Age_{ind.avg,t} - CEO\ Age_{i,t}] + [CEO\ Tenure_{ind.avg,t} - CEO\ Tenure_{i,t}] \quad (2)$$

A higher value of the *Career Horizon* variable corresponds to a longer career horizon. The related results are reported in Table 12. Panel A reports the differences between tenure and career horizon for departing and successor CEOs. The departing CEOs have a significantly lower tenure and career horizon compared to the successor CEOs. For instance, the departing CEOs only have an average 2.5 years tenure compared to 5.6 years for the successor CEOs. Given this short tenure and the fact that it could take up to three years for a patent to be granted (Cao *et al.*, 2020), the departing CEOs have a disincentive to invest in long term innovative projects, because they are less likely to reap the rewards for such investments before their departure. To further confirm the arguments above, we rerun equation (1) by interacting the *Career Horizon* with *New CEO Post*. Results in Panel B suggest that the incoming CEOs with a longer career horizon spur innovation through a marginal higher R&D spend per patent and more and high-quality patents, which is in line

with the literature indicating that longer career horizon is critical for CEOs to develop more innovation (Lee *et al.*, 2018)¹².

[INSERT TABLE 12 HERE]

5.2 CEO Overseas Experience

Next, we test foreign experience as a potential channel in explaining the observed relation between CEO turnover and innovation. Prior literature, particularly in the Chinese context, suggests that managerial foreign experience is important for firm performance and innovation (Giannetti *et al.*, 2015; Yuan & Wen, 2018). The Chinese economy has seen rapid growth since 1970s and is now the world's largest emerging economy¹³. However, Chinese market is still characterised by weak legal institutions, weak investor protection and less developed labour market (Yuan & Wen, 2018) leading to lagging in innovation (Lin *et al.*, 2011). Consequently, the Chinese provincial governments have adopted various policies to attract foreign experienced talent to foster economic activity. In particular, the Chinese central government introduced a policy called "*High-level Overseas Talent Introduction Plan*" in December 2008 with a view to develop key emerging industries, accelerating the change of economic development patterns, and improving the productivity of independent innovation (Giannetti *et al.*, 2015; Zweig, 2006). The induction of talent with foreign experience is believed to bring knowledge spill over effects (Zhang *et al.*, 2018) with transmission of highly specialised skills, advanced managerial practices and creative abilities: the essential skills needed for successful innovation activities. In line with these arguments, the evidence

¹² Since our main independent variable, CEO turnover, is a binary variable, we are not able to test the non-linearity in the relation between CEO turnover and innovation. However, we use an interaction of New CEO Post and quadratic term of Career Horizon along with Career Horizon and all other controls. We find insignificant coefficient on the interaction term. Although not reported for the sake of brevity, these results are available upon request from authors.

¹³ According to World Bank, China has reached 9.5% of the average real GDP growth rate ever since the "economic reform" and "free-market reform" policies. See <https://www.worldbank.org/en/home> for more information in detail.

suggests that managers with foreign experience improve firm performance (Giannetti *et al.*, 2015) and innovation (Yuan & Wen, 2018) in China.

To test foreign experience as a mechanism in explaining the impact of CEO turnover on innovation, we use two dummy variables: *Overseas Work* and *Overseas Study*. Panel A of Table 13 reports the means of *Overseas Work* and *Overseas Study* experience in years for departing and successor CEOs. We find that the successor CEOs hold significantly more overseas experience (work and education) than the departing ones. After the univariate analysis, we interact CEO overseas experience dummies (work and study) with *New CEO Post* in our DID framework. Results from Panel B and C of Table 13 suggest that successor CEO's foreign experience is positively associated with corporate innovation. Moreover, comparing the coefficients of the interaction terms for overseas study and work, results suggest that overseas work experience of a successor CEO matters more for innovation compared to the overseas education.

[INSERT TABLE 13 HERE]

6. Conclusion

In this paper, we examine the effects of CEO turnover on one of the firms' most important corporate policies, innovation. Contrary to the existing literature which focuses on CEO turnover and firm performance in developed markets, we study whether CEO turnover affects innovation in Chinese listed firms? A closer look at CEO turnover-innovation relationship in China is relevant since China has emerged as one of the most innovative countries in the last decade. Furthermore, China is an interesting setting because of the lack of well-defined property rights, underdeveloped investor protection legislation and weaker institutions.

We exploit plausibly exogenous variations in CEO turnover generated by contract expiration, health issues and retirement to mitigate the challenges posed by the endogenous CEO changes. Using a large sample of listed firms, we find that CEO turnover is associated with significant improvements in post-turnover innovation. Firms experiencing an exogenous CEO turnover subsequently improve innovation efficiency, increase patents applications and receive more citations to their patents compared to matched firms which do not experience a CEO change. Our results are robust to a battery of tests including placebo effect, endogeneity concerns, additional controls for CEO and corporate governance related attributes, and alternative estimation approaches. Having established that CEO turnovers are associated with significant increase in innovation, we examine the channels through which successor CEOs increase innovation. Our analysis indicates that the career horizon and overseas experience are potential channels through which successor CEOs make significant improvement in post turnover innovation.

Overall, we interpret our results as evidence that CEO turnovers are more likely to initiate significant changes in firms' innovation strategies. We provide new evidence that CEO changes are not only associated with firm performance but also with innovation which is a key driver of performance. This study offers a number of interesting implications. First, our findings show that CEO change is an important driver of innovation, and that CEOs have a personal role to play in fostering innovation at their firms. Corporate innovation is inherently uncertain and carries a high risk of failure. However, organisations with a strong creative culture overcome these hurdles and have a superior ability to innovate (Fiordelisi *et al.*, 2018; Wang *et al.*, 2021). As successor CEOs drive innovation, they can further enhance innovation by fostering a more creative culture. Second, CEO replacement represents an effective mechanism in reshaping innovative trajectories of organisations. Our findings also show that successor CEOs with longer career horizon and foreign experience are better at

innovation. These results have implications for corporate boards, nominations committees and shareholders with respect to the appointments of new CEOs. Finally, our results could have implications for the governance codes in terms of roles and responsibilities of both corporate boards and CEOs.

While our results highlight that the successor CEOs enhance quantity (numbers) and quality (citations) of patents, our data does not allow us to study the particular innovative strategies (radical or disruptive) that these incoming CEOs follow. Therefore, further research into the innovative strategies adopted by the successor CEOs is warranted to provide helpful insights on the determinants of firm-level innovation.

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Table 1. Summary Statistics

This table reports the summary statistics of our paper. Panel A shows the yearly CEO turnover distribution of three exogenous turnover reasons. The first column indicates total number of the firms for both treatment and control group after matching. Panel B presents the descriptive statistics of the variables in raw with the sample period between 2008 and 2019. All variables are defined in Appendix 2.

Panel A. Yearly CEO Turnover Distribution

	Total Number of Firms	Number of Firms with Turnover	% of Turnover	Contract Expiration	Health	Retired
2008	102	17	16.67%	12	3	2
2009	113	19	16.81%	12	3	4
2010	122	22	18.03%	18	2	2
2011	121	25	20.66%	21	1	3
2012	116	21	18.10%	15	3	3
2013	105	26	24.76%	22	2	2
2014	122	24	19.67%	21	1	2
2015	134	28	20.90%	23	2	3
2016	138	26	18.84%	22	1	3
2017	142	31	21.83%	24	2	5
2018	146	33	22.60%	26	1	6
2019	168	37	22.02%	33	1	3
Total	1,529	309	20.21%	251	22	36

Panel B. Sample Descriptive Statistics

	(1) Treatment Group N=3,512		(2) Control Group N=9,343		(3) All Sample N=12,855	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
<i>Dependent Variables</i>						
Invention	15.098	43.490	10.732	24.746	12.034	31.584
Invention & Utility	31.354	76.409	22.345	51.218	25.031	59.986
Citation Adjusted	1.856	1.693	1.346	1.656	1.730	1.682
R&D/Invention Patent	0.361	0.350	0.252	0.535	0.284	0.417
<i>Firm Characteristics</i>						
Firm Size	11123.560	67693.340	10741.910	66497.830	10932.730	67602.560
Firm Age	17.529	5.314	15.834	5.733	16.340	5.665
Leverage	0.391	0.176	0.345	0.188	0.359	0.185
ROA	0.059	0.054	0.044	0.062	0.054	0.057
Operating Cash Flow	216.608	1031.969	202.090	652.432	207.892	785.976
Cash Holding Ratio	0.203	0.121	0.226	0.165	0.214	0.154
SOE	0.021	0.091	0.026	0.099	0.024	0.097

Table 2. Correlation Matrix

This table reports the correlation matrix of our variables. The sample period is between 2008 and 2019. All variables are defined in Appendix 1.

* Represents significant at 5% level

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Ln (1+Invention)	(1)	1											
Ln (1+Invention+Utility)	(2)	0.969*	1										
Citation Adjusted	(3)	0.494*	0.489*	1									
R&D/Invention Patent	(4)	0.319*	0.263*	0.312*	1								
NEW CEO_POST	(5)	0.069*	0.065*	0.049	0.029*	1							
Firm Size	(6)	0.272*	0.204*	0.085*	0.602*	0.156*	1						
Firm Age	(7)	-0.101*	-0.080*	0.181*	-0.196*	-0.152*	-0.302*	1					
Leverage	(8)	0.065*	0.021	-0.004	0.238*	0.121*	0.542*	-0.212*	1				
ROA	(9)	-0.014	-0.056	0.073*	0.016	-0.126*	-0.102*	0.167*	-0.073*	1			
OCF	(10)	-0.023	-0.022	-0.033*	-0.045*	-0.016	-0.097*	0.028*	-0.058*	-0.094	1		
CHR	(11)	-0.090*	-0.078*	0.014	-0.119*	-0.126*	-0.090*	0.070*	-0.055*	0.013*	0.039*	1	
SOE	(12)	-0.037*	-0.045*	0.037*	-0.047	-0.021	0.038*	0.117*	0.043*	0.011	-0.032	0.068*	1

Table 3. Baseline Regression (Difference-in-Difference Estimation)

This table reports the baseline regression results with using difference-in-difference regression analysis to address the endogeneity concerns between CEO turnover and corporate innovation. We use patent application number ($\ln(1+Invention)$, $\ln(1+Invention+Utility)$), citation number ($Citation\ Adjusted$) and R&D spending ($\ln(1+R\&D)$) as the dependent variables. CEO turnover firms are matched with the firms of similar size ($\pm 20\%$ of total asset, log), similar performance ($\pm 20\%$ of ROA), same industry and year. The sample period is between 2008 and 2019. Column (1)-(3) illustrate the multivariate regression results. All regressions control for year and firm fixed effects whose coefficients are suppressed. All variables are defined in Appendix 2. The t-test statistics are shown in parentheses below coefficient estimates based on the standard errors clustered by firms.

***, ** and * represent significant level at 1%, 5% and 10% level, respectively.

<i>Dep.</i>	(1) <i>Ln (1+Invention)</i>	(2) <i>Ln (1+Invention+Utility)</i>	(3) <i>Citation Adjusted</i>	(4) <i>R&D/Invention Patent</i>
New CEO Post	0.125* (1.89)	0.066** (2.25)	0.235*** (3.23)	0.003*** (3.26)
Firm Size	1.586*** (8.26)	0.582*** (7.52)	0.812*** (3.32)	0.059*** (5.70)
Firm Age	-1.344*** (-9.01)	-0.532*** (-8.61)	-0.754*** (-11.54)	-0.236*** (-3.44)
Leverage	0.349* (1.87)	0.071* (1.86)	0.318*** (2.34)	0.016*** (2.64)
ROA	0.444*** (7.63)	0.652*** (6.72)	0.323*** (4.14)	0.127*** (4.69)
OCF	-0.202 (-0.87)	-0.116 (-1.07)	-0.412 (-1.26)	-0.016 (-0.72)
CHR	0.252* (1.66)	0.093 (1.47)	0.850*** (4.64)	0.009* (1.67)
SOE	-0.204 (-0.73)	-0.072 (-0.68)	-0.405 (-1.40)	-0.019 (-1.16)
Constant	2.286*** (17.01)	1.103*** (19.08)	0.488*** (2.87)	0.038*** (6.80)
Year Effect	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES
Observations	12,832	12,837	12,852	12,816
<i>Adj-R²</i>	0.177	0.141	0.110	0.382

Table 4. Placebo Test

This table reports the placebo test of CEO turnover on firm level by using the whole sample between 2008 and 2019. We exclude the firm that actually experience the CEO turnover event, and apply the falsification at the firm level by choosing a random firm from control group (non-CEO turnover firms) and consider it as a treated firm (with a CEO change). CEO turnover firms are matched with the firms of similar size (+/- 20% of total asset, log), similar performance (+/- 20% of ROA), same industry and year. We use patent application number ($\ln(1+Invention)$), $\ln(1+Invention+Utility)$, citation number (*Citation Adjusted*) and R&D spending ($\ln(1+R\&D)$) as the dependent variables. All regressions control for year and firm fixed effects whose coefficients are suppressed. All variables are defined in Appendix 2. The t-test statistics are shown in parentheses below coefficient estimates based on the standard errors clustered by firms.

***, ** and * represent significant level at 1%, 5% and 10% level, respectively.

	(1)	(2)	(3)	(4)
<i>Dep.</i>	<i>Ln (1+Invention)</i>	<i>Ln (1+Invention+Utility)</i>	<i>Citation Adjusted</i>	<i>R&D/Invention Patent</i>
New CEO Post	0.004 (0.08)	0.088 (0.70)	0.176 (0.65)	0.028 (0.34)
Firm Size	0.189*** (2.83)	0.293*** (4.41)	0.223*** (2.97)	0.378*** (4.08)
Firm Age	-0.088 (-0.58)	-0.077 (-0.52)	-0.038 (-0.24)	-0.011 (-0.03)
Leverage	0.378*** (3.38)	0.297*** (2.76)	0.372*** (3.38)	0.113 (0.56)
ROA	0.226*** (6.08)	0.180*** (4.81)	0.240*** (6.40)	1.213*** (2.91)
OCF	-0.008 (-0.24)	-0.013 (-0.33)	-0.071 (-0.99)	-1.321 (-0.21)
CHR	0.325** (2.16)	0.137* (1.94)	0.218** (2.04)	0.092*** (2.54)
SOE	-0.613 (0.68)	-0.650 (-0.53)	-0.656 (0.05)	-1.950 (-0.92)
Constant	1.702* (1.94)	12.708* (1.91)	7.375*** (2.45)	7.106** (2.17)
Year Effect	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES
Observations	12,046	12,137	12,107	12,031
<i>Adj-R²</i>	0.158	0.145	0.222	0.293

Table 5. 2SLS

This table reports the estimation results of 2SLS using the whole sample between 2008 and 2019. We use an indicator, *Retirement Age*, as the instruments for CEO turnover in the first stage. We use patent application number ($\ln(1+Invention)$, $\ln(1+Invention+Utility)$), citation number (*Citation Adjusted*) and R&D spending ($\ln(1+R\&D)$) as the dependent variables in the second stage. CEO turnover firms are matched with the firms of similar size ($\pm 20\%$ of total asset, log), similar performance ($\pm 20\%$ of ROA), same industry and year. All regressions control for year and firm fixed effects whose coefficients are suppressed. All variables are defined in Appendix 2. The t-test statistics are shown in parentheses below coefficient estimates based on the standard errors clustered by firms.

***, ** and * represent significant level at 1%, 5% and 10% level, respectively.

Dep.	First Stage		Second Stage		
	(1) <i>CEO Turnover</i>	(2) $\ln(1+Invention)$	(3) $\ln(1+Invention+Utility)$	(4) <i>Citation Adjusted</i>	(5) <i>R&D/Invention Patent</i>
Retirement Age	0.035*** (12.55)				
New CEO Post		0.837*** (2.97)	0.212*** (3.55)	0.979*** (3.98)	0.034*** (2.75)
Firm Size	-0.150*** (-4.10)	1.340*** (8.44)	0.430*** (6.52)	1.328*** (7.12)	0.095*** (11.27)
Firm Age	-1.273*** (-5.56)	-1.537*** (-3.44)	-1.392*** (-3.06)	-1.826*** (-5.39)	-0.024*** (-4.52)
Leverage	0.241*** (5.74)	0.521** (2.48)	0.182** (2.00)	0.550** (2.24)	0.024** (2.27)
ROA	-0.900*** (-5.70)	1.989** (2.08)	0.605*** (2.44)	1.278*** (3.14)	0.173*** (3.66)
OCF	-0.065 (-0.58)	-0.351 (-1.25)	-0.203 (-1.61)	-0.874 (-1.24)	-0.026 (-1.38)
CHR	-0.017 (-0.41)	0.393*** (3.06)	0.123** (2.27)	0.046*** (2.30)	0.018** (2.08)
SOE	-0.138** (-2.36)	0.073 (0.38)	0.029 (0.35)	0.384 (1.43)	0.017 (1.09)
Constant	2.939*** (17.34)	0.192** (2.01)	0.237*** (2.83)	0.634*** (2.62)	0.013*** (2.63)
Year Effect	YES	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES	YES
Observations	12,855	12,832	12,837	12,852	12,816
Adj-R ²	0.106	0.210	0.201	0.241	0.469
Cragg-Donald Wald F statistic	163.185***				
Critical Value of Stock and Yogo (10% maximal IV size)	19.93				
Hansen J statistic	0.013				
p value of Hansen J statistic	0.910				
Durbin-Wu-Hausman test	6.74***				
p value of DWH test	0.000				

Table 6. Plausibly Exogenous Tests

This table reports the plausibly exogenous tests results with using the whole sample between 2008 and 2019. We use the union of symmetric method with the corresponding restrictions that $\gamma \in [-2\delta, +2\delta]^3$ and local-to-0 method when γ follows the normal distribution with zero mean and δ^{2I} standard deviation for the plausibly exogenous test, respectively. We use patent application number ($\ln(I+Invention)$), $\ln(I+Invention+Utility)$, citation number (*Citation Adjusted*) and *R&D/Invention Patent* as the dependent variables in the second stage. CEO turnover firms are matched with the firms of similar size (+/- 20% of total asset, log), similar performance (+/- 20% of ROA), same industry and year. All regressions control for year and firm fixed effects whose coefficients are suppressed. All variables are defined in Appendix 2. The t-test statistics are shown in parentheses below coefficient estimates based on the standard errors clustered by firms.

***, ** and * represent significant level at 1%, 5% and 10% level, respectively.

Panel A. Union of Symmetric Method

	Lower Bound	Upper Bound
New CEO Post	-3.286	5.589
Firm Size	0.557	2.349
Firm Age	-8.065	8.760
Leverage	-0.942	-0.077
ROA	-8.249	3.055
OCF	-0.986	0.879
CHR	-1.010	0.493
SOE	-1.080	0.058
Constant	-0.760	3.529

Panel B. Local-to-0 Method

	(1) <i>Ln (I+Invention)</i>	(2) <i>Ln (I+Invention+Utility)</i>	(3) <i>Citation Adjusted</i>	(4) <i>R&D/Invention Patent</i>
New CEO Post	0.905*** (2.53)	0.293*** (3.20)	0.173*** (2.97)	0.017*** (3.01)
Firm Size	1.377*** (5.33)	0.436** (2.09)	1.770*** (2.68)	0.091*** (3.47)
Firm Age	-0.291*** (-2.80)	-0.328*** (-5.96)	-0.530*** (-8.36)	-0.401*** (-3.01)
Leverage	0.166*** (6.59)	0.150*** (5.65)	0.147*** (5.48)	0.116*** (6.03)
ROA	0.231*** (4.32)	0.703*** (3.47)	1.282*** (3.68)	0.167*** (6.12)
OCF	-0.204 (-0.65)	-0.139 (-0.86)	-0.942 (-0.21)	-0.021 (-0.23)
CHR	0.030*** (3.20)	0.045*** (3.51)	0.348*** (4.81)	0.011** (2.02)
SOE	-0.160 (-0.68)	-0.080 (-0.53)	-0.247 (-0.77)	-0.008 (-0.07)
Constant	1.192*** (2.79)	0.715*** (3.23)	0.076*** (3.11)	0.033*** (4.06)
Year Effect	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES
Observations	12,832	12,837	12,852	12,816

Table 7. System GMM

This table reports the estimation results with using the system GMM approach. We use patent application number ($Ln(1+Invention)$), $Ln(1+Invention+Utility)$, citation number ($Citation\ Adjusted$) and $R\&D/Invention\ Patent$ as the dependent variables. CEO turnover firms are matched with the firms of similar size ($\pm 20\%$ of total asset, log), similar performance ($\pm 20\%$ of ROA), same industry and year. The sample period is between 2008 and 2019. All regressions control for year and firm fixed effects whose coefficients are suppressed. All variables are defined in Appendix 2. The t-test statistics are shown in parentheses below coefficient estimates based on the standard errors clustered by firms. ***, ** and * represent significant level at 1%, 5% and 10% level, respectively.

Dep.	(1) <i>Ln (1+Invention)</i>	(2) <i>Ln (1+Invention+Utility)</i>	(3) <i>Citation Adjusted</i>	(4) <i>R&D/Invention Patent</i>
L. Ln (1+Invention)	0.735*** (14.18)			
L. Ln (1+Invention+Utility)		0.782*** (12.64)		
L. Citation Adjusted			1.320*** (21.06)	
L. R&D/Invention Patent				0.412*** (9.16)
New CEO Post	0.061* (1.81)	0.024*** (2.74)	0.132*** (3.12)	0.002*** (3.98)
Firm Size	0.223*** (5.66)	0.100*** (4.72)	0.241*** (4.81)	0.037*** (3.01)
Firm Age	-0.683*** (-2.75)	-0.291* (-1.81)	-0.292* (-1.86)	-0.041** (-2.30)
Leverage	0.035* (1.93)	0.068** (2.30)	0.119*** (3.13)	0.006*** (3.33)
ROA	0.583** (2.44)	0.215** (2.06)	0.789** (2.46)	0.305*** (2.70)
OCF	-0.419 (-0.90)	-0.165 (-0.84)	-0.173 (-0.24)	-0.054 (-0.40)
CHR	1.249** (2.09)	0.556** (2.19)	0.914* (1.95)	0.007*** (2.04)
SOE	-0.182 (-0.39)	-0.168 (-0.79)	-0.358 (-0.36)	-0.007 (-0.47)
Constant	0.277 (0.82)	0.161 (1.04)	-0.826 (-1.50)	-0.032 (-1.09)
Year Effect	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES
Observations	12,832	12,837	12,852	12,816
AR (1) test (p-value)	(0.000)	(0.000)	(0.000)	(0.000)
AR (2) test (p-value)	(0.246)	(0.955)	(0.827)	(0.325)
Hansen test of over-identification (p-value)	(0.373)	(0.207)	(0.539)	(0.235)
Diff-in-Hansen tests of exogeneity (p-value)	(0.257)	(0.154)	(0.417)	(0.172)

Table 8. Heckman Two-step Sample Selection

This table reports the Heckman Two-step sample selection regression using the whole sample between 2008 and 2019. The first step is a Probit model with using CEO turnover as the dependent variable. Average Percentage of Turnover is an exogenous variable, which is the average number of the CEO turnover in each year per industry. The second stage is our baseline (DID) regression with including the inverse mills ratio (IMR) that generate from the first step. We use patent application number ($\ln(1+Invention)$, $\ln(1+Invention+Utility)$), citation number ($Citation\ Adjusted$) and $R\&D/Invention\ Patent$ as the dependent variables in the second step. CEO turnover firms are matched with the firms of similar size (+/- 20% of total asset, log), similar performance (+/- 20% of ROA), same industry and year. The sample period is between 2008 and 2019. All regressions control for year and firm fixed effects whose coefficients are suppressed. All variables are defined in Appendix 2. The t-test statistics are shown in parentheses below coefficient estimates based on the standard errors clustered by firms.

***, ** and * represent significant level at 1%, 5% and 10% level, respectively.

Dep.	First-Step	Second-Step			
	(1) CEO Turnover	(2) $\ln(1+Invention)$	(3) $\ln(1+Invention+Utility)$	(4) $Citation\ Adjusted$	(5) $R\&D/Invention\ Patent$
New CEO Post		0.067** (2.01)	0.043*** (2.46)	0.243*** (3.32)	0.003*** (3.37)
Average Percentage of Turnover	0.769*** (2.35)				
Firm Size	0.406*** (3.82)	0.215*** (7.89)	0.152*** (8.50)	1.043*** (3.48)	0.067*** (5.51)
Firm Age	-0.310*** (-3.66)	-0.402* (-1.82)	-0.179* (-1.92)	-0.258*** (-9.34)	-0.309*** (-2.98)
Leverage	0.574*** (4.54)	1.705*** (6.61)	0.766*** (6.79)	0.582* (1.92)	0.025** (2.54)
ROA	-0.289*** (-5.73)	0.712*** (6.11)	0.306*** (6.06)	0.472*** (3.60)	0.175*** (3.42)
OCF	-0.204 (-0.58)	-0.620 (0.61)	-0.219 (0.97)	-0.307 (-0.91)	-0.019 (-0.89)
CHR	-0.208 (-1.49)	1.312*** (6.99)	0.525*** (6.65)	0.714*** (3.44)	0.004*** (3.56)
SOE	0.303 (1.49)	1.463 (0.72)	0.585 (0.95)	0.244 (0.81)	0.024 (1.38)
IMR		5.064*** (10.88)	2.063*** (10.37)	0.651*** (10.21)	0.021*** (11.07)
Constant	-1.682*** (-3.97)	6.926*** (15.59)	2.994*** (15.69)	1.085** (2.37)	0.018** (2.02)
Year Effect	YES	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES	YES
Observations	12,855	12,832	12,837	12,852	12,816
Adj-R ² (Pseudo-R ²)	(0.159)	0.207	0.167	0.110	0.382

Table 9. CEO Turnover and Corporate Innovation with Additional Controls

This table reports the estimation of DID regression analysis with including additional control variables, including both CEO and board characteristics. We use patent application number ($\ln(1+Invention)$, $\ln(1+Invention+Utility)$), citation number ($Citation\ Adjusted$) and $R\&D/Invention\ Patent$ as the dependent variables. CEO turnover firms are matched with the firms of similar size ($\pm 20\%$ of total asset, log), similar performance ($\pm 20\%$ of ROA), same industry and year. The sample period is between 2008 and 2019. All regressions control for year and firm fixed effects whose coefficients are suppressed. All variables are defined in Appendix 2. The t-test statistics are shown in parentheses below coefficient estimates based on the standard errors clustered by firms.

***, ** and * represent significant level at 1%, 5% and 10% level, respectively.

Dep.	(1) <i>Ln (1+Invention)</i>	(2) <i>Ln (1+Invention+Utility)</i>	(3) <i>Citation Adjusted</i>	(4) <i>R&D/Invention Patent</i>
New CEO Post	0.173** (2.49)	0.083*** (2.70)	0.275*** (3.13)	0.002*** (3.71)
CEO Gender	0.211* (1.67)	0.080* (1.76)	0.265** (2.09)	0.006*** (2.48)
CEO Age	-0.464** (-2.33)	-0.215** (-2.41)	-0.617** (-2.27)	-0.010*** (-3.51)
CEO Compensation	0.158*** (3.60)	0.061*** (3.16)	0.191*** (3.54)	0.006*** (3.17)
CEO Political	-0.070 (-0.33)	-0.012 (-0.15)	-0.683 (-0.47)	-0.007 (-0.80)
CEO Education	0.099*** (3.04)	0.034*** (2.78)	0.282*** (2.44)	0.008* (1.73)
CEO Tenure	0.021 (0.71)	0.007 (0.51)	0.034 (0.76)	0.001 (0.54)
CEO First Tenure	0.082*** (3.45)	0.019** (2.25)	0.166* (1.65)	0.001* (1.73)
CEO Overconfidence	0.041** (2.11)	0.013*** (2.51)	0.161*** (5.92)	0.001*** (3.25)
Board Size	-0.496*** (-8.27)	-0.205*** (-7.60)	-0.314*** (-4.07)	-0.014* (-1.87)
Independent	0.255*** (3.33)	0.075*** (2.90)	1.071*** (4.44)	0.002*** (3.91)
Duality	0.064 (0.99)	0.031 (1.12)	0.143 (1.15)	0.007 (0.86)
Ownership Concentration	0.365 (1.32)	0.162 (1.36)	0.580* (1.90)	0.056 (1.13)
Firm Size	1.339*** (6.83)	0.485*** (6.07)	0.801*** (3.39)	0.205*** (2.84)
Firm Age	-0.112*** (-7.18)	-0.044*** (-6.78)	-0.188*** (-8.96)	-0.013** (-2.12)
Leverage	0.314* (1.72)	0.056*** (2.69)	0.112*** (4.48)	0.140*** (5.08)
ROA	0.432*** (7.41)	0.159*** (6.42)	0.237*** (3.08)	0.015** (2.45)
OCF	-0.063 (-0.28)	-0.059 (-0.54)	-0.280 (-0.85)	-0.006 (-1.10)
CHR	0.225* (1.78)	0.078** (2.13)	0.831*** (4.55)	0.018** (2.10)
SOE	-0.264 (-1.01)	-0.102 (-1.01)	-0.268 (-0.92)	-0.015 (-0.50)
Constant	0.505 (0.62)	0.289 (0.79)	2.020* (1.79)	0.002 (0.71)
Year Effect	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES
Observations	12,832	12,837	12,852	12,816
Adj-R ²	0.199	0.158	0.140	0.398

Table 10. Alternative Model Specification

This table reports the estimation of Poisson and Tobit regression model. We use patent application number ($\ln(1+Invention)$, $\ln(1+Invention+Utility)$), citation number ($Citation\ Adjusted$) and $R\&D/Invention\ Patent$ as the dependent variables. CEO turnover firms are matched with the firms of similar size (+/- 20% of total asset, log), similar performance (+/- 20% of ROA), same industry and year. The sample period is between 2008 and 2019. All regressions control for year and firm fixed effects whose coefficients are suppressed. All variables are defined in Appendix 2. The t-test statistics are shown in parentheses below coefficient estimates based on the standard errors clustered by firms.

***, ** and * represent significant level at 1%, 5% and 10% level, respectively.

Dep.	(1) <i>Ln (1+Invention)</i>		(2) <i>Ln (1+Invention+Utility)</i>		(3) <i>Citation Adjusted</i>		(4) <i>R&D/Invention Patent</i>	
	Poisson Model	Tobit Model	Poisson Model	Tobit Model	Poisson Model	Tobit Model	Poisson Model	Tobit Model
New CEO Post	0.024*** (3.15)	0.069*** (3.47)	0.027*** (3.52)	0.036*** (4.77)	0.028*** (4.13)	0.100*** (4.52)	0.171*** (4.38)	0.006*** (4.00)
Firm Size	0.779*** (14.92)	1.667*** (12.83)	0.524*** (11.26)	0.536*** (9.41)	0.526*** (7.38)	1.205*** (6.13)	1.967*** (20.63)	0.118*** (26.65)
Firm Age	-1.386*** (-3.16)	-3.576*** (-3.86)	-1.353*** (-3.49)	-1.627*** (-4.02)	-7.151*** (-5.92)	-2.153*** (-5.69)	-0.124*** (-4.15)	-0.061*** (-4.87)
Leverage	0.009*** (3.13)	0.267*** (4.76)	0.130*** (4.02)	0.212*** (3.18)	0.060*** (4.71)	0.050*** (4.22)	0.297** (2.04)	0.006** (2.20)
ROA	1.692*** (6.07)	3.555*** (5.88)	1.088*** (4.52)	1.107*** (4.19)	0.020*** (5.06)	0.150*** (4.16)	0.293*** (5.29)	0.213*** (10.21)
OCF	-0.189 (-0.99)	-0.448 (-1.04)	-0.208 (-1.23)	-0.234 (-1.25)	-0.612 (-1.07)	-1.571 (-1.46)	-1.024 (-1.60)	-0.030 (-1.02)
CHR	0.053*** (2.65)	0.082*** (3.50)	0.088*** (2.27)	0.091*** (3.16)	0.253*** (2.75)	0.819*** (3.34)	0.424*** (2.71)	0.001** (2.22)
SOE	-0.041 (-0.31)	-0.180 (-0.73)	-0.072 (-0.61)	-0.098 (-0.92)	-0.182 (-1.40)	-0.472 (-1.31)	-0.644 (-0.73)	-0.020 (-0.22)
Constant	0.422*** (8.66)	1.323*** (12.82)	0.204*** (4.85)	0.739*** (16.36)	0.088 (1.54)	0.487*** (3.12)	0.372*** (4.44)	0.015*** (4.27)
Year Effect	YES	YES	YES	YES	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES
Observations	12,832	12,832	12,837	12,837	12,852	12,852	12,816	12,816
Pseudo-R ²	0.131	0.124	0.114	0.130	0.128	0.119	0.188	0.137

Table 11. 1:1 Matching

This table reports the estimation of difference-in-difference model by using more restrict matching range. We use patent application number ($\ln(1+Invention)$, $\ln(1+Invention+Utility)$), citation number (*Citation Adjusted*) and *R&D/Invention Patent* as the dependent variables. CEO turnover firms are matched with the firms in 1:1 base with similar size and performance, same industry and year. The sample period is between 2008 and 2019. All regressions control for year and firm fixed effects whose coefficients are suppressed. All variables are defined in Appendix 2. The t-test statistics are shown in parentheses below coefficient estimates based on the standard errors clustered by firms.

***, ** and * represent significant level at 1%, 5% and 10% level, respectively.

Dep.	(1) <i>Ln (1+Invention)</i>	(2) <i>Ln (1+Invention+Utility)</i>	(3) <i>Citation Adjusted</i>	(4) <i>R&D/Invention Patent</i>
New CEO Post	0.174* (1.74)	0.373*** (3.55)	0.278* (1.88)	0.373*** (3.55)
Firm Size	0.404*** (12.26)	0.618*** (16.64)	0.415*** (6.79)	3.639*** (3.75)
Firm Age	-0.054*** (-2.52)	-0.101*** (-2.89)	-0.510** (-2.19)	1.869*** (2.86)
Leverage	0.153*** (3.80)	0.950*** (5.31)	0.665* (1.75)	1.919*** (4.36)
ROA	0.813*** (10.94)	1.068*** (15.77)	0.883*** (6.16)	0.322* (1.95)
OCF	-0.117 (-0.93)	-0.392 (-0.23)	-0.036 (-0.19)	-0.261 (-0.86)
CHR	0.230** (2.27)	0.188* (1.71)	0.404** (2.03)	0.402** (2.15)
SOE	-0.487 (-1.05)	-0.586 (-1.33)	-0.681 (-1.58)	-0.493 (-0.10)
Constant	0.031 (0.22)	0.876*** (5.50)	1.401*** (5.44)	5.328*** (3.46)
Year Effect	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES
Observations	7,024	7,028	7,056	7,017
Adj- R^2	0.289	0.245	0.227	0.353

Table 12. CEO Career Horizon

This table reports the analysis by treating CEO career horizon as a potential using the whole sample between 2008 and 2019. We measure CEO career horizon by calculate the difference in CEOs' tenures and ages on both the individual and industrial levels. Panel A shows the univariate analysis and Panel B present the multivariate analysis with using patent application number ($\ln(1+Invention)$), $\ln(1+Invention+Utility)$, citation number (*Citation Adjusted*) and *R&D/Invention Patent* as the dependent variables. All regressions control for year and firm fixed effects whose coefficients are suppressed. All variables are defined in Appendix 2. The t-test statistics are shown in parentheses below coefficient estimates based on the standard errors clustered by firms.

***, ** and * represent significant level at 1%, 5% and 10% level, respectively.

Panel A. Univariate Analysis

	Departing CEOs		Successor CEOs		t-test
	Mean	Std. Dev.	Mean	Std. Dev.	
Tenure	2.571	2.319	5.664	3.688	39.648***
Career Horizon	-1.172	5.150	0.943	6.108	14.998***

Panel B. Multivariate Analysis

Dep.	<i>Ln(1+Invention)</i>			<i>Ln(1+Invention+Utility)</i>			<i>Citation Adjusted</i>			<i>R&D/Invention Patent</i>		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
New CEO Post	0.125*	0.158**	0.104***	0.066**	0.077***	0.054*	0.235***	0.262***	0.271***	0.003***	0.003***	0.001***
	(1.89)	(2.37)	(2.55)	(2.25)	(2.58)	(1.82)	(3.23)	(3.36)	(3.24)	(3.26)	(3.71)	(3.53)
Career Horizon		0.041*	0.016*		0.013**	0.003***		0.033***	0.038**		0.002***	0.011*
		(1.75)	(1.83)		(2.32)	(2.27)		(3.02)	(2.05)		(3.89)	(1.92)
NEW CEO_POST*Career Horizon			0.103**			0.044**			0.017***			0.004***
			(2.22)			(2.15)			(2.28)			(2.54)
Firm Size	1.586***	1.580***	1.570***	0.582***	0.580***	0.576***	0.812***	0.807***	0.813***	0.059***	0.197***	0.058***
	(8.26)	(8.24)	(8.15)	(7.52)	(7.49)	(7.42)	(3.32)	(3.29)	(3.30)	(5.70)	(9.55)	(6.46)
Firm Age	-1.344***	-1.302***	-1.349***	-0.532***	-0.518***	-0.574***	-0.754***	-0.719***	-0.731***	-0.236***	-0.479***	-0.239***
	(-9.01)	(-8.65)	(-8.97)	(-8.61)	(-8.29)	(-8.67)	(-11.54)	(-11.33)	(-11.17)	(-3.44)	(-4.42)	(-3.58)
Leverage	0.349*	0.343*	0.267***	0.071*	0.069*	0.039***	0.318***	0.314*	0.360*	0.016***	0.059***	0.016***
	(1.87)	(1.84)	(3.37)	(1.86)	(1.84)	(2.45)	(2.34)	(1.74)	(1.66)	(2.64)	(4.62)	(2.65)
ROA	0.444***	0.447***	0.438***	0.652***	0.654***	1.630***	0.323***	0.323***	3.265***	0.127***	0.437***	0.117***
	(7.63)	(7.63)	(7.48)	(6.72)	(6.71)	(6.58)	(4.14)	(4.15)	(4.16)	(4.69)	(8.08)	(4.97)
OCF	-0.202	-0.195	-0.219	-0.116	-0.114	-0.078	-0.412	-0.417	-0.403	-0.016	-0.008	-0.014
	(-0.87)	(-0.85)	(-0.78)	(-1.07)	(-1.05)	(-0.73)	(-1.26)	(-1.28)	(-1.39)	(-0.72)	(-0.83)	(-1.14)
CHR	0.252*	0.257*	0.191***	0.093	0.095	0.112**	0.850***	0.855***	0.415***	0.009*	0.038***	0.016***
	(1.66)	(1.70)	(3.83)	(1.47)	(1.50)	(2.04)	(4.64)	(4.68)	(2.27)	(1.67)	(4.19)	(2.72)
SOE	-0.204	-0.206	-0.323	-0.072	-0.073	-0.128	-0.405	-0.407	-0.195	-0.019	-0.001	-0.008
	(-0.73)	(-0.73)	(-0.93)	(-0.68)	(-0.69)	(-0.86)	(-1.40)	(-1.40)	(-0.45)	(-1.16)	(-0.06)	(-1.12)
Constant	2.286***	2.219***	2.284***	1.103***	1.081***	1.108***	0.488***	0.543***	0.558***	0.038***	0.074***	0.038***
	(17.01)	(16.31)	(16.71)	(19.08)	(18.39)	(18.83)	(2.87)	(3.16)	(3.21)	(6.80)	(7.41)	(6.87)

Year Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	12,832	12,832	12,832	12,837	12,837	12,837	12,852	12,852	12,852	12,816	12,816	12,816
<i>Adj-R²</i>	0.177	0.178	0.179	0.141	0.141	0.142	0.110	0.110	0.110	0.382	0.382	0.383

Table 13. CEO Overseas Experience

This table reports the analysis by treating CEO overseas experience as a potential using the whole sample between 2008 and 2019. We measure CEO overseas experience by creating two dummies that represent overseas working and study, respectively. The dummy variable equals to one when a CEO has overseas work or study experience and zero otherwise. Panel A shows the univariate analysis and Panel B present the multivariate analysis with using patent application number ($\ln(1+Invention)$, $\ln(1+Invention+Utility)$), citation number (*Citation Adjusted*) and *R&D/Invention Patent* as the dependent variables. All regressions control for year and firm fixed effects whose coefficients are suppressed. All variables are defined in Appendix 2. The t-test statistics are shown in parentheses below coefficient estimates based on the standard errors clustered by firms.

***, ** and * represent significant level at 1%, 5% and 10% level, respectively.

Panel A. Univariate Analysis

	Departing CEOs		Successor CEOs		t-test
	Mean	Std. Dev.	Mean	Std. Dev.	
Overseas Work	0.032	0.178	0.061	0.237	5.146***
Overseas Study	0.034	0.182	0.053	0.225	3.686***

Panel B. Multivariate Analysis (Overseas Work)

Dep.	$\ln(1+Invention)$			$\ln(1+Invention+Utility)$			<i>Citation Adjusted</i>			<i>R&D/Invention Patent</i>		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
New CEO Post	0.125*	0.125*	0.117*	0.066**	0.067**	0.063**	0.235***	0.235***	0.237***	0.003***	0.002***	0.003***
	(1.89)	(1.89)	(1.76)	(2.25)	(2.26)	(2.11)	(3.23)	(3.23)	(3.26)	(3.26)	(2.65)	(3.13)
Overseas Work		0.069***	0.178***		0.056***	0.107***		0.038***	0.062***		0.003***	0.003***
		(2.44)	(3.27)		(2.86)	(3.71)		(2.24)	(3.29)		(2.95)	(2.95)
NEW CEO_POST* Overseas Work			0.233***			0.109***			0.052***			0.002***
			(3.71)			(3.82)			(3.15)			(3.68)
Firm Size	1.586***	1.585***	1.583***	0.582***	0.581***	0.580***	0.812***	0.812***	0.813***	0.059***	0.058***	0.056***
	(8.26)	(8.24)	(8.23)	(7.52)	(7.50)	(7.49)	(3.32)	(3.32)	(3.32)	(5.70)	(6.47)	(6.20)
Firm Age	-1.344***	1.342***	1.340***	-0.532***	-0.530***	-0.529***	-0.754***	-0.735***	-0.735***	-0.236***	-0.219***	-0.225***
	(-9.01)	(-9.00)	(-9.00)	(-8.61)	(-8.60)	(-8.59)	(-11.54)	(-11.55)	(-11.55)	(-3.44)	(-3.33)	(-3.39)
Leverage	0.349*	0.349*	0.354*	0.071*	0.070*	0.073*	0.318***	0.318***	0.317***	0.016***	0.016***	0.016***
	(1.87)	(1.87)	(1.91)	(1.86)	(1.86)	(1.89)	(2.34)	(2.34)	(2.33)	(2.64)	(2.62)	(2.64)
ROA	0.444***	0.445***	0.442***	0.652***	0.655***	0.644***	0.323***	0.323***	0.324***	0.127***	0.117***	0.119***
	(7.63)	(7.64)	(7.63)	(6.72)	(6.72)	(6.69)	(4.14)	(4.14)	(4.14)	(4.69)	(5.00)	(5.09)
OCF	-0.202	-0.200	-0.204	-0.116	-0.069	-0.071	-0.412	-0.408	-0.407	-0.016	-0.014	-0.014
	(-0.87)	(-0.72)	(-0.74)	(-1.07)	(-0.65)	(-0.68)	(-1.26)	(-1.41)	(-1.41)	(-0.72)	(-1.16)	(-1.17)
CHR	0.252*	0.197*	0.202*	0.093	0.112	0.114	0.850***	0.410***	0.411***	0.009*	0.015***	0.015***
	(1.66)	(1.85)	(1.87)	(1.47)	(1.04)	(1.06)	(4.64)	(4.25)	(3.87)	(1.67)	(2.69)	(2.71)
SOE	-0.204	-0.253	-0.257	-0.072	-0.095	-0.097	-0.405	-0.850	-0.849	-0.019	-0.008	-0.008
	(-0.73)	(-1.62)	(-1.58)	(-0.68)	(-1.49)	(-1.52)	(-1.40)	(-1.63)	(-1.63)	(-1.16)	(-1.07)	(-1.19)
Constant	2.286***	2.288***	2.289***	1.103***	1.105***	1.105***	0.488***	0.489***	0.489***	0.038***	0.036***	0.036***

	(17.01)	(17.02)	(17.01)	(19.08)	(19.10)	(19.09)	(2.87)	(2.87)	(2.87)	(6.80)	(6.64)	(6.65)
Year Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	12,832	12,832	12,832	12,837	12,837	12,837	12,852	12,852	12,852	12,816	12,816	12,816
Adj-R ²	0.177	0.177	0.177	0.141	0.141	0.141	0.110	0.110	0.110	0.382	0.382	0.382
Panel C. Multivariate Analysis (Overseas Study)												
Dep.	Ln (1+Invention)			Ln (1+Invention+Utility)			Citation Adjusted			R&D/Invention Patent		
New CEO Post	0.125* (1.89)	0.123* (1.86)	0.245*** (3.11)	0.066** (2.25)	0.065** (2.22)	0.122*** (3.48)	0.235*** (3.23)	0.232*** (3.19)	0.500*** (5.73)	0.003*** (3.26)	0.003*** (4.67)	0.003*** (4.62)
Overseas Study		0.149* (1.86)	0.149* (1.85)		0.077** (2.31)	0.077** (2.32)		0.263*** (2.58)	0.263*** (2.61)		0.003*** (3.71)	0.002*** (3.33)
New CEO Post * Overseas Study			0.084*** (2.65)			0.040*** (2.95)			0.186*** (4.16)			0.004*** (3.42)
Firm Size	1.586*** (8.26)	1.586*** (8.26)	1.641*** (8.48)	0.582*** (7.52)	0.582*** (7.51)	0.607*** (7.78)	0.812*** (3.32)	0.811*** (3.32)	0.933*** (3.76)	0.059*** (5.70)	0.058*** (6.48)	0.058*** (6.47)
Firm Age	-1.344*** (-9.01)	-1.337*** (-8.96)	-1.315*** (-8.84)	-0.532*** (-8.61)	-0.528*** (-8.55)	-0.517*** (-8.44)	-0.754*** (-11.54)	-0.742*** (-11.51)	-0.792*** (-11.15)	-0.236*** (-3.44)	-0.221*** (-3.38)	-0.221*** (-3.37)
Leverage	0.349* (1.87)	0.356* (1.91)	0.353* (1.90)	0.071* (1.86)	0.074* (1.90)	0.073* (1.89)	0.318*** (2.34)	0.330*** (2.39)	0.324*** (2.37)	0.016*** (2.64)	0.015*** (2.61)	0.016*** (2.62)
ROA	0.444*** (7.63)	0.443*** (7.62)	0.436*** (7.55)	0.652*** (6.72)	0.649*** (6.70)	0.614*** (6.61)	0.323*** (4.14)	-0.322*** (-4.14)	-0.306*** (-3.93)	0.127*** (4.69)	0.117*** (5.01)	0.117*** (4.99)
OCF	-0.202 (-0.87)	-0.203 (-0.73)	-0.210 (-0.75)	-0.116 (-1.07)	-0.072 (-0.68)	-0.075 (-0.71)	-0.412 (-1.26)	-0.404 (-1.40)	-0.417 (-1.46)	-0.016 (-0.72)	-0.014 (-1.14)	-0.014 (-1.13)
CHR	0.252* (1.66)	0.194* (1.84)	0.192* (1.83)	0.093 (1.47)	0.112 (1.04)	0.111 (1.03)	0.850*** (4.64)	0.426*** (4.30)	0.430*** (4.34)	0.009* (1.67)	0.016*** (2.76)	0.016*** (2.78)
SOE	-0.204 (-0.73)	-0.254 (-1.57)	-0.236 (-1.57)	-0.072 (-0.68)	-0.095 (-1.49)	-0.086 (-1.36)	-0.405 (-1.40)	-0.856 (-1.47)	-0.815 (-1.50)	-0.019 (-1.16)	-0.008 (-1.16)	-0.008 (-1.18)
Constant	2.286*** (17.01)	2.272*** (16.82)	2.246*** (16.53)	1.103*** (19.08)	1.096*** (18.84)	1.084*** (18.55)	0.488*** (2.87)	0.514*** (3.01)	0.571*** (3.31)	0.038*** (6.80)	0.036*** (6.70)	0.036*** (6.70)
Year Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	12,832	12,832	12,832	12,837	12,837	12,837	12,852	12,852	12,852	12,816	12,816	12,816
Adj-R ²	0.177	0.178	0.179	0.141	0.142	0.144	0.110	0.111	0.116	0.382	0.382	0.382

Appendix 1

Reasons of CEO Turnover

This table illustrates the twelve reasons for CEO turnover in our sample. We obtain the reasons based on the CSMAR database and double checked with the firm's annual report. In case of conflict between CSMAR and firm's annual report, we use the information from the annual report.

Reasons	Explanation
Personal reasons	A situation where a CEO leaves his/her position due to some personal circumstances not related to the job.
Contract Expiration	A case where CEO whose contract period (tenure) has reached the maximum and no longer eligible to become a CEO in a short period via the company's nomination or election.
Health	A situation where CEO leaves due to the poor health
Retirement	CEO reaches the retirement age according to the Chinese Labour Law.
Corporate Governance Restructuring	A company replace the CEO due to the requirement of the corporate governance restructuring.
Job Transfer	A CEO has been transferred to another position within the company.
Agent-related termination	A situation where the incoming CEO is acting temporary to help the company in the transaction period and will be replace once the period is terminated.
Change of the Controlling Right	A company changes its ownership structure and consequently replaces the CEO
Dismissed	A CEO has been dismissed/fired by the company
Resignation	A CEO has voluntarily resigned from his/her post
Case Involve	A CEO is under investigation for criminal activities

Appendix 2

Variable Definitions	
Variable Name	Explanation
<i>Corporate Innovation (Dependent Variable)</i>	
$\ln(1+\text{Invention})$	Natural logarithm of one plus the total invention patent applications
$\ln(1+\text{Invention}+\text{Utility})$	Natural logarithm of one plus the sum of invention and utility patent applications
Citation Adjusted	Number of forward citations per invention patent scaled by the average citations for the same year and industry cohort.
R&D/Invention Patents	R&D spending divided by the number of invention patent applications
<i>CEO Turnover (Main Independent Variable)</i>	
New CEO Post	A dummy variable equal to 1 when and after a firm experiences a CEO turnover in year t , and 0 otherwise.
<i>Firm Characteristics (Control Variables)</i>	
Firm Size	Natural logarithm of the total asset
Firm Age	Natural logarithmic of one plus the number of years firm is in operation
Leverage	Total debt divided by total asset
OCF	Natural logarithm of the firm's operating cashflow
CHR	Cash holding ratio defined as cash and cash equivalent divided by current liabilities
ROA	Net income divided by total asset
SOE	Percentage ownership held by the state
<i>CEO Characteristics (Additional Control Variables)</i>	
CEO Gender	A dummy equal to 1 when a CEO is male, and 0 otherwise
CEO Age	Natural logarithm of each CEO's actual age
CEO Compensation	Natural logarithm of each CEO's annual salary
CEO Political	A dummy equal to 1 when a CEO is connected to the central government and 0 otherwise
CEO Education	A dummy equal to 1 when a CEO has a master's degree or above, and 0 otherwise
CEO Tenure	Natural logarithm of each CEO's contract horizon
CEO First Tenure	A dummy equal to 1 when a CEO is in his/her first term and 0 otherwise
CEO Overconfidence	A dummy equal to 1 when a CEO does not exercise an executive option after the stock price increases by 67% and 0 otherwise.
<i>Board Characteristics (Additional Control Variables)</i>	
Board Size	Natural logarithm of the total number of board members
Independent Director	The percentage of independent director on board
Duality	A dummy equal to 1 if CEO is also the Chairman of the board, and zero otherwise.
Ownership Concentration	The percentage of shares held by top ten shareholders

Appendix 3

Trends in innovation measures for Treated and Control firms: Mean and median comparisons

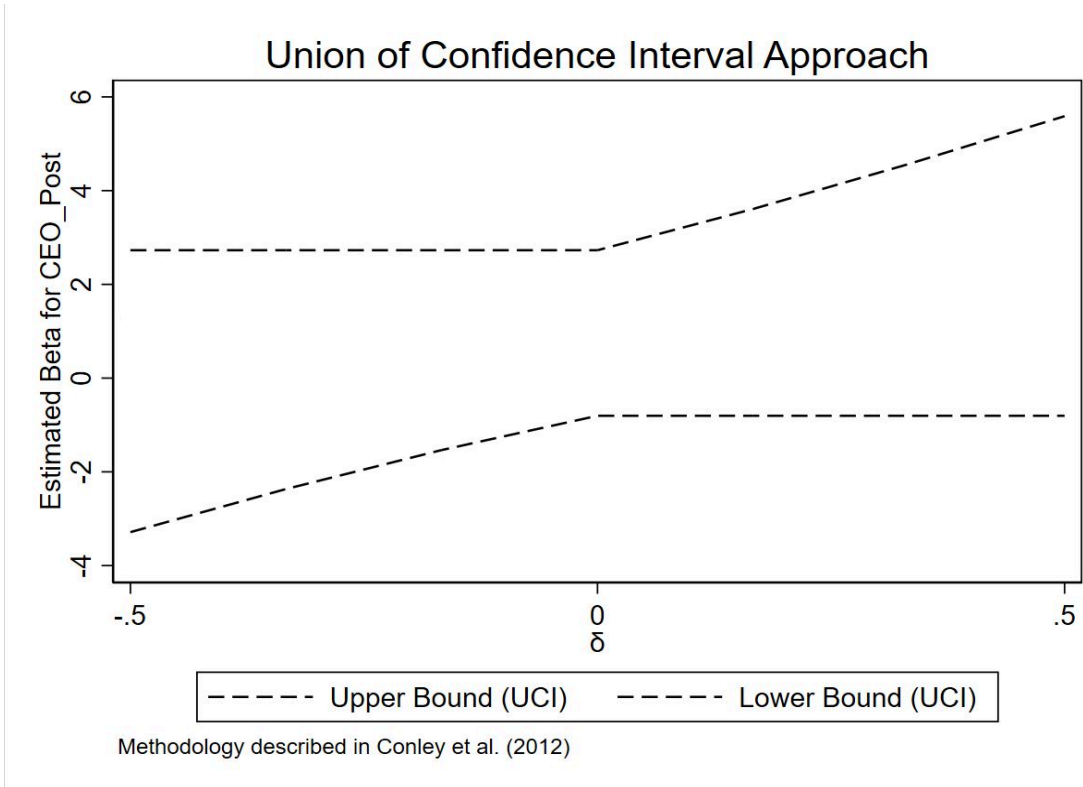
This table reports the mean and median yearly changes in innovation for firms in both treated and control groups up to three-year before the exogenous turnover. All changes in these measures are calculated relative to the value of the measure at the year of the turnover ($t=0$). Innovation measures are invention patent application numbers, defined as $\ln(1+\text{number of the invention patent applications})$, invention and utility patent applications, defined as $\ln(1+\text{number of the invention and utility patent application})$, Citation Adjust, defined as each firm's citation counts divide by the average number of patent citation in the same cohort. The first row presents the changes of innovation in three-year ahead before the exogenous turnover. In particular, the difference has been calculated between innovation at $t=-3$ (three years prior to the turnover) and $t=0$ (the exogenous turnover event year). The table also reports p-values associated with test statistics for differences in means (standard t-test) and medians (Wilcoxon-Mann-Whitney test) across treated and control groups.

*, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

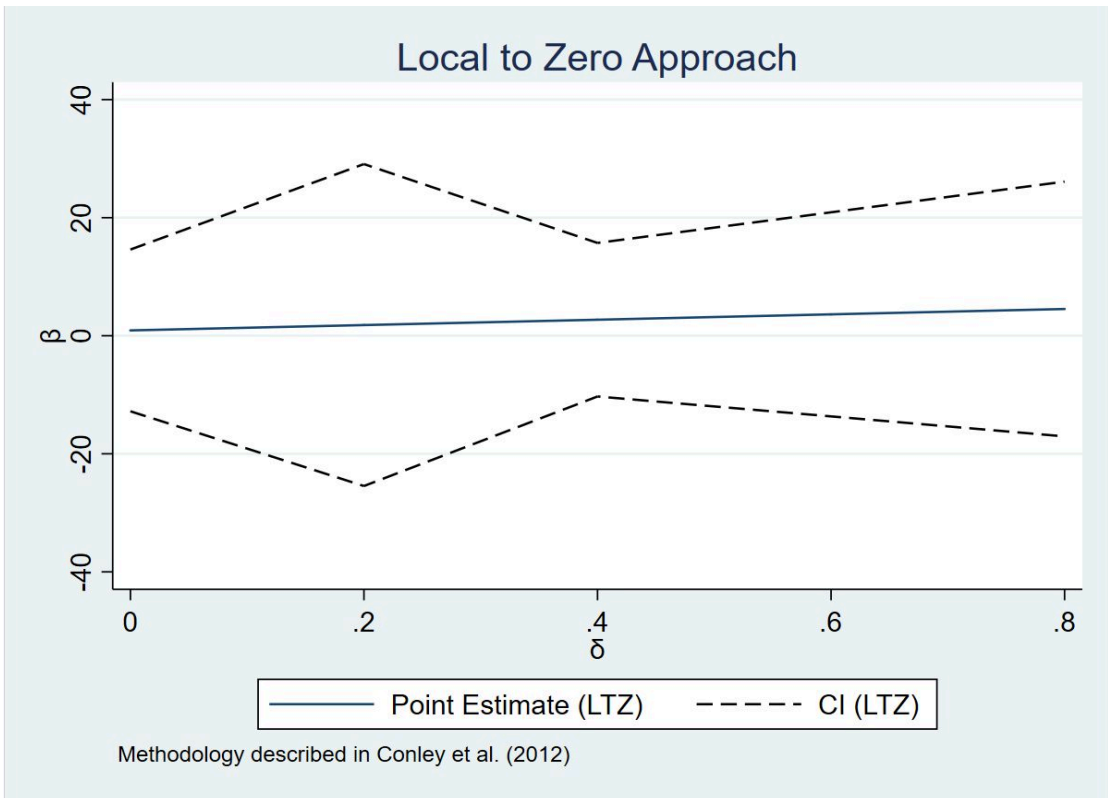
Time Horizon	Control Mean [Median]	Treatment Mean [Median]	p-value of difference t-test [Wilcoxon- Mann-Whitney test]	Control Mean [Median]	Treatment Mean [Median]	p-value of difference t-test [Wilcoxon- Mann-Whitney test]	Control Mean [Median]	Treatment Mean [Median]	p-value of difference t-test [Wilcoxon- Mann-Whitney test]	Control Mean [Median]	Treatment Mean [Median]	p-value of difference t-test [Wilcoxon- Mann-Whitney test]
	<i>Ln (1+Invention)</i>			<i>Ln (1+Invention+Utility)</i>			<i>Citation Adjusted</i>			<i>R&D/Invention Patent</i>		
3 years prior to turnover	0.104 [0.000]	0.191 [0.000]	-0.515 [0.686]	0.107 [0.00]	0.141 [0.000]	-0.179 [0.748]	0.062 [0.000]	0.132 [0.000]	-0.622 [0.529]	0.051 [0.000]	0.171 [0.000]	0.650 [0.754]
2 years prior to turnover	0.206 [0.000]	0.111 [0.000]	0.782 [0.348]	0.200 [0.000]	0.159 [0.000]	0.289 [0.466]	0.114 [0.000]	0.085 [0.000]	0.773 [0.278]	0.133 [0.000]	0.189 [0.000]	0.786 [0.627]
1 years prior to turnover	0.203 [0.000]	0.148 [0.000]	0.448 [0.465]	0.254 [0.000]	0.203 [0.000]	0.360 [0.409]	0.109 [0.000]	0.040 [0.000]	0.915 [0.253]	0.075 [0.000]	0.140 [0.000]	0.689 [0.955]

Appendix 4.

Plausibly Exogenous Tests--- Union of Symmetric Method



Plausibly Exogenous Tests--- Local-to-0 Method



Appendix 5

CEO Turnover and Firm Innovation (Only Health and Retirement Reasons)

This table reports the estimation of difference-in-difference (DID) regression analysis of the relationship between CEO turnover and firm innovation by only considering health and retirement reasons for exogenous CEO turnover. We use patent application number ($\ln(1+Invention)$, $\ln(1+Invention+Utility)$), citation number ($Citation\ Adjusted$) and $R\&D/Invention\ Patent$ as the dependent variables. The sample period is between 2008 and 2019. All regressions control for year, industry and province fixed effects whose coefficients are suppressed. All variables are defined in Appendix 2. The t-test statistics are shown in parentheses below coefficient estimates based on the standard errors clustered by firms.

***, ** and * represent significant level at 1%, 5% and 10% level, respectively.

	(1)	(2)	(3)	(4)
<i>Dep.</i>	<i>Ln (1+Invention)</i>	<i>Ln (1+Invention+Utility)</i>	<i>Citation Adjusted</i>	<i>R&D/Invention Patent</i>
New CEO Post	0.100** (2.15)	0.095** (2.30)	0.068* (1.84)	0.221* (1.70)
Firm Size	0.182*** (10.25)	0.364*** (21.23)	0.102*** (8.91)	0.247*** (6.46)
Firm Age	-0.587 (-0.67)	-1.034 (-1.35)	-0.529 (-0.92)	-0.148 (-0.93)
Leverage	0.510*** (3.69)	0.677*** (5.58)	0.203** (2.30)	3.693*** (2.47)
ROA	0.295*** (3.28)	0.047*** (3.61)	0.230*** (4.11)	0.203*** (3.06)
OCF	-0.064 (-0.31)	-0.011 (-0.05)	-0.066 (-0.50)	-1.750 (-0.44)
CHR	1.062*** (2.52)	1.876*** (2.66)	0.768* (1.76)	0.498*** (3.21)
SOE	-0.191 (-1.30)	-0.398 (-1.09)	-0.083 (-0.87)	-1.541 (-0.38)
Constant	1.470*** (6.80)	4.859*** (17.09)	0.797*** (5.63)	4.880*** (17.23)
Year Effect	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES
Observations	8,855	8,863	8,902	8,839
<i>Adj-R²</i>	0.171	0.175	0.125	0.474

Appendix 6.

CEO Turnover and Firm Innovation (Including Personal Reason)

This table reports the estimation of difference-in-difference (DID) regression analysis of the relationship between CEO turnover and firm innovation by including personal reason as an exogenous reason for CEO turnover. We use patent application number ($\ln(1+Invention)$, $\ln(1+Invention+Utility)$), citation number ($Citation\ Adjusted$) and $R\&D/Invention\ Patent$ as the dependent variables. The sample period is between 2008 and 2019. All regressions control for year, industry and province fixed effects whose coefficients are suppressed. All variables are defined in Appendix 2. The t-test statistics are shown in parentheses below coefficient estimates based on the standard errors clustered by firms.

***, ** and * represent significant level at 1%, 5% and 10% level, respectively.

	(1)	(2)	(3)	(4)
<i>Dep.</i>	<i>Ln (1+Invention)</i>	<i>Ln (1+Invention+Utility)</i>	<i>Citation Adjusted</i>	<i>R&D/Invention Patent</i>
New CEO Post	0.301*** (3.07)	0.461*** (4.00)	0.225** (2.39)	0.737*** (3.41)
Firm Size	0.338*** (19.16)	0.379*** (18.75)	0.153*** (9.26)	0.517*** (8.54)
Firm Age	-0.091* (-1.83)	-0.149*** (-2.58)	-0.036*** (-2.73)	-0.684*** (-2.60)
Leverage	0.063*** (2.67)	0.164*** (3.47)	0.118** (2.31)	0.498** (2.30)
ROA	1.508*** (4.38)	1.524*** (3.91)	1.995*** (5.86)	2.041*** (6.13)
OCF	-0.146 (-0.69)	-0.256 (-0.68)	-0.437 (-0.37)	-0.096 (-0.10)
CHR	0.036 (0.32)	0.030 (0.23)	0.099 (0.91)	1.875 (0.74)
SOE	-0.248 (-0.84)	-0.262 (-0.15)	-0.153 (-0.50)	-0.352 (-0.50)
Constant	-3.334*** (-6.97)	-3.261*** (-5.96)	-1.008** (-2.24)	-4.574*** (-4.91)
Year Effect	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES
Observations	13,946	14,018	14,132	13,927
<i>Adj-R²</i>	0.292	0.351	0.123	0.568

Appendix 7.

PSM

This table reports the estimation of difference-in-difference (DID) regression analysis of the relationship between CEO turnover and firm innovation with using PSM procedure. We include firm size, firm age, leverage, ROA, OCF, CHR and SOE as the matching criteria and use patent application number ($\ln(I+Invention)$), $\ln(I+Invention+Utility)$, citation number (*Citation Adjusted*) and *R&D/Invention Patent* as the dependent variables. The sample period is between 2008 and 2019. All regressions control for year, industry and province fixed effects whose coefficients are suppressed. All variables are defined in Appendix 2. The t-test statistics are shown in parentheses below coefficient estimates based on the standard errors clustered by firms.

***, ** and * represent significant level at 1%, 5% and 10% level, respectively.

<i>Dep.</i>	(1) <i>Ln (I+Invention)</i>	(2) <i>Ln (I+Invention+Utility)</i>	(3) <i>Citation Adjusted</i>	(4) <i>R&D/Invention Patent</i>
New CEO Post	0.233*** (4.32)	0.293*** (4.53)	0.365*** (4.56)	0.846*** (3.19)
Firm Size	0.321*** (2.71)	0.334*** (2.40)	0.543*** (3.42)	1.476*** (7.90)
Firm Age	-0.147*** (-4.55)	-0.266*** (-7.02)	-0.233*** (-6.26)	-0.113*** (-7.71)
Leverage	0.129** (2.08)	0.214*** (2.95)	0.114*** (2.59)	0.372** (2.02)
ROA	0.811*** (3.68)	0.741*** (2.92)	2.309*** (9.45)	4.021*** (7.16)
OCF	-0.052* (-1.66)	-0.008 (-0.23)	-0.014 (-0.47)	-0.249 (-0.90)
CHR	0.124*** (3.24)	0.116*** (3.02)	0.128*** (3.34)	0.211*** (3.94)
SOE	-0.023 (-1.10)	-0.109 (-1.38)	-0.109 (-1.40)	-0.386** (-2.56)
Constant	2.6264** (2.08)	2.419* (1.740)	0.575*** (3.354)	3.394*** (15.31)
Year Effect	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES
Observations	12,832	12,837	12,852	12,816
<i>Adj-R²</i>	0.304	0.353	0.259	0.355

Appendix 8

CEO Turnover and Firm Innovation (Using 2-period ahead for dependent variable)

This table reports the estimation of difference-in-difference (DID) regression analysis of the relationship between CEO turnover and firm innovation with using two period ahead for the dependent variables. We use patent application number ($\ln(1+Invention)$, $\ln(1+Invention+Utility)$), citation number (*Citation Adjusted*) and *R&D/Invention Patent* as the dependent variables. The sample period is between 2008 and 2019. All regressions control for year, industry and province fixed effects whose coefficients are suppressed. All variables are defined in Appendix 2. The t-test statistics are shown in parentheses below coefficient estimates based on the standard errors clustered by firms.

***, ** and * represent significant level at 1%, 5% and 10% level, respectively.

<i>Dep.</i>	(1) <i>Ln (1+Invention)</i>	(2) <i>Ln (1+Invention+Utility)</i>	(3) <i>Citation Adjusted</i>	(4) <i>R&D/Invention Patent</i>
New CEO Post	0.151** (2.02)	0.074** (2.31)	0.214*** (2.79)	0.006*** (2.64)
Firm Size	0.624*** (2.75)	0.195** (2.18)	2.224*** (6.92)	0.060*** (5.39)
Firm Age	-1.122*** (-5.31)	-0.463*** (-5.17)	-0.319*** (-11.95)	-0.257*** (-3.27)
Leverage	0.007 (0.03)	-0.105 (-1.18)	0.311 (1.12)	0.014* (1.85)
ROA	0.480*** (4.69)	0.123*** (4.41)	0.571*** (5.98)	0.076*** (2.83)
OCF	-0.256 (-1.00)	-0.146 (-1.24)	-0.573 (-1.58)	-0.005 (-0.37)
CHR	0.062*** (2.36)	0.011*** (2.14)	0.230*** (3.03)	0.005*** (2.70)
SOE	-0.153 (-0.49)	-0.096 (-0.79)	-0.476 (-1.43)	-0.005 (-0.89)
Constant	0.151** (2.02)	0.074** (2.31)	-0.214*** (-2.79)	-0.045*** (-6.60)
Year Effect	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES
Observations	11,246	11,271	11,312	11,237
<i>Adj-R²</i>	0.185	0.150	0.193	0.349

Appendix 9.

CEO Turnover and Firm Innovation (Only Treated Firms)

This table reports the estimation of difference-in-difference (DID) regression analysis of the relationship between CEO turnover and firm innovation using the firms in the treatment group only. We use patent application number ($Ln(1+Invention)$, $Ln(1+Invention+Utility)$), citation number (*Citation Adjusted*) and *R&D/Invention Patent* as the dependent variables. All regressions control for year, industry and province fixed effects whose coefficients are suppressed. All variables are defined in Appendix 2. The t-test statistics are shown in parentheses below coefficient estimates based on the standard errors clustered by firms.

***, ** and * represent significant level at 1%, 5% and 10% level, respectively.

<i>Dep.</i>	(1) <i>Ln (1+Invention)</i>	(2) <i>Ln (1+Invention+Utility)</i>	(3) <i>Citation Adjusted</i>	(4) <i>R&D/Invention Patent</i>
New CEO Post	0.200*** (2.82)	0.103*** (3.25)	0.263*** (3.12)	0.225*** (3.09)
Firm Size	0.996*** (2.95)	0.316** (2.39)	0.536* (1.83)	0.773*** (3.18)
Firm Age	-1.287*** (-5.63)	-0.505*** (-5.41)	-0.238*** (-8.34)	-0.228*** (-11.05)
Leverage	0.484* (1.66)	0.147* (1.75)	0.370** (2.16)	0.321*** (2.36)
ROA	0.358*** (3.86)	0.119*** (3.11)	0.278*** (3.02)	0.308*** (3.98)
OCF	-0.303 (-0.95)	-0.120 (-0.77)	-0.613 (-1.33)	-0.419 (-1.45)
CHR	0.562*** (2.77)	0.203** (2.34)	1.205*** (4.72)	0.410*** (3.25)
SOE	-0.044 (-0.13)	-0.006 (-0.05)	-0.192 (-0.55)	-0.902*** (-4.89)
Constant	1.972*** (9.48)	0.951*** (10.45)	0.440* (1.87)	0.046*** (3.20)
Year Effect	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES
Observations	3,512	3,537	3,562	3,493
<i>Adj-R²</i>	0.169	0.136	0.114	0.340

Appendix 10.

CEO Turnover and Firm Innovation (Year * Firm Fixed Effect)				
This table reports the estimation of difference-in-difference (DID) regression analysis of the relationship between CEO turnover and firm innovation by considering the joint fixed effect between year and firm. We use patent application number ($\ln(1+Invention)$, $\ln(1+Invention+Utility)$), citation number (<i>Citation Adjusted</i>) and <i>R&D/Invention Patent</i> as the dependent variables. The sample period is between 2008 and 2019. All regressions control for year, industry and province fixed effects whose coefficients are suppressed. All variables are defined in Appendix 2. The t-test statistics are shown in parentheses below coefficient estimates based on the standard errors clustered by firms.				
***, ** and * represent significant level at 1%, 5% and 10% level, respectively.				
<i>Dep.</i>	(1) <i>Ln (1+Invention)</i>	(2) <i>Ln (1+Invention+Utility)</i>	(3) <i>Citation Adjusted</i>	(4) <i>R&D/Invention Patent</i>
New CEO Post	0.092* (1.93)	0.049** (1.98)	0.127** (2.15)	0.003* (1.85)
Firm Size	1.593*** (9.44)	0.561*** (8.44)	0.245*** (10.19)	0.081*** (8.81)
Firm Age	-0.862*** (-7.57)	-0.323*** (-6.43)	-0.195*** (-11.40)	-0.094*** (-2.70)
Leverage	0.263*** (2.57)	0.021** (2.29)	0.018*** (3.09)	0.015** (2.47)
ROA	4.386*** (8.47)	1.565*** (7.15)	1.874*** (2.70)	0.162*** (6.58)
OCF	-0.191 (-0.85)	-0.111 (-1.05)	-0.553 (-1.02)	-0.016*** (-2.95)
CHR	0.190* (1.73)	0.057* (1.94)	0.685*** (3.82)	0.006*** (3.20)
SOE	-0.230 (-0.90)	-0.093 (-0.95)	-0.428 (-1.56)	-0.015 (-0.86)
Constant	-0.159 (-0.91)	-0.042 (-0.56)	0.322 (1.30)	0.029*** (7.60)
Year * Firm Fixed Effect	YES	YES	YES	YES
Observations	12,832	12,837	12,852	12,816
<i>Adj-R²</i>	0.157	0.132	0.129	0.337