How Creative are Professor Directors?
The Impact of Academic Expertise on Corporate Innovation

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ABSTRACT

Corporate innovation is vital to firms' long-term success and survival. This study explores a unique aspect of board of directors by associating professor directors and their academic expertise with corporate innovation. Professors have become a staple in the boardroom in recent years. As professors are highly intellectual and extremely knowledgeable in their fields of study, their academic expertise may improve corporate innovation through knowledge transfer and enhanced board diversity. Our findings show that firms with professor directors report higher levels of innovative activity and success in terms of patent output and citation. More importantly, the influence of professor directors varies depending on their academic expertise. We find increasing representation of professor directors with polytechnic and financial expertise on the board, but not professor directors with other expertise, is associated with greater corporate innovation. We further find a significant synergy effect on patent output when a firm appoints both professors with polytechnic expertise and those with financial expertise to the same corporate board. Lastly, we show that their impact on innovation varies with professor directors' individual characteristics. Overall, our findings demonstrate that corporate innovation benefits arise from professor directors' academic expertise and not from their mere presence on a board. This study highlights the importance of considering director heterogeneity in engendering corporate innovation.

Keywords: Corporate Innovation; Professor Director; Academic Expertise; Knowledge Transfer

JEL Codes: M14; O34

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1. Introduction

Over the last two decades, university professors have become a staple in the boardroom. Francis, Hasan, and Wu (2015) and Cho, Jung, Kwak, Lee, and You (2017) have shown that approximately 40% of S&P 1500 firms have at least one professor on their boards. Academics are presumed to possess the intellectual capacity to fulfill both the monitoring and advisory roles of a board of directors (Audretsch and Stephen 1996; Audretsch and Lehmann 2006). They also tend to be independent, critical thinkers with their own opinions and judgments, and they are less susceptible to the influence of others (Jiang and Murphy 2007). Therefore, professor directors are suited as external monitors and advisors (Francis et al. 2015). As professors come from an academic background rather than industry, many of them have few industry connections, which ensures better separation between the board of directors and management to serve its monitoring function (Francis et al. 2015). Moreover, Forbes and Milliken (1999) and Anderson, Reeb, Upadhyay, and Zhao (2011) contend that professors approach problems differently, they challenge the status quo and provide a board with more diverse perspectives. Directors coming from an industry background, on the other hand, could be less creative, as their familiarity with industry norms may blind them from changing industry dynamics and opportunities for reinvention through groundbreaking innovations (Faleye, Hoitash, and Hoitash 2017). Lastly, firms also appoint professors to their boards because they are commonly regarded as lending the board authority and prestige (Singh, Terjesen, and Vinnicombe 2008).

At the same time, a common criticism is that professor directors are too academic in focus. They may lack practical business experience to aid them in corporate monitoring and advising. Professors with strong theoretical and research abilities may find it difficult to connect their

theories to practice (Jiang and Murphy 2007). They may have conflicting goals between academic and practical research (Dasgupta and David 1994; Sauermann and Stephan 2013). Furthermore, they may find it challenging to communicate with other board members in a corporate setting.

In this study, we examine whether and how professor directors matters for corporate innovation. Research relating the upper-echelons theory (Hambrick and Mason 1984) to corporate innovation shows top management plays an especially crucial role in making risky decisions on innovative strategies (Bantel and Jackson 1989; Hoffman and Hegarty 1993; Daellenbach, McCarthy, and Shoeneker 1999). Hence, outside directors become an essential mechanism to monitor and advise management on innovative investment (Hill and Snell 1988; Baysinger, Kosnik, and Turk 1991; Hoskisson, Hitt, Johnson, and Grossman 2002; Kor 2006; Kor and Misangyi 2008). Francis et al. (2015) provide some evidence that professor directors, as a homogeneous group, exert positive influence on corporate innovation. However, professor directors differ in terms of knowledge (White, Woidtke, Black, and Schweitzer 2014). In this study, we investigate the channels through which professor directors can engender firms' innovative activities. We conjecture professor directors of different academic disciplines could exert different impact on corporate innovation, when they bring their unique but diverse knowledge in serving the monitoring and advising functions on corporate innovative activities.

We focus on corporate innovation because it plays a crucial role for firms' long-term success and survival (Pakes 1985; Austin 1993). More importantly, innovative projects have unique features that could benefit from the specialized knowledge as well as the different opinions brought upon by professor directors of difference academic disciplines. First, innovative projects require specific technical knowledge to evaluate the feasibility of their processes. The learning-by-doing literature has long established firms' innovative activities require scientific knowledge and expertise, and hence are particularly reliant on knowledge

transfer from outside industry experts (e.g., Almeida and Kogut 1999; Singh and Agrawal 2011; Kaiser, Kongsted, and Rønde 2015; Jain 2016). Relatedly, academic research has also been shown to be an important driver of corporate innovation (Jaffe 1989; Murray 2004; Kaiser, Kongsten, Laursen, and Ejsing 2018). In particular, Kaiser et al. (2018) demonstrates that hiring scientific researchers from academia has a stronger impact on innovation than hiring someone with no or little academic background. Second, corporate innovations involve the development of new ideas into commercial applications. However, innovative projects usually require longer time horizons, greater financial risks and they have higher chances of failure when compared to other capital investment projects (Holmstrom 1989; Manso 2011). Given the high uncertainty in the potential returns of innovative projects, it is essential but difficult to assess the expected financial values of different innovative activities (Balsmeier, Buchwald, and Stiebale 2014). Third, George, Kotha, and Zheng (2008) and Kotha, Zheng, and George (2011) argue the commercialization of impactful innovative projects require involvement of multiple specialists. Hence, innovative projects require significant efforts and knowledge in organization and management (Gittelman 2007; Kotha, George, and Srikanth 2013). Lastly, board diversity is shown to be related to its effectiveness (e.g., Forbes and Milliken 1999; Hillman and Dalziel 2003; Anderson et al. 2011; Kim, Mauldin, and Patro 2014; Rhode and Packel 2014; Frijns, Dodd, and Cimerova 2016). The team behavior literature also shows diversity is related to performance (e.g., Harrison, Price, and Bell 1998; Earley and Mosakowski 2000). The innovation processes, in particular, require different players to come up with ideas, to challenge each other, and to foster creativity (Doz, Santos, and Williamson 2004; Rodan and Galunic 2004; Kerr and Lincoln 2010; Østergaard, Timmersman, and Krintinsson 2011). Consequently, innovative projects that combine different knowledge domains are shown to be more valuable (e.g., Fleming and Sorenson 2004; Makri, Hitt, and Lane 2010). Miller and Triana (2009) and Bernile, Bhagwat, and Yonker (2018) find supporting

empirical evidences of a positive relationship between board diversity and innovative activities. Hence, innovative projects could also benefit from the diverse knowledge and background of different professor directors.

Summarizing the above arguments, we expect professor directors are associated with improved corporate innovation in two ways. First, professor directors apply their unique knowledge and expertise into monitoring and advising firms' innovative projects. Second, professor directors introduce different opinions and ideas to the board, enhancing the impact of board diversity on innovative activities. We empirically test these two conjectures by examining the association between professor directors with different areas of academic expertise and corporate innovation in a multivariate framework, controlling for other firm and board determinants of innovation. We classify professor directors according to their unique areas of academic expertise: (1) polytechnic, (2) financial, (3) economics or management, (4) law, and (5) other. Following the literature (e.g., Fama 1980; Fama and Jensen 1983; Weibach 1988; Brickley, Coles, and Terry 1994), we focus on independent and unaffiliated professor directors. To measure corporate innovation and innovative activities, we look at patents instead of R&D spending, as patents allow us to more directly assess innovation project outcomes.[1] Our measures of corporate innovation include patent output, measured by the one to three-year-ahead log number of patent applications obtained, as well as patent success, measured by the one to three-year-ahead log number of patent citations.[2]

[1] Patents have been used as an important performance measure of corporate innovation by a long line of finance, economics and management studies. These studies, for example, include Ahuja and Katlia (2001); Aghion, Bloom, Blundell, Griffith, and Howitt (2005); Hall, Jaffe, and Trajtenberg (2005); Acharya and Subramanian (2009); Joshi and Nerkar (2011); Hirshleifer, Low, and Teoh (2012); Balsmeier et al. (2014); Seru (2014); Tian and Wang (2014); and Sunder, Sunder, and Zhang (2017). On the other hand, it is unclear whether increased R&D spending is desirable if such spending reflects wasteful overinvestment that damages future earnings (Chan, Lin, and Wang 2015).

[2] Given that innovation projects take time to complete, we follow Balsmeier et al. (2014) and allow a one-year lag between patent activities and our explanatory variables. In addition, we also examine patent activities with two-year and three-year lags to take into consideration the longer-term effect of patents (e.g., Harhoff, Narin, Scherer, and Vopel 1999; Balsmeier et al. 2014; Balsmeier, Fleming, and Manso 2017).

We utilize a hand-collected database of professor directors and their academic expertise for Chinese manufacturing and technology companies over the period 2011-2014, with one to three year-ahead patent data spanning the period of 2012-2017. Our baseline results show the presence of professor directors has a significant and positive association with corporate innovation, consistent with prior findings by Francis et al. (2015) on the relationship between professor directors and corporate innovation in the U.S. setting. Moreover, we show increasing representation of professor directors, measured by the number and the ratio of professor directors on board, results in more corporate innovative activities in terms of both innovation applications obtained and citation.

Importantly, our main findings indicate that professors are not a homogenous group and their academic expertise matters significantly for corporate innovation. Specifically, we find that the presence of professor directors with polytechnic expertise and professor directors with financial expertise are both associated with increasing corporate innovation output from time *t+1* to *t+3*. We find that professor directors with financial expertise exert a more significant positive impact on corporate innovation output, as the presence of a professor director with financial expertise at time *t* is associated to larger increase in the number of patents at time *t+1*. When we examine patent success by citations, we once again find that professor directors with polytechnic expertise and financial expertise are associated with higher firms' patent citation counts. However, professor directors with polytechnic expertise now exerts a more significant positive impact when compared to professor directors with financial expertise. Our findings imply that polytechnic professors transfer their unique knowledge to monitor and advice on firms' innovative strategies, which results in higher levels of patent applications obtained and citations. The results complement prior studies on the importance of scientific academic research on corporate innovation (e.g., Jaffe 1989; Murray 2004; Kaiser et al. 2018). Moreover, we provide novel evidences that professor directors with financial expertise are also

instrumental in the process of corporate innovation, improving on the patent application processes and resulting in higher levels of patent applications obtained and citations. Our findings bear some similarities to the findings of Minton, Taillard, and Williamson (2014), who show financial expertise on board encourages firms to engage in more risk taking activities that have potentially higher returns. Lastly, we do not find professor directors with other expertise have any positive significant influence on corporate innovation. The findings reinforce professor directors are not homogenous (White et al. 2014), and their specific knowledge matters for corporate innovation. Overall, the findings highlight the importance of professor directors' knowledge transfer by showing their areas of academic expertise, and not their mere presence, for stimulating innovation.

Prior research has shown board diversity affects firm performance (e.g., Anderson et al. 2011; Kim et al. 2014) and corporate innovation (Miller and Triana 2009; Bernile et al. 2018). However, our findings so far seem to indicate corporate innovation does not benefit from enhanced diversity introduced by the presence of just *any* professor director, and their academic expertise matters. We next investigate whether corporate innovation could benefit with the complementarity of having professor directors of polytechnic expertise and professor directors of financial expertise serving on the same corporate board. Mudambi and Swift (2009) show innovative activities are a joint effort of scientific research and good management, and Agrawal and Ohyama (2013) stress innovation projects require evaluating their technicality as well as commercial feasibility. We conjecture that there is a synergy effect when professors with polytechnic and financial expertise work together and contribute their unique knowledge to innovative projects. Consistent with our expectation, we find a significant interaction effect on patent output with increasing representation of professors with polytechnic expertise and those with financial expertise serving on the same corporate board. The findings show that diversity improves innovative performance when directors have the *right* mix of expertise. Interestingly,

for patent citation, the interaction effect is insignificant and polytechnic professor directors remain significantly associated with higher levels of patent citations. One interpretation of this result is that professor directors with financial expertise can more effectively work with professor directors with polytechnic expertise as well as the rest of the corporate board to facilitate the patent application process. However, they are less useful to ascertain the subsequent success of those patents obtained.

Lastly, we examine how the impact of academic expertise on corporate innovation is influenced by professor directors' individual characteristics. Specifically, we evaluate their education, university affiliation, gender, age, director experience, director compensation, and activity on corporate boards. We find polytechnic professors that were educated overseas and currently work at a top Chinese university are associated with firms that have more patent citations. Our findings show quantifiable benefits of hiring polytechnic professor directors with foreign background and from reputed institutions, consistent with findings in the U.S. from White et al. (2014) on director appointment from mostly top universities. For professor directors with financial expertise, we find that those motivated by monetary rewards (i.e., with higher director compensation) are associated with firms with higher patent output and citations. In addition, we find that female professor directors and older professor directors with financial expertise, but not those with polytechnic expertise, have a negative impact on corporate innovation. These findings are interesting: While it is consistent with the idea that female directors and older directors are more risk averse (e.g., Zajac and Westphal 1996; Golden and Zajac 2001; Chen, Crossland, and Huang 2016), we show that directors from the polytechnic field seem to deviate from this social norm. Lastly, we also find professor directors of financial expertise improve corporate innovation when they are from top universities and when they sit on the audit committee.

To further ascertain professor directors transfer their unique knowledge for corporate innovation, we conduct an additional analysis utilizing the specific patent types reported by Chinese firms. China's State Intellectual Property Office (SIPO) grants three types of patents: *Invention*, *Utility* and *Design* patents. We argue that professor directors with certain academic expertise would be more effective in the innovative process with regard to particular type(s) of patents. For instance, those with polytechnic expertise could be more influential in invention patent, but less helpful in design patent, which relates to the exterior design features of a product. We find that polytechnic professor directors are associated with higher levels of invention patent applications obtained. We show professor directors of financial expertise are associated with higher output in all types of patents, indicating their knowledge and skills are more transferable to different types of innovative activities. The additional analysis also shows professor directors of legal expertise marginally (at the 10% levels) increase the number of invention patent applications obtained, and professor directors of economics or management expertise increase the number of design patents obtained. Lastly, professor directors of other expertise exert a negative association with the number of invention patents.

Several prior studies that have examined professor directors (e.g., Audretsch and Stephen 1996; Audretsch and Lehmann 2006; White et al. 2014) argue that firms recruit professors for their expertise, which implies that reverse causality may exist when firms with more corporate innovation incentives favor appointing professor directors with particular knowledge. To alleviate this endogeneity concern, we conduct our robustness analysis with matched sample obtained by propensity score matching (PSM), and an alternative instrumental variable approach. Our results remain unchanged with the alternative analysis.

We conduct our study in a Chinese setting for several important reasons. First, Chinese firms appoint university professors as independent directors at an especially high rate (Zhuang, Chang, and Lee 2018). While Francis et al. (2015) and Cho et al. (2017) both document that

approximately 40% of S&P 1500 firms have at least one academic director serving on their boards, in our sample of Chinese manufacturing and technology firms, 81% (4,583 out of 5,633 firms) have professors serving as independent directors on their boards. Moreover, many of these Chinese firms hire more than one professor director from different academic disciplines, which enables us to examine the synergy potential of different areas of academic expertise. A recent study by Chen, Garel, and Tourani-Rad (2019) also shows professor directors in China are valued by investors and they are not a mere token in the Chinese financial market, thus making it more interesting to examine the real operating impact of these professor directors. Second, China has become a global competitor in innovation and technology, and its accelerating innovation efforts have been impressive. According to the World Intellectual Property Organization (WIPO), in 2011 China's SIPO became the world's top office in terms of patent filings, and the gap between China and other countries has widened considerably since then.[3] Accordingly, the Chinese intellectual property system has matured quickly, according to industry (e.g., Langer 2018) and academic (e.g., Bian 2017) experts. Lastly, the Chinese government implemented a "Code of Corporate Governance for Listed Firms" in 2002, which aimed to improve the corporate governance environment. However, the effectiveness of boards of directors remains a serious concern in China. Many studies have questioned the independence and the usefulness of board of directors in China and the evidences are mixed.[4] Our study contributes to the literature in several ways. First, we add to the literature examining the impact of corporate governance and board of directors on corporate innovation. Indisputably, innovation is vital for corporate growth and long-term survival (Pakes 1985;

[3] In 2013, China was the top patent office with 825,136 filings, followed by the U.S. (571,612) and Japan (328,436). According to a recent WIPO report, "World Intellectual Property Indicators 2017," China's patent office received 1.3 million patent applications in 2016, more than the next four patent offices (U.S., Japan, Korea, and the European Union) combined.

[4] See, for example, Schipani and Liu (2002); Clarke (2003); Chen, Firth, Gao, and Rui (2006); Lin, Piotroski, Yang, and Tan (2012); Liu, Wei, and Xie (2014); Liu, Miletkov, Wei and Yang (2015); Ma and Khanna (2016); Zhu, Ye, Tucker, and Chan (2016); Cheng and Sun (2018); Zhuang et al. (2018).

Austin 1993), and particularly in the new economy (Hall et al. 2005). We highlight an increasingly important group of players on corporate boards, professor directors, and we focus on understanding the channel these directors can facilitate corporate innovation through their academic expertise. Previous studies have established that academic knowledge at the employee level could be beneficial for corporate innovation (e.g., Gambardella 1992; Fleming and Sorenson 2004; Kaiser et al. 2018). We demonstrate corporate innovation also benefits from knowledge transfer at the upper echelons level. Our study shows professor directors of polytechnic and financial expertise are valuable resources for firms that require specialized knowledge in implementing, operating, and managing innovative projects and strategies. In so doing, we explore an alternative avenue for firms to obtain the necessary expertise on corporate boards, aside from appointing industry experts for knowledge spillover across firms (e.g., Balsmeier, et al. 2014; Helmers, Patnam, and Rau 2015; Oh and Barker 2018).

Second, we add to the growing literature on the role of professors on corporate boards. Most prior studies on professor directors have so far considered academics as a homogenous group (e.g., Fich 2005; Duchin, Matsusaka, and Ozbas 2010; Agrawal and Chen 2017; Fedaseyeu, Linck, and Wagner 2018). While Fedaseyeu et al. (2018) shows top management seems to view positively on the presence of professor directors as reflected by their higher direct compensation, other studies find that professor directors have little real effect on firm performance (e.g., Fich 2005; Duchin et al. 2010; Agrawal and Chen 2017; with the exception of Francis et al. 2015). However, professor expertise is unique and heterogeneous. White et al. (2014) argues firms hire professor directors mostly because of their expertise, implying that they are not hired merely because they are professors. Our study complements the scant literature (Jiang and Murphy 2007; Cho et al. 2017; Chen et al. 2019) considering the impact of professor director heterogeneity. By focusing on professor directors' academic expertise, our study is also relevant to studies that stress the importance of director industry experience

(e.g., Kor and Misangyi 2008; Kor and Sundaramurthy 2009; Dass, Kini, Nanda, Önal, and Wang 2013; Gray and Nowland 2013; Wang, Xie, and Zhu 2015; Faleye et al. 2017).

Third, our study contributes to the extensive literature on board diversity. A long line of literature has shown board diversity could affect firm performance, albeit positively or negatively (e.g., Forbes and Milliken 1999; Hillman and Dalziel 2003; Anderson et al. 2011; Kim et al. 2014; Rhode and Packel 2014; Frijins et al. 2016). Many studies further explore the impact of individual director characteristics, such as gender, and also obtain mixed findings (e.g., Gul, Srinidhi, and Tsui 2008; Adams and Ferreira 2009; Srinidhi, Gul, and Tsui 2011; Gul, Srinidhi, and Ng 2011; Adams and Funk 2012; Ntim 2013; Levi, Li, and Zhang 2014; Liu et al. 2014; Chen et al. 2016). Our study provides interesting evidences contributing to the debate on the impact of board diversity, as we show that increasing board diversity only benefits corporate innovation when directors possess specific types of expertise and certain characteristics. Our study offers new insights to the literature on director characteristics, highlighting the interactive and synergetic dynamics of different director expertise and characteristics in affecting innovation outcomes.

The remainder of this paper is organized as follows. We review related literature in the next section. In Section 3, we develop our hypotheses. We describe the sample and present descriptive statistics in Section 4. Section 5 provides our empirical analysis, and Section 6 discusses our additional analysis and robustness tests. The last section provides our conclusions.

2. Related literature

Corporate innovation and its relation to corporate governance mechanisms

The literature on corporate innovation is extensive and prior studies have investigated various industry-level and firm-level determinants of corporate innovation.[5] On the contrary, research

[5] Studies that link innovation with industry environment and firm operations have examined industry

related to the governance effect on innovation is relatively scarce. Atanassov (2013) examines the impact of corporate governance on innovation by documenting how the passing of antitakeover laws decreased the number of patents for firms incorporated in states that passed such laws. Acharya, Baghai, and Subramanian (2014) show that wrongful discharge laws spur innovation and the creation of new firms. Fang, Tian, and Tice (2014) show that an increase in stock liquidity decreases firm innovation, and interpret the findings to indicate that an increased risk of hostile takeover and passive institutional investment in more liquid firms impede innovation. Aghion, Van Reenen, and Zingales (2013) find that greater institutional ownership is associated with more innovation but decreases managers' career risk. Hirshleifer et al. (2012) show that overconfident CEOs who are subject to fewer governance concerns invest more in innovation, resulting in more patents and patent citations for the firm. He and Tian (2013) show that firms covered by large numbers of analysts generate fewer patents, as analysts exert pressure on managers to meet short-term earnings goals.

On the role of the board of directors on corporate innovation, Hoskisson et al. (2002) show the profiles of board of directors shape corporate innovative strategies. Kor (2006) shows that both top management and board composition have direct additive effects on R&D investment intensity. However, Baysinger et al. (1991) and Balsmeier et al. (2017) show that monitoring by independent directors could make innovation less attractive to managers. Similarly, Faleye, Hoitash, and Hoitash (2011) document that intense monitoring by a board induces greater management myopia, resulting in decreased innovative activity. Kang, Liu, Low, and Zhang

concentration (e.g., Acs and Audretsch 1988), industry type (e.g., Hsu, Tian, and Xu 2014), risk and uncertainty (e.g., Caggese 2012), diversification (e.g., Cardinal and Opler 1995), and responsibility delegation within a firm (e.g., Dutta and Fan 2012). Many studies evaluate the importance of firms' corporate ownership structure in engendering innovative activities. For instance, researchers have examined ownership concentration (Francis and Smith 1995), private-to-public ownership (Bernstein 2015), leverage buyouts (Lerner, Sorensen, and Stromberg 2011), venture capitalist involvement (Chemmanur, Loutkina, and Tian 2014; Tian and Wang 2014), and mergers and acquisitions (Fulghieri and Sevilir 2011; Phillips and Zhdanov 2013; Bena and Li 2014; Seru 2014). Studies have also examined compensation and incentive schemes optimal for promoting innovation (e.g., Holthausen, Larcker, and Sloan 1995; Manso 2011; Ederer and Manso 2013; Baranchuk, Kieschnick, and Moussawi 2014; Chang, Fu, Low, and Zhang 2015).

(2018) find that friendly boards, in which the CEO and board of directors are more socially connected, increase innovation, especially when the firms' advisory needs are higher. Few studies also document information and knowledge transfer across firms via the board of directors. For examples, Balsmeier et al. (2014) provide evidence those executives who sit on the boards of other firms increase innovative activity at those firms when their own firms are innovative. Helmers et al. (2015) show that board interlocks, where directors sit on more than one board, have a significantly positive contagion effect on both R&D investment and patents. Oh and Barker (2018) find that CEOs who serve as independent board members at other firms imitate those firms' R&D strategies at their own firms.

The role of professor directors on corporate boards

Audretsch and Stephan (1996) and Audretsch and Lehmann (2006) argue that professor directors serve an important function on boards. The recent study by Fedaseyeu et al. (2018) finds directors with academic background are rewarded with higher compensation, indicating top management values the appointment of professor directors. However, studies examining the importance of professor directors on firm performance have mixed findings. For instance, Fich (2005) documents little market reaction to the appointment of professor directors. Duchin et al. (2010) find that professor directors do not improve firm performance. Agrawal and Chen (2017) do not find academics behave differently in boardroom disputes. Francis et al. (2015), on the other hand, find that the presence of professor directors on corporate boards is positively associated with various firm performance measures, including corporate innovation. Several studies that focus on professors from the business field also obtain mixed results. While Jiang and Murphy (2007) show that executives who are former business school professors have a positive impact on firm performance, Güner et al. (2008) find that finance professors have no

effect on most corporate decisions, except in connection with financial decisions such as executive pay.

Recent studies have begun to acknowledge the importance of professor director heterogeneity. A pioneering study by White et al. (2014) shows that the market responds favorably to the appointment of science, medicine, and engineering professors but has little reaction to the appointment of business school professors. Cho et al. (2017) document that firms with professor directors from specialized fields such as science, medicine, and engineering have higher corporate social responsibility (CSR) performance ratings. Chen et al. (2019) examine the contribution of professor directors to firm market value by looking at professor director resignations in the Chinese setting. While the authors document a negative market reaction for professor director resignation, they do not find stronger effect for R&D intensive firms, nor for resignations of academia from the business, law or engineering fields.

Board diversity and director characteristics on firm performance

Hillman and Dalziel (2003) argue different board of directors provide different levels of monitoring and resources to firms. As a result, research has shown that diversity affects board effectiveness and firm performance (e.g., Forbes and Milliken 1999; Kim et al. 2014). However, there are inconclusive evidences whether board diversity improves firm performance. For instance, Anderson et al. (2011) show that director heterogeneity brings a variety of backgrounds, experiences, and skills to the boardroom that improve monitoring. However, it also creates conflicts among board members and incur costs due to greater communication and coordination problem. Their empirical findings show positive association between board heterogeneity and firm performance for complex entities, though such association does not apply to less complex firms. Rhode and Packel (2014) review literature on board diversity and conclude only when diversity is well managed, it can improve corporate decision-making.

Frijin et al. (2016) examine the impact of cultural diversity of the board of directors on firm performance, and they find a negative effect when there is too much diversity on the board.

Many studies examine board diversity by focusing on certain director characteristics or experiences, examining how they affect directors' ability to govern and advise management. For example, a long line of research has focused on the role of female directors (e.g., Gul et al. 2008; Srinidhi et al. 2011; Gul et al. 2011; Adams and Funk 2012; Ntim 2013; Levi et al. 2014; Liu et al. 2014; Chen et al. 2016). Relating to firm performance, Adams and Ferreira (2009) show female directors have significant impact on board inputs, and they exert more effort on monitoring. However, the average effect of gender diversity on firm performance is negative. Ahern and Dittmar (2012) obtain similar findings with the imposition of mandated female board representation for Norwegian firms. Liu et al. (2014), examining the Chinese setting, document a positive relationship between board gender diversity and firm performance.

Another stream of research has focused on the importance of director industry experience (e.g., Kor and Misangyi 2008; Kor and Sundaramurthy 2009; Dass et al. 2013; Gray and Nowland 2013; Wang et al. 2015; Faleye et al. 2017). These studies generally conclude that director industry-specific experience is beneficial for firms. For example, Kor and Misangyi (2008) provide evidences experience supplemented by outside directors are essential especially for young, innovative firms. Dass et al. (2013) show the appointment of directors from related industries provide benefits due to the directors' information and expertise. A related stream of research has specifically looked at financial expertise (e.g., DeFond, Hann, and Hu 2005; Güner et al. 2008; Duchin et al. 2010; Cohen, Hoitash, Krishnamoorthy, and Wright 2014; Minton et al. 2014; Wang et al. 2015). The consensus of these studies is that financial expertise is also beneficial, particularly when directors with financial expertise sits on the audit committee (e.g., Defond et al. 2005; Cohen et al. 2014).

Lastly, directors also differ on other characteristics. For instance, they could have different levels of concerns for their reputation, which affects their monitoring incentives (e.g., Ferris, Jagannathan, and Pritchard 2003; Fich and Shivdasani 2006; Adams, Hermalin, and Weisbach 2010). Several studies have examined whether the directors are being foreign-born with overseas experiences (Miller and Triana 2009; Masulis, Wang, and Xie 2012; Gianetti, Liao, and Yu 2015; Estélyi and Nisar 2016). Other studies have looked into the amount of human capital possessed by the directors (Westphal 1999; Hillman and Dalziel 2003; Hwang and Kim 2009), or if the director is politically well connected (Agrawal and Knoeber 2001; Hillman 2005; Goldman, Rocholl, and So 2009; Boubakri, Guedhami, Mishra, and Saffar 2012; Cheng and Sun 2018).

3. Hypothesis development

We first conjecture that professors with polytechnic expertise are able to motivate firms to pursue innovative projects by sharing their advanced scientific knowledge and expertise. The economic and management literature has long established the importance of knowledge transfer from the academic community to society for technological advance (e.g., Jaffe 1989; Levin and Stephan 1991; Zucker, Darby, and Brewer 1998; Zucker, Darby, and Armstrong 2002; Kotha et al. 2013; Kaiser et al. 2018). Several studies (Audretsch and Stephen 1996; Audretsch and Lehmann 2006; White et al. 2014) have documented the strategic hiring of professor directors at firms where specific technical knowledge transfer is crucial. We believe that the specialized knowledge and expertise of a professor in the polytechnic field may be especially important for monitoring and advising management on corporate innovation. Moreover, their specific knowledge could be transferable to a variety of innovative projects, as Klevorick, Levin, Nelson and Winter (1995) show innovations exhibit strong links across tech industries. In addition, many of these professors desire to develop new technological ideas, a drive that

may be significant for corporate innovation and is hard to replicate with a non-academic director. For instance, Kaiser et al. (2018) show the hiring of scientists with university experiences in the research department has stronger effect on innovation output when compared to recruiting someone without academic experience. However, polytechnic professor directors may have conflicting institutional logics in terms of research goals and desired rewards (Dasgupta and David 1994; Sauermann and Stephan 2013). Moreover, polytechnic professor directors may find it more difficult to communicate in the boardroom, as they often lack practical business knowledge and experience. We propose and test our first hypothesis as follows:

H_{1A}: Professor directors with polytechnic expertise are associated with higher levels of corporate innovation.

Next, professors with financial expertise[6] may foster innovative corporate activity because their academic expertise helps them to better assess the costs and benefits of innovative projects. Innovation is usually costly, time-consuming with high chances of failure (Holmstrom 1989; Manso 2011), hence professor directors with financial expertise are particularly important in assessing the financial feasibility of innovation projects. Moreover, professor directors also tend to provide better governance than non-academic financial experts, because they have fewer conflicts of interest (Francis et al. 2015). Güner et al. (2008) find that many financial experts such as investment bankers have incentive conflicts that undermine their duties as board members. In addition, professors with financial expertise usually have some business experience, which can aid them in monitoring and advising management. This is especially true in the context of China, where academics from the business fields usually have practical work experiences (Cheng and Sun 2018). Lastly, Minto et al. (2014) also show that board members with financial expertise tend to have higher risk tolerance. Hence, professor

[6] We follow the literature (e.g., Custodlio and Metzger 2014) and define financial expertise as expertise in finance or in accounting. In our context, we classify professor directors with financial expertise as finance and accounting professors.

directors with financial expertise may encourage firms to engage in more innovative activities. Alternatively, they could be more willing to take risks only for investment and not for innovative projects, and they may not be able to contribute much because they do not understand complicated technological aspect of the processes. We present our second hypothesis is as follows:

H_{1B}: Professor directors with financial expertise are associated with higher levels of corporate innovation.

We conjecture professors with other business expertise in the economics or management fields help improve corporate innovation performance. Gittleman (2007) shows that knowledge transfer relies on a good network of researchers collaborating with each other, and Kotha et al. (2013) show coordination costs significantly influences whether an innovation project can be developed into commercialization outcomes. Hence, professor directors with expertise in organizations, operations and management can aid in improving the collaboration and coordination of innovation projects. However, like professors with financial expertise, the complicated technological processes may be too difficult for these professor directors to get actively involved and to contribute their specific management knowledge into these projects. Accordingly, our third hypothesis is as follows:

H_{1C}: Professor directors with economics or management expertise are associated with higher levels of corporate innovation.

We postulate that professors with legal expertise also improve corporate innovation. Directors with legal expertise can offer important advices especially with complex legal procedures (Agrawal and Knoeber 2001). However, although Gray and Nowland (2013) show that directors with legal expertise improve firm performance, Krishnan, Wen, and Zhao (2011) find mixed evidence. They find that the appointment of directors with legal expertise is associated with higher financial reporting quality when they serve on the audit committee, but

there is no impact when they serve on other committees. With respect to corporate innovation, the patenting process usually requires due diligence from a firm's legal department and a thorough understanding of related legal procedures. Directors with legal expertise can thus assist by providing advice throughout the patent application process. Moreover, these directors may be more vigilant in situations of patent infringement. While legal expertise can be obtained by appointing lawyers to the board (Linck, Netter, and Yang 2008), the literature has long debated the costs of having professional lawyers serve as independent directors (Albert 1996; Peloso et al. 1998; and Litov, Sepe, and Whitehead 2014). Lawyer directors usually have a business relationship with the firm and are less able to objectively assess board actions, especially if acting as outside counsel; they are also less able to monitor the managers and executives who pay their legal fees. It is therefore quite common to appoint law professors to corporate boards (White et al. 2014). Professors with legal expertise are also different from lawyers because they can offer a second legal opinion. This leads to our fourth hypothesis:

H_{1D}: Professor directors with legal expertise are associated with higher levels of corporate innovation.

We also conjecture that a professor director with other expertise may benefit corporate innovation due to the diversity they bring to the board. Forbes and Milliken (1999) and Francis et al. (2015) contend that professors think through problems differently and can provide other perspectives and more diversity to boards. Research has shown that board members with diverse backgrounds monitor and advise management differently, affecting firm performance (Beasley 1996; Monks and Minow 2006; Anderson et al. 2011; Kim et al. 2014; Rhode and Packel 2014; Frijins et al. 2016). In terms of corporate innovation, we conjecture professors' desire to obtain new knowledge may mean they are more receptive to innovative projects. Moreover, professors are highly educated, so they should be able to assess an innovative project even outside their main area of expertise. Chen et al. (2019) further show professor directors

bring value to the boardroom, and it does not matter whether these professors are from engineering, business, law or other fields. In the team behavior literature, Johnson, Van de Schoot, Delmar, and Crano (2015) show dissenting minority members in a group who share different opinions with the majority can improve performance via creativity and innovation. Nevertheless, professor directors with other expertise may be too idealistic in nature and may lack practical experience, or their expertise may not be too remote to be relevant to understanding the technological processes. Hence, we present our fifth hypothesis as follows:

H_{1E}: Professor directors with other expertise are associated with higher levels of corporate innovation.

We further examine the complementarity of professor directors with different areas of academic expertise. We focus exclusively on professor directors and their academic expertise, and conjecture that appointing professor directors with different areas of academic expertise to the same board further engenders corporate innovative activity because of the potential for synergy and the benefits of diversity when each professor contributes his/her unique knowledge to projects. For instance, while professors with financial expertise can better assess the expected costs of innovative projects, professors with legal expertise can advise on the legal implications of the patenting process. Moreover, professor directors may be more willing to communicate and collaborate with each other than with non-academic directors because they share similar educational backgrounds and academic experience. However, increasing diversity could create conflicts and problems in communication and coordination (Anderson et al. 2011). This leads to our next hypothesis:

H_2: Having professor directors with different areas of academic expertise on the same board creates synergy potential for corporate innovation.

Lastly, we examine the effect of professor directors' individual characteristics. Specifically, we examine how the impact of the academic expertise of professor directors on

corporate innovation varies with their individual characteristics: educational background, university affiliation, gender, age, director experience and compensation, and activity on corporate boards. For instance, professors from overseas or top schools may have more insights, knowledge, and exposure to new ideas and new technology (e.g., Miller and Triana 2009). Moreover, professors who are more reputable working at prestige universities may be more concerned for their reputation and thus motivated to act as better monitors and advisors on the board (Trainor and Finnegan 2013). These educational and occupational characteristics may have a positive effect on professor directors applying their expertise on corporate innovation. We next examine factors that capture directors' personal characteristics. Women generally tend to be more conservative (e.g., Jianakoplos and Bernasek 1998; Barber and Odean 2001; Brooks and Zank 2005; Charness and Gneezy 2012) and some studies show female directors are no exception (e.g., Chen et al. 2016). Thus, female directors may be more reluctant to support innovative projects. Zajac and Westphal (1996) show older directors could be less likely to embrace newer perspectives; hence, they could be less open-minded to innovative projects. Lastly, we argue professor directors' experiences and their involvement on the boards matter. In general, directors' board experience may have a positive or negative effect, as professor directors may propose highly creative ideas when they first join a firm, but run out of new ideas as time goes by or as they join more firms. Director compensation is expected to have a positive effect, as it helps align the interests of directors and firms. Such would be especially true for professor directors, who tend to earn less from their teaching positions relative to the salaries of non-academic directors. Moreover, professor directors serving on some particular committees on corporate board may have a different effect on innovation. For instance, professor directors who serve on the strategy or budget committee may obtain better insights on the firm's innovation goals and implementation strategies, so they may be more open to innovation ideas. Vefeas (1999b) also shows board nominating committee exerts an impact on

firms' corporate governance. We hypothesize that the impact of academic expertise on corporate innovation varies with professor directors' individual characteristics, and present our last hypothesis as follows:

H_3: The impact of academic expertise on corporate innovation varies with professor directors' individual characteristics.

4. Sample and descriptive statistics

Our sample covers all Chinese publicly listed firms (A shares) over the period 2011-2014 in the China Stock Market & Accounting Research database. We focus on a sample period beginning in 2011 when China became the top patent filing country. We end our sample in 2014, as we need patent data for up to three years ahead to 2017. We start with an initial sample of 9,478 firm-year observations. We then eliminate 3,025 firm-year observations retaining firms in manufacturing or high technology industries, because firms in other sectors typically do not register patents (Balsmeier et al. 2014). We further eliminate 820 firm-year observations with missing financial and/or governance data. Our final sample includes 5,633 firm-year observations. We hand-collect information on professor directors from annual reports and the websites of their affiliated universities. The number of firm-year observations with at least one independent professor director on the board is 4,583 (81.36%). Table 1, Panel A, outlines the sample selection process and describes the sample distribution for firm-year observations. Panel B shows the distribution of total professor-year observations. For the firm-year observations with one or more professor directors on a board, we have 10,924 professor-year observations. After excluding observations with missing professor characteristics data, our final sample consists of 7,005 professor-year observations. There are 2,954 observations that belong to professor directors with financial expertise, followed by 1,644 observations of professor directors with polytechnic expertise and 1,440 observations of professor directors

with economic or management expertise. Among firms with professor directors, many firms tend to appoint one professor director (2,207 professor-year observations). Nevertheless, it is also extremely common for Chinese firms to have two or three professor directors (2,899 and 1,495 observations respectively) on the same board.[7] It is rare for firms to appoint five or more professor directors to the same board (i.e., only 60 observations).

[Insert Table 1 about here]

Table 2, Panel A, presents descriptive statistics for firm-year observations. We measure our dependent variables, innovation output *(Patent)* and success *(Citation)*, respectively by the natural log of one plus the total number of patent applications obtained and citations in years *t+1, t+2 and t+3* over the period of 2012-2017. We report an average of 15.64 ($e^{2.8121}$-1) and a median of 18 ($e^{2.9444}$-1) patent applications obtained at time *t+1*. The corresponding average and median of patent citations are 6.94 ($e^{2.0311}$-1) and 7 ($e^{2.0794}$-1) at time *t+1*. The averages and medians of patent applications obtained and citations are slightly higher at time *t+2* and *t+3*, reflecting the trend of increasing patent activities in China. We present definitions for these variables as well as other variables used in the empirical analysis in the Appendix.

[Insert Table 2 about here]

We use three sets of variables to capture the influence of professor directors' academic expertise on corporate innovation. We first represent the presence of professor directors on a corporate board with a dummy variable *(Prof)* that equals to one if a firm has at least one professor director on its board. *Prof_Tech*, *Prof_Fin*, *Prof_Bus, Prof_Law*, and *Prof_Other* respectively represent the presence of professor directors with polytechnic, financial, economic or management, legal, and other expertise on the board. We define professor directors with polytechnic expertise as professors in the life science, physics, chemistry, biology, medicine,

[7] Compared to the findings of Francis et al. (2015) on S&P firms, Chinese firms seem more likely to appoint more than one professor director. Francis et al. (2015) show that for firms with professor directors, 77% have only one professor director, 19% have two, and 4% have more than two. Our sample shows 48% have only one professor director and the remaining 52% of firms have two or more.

engineering and information technology fields. Professor directors with financial expertise include finance and accounting professors. We classify professor directors with other business disciplines (i.e., economics, management, marketing, human resource, organizational behavior, strategy, operation management, etc.) in the third category. Professor directors with legal expertise includes law professors. Lastly, we classify professors with other expertise (i.e., arts, philosophy, journalism, literature, language, political science, etc.) in our last category. Panel B of Table 2 shows, on average, 48.34% of the sample firms have at least one professor director with financial expertise, followed by professor directors with polytechnic expertise (31.87%), economic or management expertise (26.40%), and legal expertise (15.09%). The proportion of professor directors with other expertise serving on corporate boards is very low (3.37%).

We next measure the influence of professor directors by the number of professor directors on the board *(Sum_Prof)* and the ratio of the number of professor directors to the total number of independent directors on the board (*Ratio_Prof)*. Broome, Conley, and Krawiec (2011) argue that critical mass matters in the boardroom. Liu et al. (2015) show both the number and the ratio of outside independent directors are important because, unless a critical mass is reached, they find that minority directors do not exert any significant impact on corporate decisions and outcomes. In particular, they show solo independent director (i.e., firms with only a single independent director) merely serves as a token on boards with no significant impact on ROA. Liu et al. (2014) examine the effect of female directors on firm performance in Chinese firms and find the effect becomes more significant when there are three or more female directors. Panel B of Table 2 shows the average number of professor directors, *Sum_Prof,* is 1.3881. *Sum_Tech, Sum_Fin, Sum_Bus, Sum_Law*, and *Sum_Other* represent respectively the number of polytechnic, financial, economics or management, law, and other professor directors on a corporate board. The average ratio of professor directors, *Ratio_Prof,* is 43.64% out of the total number of independent directors. *Ratio_Tech, Ratio_Fin, Ratio_Bus, Ratio_Law*, and

Ratio_Other represent respectively the ratio of polytechnic, financial, economics or management, law, and other professor directors to the total number of independent directors on a corporate board.

Panel C of Table 2 reports descriptive statistics of the firm control variables in our multivariate analysis. *Size*, measured by the natural log of the book value of total assets, has a mean of 21.65. *Leverage* is measured by the ratio of debt to total assets. Mean leverage of our sample is 38.51%. *ROA,* return on total assets, has a mean of 4.78%. *PPE* measures firms' property, plant, and equipment, scaled by total assets, and it has a mean of 0.23. *Firm_Age* is the natural log of firm age in years. It has a mean of 2.54, indicating an average firm age of 12.73 years. *State_Owned*, a dummy variable that equals to one if the firm is a state-owned enterprise controlled by the government, has a mean of 32.22%. We also include variables capturing firms' governance features and we report their descriptive statistics in Panel D. *Independent* has a mean of 37.14%, implying slightly more than one-third of the board comprises of independent outside directors. *Inside_Owned,* the percentage of share ownership by top management, has an average of 6.19%. *Institution_Owned,* the percentage of institutional ownership, has an average of 34.96%. The average *Board_Size* in natural log terms is 2.14, implying the average number of directors on the board is about 8.54. The natural log number of board meetings averages 2.13, which translates to an average of 8.45 meetings annually. Lastly, we include the financial expertise of executive chair and CEO, which are indicator variables that equal to one if the executive chair and the CEO has a financial background. The ratios are quite low, with means of 0.13 and 0.14 respectively.

Table 3 presents the descriptive statistics of the professor directors' characteristics for the professor-year observations. We examine various characteristics of the professor directors. *Overseas* is a dummy variable that equals to one if the professor director obtained his/her terminal degree overseas or has occupied visiting or post-doctoral positions at an overseas

university. There exists 31.46% of the observations with overseas educational backgrounds. *Top_U* is a dummy variable that equals to one if the professor director works at a university that is classified as a top university in China.[8] An average of 39.07% of the observations are from the top universities in China. *Female* equals to one if the professor director is female, and we find that 15.92% of the observations belong to female directors. *Ln_Age* measures the natural log age of the professor director and these professor directors have a mean age of about 52 years old ($e^{3.9484}$). *Ln_Work* measures the natural log of the number of firms in which the professor holds a position as a director (or as consultant, advisor etc.) and it averages 3.39 firms ($e^{1.2197}$) for each professor director. We also include board-specific professor characteristics: *Ln_Comp*, the natural log of the compensation amount received for serving on the board. *Audit_Committee* is a dummy variable that equals to one if the professor director serves on the audit committee. Finally, *Other_Committee*, is a dummy variable if the professor director serves on the compensations, strategy, nominations, or budget committee.

The next sections of Table 3 present the descriptive statistics of the characteristics of professor directors with different areas of academic expertise. We find that the highest proportion of overseas background is from professor directors with polytechnic expertise (37.04%) and the highest proportion of prestige university affiliation is from economics or management professor directors (49.51%). Female professor directors are more likely to have financial expertise (23.53%). Not surprisingly, professor directors with financial and legal expertise have more extensive experience serving on corporate boards (with respective mean log experience of 1.46 and 1.36), and professor directors with financial expertise are as expected the most likely to sit on the audit committee (74.48%). The likelihood of professor

[8] We define top universities as the 39 universities that are under the sponsorship of Project 985. The Project 985 was initiated in 1998 by the Chinese government to promote the development and to raise the reputation of the Chinese higher education system. Alternatively, in results unreported we use the list of top 20 universities from the China University Evaluation Report issued by the Alumni Association of China in 2013. Our findings are similar with the use of the two proxies of top universities.

directors sitting on other committees (strategy, compensations, nominations, or budget) varies across different academic disciplines, ranging from 71% to 86%.

5. Empirical findings

The effect of professor directors on corporate innovation

We first present our baseline analysis of the importance of professor directors for corporate innovation. We conduct multivariate analysis on the impact of professor directors on corporate innovation, controlling for firm-level factors and governance features that might affect corporate innovation activities. We run the following OLS regression specification with industry and year fixed effects:

$$\begin{aligned} \textit{Patent (Citations)} = {} & a + b_1\, \textit{Prof} + b_2\, \textit{Size} + b_3\, \textit{Leverage} + b_4\, \textit{ROA} + b_5\, \textit{PPE} \\ & + b_6\, \textit{Firm\_Age} + b_7\, \textit{State\_Owned} + b_8\, \textit{Independent} \\ & + b_9\, \textit{Inside\_Owned} + b_{10}\, \textit{Institution\_Owned} \\ & + b_{11}\, \textit{Board\_Size} + b_{12}\, \textit{Board\_Meet} \\ & + b_{13}\, \textit{Chair\_Fin\_} + b_{14}\, \textit{CEO\_Fin} + \varepsilon \end{aligned} \quad (1)$$

Following Francis et al. (2015), we expect a positive and significant coefficient for b_1. We include firm-level control variables suggested by prior work (e.g., Hill and Snell 1988; Baysinger and Hoskisson 1990; Hall and Ziedonis 2001; Balsmeier et al. 2014; Liu et al. 2015; Faleye et al. 2017), including *Size, Leverage*, *ROA*, *PPE*, and *Firm_Age*.[9] We also include the variable *State_Owned* because of the special operating environment for Chinese state-owned enterprises (e.g., Chen, Sun, Tang, and Wu 2011; He, Wong, and Young 2012; Liu et al. 2015; Ma and Khanna 2016; Zhu et al. 2016). For board governance features, we include *Independent* (e.g., Anderson, Mansi, and Reeb 2004; Liu et al. 2015), *Inside_Owned* (e.g., Mahoney,

[9] We follow prior studies (e.g., Kaiser et al. 2018) for not including R&D spending in our main specification because it is highly correlated with innovation output measures. In an unreported analysis, we investigate the effect of professor directors on R&D spending, and obtain qualitatively similar findings as using patent activities as the dependent variables.

Sundaramurthy, and Mahoney 1997; Kor 2006), *Institution_Owned* (e.g., Hoskisson et al. 2002; Kor 2006), *Board_Size* (e.g., Yermack 1996; Anderson et al. 2004; Liu et al. 2015), and *Board_Meet* (e.g., Vefeas 1999a). We also include *Chair_Fin* and *CEO_Fin*, as there are some executive chairs and CEOs in China have financial background. Kor and Misangyi (2008) argue outside expertise is particularly important when such skills and expertise are lacking from top management.

Table 4 reports our findings, with Panel A & B presenting results with *Patent* and *Citations* as dependent variables respectively. In the first column of Panel A, we find that the coefficient of *Prof* is marginally significant (at the 10% level), indicating a positive association of the presence of professor director and patent output at time *t+1*. Our finding is weakly consistent with Francis et al. (2015), who find that the appointment of professor directors improves corporate innovation in the U.S. setting. Of the firm-level control variables, we find that *Size* and *Leverage* have significant positive and negative effects respectively on corporate innovation. We also find that better-performing firms with higher *ROA* are likely to obtain more patents. *PPE* has a negatively significant association with patent output, which indicates a substitution effect between tangible and intangible investment. As expected, innovation output is higher at younger firms. Lastly, we do not find any difference in innovation output for state-owned and non-state-owned enterprises. Of the governance variables, both insider and institutional ownership have positive and significant effects on corporate innovation. We also show the number of board meetings is positively related to innovative output.

[Insert Table 4 about here]

We next examine the impact on corporate innovation output of having *more* professor directors on a board. We replicate specification (1) by replacing the variable *Prof* with *Sum_Prof* and *Ratio_Prof*, and the results of the regression analysis are reported in the second and third columns of Table 4 respectively. We now find that the coefficients of b_1 are highly

significant and positive (at the 1% levels). The results imply that having more than one professor director and a higher representation of academics on the board is beneficial for corporate innovation. The remaining columns of Panel A report the empirical results using patent output at time *t+2* and *t+3* as dependable variables. We find similar results that the number and the proportion of professor directors are positively related to corporate innovation.

Panel B of Table 4 reports the results for patent citations. We obtain significant coefficients for *Prof*, *Sum_Prof* and *Ratio_Prof*, associating with higher patent citations across all years. Moreover, the coefficients are all higher than the coefficients reported in Panel A. Of the firm-level control and governance variables, we continue to find *Size*, *Leverage*, *PPE*, *Firm-Age*, *Institution_Owned*, and *Board_Meet* exert significant impact on corporate innovation.

Academic expertise and corporate innovation

Studies that have treated professor directors as a homogenous group have overlooked the impact of academic expertise on corporate innovation. In our main analysis, to test the first set of hypotheses (H_1), we augment specification (1) by replacing *Prof* with dummy variables of professors with different areas of academic expertise:

$$\textit{Patent (Citations)} = a + b_{1A}\,\textit{Prof\_Tech} + b_{1B}\,\textit{Prof\_Fin} + b_{1C}\,\textit{Prof\_Bus} + b_{1D}\,\textit{Prof\_Law} + b_{1E}\,\textit{Prof\_Other} + b_{2\text{-}14}\,\textit{Controls} + \varepsilon \quad (2)$$

Table 5 reports the results of our main analysis. For brevity, we do not report the results of the firm-level and governance variables. The first column of Panel A presents the findings concerning the impact of the presence of professor directors with different areas of academic expertise on corporate innovation output. We find that the coefficient of *Prof_Tech* is positive and highly significant (at the 5% level), indicating that the presence of professor directors with polytechnic expertise improves corporate innovation. Our findings provide evidence that professor directors' academic expertise in the polytechnic field is a significant determinant of

corporate innovation, and is consistent with the view that academic scientific expertise may be of great importance and have real-life application to firms seeking knowledge transfer to develop or improve their research capabilities. Moreover, our findings explain prior findings by White et al. (2014) that the market views the appointment of professor directors with polytechnic expertise more positively at high-tech firms.

[Insert Table 5 about here]

We find that the coefficient of *Prof_Fin* is positive and highly significant (at the 1% level). We attribute the significance of financial expertise for corporate innovation to these professor directors being better able to assess the economic benefits of innovative projects, leading to higher number of patent applications obtained. Moreover, professor directors with financial expertise could be more accepting to risky innovative projects. The findings may also indicate these professor directors possess business experience and are better able to communicate with others in the boardroom. Interestingly, the impact of professor directors with financial expertise is significantly statistically larger than the impact of professor directors with polytechnic expertise. Overall, the findings imply that professor directors with financial expertise play a prominent role in advising and monitoring innovative projects.

Contrary to our conjectures, we do not find professor directors with economics or management, legal and other expertise have any consistent impact on corporate innovation. These results suggest that it is the specialized knowledge transfer of professor directors with polytechnic and financial expertise, rather than the wider range of ideas contributed by greater board diversity, that engenders corporate innovation. Finally, the remaining columns of Table 5 yield very similar findings when we replace our dummy variables with the number and ratio of professor directors in each academic discipline, and when we examine the longer-term impact of innovation output at time $t+2$ and $t+3$.

In Panel B of Table 5, we report the results of patent citations. We continue to observe

significant association between professor directors with polytechnic and financial expert with corporate innovation. However, the impact of professor directors with polytechnic expertise is now significantly statistically larger than the impact of professor directors with financial expertise. The results imply professor directors of financial expertise may be better in advising and monitoring through the patent application processes, but polytechnic professors contribute more to the success and quality of these patents obtained. Interestingly, we now also find professor directors of other academic expertise is negatively associated with patent citations. The results may imply dissenting ideas or opinions could be detrimental to the innovative process when these ideas seem too far-fetched to be applicable to the innovative projects.

Synergy potential of different areas of academic expertise

The findings in Table 5 suggest that specialized knowledge transfer by professor directors with polytechnic and financial expertise engenders innovation. In this section, we test our second hypothesis (H_2), focusing on the synergy potential and diversity effect of polytechnic and financial expertise. We argue professor directors with financial expertise may help those with polytechnic expertise to better understand the financial implications of innovative projects and better communicate their knowledge and findings to the rest of the board. At the same time, professor directors with polytechnic expertise may also help those with financial expertise to better assess the technical feasibility of projects and evaluate resource allocation.[10]

We modify specification (2) by focusing on professor directors with polytechnic and financial expertise, *Prof_Tech* and *Prof_Fin*, and capture the synergy and diversity effect between these professor directors with the interaction term *Prof_Tech*Prof_Fin*:

$$\textit{Patent (Citations)} = a + b_{1A}\, \textit{Prof\_Tech} + b_{1B}\, \textit{Prof\_Fin} + b_{1C}\, \textit{Prof\_Tech*Prof\_Fin}$$

[10] In an unreported analysis, we examine the interaction effects of professor directors with all forms of expertise. However, we do not find any significance for the interaction terms that relate to the other academic expertise. For brevity, we do not report these results, but they are available upon request.

$$+ b_{2\text{-}14}\, Controls + \varepsilon \qquad (3)$$

Table 6 reports the regression results, with Panel A presenting the findings for patent output. We find that the coefficients of the interaction term b_{1C} is mostly insignificant when we only look at *Prof_Tech*Prof_Fin*. At first glance, it seems to indicate there is little synergy effect between professor directors of different academic disciplines. However, when we consider the sum and ratio of these professor directors, we find all the coefficients of the interaction term b_{1C} are positive and highly significant (at the 1% or 5% levels). These findings imply that appointing professors with polytechnic and financial expertise to the same board is extremely beneficial for corporate innovation when it reaches a critical mass. Such benefits stem from the increasing number and representation of professor directors with polytechnic and financial expertise. Interestingly, concerning the main effect, while the coefficient of *Prof_Fin* remains significant in most columns, the coefficient of *Prof_Tech* is no longer significant. One possible interpretation of this finding is that professor directors with polytechnic expertise, while contributing their specific knowledge to innovative projects, may benefit substantially by having other professor directors with financial expertise on the same board to help communicate and facilitate knowledge transfer.

In Panel B of Table 6, we present results of examining the interaction effect on patent citations. We obtain very interesting and different findings. The interaction terms are no longer significant in most columns, and the coefficients of professor directors with polytechnic expertise remain highly significant (at the 1% levels) in all regressions. These results show that professor directors with polytechnic expertise represent one of the most important drivers of innovation success. While professor directors with financial expertise can help with the patent application processes, polytechnic professor directors utilize their specific knowledge to contribute practical ideas and advices that improve the quality of the innovation.

[Insert Table 6 about here]

Individual characteristics of professor directors and corporate innovation

In this section, we test our third hypothesis (H_3) by examining the individual characteristics of professor directors with different areas of academic expertise and explore the determinants most conducive to corporate innovation. Once again, we focus on professor directors with polytechnic and financial expertise, and evaluate the relative importance of their professor directors' characteristics on corporate innovation. We examine both professional and personal characteristics, and their involvement on corporate boards. We run the following specification:

$$\begin{aligned} \textit{Patent (Citations)} = {} & a + b_1\, \textit{Overseas} + b_2\, \textit{Top\_U} + b_3\, \textit{Female} + b_4\, \textit{Ln\_Age} \\ & + b_5\, \textit{Ln\_Work} + b_6\, \textit{Ln\_Comp} + b_7\, \textit{Audit\_Committee} \\ & + b_8\, \textit{Other\_Committee} \\ & + b_9\, \textit{Audit\_Committee*Other\_Committee} + b_{10\text{-}22}\, \textit{Controls} + \varepsilon \quad (4) \end{aligned}$$

As discussed earlier, we expect that professor directors' educational background and university affiliation, as measured by *Overseas* and *Top_U*, have positive impact on corporate innovation. We include gender and age, as measured by *Female* and *Ln_Age*, because studies have shown that they are important director personal characteristics that affect board policies and firm performance (e.g., Zajac and Westphal 1996; Adams and Ferreira 2009). We use *Ln_Work* and *Ln_Comp* to capture professor directors' experience and incentives. Lorsch and MacIver (1989) show that most of a board's function is performed by committee subgroups. We use dummy variables *Audit_Committee* and *Other_Committee* to capture whether the professor director sits on the audit committee or other committees on the current board (compensation, strategy, nominations or budget). We separate audit committee because such committee requires specific financial expertise to oversee financial reporting (e.g., Defond et al. 2005) and because the audit committee may have objectives that conflict with the other committees (Hoitash and Hoitash 2009). Lastly, we also include the interaction term of

Audit_Committee and *Other_Committee* because of such conflicting objectives.

In Panel A of Table 7, we present regression results for professor directors with polytechnic expertise. The first (last) three columns report results of director characteristics on patent output (citations). While we find some evidences that professor directors with polytechnic expertise from top universities (*Top_U*) is associated with higher patent output at time *t+1*, we obtain stronger and consistent impact of *Overseas* and *Top_U* on patent citations across time *t+1* to *t+3*. The findings imply polytechnic professors with an overseas background or from a top university are most effective in improving the quality of corporate innovation.

[Insert Table 7 about here]

We present regression results for professor directors with financial expertise in Panel B of Table 7. For these professor directors, we find that director compensation is significantly positively related to innovation in terms of both output and citations, suggesting that monetary rewards help align the interests of these professor directors and the firms. We also observe that *Top_U* is marginally significant (at 10% levels) in increasing patent output at time *t+2* and *t+3*. In contrast to the insignificant results of gender and age for directors with polytechnic expertise, we note that female directors and older directors with financial expertise have a negative impact on patent citations. This result is consistent with prior research showing that they are more risk-averse (e.g., Chen et al. 2016). Interestingly, the coefficient of *Audit_Committee* is marginally significant (at 10% levels) on patent citations. One possible explanation of these findings is that audit committee members with financial expertise are more professional and more adaptable to changes and innovation (Benjamin and Karrahemi 2013).

Overall, the findings in Table 7 show that individual characteristics of professor directors have differential impacts on innovation. Furthermore, there are notable characteristic differences between professor directors with polytechnic and professor directors with financial expertise in engendering innovation.

6. Additional and robustness analysis

Professor directors' academic expertise on types of patents

The State Intellectual Property Office (SIPO) in China further classifies patents into three types: *Invention*, *Utility* and *Design*. An invention patent is granted for new technologies for a product or process. A utility model patent is granted for improvements to an existing product or process, usually with a lower degree of inventiveness. A design patent is granted for innovations in the external features or design of a product. We are able to obtain the number of patent applications by the types of patents, though citation data is not available at the level of patent types. We conjecture that professor directors with certain academic expertise would be more effective in the innovative processes with regard to particular type(s) of patents. Table 8 reports the findings. We report the results for invention patents in Panel A. We find that professor directors with polytechnic and financial expertise are both associated with the number of invention patent applications obtained, but the coefficients of polytechnic professor directors are higher than the coefficients of financial professor directors in all regressions. We also find the coefficients of professor directors with legal expertise are marginally significant (at 10% levels) for most columns. We also find that professor directors of other expertise has a weakly significant (at 10% levels) negative relationship with patent output for most columns.

[Insert Table 8 about here]

We report the results of utility and design patents in Panels B & C respectively. We find that only professor directors with financial expertise improve the patent output in terms of utility model patents. Lastly, we obtain interesting findings that design patent outputs are most strongly related to professor directors with economics or management expertise. We believe this finding can be attributed to certain management expertise (such as marketing) being useful in the design of a product. Overall, the findings in Table 8 show particular knowledge or skills

is needed to facilitate different innovation processes. The findings highlight corporate innovation is also not homogenous and stress the importance of different academic expertise in different innovative projects.

Propensity score matching

Directors are appointed to corporate boards for their expertise, instead of being randomly chosen (Coles, Daniel, and Naveen 2008). Previous studies (e.g., Audretsch and Stephen 1996; Audretsch and Lehmann 2006; White et al. 2014) have identified concerns over reverse causality of professor directors, as firms that focus on specific corporate objectives may prefer to appoint professor directors with specific expertise to aid them in devising such corporate strategies. For instance, the demand for corporate innovation may be why our sample firms appoint professor directors with polytechnic expertise in the first place. To alleviate this endogeneity concern, we first adopt a propensity score matching design. For each firm with a professor director of polytechnic or financial expertise, we match it with a firm without these professor directors. We calculate the propensity scores using the firm-level controls and governance features. Our results with this alternative analysis, presented in Table 9, report the findings. In particular, we continue to show that both professor directors with polytechnic and financial expertise increase patent output. However, we find only polytechnic professor directors are positively significantly associated with patent success by citations.

[Insert Table 9 about here]

Instrumental variable approach

We also use instrumental variable regressions to alleviate the endogeneity concern. We use two variables as instruments. First, we calculate the distance between the firms' headquarters and the universities affiliated with the professor directors of polytechnic or financial expertise. We

choose this variable as an instrument because corporate innovation should be unaffected by the distances between the firms and the universities, unless there exists knowledge transfer between firms and academia. Second, we use the number of top universities in the same province as the firms' headquarters as an instrumental variable, as university affiliation is an important factor in the relationship between professor directors and corporate innovation. Our first stage regressions (un-reported) show the instruments significantly explain the presence, sum and ratio of professor directors with polytechnic or financial expertise on boards. We present the second stage results in Table 10. In Panel A, we show that professor directors of polytechnic expertise continue to exert significant impact on patent output. In Panel B, we once again observe they exert significant impact on patent citations, with higher coefficients when compared to output. Panels C and D report the results for professor directors with financial expertise. We find that they significantly improve patent output, but not citations.

[Insert Table 10 about here]

7. Concluding remarks

This paper presents evidence for the impact of professor directors and their academic expertise on corporate innovation. Our findings show that firms with professor directors on their boards report higher levels of innovative activities. More importantly, the impact of professor directors varies according to their academic expertise, as we find that only professor directors with polytechnic and financial expertise are associated with greater corporate innovation. Our results establish the significance of professor directors' polytechnic expertise for firms that seek knowledge transfer to develop or improve their research capabilities. Our results also highlight the importance of financial expertise in the context of corporate innovation, in that professor directors with financial expertise can help assess the financial benefits of innovative projects. Furthermore, we observe a synergy and diversity effect between these professor directors, as

the level of corporate innovation output is substantially higher when a firm increases the representation of both professors with polytechnic expertise and those with financial expertise serving on the same board. This result highlights the benefits of director heterogeneity and collaboration when the directors possess the right skills and expertise. Lastly, we have explored how the impact of academic expertise on corporate innovation varies with professor directors' individual characteristics.

Overall, our findings indicate that corporate innovation is enhanced by more than the mere presence of professor directors. Corporate innovation depends on the specifics of their academic expertise and individual characteristics. Firms can achieve innovation success with the aid of professor directors who possess specific knowledge or skills relevant to the innovative projects. Board composition is also critical to utilize the diversity and synergy effect of these professor directors. Importantly, our study demonstrates the importance of professor director heterogeneity in engendering corporate innovation.

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APPENDIX: Variable Definitions

Innovation	
$Patent_{t+1}$	Natural logarithm of one plus firm *i*'s total number of patents obtained in year *t+1*
$Patent_{t+2}$	Natural logarithm of one plus firm *i*'s total number of patents obtained in year *t+2*
$Patent_{t+3}$	Natural logarithm of one plus firm *i*'s total number of patents obtained in year *t+3*
$Citation_{t+1}$	Natural logarithm of one plus firm *i*'s total number of patent citations in year *t+1*
$Citation_{t+2}$	Natural logarithm of one plus firm *i*'s total number of patent citations in year *t+2*
$Citation_{t+3}$	Natural logarithm of one plus firm *i*'s total number of patent citations in year *t+3*
Professor Director and Academic Expertise	
Prof	Dummy variable that equals to one if firm *i* has at least one professor director on the corporate board at time *t*
Prof_Tech	Dummy variable that equals to one if firm *i* has at least one professor director with polytechnic expertise on the corporate board at time *t*
Prof_Fin	Dummy variable that equals to one if firm *i* has at least one professor director with financial expertise on the corporate board at time *t*
Prof_Bus	Dummy variable that equals to one if firm *i* has at least one professor director with economics or management expertise on the corporate board at time *t*
Prof_Law	Dummy variable that equals to one if firm *i* has at least one professor director with legal expertise on the corporate board at time *t*
Prof_Other	Dummy variable that equals to one if firm *i* has at least one professor director with other expertise on the corporate board at time *t*
Sum_Prof	Number of professor directors for firm *i* at time *t*
Sum_Tech	Number of professor directors with polytechnic expertise for firm *i* at time *t*
Sum_Fin	Number of professor directors with financial expertise for firm *i* at time *t*
Sum_Bus	Number of professor directors with economics or management expertise for firm *i* at time *t*
Sum_Law	Number of professor directors with legal expertise for firm *i* at time *t*
Sum_Other	Number of professor directors with other expertise for firm *i* at time *t*
Ratio_Prof	Number of professor directors to total number of independent directors for firm *i* at time *t*
Ratio_Tech	Number of professor directors with polytechnic expertise to total number of independent directors for firm *i* at time *t*
Ratio_Fin	Number of professor directors with financial expertise to total number of independent directors for firm *i* at time *t*
Ratio_Bus	Number of professor directors with economics or management expertise to total number of independent directors for firm *i* at time *t*
Ratio_Law	Number of professor directors with legal expertise to total number of independent directors for firm *i* at time *t*
Ratio_Other	Number of professor directors with other expertise to total number of independent directors for firm *i* at time *t*
Firm-Level Controls	
Size	Natural logarithm of book value of total assets at time *t*
Leverage	Leverage ratio, defined as book value of debt divided by book value of total assets at time *t*
ROA	Net income divided by total assets at time *t*
PPE	Property, plant, and equipment scaled by total assets at time *t*
Firm_Age	Natural logarithm of firm age in years since the founding date to time *t*
State_Owned	Dummy variable that equals to one if firm *i* is a state-owned enterprise at time *t*
Governance Features	
Independent	Fraction of independent directors on the corporate board at time *t*
Inside_Owned	Proportion of shares owned by insiders to outstanding shares at time *t*
Institution_Owned	Proportion of shares owned by institutional owners to outstanding shares at time *t*
Board_Size	Natural logarithm of number of directors on the corporate board at time *t*
Board_Meet	Natural logarithm of the number of board meetings for fiscal year *t*
Chair_Fin	Dummy variable that equals to one if the executive chair of firm *i* has accounting or finance background
CEO_Fin	Dummy variable that equals to one if the CEO of firm *i* has accounting or finance background

Professor Director Characteristics	
Overseas	Dummy variable that equals one if the professor director at firm *i* has obtained his/her terminal degree at an overseas institution (including Hong Kong, Macau, and Taiwan), or has assumed the role of visiting scholar or post-doctoral fellow at an overseas institution
Top_U	Dummy variable that equals one if the professor director at firm *i* works at one of the top universities in China under Project 985
Female	Dummy variable that equals one if the professor director at firm *i* is female
Ln_Age	Natural logarithm of professor director's age at time *t*
Ln_Work	Natural logarithm of the number of firms in which the professor holds a position as a director (or as consultant, advisor etc.)
Ln_Comp	Natural logarithm of professor director's compensation for fiscal year *t*
Audit_Committee	Dummy variable that equals one if the professor director at firm *i* serves on the audit committee for fiscal year *t*
Other_Committee	Dummy variable that equals one if the professor director at firm *i* serves on the compensation, strategy, nominations, or budget committee for fiscal year *t*
Additional Variables	
$Invention_{t+1}$	Natural logarithm of one plus firm *i*'s total number of invention patents obtained in year *t+1*
$Invention_{t+2}$	Natural logarithm of one plus firm *i*'s total number of invention patents obtained in year *t+2*
$Invention_{t+3}$	Natural logarithm of one plus firm *i*'s total number of invention patents obtained in year *t+3*
$Utility_{t+1}$	Natural logarithm of one plus firm *i*'s total number of utility patents obtained in year *t+1*
$Utility_{t+2}$	Natural logarithm of one plus firm *i*'s total number of utility patents obtained in year *t+2*
$Utility_{t+3}$	Natural logarithm of one plus firm *i*'s total number of utility patents obtained in year *t+3*
$Design_{t+1}$	Natural logarithm of one plus firm *i*'s total number of design patents obtained in year *t+1*
$Design_{t+2}$	Natural logarithm of one plus firm *i*'s total number of design patents obtained in year *t+2*
$Design_{t+3}$	Natural logarithm of one plus firm *i*'s total number of design patents obtained in year *t+3*

Table 1: Sample Selection & Distribution

Panel A presents the sample selection process, as well as sample distribution for the firm-year observations. Panel B presents sample distribution for the professor-year observations.

Panel A	
Total firm-year observations of Chinese publicly listed firms (A shares) over the period of 2011-2014	9,478
Less: non-manufacturing and non-high technology industries	(3,025)
Less: missing financial data and/or governance data	(820)
Final sample of firm-year observations	5,633
Including:	
With professor directors	4,583
Without professor directors	1,050
	5,633
Panel B	
Total professor-year observations	10,924
Less: missing professor characteristics	(3,919)
Final sample of professor-year observations	7,005
Including:	
Polytechnic expertise	1,644
Financial expertise	2,954
Economics or management expertise	1,440
Legal expertise	826
Other expertise	141
	7,005
Single professor director	2,207
Two professor directors on the same corporate board	2,899
Three professor directors on the same corporate board	1,495
Four professor directors on the same corporate board	344
Five professor directors on the same corporate board	60
	7,005

Table 2: Descriptive Statistics of Firm Variables

This table presents the descriptive statistics of firm variables. Panel A presents the summary statistics of variables on corporate innovation. Panel B presents the summary statistics of variables on professor director and academic expertise. Panels C & D respectively present summary statistics of firm-level controls and governance features for the total sample of firm-year observations.

	N	Mean	Standard Deviation	Min	p25	Median	p75	Max
Panel A: Innovation								
$Patent_{t+1}$	5633	2.8121	1.6042	0.0000	1.7918	2.9444	3.8918	6.6682
$Patent_{t+2}$	5633	2.9433	1.6275	0.0000	1.9459	3.0445	4.0254	6.8035
$Patent_{t+3}$	5633	3.0456	1.6482	0.0000	2.0794	3.1781	4.1271	6.9431
$Citation_{t+1}$	5633	2.0311	1.8387	0.0000	0.0000	2.0794	3.4340	6.2480
$Citation_{t+2}$	5633	2.3937	2.0682	0.0000	0.0000	2.7081	4.0073	6.7957
$Citation_{t+3}$	5633	2.6233	2.2176	0.0000	0.0000	3.0910	4.3567	7.1373
Panel B: Professor Director and Academic Expertise								
Prof	5633	0.8136	0.3895	0.0000	1.0000	1.0000	1.0000	1.0000
Prof_Tech	5633	0.3187	0.4660	0.0000	0.0000	0.0000	1.0000	1.0000
Prof_Fin	5633	0.4834	0.4998	0.0000	0.0000	0.0000	1.0000	1.0000
Prof_Bus	5633	0.2640	0.4408	0.0000	0.0000	0.0000	1.0000	1.0000
Prof_Law	5633	0.1509	0.3580	0.0000	0.0000	0.0000	0.0000	1.0000
Prof_Other	5633	0.0337	0.1805	0.0000	0.0000	0.0000	0.0000	1.0000
Sum_Prof	5633	1.3881	0.9759	0.0000	1.0000	1.0000	2.0000	5.0000
Sum_Tech	5633	0.3568	0.5601	0.0000	0.0000	0.0000	1.0000	4.0000
Sum_Fin	5633	0.5517	0.6272	0.0000	0.0000	0.0000	1.0000	4.0000
Sum_Bus	5633	0.2895	0.5086	0.0000	0.0000	0.0000	1.0000	3.0000
Sum_Law	5633	0.1553	0.3743	0.0000	0.0000	0.0000	0.0000	2.0000
Sum_Other	5633	0.0346	0.1876	0.0000	0.0000	0.0000	0.0000	2.0000
Ratio_Prof	5633	0.4364	0.2993	0.0000	0.3333	0.3333	0.6667	1.0000
Ratio_Tech	5633	0.1114	0.1747	0.0000	0.0000	0.0000	0.3333	1.0000
Ratio_Fin	5633	0.1756	0.2017	0.0000	0.0000	0.0000	0.3333	1.0000
Ratio_Bus	5633	0.0904	0.1603	0.0000	0.0000	0.0000	0.2500	1.0000
Ratio_Law	5633	0.0487	0.1188	0.0000	0.0000	0.0000	0.0000	0.6667
Ratio_Other	5633	0.0104	0.0568	0.0000	0.0000	0.0000	0.0000	0.6667
Panel C: Firm-Level Controls								
Size	5633	21.6477	1.1238	19.2175	20.8574	21.4980	22.2203	26.6603
Leverage	5633	0.3851	0.2130	0.0411	0.2072	0.3680	0.5442	0.9361
ROA	5633	0.0478	0.0575	-0.1493	0.0148	0.0428	0.0764	0.2380
PPE	5633	0.2269	0.1446	0.0021	0.1176	0.2005	0.3124	0.7337
Firm_Age	5633	2.5439	0.4360	0.4700	2.3536	2.6159	2.8627	3.5550
State_Owned	5633	0.3222	0.4674	0.0000	0.0000	0.0000	1.0000	1.0000
Panel D: Governance Features								
Independent	5633	0.3714	0.0524	0.3000	0.3333	0.3333	0.4286	0.5714
Inside_Owned	5633	0.0619	0.1247	0.0000	0.0000	0.0000	0.0450	0.5143
Institution_Owned	5633	0.3496	0.2341	0.0037	0.1370	0.3412	0.5314	0.8782
Board_Size	5633	2.1448	0.1899	1.6094	2.0794	2.1972	2.1972	2.7081
Board_Meet	5633	2.1342	0.3381	1.3863	1.9459	2.0794	2.3979	3.0445
Chair_Fin	5633	0.1339	0.3405	0.0000	0.0000	0.0000	0.0000	1.0000
CEO_Fin	5633	0.1386	0.3456	0.0000	0.0000	0.0000	0.0000	1.0000

Table 3: Descriptive Statistics of Professor Variables

This table presents the descriptive statistics of professor variables. Panel A presents the summary statistics of professor director characteristics for the total sample of professor-year observations. Panels B-F respectively present the summary statistics of professor director characteristics for professor directors of polytechnic, financial, economics or management, legal and other academic expertise.

	N	Mean	Standard Deviation	Min	p25	Median	p75	Max
Panel A: Professor Director								
Overseas	7005	0.3146	0.4644	0.0000	0.0000	0.0000	1.0000	1.0000
Top_U	7005	0.3907	0.4879	0.0000	0.0000	0.0000	1.0000	1.0000
Female	7005	0.1592	0.3659	0.0000	0.0000	0.0000	0.0000	1.0000
Ln_Age	7005	3.9484	0.1490	3.4012	3.8712	3.9318	4.0431	4.4067
Ln_Work	7005	1.2197	0.9059	0.0000	0.0000	1.3863	1.9459	3.2581
Ln_Comp	7005	10.9282	0.4539	7.3132	10.7790	10.9937	11.1761	13.7332
Audit_Committee	7005	0.5586	0.4966	0.0000	0.0000	1.0000	1.0000	1.0000
Other_Committee	7005	0.7526	0.4315	0.0000	1.0000	1.0000	1.0000	1.0000
Panel B: Professor Director - Polytechnic								
Overseas	1644	0.3704	0.4831	0.0000	0.0000	0.0000	1.0000	1.0000
Top_U	1644	0.4240	0.4943	0.0000	0.0000	0.0000	1.0000	1.0000
Female	1644	0.0566	0.2311	0.0000	0.0000	0.0000	0.0000	1.0000
Ln_Age	1644	4.0034	0.1582	3.5835	3.8918	3.9703	4.1109	4.4067
Ln_Work	1644	0.8055	0.8832	0.0000	0.0000	0.6931	1.6094	3.1781
Ln_Comp	1644	10.9068	0.4376	7.8240	10.7790	10.9151	11.0821	13.0711
Audit_Committee	1644	0.2883	0.4531	0.0000	0.0000	0.0000	1.0000	1.0000
Other_Committee	1644	0.7153	0.4514	0.0000	0.0000	1.0000	1.0000	1.0000
Panel C: Professor Director - Financial								
Overseas	2954	0.2800	0.4491	0.0000	0.0000	0.0000	1.0000	1.0000
Top_U	2954	0.3162	0.4651	0.0000	0.0000	0.0000	1.0000	1.0000
Female	2954	0.2353	0.4242	0.0000	0.0000	0.0000	0.0000	1.0000
Ln_Age	2954	3.9152	0.1343	3.4012	3.8501	3.9120	4.0073	4.3307
Ln_Work	2954	1.4600	0.8434	0.0000	0.6931	1.6094	2.0794	3.2581
Ln_Comp	2954	10.9398	0.4624	7.3132	10.7810	10.9937	11.1844	13.7332
Audit_Committee	2954	0.7448	0.4361	0.0000	0.0000	1.0000	1.0000	1.0000
Other_Committee	2954	0.7404	0.4385	0.0000	0.0000	1.0000	1.0000	1.0000
Panel C: Professor Director - Economics or Management								
Overseas	1440	0.3264	0.4691	0.0000	0.0000	0.0000	1.0000	1.0000
Top_U	1440	0.4951	0.5002	0.0000	0.0000	0.0000	1.0000	1.0000
Female	1440	0.1347	0.3415	0.0000	0.0000	0.0000	0.0000	1.0000
Ln_Age	1440	3.9619	0.1465	3.4657	3.8712	3.9512	4.0604	4.4067
Ln_Work	1440	1.1718	0.8815	0.0000	0.0000	1.0986	1.9459	3.2189
Ln_Comp	1440	10.9219	0.4610	8.3428	10.7748	10.9998	11.1844	12.2061
Audit_Committee	1440	0.5097	0.5001	0.0000	0.0000	1.0000	1.0000	1.0000
Other_Committee	1440	0.8021	0.3986	0.0000	1.0000	1.0000	1.0000	1.0000
Panel D: Professor Director - Legal								
Overseas	826	0.3111	0.4632	0.0000	0.0000	0.0000	1.0000	1.0000
Top_U	826	0.4031	0.4908	0.0000	0.0000	0.0000	1.0000	1.0000
Female	826	0.1477	0.3550	0.0000	0.0000	0.0000	0.0000	1.0000
Ln_Age	826	3.9310	0.1477	3.5553	3.8286	3.9120	4.0431	4.2905
Ln_Work	826	1.3587	0.8939	0.0000	0.6931	1.6094	2.0794	3.2581
Ln_Comp	826	10.9362	0.4185	8.9227	10.7790	11.0021	11.1761	12.1007
Audit_Committee	826	0.5266	0.4996	0.0000	0.0000	1.0000	1.0000	1.0000
Other_Committee	826	0.7651	0.4242	0.0000	1.0000	1.0000	1.0000	1.0000
Panel E: Professor Director - Other								
Overseas	141	0.2908	0.4557	0.0000	0.0000	0.0000	1.0000	1.0000
Top_U	141	0.4255	0.4962	0.0000	0.0000	0.0000	1.0000	1.0000
Female	141	0.0780	0.2692	0.0000	0.0000	0.0000	0.0000	1.0000
Ln_Age	141	3.9695	0.1544	3.4657	3.8918	3.9703	4.0431	4.4067
Ln_Work	141	0.6879	0.7408	0.0000	0.0000	0.6931	1.0986	2.3026
Ln_Comp	141	10.9501	0.5712	8.5172	10.7144	11.0021	11.2306	12.6571
Audit_Committee	141	0.4965	0.5018	0.0000	0.0000	0.0000	1.0000	1.0000
Other_Committee	141	0.8652	0.3427	0.0000	1.0000	1.0000	1.0000	1.0000

Table 4: Professor Directors on Corporate Innovation

Panel A of this table presents the regression results of *Patent* on the professor director variables, firm-level controls, and board governance features for the sample of firm-year observations over 2011-2014. Panel B of this table presents the regression results of *Citation* on the professor director variables, firm-level controls, and board governance features for the sample of firm-year observations over 2011-2014. All variables are as defined in the Appendix. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Robust t-statistics in parentheses.

Panel A									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$Patent_{t+1}$	$Patent_{t+1}$	$Patent_{t+1}$	$Patent_{t+2}$	$Patent_{t+2}$	$Patent_{t+2}$	$Patent_{t+3}$	$Patent_{t+3}$	$Patent_{t+3}$
Professor Directors									
Prof	0.1420*			0.1149			0.0943		
	(1.9485)			(1.5318)			(1.2450)		
Sum_Prof		0.0930***			0.0979***			0.1010***	
		(3.3320)			(3.4549)			(3.4729)	
Ratio_Prof			0.2992***			0.3118***			0.3281***
			(3.3657)			(3.4412)			(3.5569)
Firm-Level Controls									
Size	0.6051***	0.6033***	0.6035***	0.5957***	0.5941***	0.5943***	0.5780***	0.5766***	0.5768***
	(18.3833)	(18.2835)	(18.2993)	(17.9217)	(17.8486)	(17.8641)	(17.0339)	(17.0015)	(17.0148)
Leverage	-0.4900***	-0.4997***	-0.4993***	-0.5264***	-0.5346***	-0.5342***	-0.5299***	-0.5370***	-0.5367***
	(-2.8682)	(-2.9248)	(-2.9244)	(-2.9882)	(-3.0378)	(-3.0364)	(-2.9577)	(-3.0015)	(-3.0008)
ROA	3.2069***	3.2042***	3.2050***	3.6046***	3.5939***	3.5951***	3.6939***	3.6773***	3.6778***
	(6.6313)	(6.6559)	(6.6605)	(7.0093)	(7.0313)	(7.0354)	(6.8893)	(6.9052)	(6.9091)
PPE	-1.1056***	-1.0937***	-1.0950***	-1.0297***	-1.0120***	-1.0138***	-0.9381***	-0.9163***	-0.9174***
	(-4.4149)	(-4.3721)	(-4.3822)	(-4.0553)	(-3.9928)	(-4.0041)	(-3.5916)	(-3.5174)	(-3.5269)
Firm_Age	-0.1978***	-0.1951***	-0.1940***	-0.2015***	-0.1974***	-0.1963***	-0.2027***	-0.1974***	-0.1961***
	(-2.7885)	(-2.7657)	(-2.7486)	(-2.8384)	(-2.7956)	(-2.7780)	(-2.8707)	(-2.8121)	(-2.7907)
State-Owned	0.0494	0.0499	0.0500	0.0552	0.0534	0.0537	0.0647	0.0612	0.0613
	(0.6602)	(0.6700)	(0.6722)	(0.7341)	(0.7143)	(0.7177)	(0.8487)	(0.8081)	(0.8092)
Governance Features									
Independent	0.4302	0.2409	0.5820	0.7293	0.5191	0.8771	0.5533	0.3289	0.7003
	(0.7676)	(0.4303)	(1.0367)	(1.2593)	(0.8965)	(1.5105)	(0.9136)	(0.5416)	(1.1585)
Inside_Owned	0.6809***	0.6709***	0.6711***	0.8047***	0.7951***	0.7954***	0.9298***	0.9206***	0.9207***
	(2.8714)	(2.8371)	(2.8343)	(3.3158)	(3.2910)	(3.2859)	(3.7065)	(3.6870)	(3.6818)
Institution_Owned	0.4478***	0.4350***	0.4345***	0.5121***	0.4976***	0.4974***	0.5176***	0.5021***	0.5014***
	(3.6614)	(3.5577)	(3.5550)	(4.0913)	(3.9796)	(3.9782)	(4.0700)	(3.9528)	(3.9476)
Board_Size	0.1990	0.1127	0.2427	0.1531	0.0549	0.1917	0.2985	0.1921	0.3334*
	(1.0774)	(0.6065)	(1.3073)	(0.8114)	(0.2882)	(1.0112)	(1.5874)	(1.0085)	(1.7761)
Board_Meet	0.2661***	0.2709***	0.2701***	0.2443***	0.2486***	0.2477***	0.2454***	0.2492***	0.2483***
	(3.5250)	(3.5974)	(3.5879)	(3.2674)	(3.3370)	(3.3268)	(3.2000)	(3.2677)	(3.2581)
Chair_Fin	-0.1166	-0.1205	-0.1208	-0.0691	-0.0737	-0.0740	-0.0893	-0.0944	-0.0949
	(-1.3364)	(-1.3805)	(-1.3851)	(-0.7850)	(-0.8380)	(-0.8418)	(-1.0164)	(-1.0746)	(-1.0801)
CEO_Fin	-0.0751	-0.0765	-0.0763	-0.1106	-0.1131	-0.1127	-0.1132	-0.1164	-0.1162
	(-0.9128)	(-0.9277)	(-0.9252)	(-1.3484)	(-1.3754)	(-1.3725)	(-1.3809)	(-1.4189)	(-1.4174)
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-10.3144***	-10.0537***	-10.4619***	-10.0072***	-9.7484***	-10.1758***	-9.9718***	-9.7160***	-10.1614***
	(-13.2101)	(-12.8056)	(-13.3805)	(-12.6608)	(-12.2690)	(-12.8677)	(-12.4283)	(-12.0527)	(-12.6535)
Observations	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633
Adjusted R^2	0.3388	0.3406	0.3407	0.3341	0.3366	0.3366	0.3187	0.3216	0.3218

Panel B

	(1) $Citation_{t+1}$	(2) $Citation_{t+1}$	(3) $Citation_{t+1}$	(4) $Citation_{t+2}$	(5) $Citation_{t+2}$	(6) $Citation_{t+2}$	(7) $Citation_{t+3}$	(8) $Citation_{t+3}$	(9) $Citation_{t+3}$
Professor Directors									
Prof	0.2805***			0.3038***			0.3195***		
	(3.6650)			(3.4518)			(3.3363)		
Sum_Prof		0.1070***			0.1161***			0.1219***	
		(3.3678)			(3.2345)			(3.1534)	
Ratio_Prof			0.3675***			0.4028***			0.4253***
			(3.7466)			(3.6208)			(3.5403)
Firm-Level Controls									
Size	0.5970***	0.5939***	0.5941***	0.6716***	0.6682***	0.6684***	0.7165***	0.7129***	0.7131***
	(16.4957)	(16.3231)	(16.3443)	(16.6038)	(16.4368)	(16.4573)	(16.5732)	(16.4139)	(16.4334)
Leverage	-0.4273**	-0.4449**	-0.4446**	-0.4877**	-0.5068**	-0.5065**	-0.5460**	-0.5660**	-0.5658**
	(-2.3450)	(-2.4346)	(-2.4346)	(-2.3444)	(-2.4289)	(-2.4291)	(-2.4254)	(-2.5071)	(-2.5074)
ROA	0.7053	0.7291	0.7273	0.9919*	1.0175*	1.0151*	1.1423*	1.1694*	1.1665*
	(1.3194)	(1.3612)	(1.3589)	(1.6539)	(1.6940)	(1.6913)	(1.7685)	(1.8080)	(1.8050)
PPE	-1.1972***	-1.2007***	-1.1998***	-1.3555***	-1.3592***	-1.3578***	-1.4133***	-1.4173***	-1.4156***
	(-4.5917)	(-4.5971)	(-4.5985)	(-4.5832)	(-4.5870)	(-4.5870)	(-4.4176)	(-4.4215)	(-4.4206)
Firm_Age	-0.2130***	-0.2145***	-0.2125***	-0.2378**	-0.2393***	-0.2370**	-0.2558**	-0.2574**	-0.2549**
	(-2.6239)	(-2.6368)	(-2.6131)	(-2.5702)	(-2.5826)	(-2.5585)	(-2.5498)	(-2.5624)	(-2.5381)
State-Owned	0.0975	0.1057	0.1053	0.1025	0.1114	0.1108	0.1067	0.1161	0.1154
	(1.1627)	(1.2633)	(1.2587)	(1.0822)	(1.1783)	(1.1727)	(1.0448)	(1.1389)	(1.1326)
Governance Features									
Independent	0.1074	-0.0734	0.3273	0.1815	-0.0149	0.4214	0.1508	-0.0550	0.4037
	(0.1530)	(-0.1045)	(0.4641)	(0.2285)	(-0.0188)	(0.5280)	(0.1767)	(-0.0645)	(0.4711)
Inside_Owned	0.4948*	0.4801	0.4798	0.5253	0.5094	0.5090	0.5479	0.5311	0.5307
	(1.6899)	(1.6360)	(1.6358)	(1.5801)	(1.5288)	(1.5284)	(1.5247)	(1.4748)	(1.4743)
Institution_Owned	0.6200***	0.6083***	0.6065***	0.6890***	0.6763***	0.6741***	0.7357***	0.7224***	0.7199***
	(4.4138)	(4.3402)	(4.3284)	(4.3232)	(4.2520)	(4.2389)	(4.2729)	(4.2033)	(4.1895)
Board_Size	0.0496	-0.0244	0.1262	0.0482	-0.0323	0.1313	0.0496	-0.0347	0.1371
	(0.2450)	(-0.1195)	(0.6202)	(0.2114)	(-0.1405)	(0.5739)	(0.2027)	(-0.1402)	(0.5582)
Board_Meet	0.2311***	0.2393***	0.2384***	0.2854***	0.2942***	0.2932***	0.3202***	0.3295***	0.3285***
	(2.8817)	(2.9909)	(2.9813)	(3.1649)	(3.2708)	(3.2617)	(3.2934)	(3.3968)	(3.3880)
Chair_Fin	-0.0991	-0.1019	-0.1028	-0.1075	-0.1105	-0.1115	-0.1155	-0.1186	-0.1198
	(-1.0790)	(-1.1059)	(-1.1165)	(-1.0236)	(-1.0498)	(-1.0606)	(-1.0159)	(-1.0414)	(-1.0523)
CEO_Fin	0.0131	0.0147	0.0147	0.0326	0.0344	0.0342	0.0496	0.0514	0.0512
	(0.1498)	(0.1680)	(0.1675)	(0.3271)	(0.3434)	(0.3424)	(0.4580)	(0.4735)	(0.4722)
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-10.1689***	-9.8159***	-10.3020***	-11.5148***	-11.1321***	-11.6624***	-12.4010***	-11.9990***	-12.5574***
	(-11.2427)	(-10.8296)	(-11.2803)	(-11.4544)	(-11.0468)	(-11.4891)	(-11.5849)	(-11.1783)	(-11.6233)
Observations	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633
Adjusted R^2	0.3769	0.3765	0.3770	0.3519	0.3515	0.3520	0.3286	0.3282	0.3288

Table 5: Academic Expertise on Corporate Innovation

Panel A of this table presents the regression results of *Patent* on the academic expertise variables, firm-level controls, and board governance features for the sample of firm-year observations over 2011-2014. Panel B of this table presents the regression results of *Citation* on the academic expertise variables, firm-level controls, and board governance features for the sample of firm-year observations over 2011-2014. All variables are as defined in the Appendix. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Robust t-statistics in parentheses.

Panel A

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$Patent_{t+1}$	$Patent_{t+1}$	$Patent_{t+1}$	$Patent_{t+2}$	$Patent_{t+2}$	$Patent_{t+2}$	$Patent_{t+3}$	$Patent_{t+3}$	$Patent_{t+3}$
Academic Expertise									
Prof_Tech	0.1400**			0.1444**			0.1715***		
	(2.4393)			(2.4784)			(2.8874)		
Prof_Fin	0.2024***			0.2141***			0.1933***		
	(3.8502)			(4.0268)			(3.5396)		
Prof_Bus	0.0363			0.0035			0.0329		
	(0.6046)			(0.0577)			(0.5231)		
Prof_Law	0.0863			0.0975			0.1091		
	(1.1743)			(1.3240)			(1.4690)		
Prof_Other	-0.2260			-0.2372			-0.3067*		
	(-1.4404)			(-1.5271)			(-1.8942)		
Sum_Tech		0.1185**			0.1203**			0.1331***	
		(2.4707)			(2.4823)			(2.6576)	
Sum_Fin		0.1328***			0.1537***			0.1380***	
		(3.0731)			(3.5858)			(3.1395)	
Sum_Bus		0.0324			0.0104			0.0364	
		(0.6230)			(0.1959)			(0.6758)	
Sum_Law		0.0952			0.1048			0.1201*	
		(1.3640)			(1.5026)			(1.6995)	
Sum_Other		-0.2390			-0.2463*			-0.3025*	
		(-1.5947)			(-1.6521)			(-1.9553)	
Ratio_Tech			0.3616**			0.3697**			0.4145***
			(2.4395)			(2.4524)			(2.6389)
Ratio_Fin			0.4289***			0.4883***			0.4584***
			(3.1822)			(3.6471)			(3.3347)
Ratio_Bus			0.1383			0.0551			0.1345
			(0.8435)			(0.3287)			(0.7881)
Ratio_Law			0.2597			0.2914			0.3324
			(1.1892)			(1.3351)			(1.5080)
Ratio_Other			-0.7821			-0.7803			-0.9422*
			(-1.5470)			(-1.5517)			(-1.7874)
Firm-Level Controls									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Governance Features									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-10.2750***	-10.1655***	-10.5750***	-9.9953***	-9.8750***	-10.3019***	-9.9622***	-9.8402***	-10.2852***
	(-13.2122)	(-13.0048)	(-13.5901)	(-12.6932)	(-12.4694)	(-13.0768)	(-12.4793)	(-12.2639)	(-12.8758)
Observations	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633
Adjusted R^2	0.3434	0.3424	0.3423	0.3397	0.3390	0.3388	0.3249	0.3240	0.3240

Panel B									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$Citation_{t+1}$	$Citation_{t+1}$	$Citation_{t+1}$	$Citation_{t+2}$	$Citation_{t+2}$	$Citation_{t+2}$	$Citation_{t+3}$	$Citation_{t+3}$	$Citation_{t+3}$
Academic Expertise									
Prof_Tech	0.2756***			0.3152***			0.3414***		
	(4.1823)			(4.1886)			(4.1903)		
Prof_Fin	0.1162*			0.1232*			0.1296*		
	(1.9382)			(1.8141)			(1.7677)		
Prof_Bus	0.0324			0.0267			0.0254		
	(0.4628)			(0.3385)			(0.2988)		
Prof_Law	0.1330			0.1436			0.1390		
	(1.5146)			(1.4508)			(1.3040)		
Prof_Other	-0.4605***			-0.5029***			-0.5240**		
	(-2.7052)			(-2.5816)			(-2.4778)		
Sum_Tech		0.2399***			0.2740***			0.2937***	
		(4.3902)			(4.3985)			(4.3704)	
Sum_Fin		0.0901*			0.0941*			0.0993*	
		(1.8508)			(1.7142)			(1.6808)	
Sum_Bus		0.0310			0.0269			0.0272	
		(0.5139)			(0.3944)			(0.3700)	
Sum_Law		0.1386			0.1461			0.1404	
		(1.6391)			(1.5339)			(1.3745)	
Sum_Other		-0.4569***			-0.5020***			-0.5243***	
		(-2.8504)			(-2.7324)			(-2.6296)	
Ratio_Tech			0.7724***			0.8872***			0.9563***
			(4.5812)			(4.5858)			(4.5684)
Ratio_Fin			0.3131**			0.3310**			0.3504*
			(2.1196)			(1.9834)			(1.9475)
Ratio_Bus			0.1694			0.1669			0.1745
			(0.9171)			(0.7974)			(0.7706)
Ratio_Law			0.4341*			0.4624			0.4448
			(1.6662)			(1.5663)			(1.3978)
Ratio_Other			-1.4077***			-1.5365**			-1.5977**
			(-2.6445)			(-2.5182)			(-2.4089)
Firm-Level Controls									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Governance Features									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-10.0770***	-9.9464***	-10.4166***	-11.4172***	-11.2749***	-11.7870***	-12.3012***	-12.1517***	-12.6915***
	(-11.1422)	(-11.0035)	(-11.4357)	(-11.3639)	(-11.2272)	(-11.6473)	(-11.5023)	(-11.3636)	(-11.7860)
Observations	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633
Adjusted R^2	0.3812	0.3817	0.3816	0.3563	0.3568	0.3567	0.3330	0.3333	0.3333

Table 6: Synergy Potential of Academic Expertise

Panel A of this table presents the regression results of *Patent* on the polytechnic and financial academic expertise variables, their interaction term, firm-level controls, and board governance features for the sample of firm-year observations over 2011-2014. Panel B of this table presents the regression results of *Citation* on the polytechnic and financial academic expertise variables, their interaction term, firm-level controls, and board governance features for the sample of firm-year observations over 2011-2014. All variables are as defined in the Appendix. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Robust t-statistics in parentheses.

Panel A									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$Patent_{t+1}$	$Patent_{t+1}$	$Patent_{t+1}$	$Patent_{t+2}$	$Patent_{t+2}$	$Patent_{t+2}$	$Patent_{t+3}$	$Patent_{t+3}$	$Patent_{t+3}$
Academic Expertise									
Prof_Tech	0.0926			0.0820			0.0784		
	(1.2426)			(1.0831)			(1.0130)		
Prof_Fin	0.1728***			0.1734***			0.1332**		
	(2.6976)			(2.6939)			(2.0007)		
Prof_Tech *	0.0926			0.1330			0.1913*		
Prof_Fin	(0.8789)			(1.2435)			(1.7632)		
Sum_Tech		0.0238			0.0293			0.0223	
		(0.4139)			(0.5043)			(0.3682)	
Sum_Fin		0.0792			0.1018**			0.0753	
		(1.5542)			(2.0332)			(1.4738)	
Sum_Tech *		0.1799**			0.1778**			0.2109***	
Sum_Fin		(2.3975)			(2.3415)			(2.6697)	
Ratio_Tech			0.0814			0.0816			0.0468
			(0.4519)			(0.4447)			(0.2422)
Ratio_Fin			0.2703*			0.3234**			0.2493
			(1.7310)			(2.1076)			(1.5872)
Ratio_Tech *			1.6921**			1.8084**			2.2563***
Ratio_Fin			(2.3752)			(2.5071)			(2.9630)
Firm-Level Controls									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Governance Features									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-10.2594***	-10.1757***	-10.5254***	-9.9638***	-9.8735***	-10.2653***	-9.9274***	-9.8486***	-10.2313***
	(-13.1879)	(-13.0462)	(-13.5081)	(-12.6540)	(-12.5026)	(-13.0111)	(-12.4128)	(-12.2852)	(-12.7771)
Observations	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633
Adjusted R^2	0.3427	0.3425	0.3424	0.3391	0.3390	0.3391	0.3241	0.3239	0.3243

Panel B									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Citation$_{t+1}$	*Citation*$_{t+1}$	*Citation*$_{t+1}$	*Citation*$_{t+2}$	*Citation*$_{t+2}$	*Citation*$_{t+2}$	*Citation*$_{t+3}$	*Citation*$_{t+3}$	*Citation*$_{t+3}$
Academic Expertise									
Prof_Tech	0.2393***			0.2785***			0.2963***		
	(2.8013)			(2.8341)			(2.7750)		
Prof_Fin	0.0944			0.1011			0.1018		
	(1.2877)			(1.2182)			(1.1368)		
Prof_Tech *	0.0732			0.0762			0.0946		
Prof_Fin	(0.6190)			(0.5644)			(0.6476)		
Sum_Tech		0.1721***			0.1980***			0.2075**	
		(2.6347)			(2.6179)			(2.5265)	
Sum_Fin		0.0524			0.0516			0.0509	
		(0.9146)			(0.7995)			(0.7344)	
Sum_Tech *		0.1301			0.1480			0.1687*	
Sum_Fin		(1.5613)			(1.5686)			(1.6555)	
Ratio_Tech			0.5620***			0.6503***			0.6834***
			(2.7542)			(2.7496)			(2.6597)
Ratio_Fin			0.1940			0.1966			0.1955
			(1.1316)			(1.0148)			(0.9369)
Ratio_Tech *			1.2300			1.4069			1.6405*
Ratio_Fin			(1.5896)			(1.5964)			(1.7190)
Firm-Level Controls									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Governance Features									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-10.0134***	-9.9062***	-10.3291***	-11.3431***	-11.2234***	-11.6948***	-12.2180***	-12.0922***	-12.5969***
	(-11.0356)	(-10.9235)	(-11.3584)	(-11.2520)	(-11.1402)	(-11.5753)	(-11.3884)	(-11.2775)	(-11.7189)
Observations	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633
Adjusted R^2	0.3787	0.3794	0.3794	0.3540	0.3547	0.3547	0.3309	0.3316	0.3317

Table 7: Professor Director Characteristics on Academic Expertise and Corporate Innovation

Panel A of this table presents the regression results of *Patent* and *Citation* on the professor director characteristics of polytechnic expertise for the sample of professor-year observations over 2011-2014. Panel B of this table presents the regression results of *Patent* and *Citation* on the professor director characteristics of financial expertise for the sample of professor-year observations over 2011-2014. All variables are as defined in the Appendix. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Robust t-statistics in parentheses.

Panel A						
	(1)	(2)	(3)	(4)	(5)	(6)
	$Patent_{t+1}$	$Patent_{t+2}$	$Patent_{t+3}$	$Citation_{t+1}$	$Citation_{t+2}$	$Citation_{t+3}$
Professor Director Characteristics						
Overseas	0.0580	0.0391	0.0410	0.2662***	0.2763**	0.2825**
	(0.6259)	(0.4313)	(0.4389)	(2.7191)	(2.4024)	(2.2297)
Top_U	0.1878**	0.1350	0.0932	0.2306**	0.2568**	0.2535*
	(2.0240)	(1.4253)	(0.9594)	(2.0842)	(2.0170)	(1.8289)
Female	-0.2632	-0.1773	-0.2572	-0.2702	-0.3003	-0.3134
	(-1.1620)	(-0.8544)	(-1.2141)	(-1.1879)	(-1.1879)	(-1.1666)
Ln_Age	-0.1398	-0.0147	0.0669	-0.2679	-0.3703	-0.4301
	(-0.5073)	(-0.0533)	(0.2382)	(-0.8333)	(-1.0071)	(-1.0733)
Ln_Work	0.0544	0.0564	0.0539	0.0664	0.0909	0.1041
	(1.2554)	(1.3220)	(1.2487)	(1.3259)	(1.5659)	(1.6308)
Ln_Comp	0.1278	0.1881	0.1748	0.1286	0.1566	0.1826
	(1.0459)	(1.5963)	(1.4868)	(1.0327)	(1.0960)	(1.1766)
Audit_Committee	-0.1649	-0.4373	-0.4143	-0.0046	0.0692	0.1539
	(-0.5347)	(-1.3245)	(-1.3513)	(-0.0130)	(0.1637)	(0.3223)
Other_Committee	0.0501	0.0493	-0.0378	0.0339	0.0662	0.0771
	(0.5035)	(0.4823)	(-0.3540)	(0.3026)	(0.5048)	(0.5336)
*Audit_Committee * Other_Committee*	0.1556	0.4156	0.4413	0.0799	0.0147	-0.0679
	(0.4894)	(1.2209)	(1.3878)	(0.2150)	(0.0334)	(-0.1372)
Firm-Level Controls						
	Yes	Yes	Yes	Yes	Yes	Yes
Governance Features						
	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-11.7881***	-12.5849***	-12.8234***	-13.2561***	-14.4403***	-15.1583***
	(-6.3625)	(-6.6261)	(-6.7325)	(-6.1924)	(-5.9725)	(-5.7514)
Observations	1,644	1,644	1,644	1,644	1,644	1,644
Adjusted R^2	0.3039	0.2909	0.2908	0.4113	0.3683	0.3324

Panel B						
	(1)	(2)	(3)	(4)	(5)	(6)
	Patent$_{t+1}$	*Patent*$_{t+2}$	*Patent*$_{t+3}$	*Citation*$_{t+1}$	*Citation*$_{t+2}$	*Citation*$_{t+3}$
Professor Director Characteristics						
Overseas	-0.0241	-0.0498	-0.0928	-0.0016	-0.0006	-0.0016
	(-0.3082)	(-0.6471)	(-1.1515)	(-0.0184)	(-0.0055)	(-0.0184)
Top_U	0.1303	0.1412*	0.1443*	-0.0439	-0.0366	-0.0439
	(1.5984)	(1.7076)	(1.6752)	(-0.4429)	(-0.3297)	(-0.4429)
Female	-0.1065	-0.0825	-0.1424*	-0.1614*	-0.1854*	-0.1614*
	(-1.3607)	(-1.0621)	(-1.7241)	(-1.7162)	(-1.7456)	(-1.7162)
Ln_Age	-0.3451	-0.1991	0.0254	-0.5428*	-0.6206*	-0.5428*
	(-1.4525)	(-0.8096)	(0.0983)	(-1.7541)	(-1.7795)	(-1.7541)
Ln_Work	0.0352	0.0149	0.0098	0.0523	0.0647	0.0523
	(0.8612)	(0.3610)	(0.2310)	(1.1462)	(1.2461)	(1.1462)
Ln_Comp	0.2389***	0.2143***	0.1381*	0.2797***	0.3153***	0.2797***
	(2.9468)	(2.7278)	(1.6976)	(3.0157)	(3.0316)	(3.0157)
Audit_Committee	0.0603	-0.0144	-0.1807	0.2812*	0.3117*	0.2812*
	(0.4095)	(-0.0956)	(-1.1643)	(1.6716)	(1.6469)	(1.6716)
Other_Committee	0.0229	0.0321	-0.0640	0.2026	0.2529	0.2026
	(0.1374)	(0.1858)	(-0.3579)	(1.1171)	(1.2210)	(1.1171)
*Audit_Committee **	0.0752	0.0629	0.2391	-0.1056	-0.1346	-0.1056
Other_Committee	(0.3555)	(0.2908)	(1.0576)	(-0.4476)	(-0.5060)	(-0.4476)
Firm-Level Controls						
	Yes	Yes	Yes	Yes	Yes	Yes
Governance Features						
	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-11.8504***	-11.9701***	-11.3141***	-12.3419***	-13.5118***	-12.3419***
	(-7.7275)	(-7.7183)	(-7.0595)	(-6.5570)	(-6.5100)	(-6.5570)
Observations	2,954	2,954	2,954	2,954	2,954	2,954
Adjusted R^2	0.3494	0.3406	0.3178	0.4007	0.3781	0.4007

Table 8: Additional Analysis - Patent Types

This table presents the results of regressing specific patents on the academic expertise variables, firm-level controls, and board governance features for the sample of firm-year observations over 2011-2014. Panel A reports results for invention patents (*Invention*). Panel B reports results for utility patents (*Utility*). Panel C reports results for design patents (*Design*). All variables are as defined in the Appendix. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Robust t-statistics in parentheses.

Panel A

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Invention$_{t+1}$	*Invention*$_{t+1}$	*Invention*$_{t+1}$	*Invention*$_{t+2}$	*Invention*$_{t+2}$	*Invention*$_{t+2}$	*Invention*$_{t+3}$	*Invention*$_{t+3}$	*Invention*$_{t+3}$
Academic Expertise									
Prof_Tech	0.1877***			0.2023***			0.2382***		
	(3.4112)			(3.5380)			(4.0920)		
Prof_Fin	0.1626***			0.1817***			0.1761***		
	(3.2764)			(3.5512)			(3.3581)		
Prof_Bus	-0.0014			-0.0413			-0.0161		
	(-0.0243)			(-0.6983)			(-0.2657)		
Prof_Law	0.1133			0.1288*			0.1291*		
	(1.5789)			(1.7624)			(1.7469)		
Prof_Other	-0.2430			-0.2448			-0.2903*		
	(-1.6310)			(-1.6023)			(-1.7830)		
Sum_Tech		0.1641***			0.1706***			0.1923***	
		(3.5546)			(3.5517)			(3.9115)	
Sum_Fin		0.1156***			0.1309***			0.1222***	
		(2.8049)			(3.0801)			(2.7839)	
Sum_Bus		0.0003			-0.0323			-0.0175	
		(0.0054)			(-0.6276)			(-0.3333)	
Sum_Law		0.1166*			0.1306*			0.1297*	
		(1.6780)			(1.8496)			(1.8244)	
Sum_Other		-0.2587*			-0.2480*			-0.2809*	
		(-1.8040)			(-1.7129)			(-1.8177)	
Ratio_Tech			0.5072***			0.5360***			0.6083***
			(3.5632)			(3.6211)			(3.9818)
Ratio_Fin			0.3686***			0.4223***			0.4153***
			(2.9080)			(3.2271)			(3.0849)
Ratio_Bus			0.0410			-0.0617			-0.0243
			(0.2671)			(-0.3842)			(-0.1484)
Ratio_Law			0.3482			0.3856*			0.3816*
			(1.6324)			(1.7810)			(1.7538)
Ratio_Other			-0.7971*			-0.7846			-0.8759*
			(-1.6897)			(-1.6157)			(-1.6804)
Firm-Level Controls									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Governance Features									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-10.6767***	-10.5635***	-10.9673***	-10.5069***	-10.3813***	-10.8039***	-10.4064***	-10.2792***	-10.7272***
	(-14.1712)	(-13.9805)	(-14.5329)	(-13.5969)	(-13.3962)	(-13.9245)	(-13.5327)	(-13.3305)	(-13.8648)
Observations	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633
Adjusted R^2	0.3082	0.3081	0.3076	0.3027	0.3021	0.3018	0.2927	0.2916	0.2915

Panel B									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$Utility_{t+1}$	$Utility_{t+1}$	$Utility_{t+1}$	$Utility_{t+2}$	$Utility_{t+2}$	$Utility_{t+2}$	$Utility_{t+3}$	$Utility_{t+3}$	$Utility_{t+3}$
Academic Expertise									
Prof_Tech	0.0375			0.0502			0.0760		
	(0.6902)			(0.9040)			(1.3164)		
Prof_Fin	0.1050**			0.1236**			0.1054**		
	(2.1249)			(2.4335)			(1.9907)		
Prof_Bus	0.0132			0.0125			0.0299		
	(0.2299)			(0.2115)			(0.4926)		
Prof_Law	0.0400			0.0630			0.0601		
	(0.5631)			(0.8773)			(0.8144)		
Prof_Other	-0.1295			-0.1856			-0.2418		
	(-0.8827)			(-1.2762)			(-1.6236)		
Sum_Tech		0.0199			0.0375			0.0495	
		(0.4278)			(0.8038)			(1.0081)	
Sum_Fin		0.0607			0.0786*			0.0632	
		(1.5237)			(1.9531)			(1.5221)	
Sum_Bus		0.0309			0.0360			0.0516	
		(0.6199)			(0.7145)			(0.9943)	
Sum_Law		0.0434			0.0646			0.0725	
		(0.6431)			(0.9527)			(1.0351)	
Sum_Other		-0.1401			-0.1947			-0.2466*	
		(-1.0187)			(-1.4087)			(-1.7456)	
Ratio_Tech			0.0605			0.1125			0.1567
			(0.4231)			(0.7742)			(1.0208)
Ratio_Fin			0.2034*			0.2541**			0.2161*
			(1.6486)			(2.0334)			(1.6711)
Ratio_Bus			0.1420			0.1433			0.1994
			(0.9117)			(0.9042)			(1.2231)
Ratio_Law			0.1208			0.2083			0.2168
			(0.5678)			(0.9797)			(0.9943)
Ratio_Other			-0.4948			-0.6237			-0.7375
			(-1.0571)			(-1.3352)			(-1.5206)
Firm-Level Controls									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Governance Features									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-8.5291***	-8.4823***	-8.6508***	-8.1067***	-8.0416***	-8.2604***	-8.3140***	-8.2477***	-8.4673***
	(-11.3946)	(-11.2618)	(-11.6060)	(-10.5307)	(-10.3793)	(-10.7563)	(-10.5258)	(-10.3806)	(-10.7671)
Observations	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633
Adjusted R^2	0.3870	0.3866	0.3868	0.3757	0.3753	0.3754	0.3546	0.3543	0.3543

Panel C									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$Design_{t+1}$	$Design_{t+1}$	$Design_{t+1}$	$Design_{t+2}$	$Design_{t+2}$	$Design_{t+2}$	$Design_{t+2}$	$Design_{t+2}$	$Design_{t+2}$
Academic Expertise									
Prof_Tech	0.0378			0.0251			0.0223		
	(0.7557)			(0.4931)			(0.4316)		
Prof_Fin	0.1028**			0.0900**			0.0767		
	(2.2776)			(1.9622)			(1.6361)		
Prof_Bus	0.1175**			0.1047*			0.1063*		
	(2.1467)			(1.8963)			(1.8680)		
Prof_Law	-0.0802			-0.0846			-0.0464		
	(-1.2791)			(-1.3351)			(-0.7058)		
Prof_Other	-0.0620			-0.0076			-0.1097		
	(-0.4732)			(-0.0572)			(-0.8286)		
Sum_Tech		0.0342			0.0157			0.0122	
		(0.8399)			(0.3823)			(0.2938)	
Sum_Fin		0.0752**			0.0635*			0.0589	
		(2.1147)			(1.7580)			(1.5715)	
Sum_Bus		0.0981**			0.0937**			0.1023**	
		(2.1116)			(1.9754)			(2.1164)	
Sum_Law		-0.0709			-0.0757			-0.0331	
		(-1.1555)			(-1.2347)			(-0.5207)	
Sum_Other		-0.0680			-0.0246			-0.1113	
		(-0.5523)			(-0.1958)			(-0.8959)	
Ratio_Tech			0.0505			0.0079			0.0013
			(0.4006)			(0.0623)			(0.0100)
Ratio_Fin			0.2093*			0.1767			0.1789
			(1.9150)			(1.6005)			(1.5685)
Ratio_Bus			0.2769*			0.2671*			0.2990**
			(1.9153)			(1.8173)			(2.0082)
Ratio_Law			-0.2551			-0.2733			-0.1385
			(-1.3470)			(-1.4397)			(-0.7083)
Ratio_Other			-0.1326			0.0241			-0.2823
			(-0.3180)			(0.0568)			(-0.6723)
Firm-Level Controls									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Governance Features									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-4.7639***	-4.7240***	-4.9037***	-4.9821***	-4.9539***	-5.0973***	-5.0709***	-5.0350***	-5.1934***
	(-5.7962)	(-5.7289)	(-5.9556)	(-6.0493)	(-5.9973)	(-6.1717)	(-6.1097)	(-6.0438)	(-6.2478)
Observations	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633
Adjusted R^2	0.1325	0.1320	0.1315	0.1464	0.1461	0.1459	0.1452	0.1454	0.1451

Table 9: Robustness Analysis - Propensity Score Matching

This table presents the results of regressions with the matched sample using propensity score matching (PSM). Panel A of this table presents the regression results of *Patent* on the academic expertise variables, firm-level controls, and board governance features for the sample of firm-year observations over 2011-2014, using PSM design. Panel B of this table presents the regression results of *Citation* on the academic expertise variables, firm-level controls, and board governance features for the sample of firm-year observations over 2011-2014, using PSM design. All variables are as defined in the Appendix. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Robust t-statistics in parentheses.

Panel A									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$Patent_{t+1}$	$Patent_{t+1}$	$Patent_{t+1}$	$Patent_{t+2}$	$Patent_{t+2}$	$Patent_{t+2}$	$Patent_{t+3}$	$Patent_{t+3}$	$Patent_{t+3}$
Academic Expertise									
Prof_Tech	0.1445*			0.1354			0.1610*		
	(1.6772)			(1.5353)			(1.7440)		
Prof_Fin	0.2225***			0.2040***			0.1691**		
	(2.9625)			(2.6810)			(2.1756)		
Prof_Bus	0.0227			-0.0481			-0.0121		
	(0.2991)			(-0.6156)			(-0.1504)		
Prof_Law	0.0149			0.0131			0.0383		
	(0.1544)			(0.1347)			(0.3970)		
Prof_Other	-0.2481			-0.2709			-0.3184		
	(-1.1602)			(-1.2535)			(-1.3751)		
Sum_Tech		0.1531**			0.1317*			0.1520*	
		(2.1321)			(1.7887)			(1.9356)	
Sum_Fin		0.1310**			0.1256**			0.0957	
		(2.1260)			(2.0675)			(1.5038)	
Sum_Bus		0.0126			-0.0403			-0.0092	
		(0.1896)			(-0.5823)			(-0.1302)	
Sum_Law		0.0248			0.0162			0.0470	
		(0.2700)			(0.1734)			(0.5090)	
Sum_Other		-0.2451			-0.3001			-0.3374	
		(-1.2011)			(-1.4050)			(-1.4916)	
Ratio_Tech			0.4226**			0.3504*			0.4189*
			(2.0349)			(1.6500)			(1.8334)
Ratio_Fin			0.4281**			0.4087**			0.3542*
			(2.3649)			(2.2904)			(1.9035)
Ratio_Bus			0.0628			-0.1184			-0.0124
			(0.3124)			(-0.5658)			(-0.0586)
Ratio_Law			0.0871			0.0545			0.1499
			(0.3229)			(0.1979)			(0.5506)
Ratio_Other			-0.7759			-0.8809			-0.9882
			(-1.1942)			(-1.3396)			(-1.4000)
Firm-Level Controls									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Governance Features									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-11.1735***	-11.0714***	-11.2858***	-11.1721***	-11.0792***	-11.2242***	-10.8660***	-10.7799***	-10.9605***
	(-10.2255)	(-10.1225)	(-10.2861)	(-9.9758)	(-9.9110)	(-9.9738)	(-9.4141)	(-9.3574)	(-9.4548)
Observations	3,139	3,139	3,139	3,139	3,139	3,139	3,139	3,139	3,139
Adjusted R^2	0.3195	0.3182	0.3185	0.3134	0.3124	0.3125	0.3001	0.2993	0.2996

Panel B									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Citation$_{t+1}$	*Citation*$_{t+1}$	*Citation*$_{t+1}$	*Citation*$_{t+2}$	*Citation*$_{t+2}$	*Citation*$_{t+2}$	*Citation*$_{t+3}$	*Citation*$_{t+3}$	*Citation*$_{t+3}$
Academic Expertise									
Prof_Tech	0.3176***			0.3733***			0.4061***		
	(3.3729)			(3.4324)			(3.4339)		
Prof_Fin	0.1000			0.1154			0.1272		
	(1.2082)			(1.2313)			(1.2573)		
Prof_Bus	0.1272			0.1186			0.1153		
	(1.4918)			(1.2231)			(1.0975)		
Prof_Law	0.1230			0.1330			0.1221		
	(1.1227)			(1.0696)			(0.9040)		
Prof_Other	-0.3968*			-0.4411*			-0.4523		
	(-1.8214)			(-1.7442)			(-1.6187)		
Sum_Tech		0.3172***			0.3757***			0.4073***	
		(4.0151)			(4.1114)			(4.1193)	
Sum_Fin		0.0649			0.0701			0.0766	
		(0.9888)			(0.9501)			(0.9645)	
Sum_Bus		0.1064			0.1004			0.0995	
		(1.4707)			(1.2118)			(1.1026)	
Sum_Law		0.1326			0.1384			0.1253	
		(1.2798)			(1.1795)			(0.9847)	
Sum_Other		-0.3985*			-0.4419*			-0.4534*	
		(-1.8849)			(-1.7995)			(-1.6754)	
Ratio_Tech			0.9073***			1.0709***			1.1623***
			(4.0132)			(4.0933)			(4.1105)
Ratio_Fin			0.2274			0.2469			0.2710
			(1.1750)			(1.1344)			(1.1578)
Ratio_Bus			0.3334			0.3158			0.3139
			(1.5367)			(1.2690)			(1.1577)
Ratio_Law			0.3814			0.4028			0.3622
			(1.2381)			(1.1474)			(0.9494)
Ratio_Other			-1.2120*			-1.3452*			-1.3808*
			(-1.8570)			(-1.7802)			(-1.6585)
Firm-Level Controls									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Governance Features									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-12.2095***	-12.1737***	-12.4719***	-13.7990***	-13.7525***	-14.0744***	-14.7749***	-14.7212***	-15.0590***
	(-10.2482)	(-10.1895)	(-10.4151)	(-10.4543)	(-10.3946)	(-10.6156)	(-10.5328)	(-10.4727)	(-10.6902)
Observations	3,139	3,139	3,139	3,139	3,139	3,139	3,139	3,139	3,139
Adjusted R^2	0.3448	0.3459	0.3457	0.3230	0.3242	0.3240	0.3020	0.3031	0.3029

Table 10: Robustness Analysis – IV Regressions

This table presents the results of the IV regressions. We use the distance between firms' headquarters and the universities of the professor directors and the sum of top universities in the province where the firm is located as instruments. Panel A & B of this table present the second-stage IV-regression results of *Patent* and *Citation* for professor directors with polytechnic expertise on the academic expertise variables, firm-level controls, and board governance features for the sample of firm-year observations over 2011-2014. Panel C & D of this table present the second-stage IV-regression results of *Patent* and *Citation* for professor directors with polytechnic expertise on the academic expertise variables, firm-level controls, and board governance features for the sample of firm-year observations over 2011-2014. All variables are as defined in the Appendix. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Robust t-statistics in parentheses.

Panel A

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$Patent_{t+1}$	$Patent_{t+1}$	$Patent_{t+1}$	$Patent_{t+2}$	$Patent_{t+2}$	$Patent_{t+2}$	$Patent_{t+3}$	$Patent_{t+3}$	$Patent_{t+3}$
Academic Expertise									
Prof_Tech	0.1185*			0.1431**			0.1553**		
	(1.7291)			(2.0922)			(2.2163)		
Sum_Tech		0.1032*			0.1252**			0.1360**	
		(1.7020)			(2.0677)			(2.1900)	
Ratio_Tech			0.3315*			0.4007**			0.4351**
			(1.7232)			(2.0851)			(2.2072)
Firm-Level Controls									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Governance Features									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-11.3070***	-11.2695***	-11.3853***	-10.9147***	-10.8691***	-11.0093***	-10.7605***	-10.7110***	-10.8632***
	(-14.6953)	(-14.6408)	(-14.7705)	(-13.9504)	(-13.8759)	(-14.0625)	(-13.4973)	(-13.4147)	(-13.6254)
Observations	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633
Adjusted R^2	0.3389	0.3389	0.3387	0.3347	0.3346	0.3344	0.3202	0.3198	0.3196

Panel B

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$Citation_{t+1}$	$Citation_{t+1}$	$Citation_{t+1}$	$Citation_{t+2}$	$Citation_{t+2}$	$Citation_{t+2}$	$Citation_{t+3}$	$Citation_{t+3}$	$Citation_{t+3}$
Academic Expertise									
Prof_Tech	0.2815***			0.3166***			0.3370***		
	(3.5721)			(3.5149)			(3.4497)		
Sum_Tech		0.2460***			0.2766***			0.2945***	
		(3.5404)			(3.4834)			(3.4189)	
Ratio_Tech			0.7881***			0.8863***			0.9435***
			(3.5746)			(3.5177)			(3.4522)
Firm-Level Controls									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Governance Features									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-9.9220***	-9.8325***	-10.1079***	-11.2758***	-11.1751***	-11.4849***	-12.1892***	-12.0820***	-12.4118***
	(-11.0899)	(-10.9936)	(-11.2959)	(-11.3686)	(-11.2706)	(-11.5749)	(-11.5552)	(-11.4552)	(-11.7605)
Observations	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633
Adjusted R^2	0.3779	0.3781	0.3781	0.3532	0.3535	0.3535	0.3302	0.3304	0.3305

Panel C									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$Patent_{t+1}$	$Patent_{t+1}$	$Patent_{t+1}$	$Patent_{t+2}$	$Patent_{t+2}$	$Patent_{t+2}$	$Patent_{t+3}$	$Patent_{t+3}$	$Patent_{t+3}$
Academic Expertise									
Prof_Fin	0.1765***			0.1897***			0.1434**		
	(2.6313)			(2.8095)			(2.1009)		
Sum_Fin		0.1513***			0.1630***			0.1227**	
		(2.6048)			(2.7885)			(2.0781)	
Ratio_Fin			0.4745***			0.5108***			0.3850**
			(2.6160)			(2.7987)			(2.0869)
Firm-Level Controls									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Governance Features									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-11.3566***	-11.3022***	-11.5643***	-10.9712***	-10.9127***	-11.1947***	-10.8126***	-10.7684***	-10.9810***
	(-14.8128)	(-14.6885)	(-14.9902)	(-14.0567)	(-13.9314)	(-14.2608)	(-13.5591)	(-13.4660)	(-13.6997)
Observations	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633
Adjusted R^2	0.3413	0.3399	0.3400	0.3374	0.3364	0.3365	0.3213	0.3206	0.3209

Panel D									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$Citation_{t+1}$	$Citation_{t+1}$	$Citation_{t+1}$	$Citation_{t+2}$	$Citation_{t+2}$	$Citation_{t+2}$	$Citation_{t+3}$	$Citation_{t+3}$	$Citation_{t+3}$
Academic Expertise									
Prof_Fin	0.0957			0.0971			0.1034		
	(1.2490)			(1.1202)			(1.1046)		
Sum_Fin		0.0799			0.0808			0.0861	
		(1.2059)			(1.0771)			(1.0629)	
Ratio_Fin			0.2526			0.2558			0.2724
			(1.2194)			(1.0904)			(1.0758)
Firm-Level Controls									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Governance Features									
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-9.9922***	-9.9631***	-10.1024***	-11.3532***	-11.3237***	-11.4648***	-12.2716***	-12.2402***	-12.3904***
	(-11.1446)	(-11.1031)	(-11.1984)	(-11.4181)	(-11.3774)	(-11.4621)	(-11.6034)	(-11.5614)	(-11.6469)
Observations	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633	5,633
Adjusted R^2	0.3743	0.3742	0.3743	0.3494	0.3493	0.3494	0.3262	0.3261	0.3262