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China Stock Market Listed Firms' Governance and Innovation Outcomes

Mohamed Yacine Si Tayeb[1], Chen Gang Ye[2], M. Mustafa Ozguven[3]

ABSTRACT

This study examines the corporate governance and innovation relationship of China listed firms. It aims to contribute to the literature on corporate innovation antecedents, corporate governance of Chinese firms, and its impact on innovation outcomes.

Relying on agency and resource-dependence theories to understand corporate governance elements, and patents granted as a measure of successful corporate innovation, this study utilizes a quantitative research methodology and a longitudinal design to leverage data collected from the State Intellectual Property Office of China, the Chinese Research Data Services Platform as well as the China Stock Market & Accounting Database. The study sample includes 3,337 firms with a total 13,182 firm-year observations from the year 2010 to 2019.

A better understanding of Chinese corporate governance practices in light of the country's Securities Regulatory Commission (CSRC) recent reforms is needed, especially considering the necessity to derive a corporate governance theory from China for Chinese firms that has emerged in the literature. We find that board independence is the corporate governance component with the highest predictive significance on innovation, followed by CEO duality, and that board size is not a significant innovation predictor. We also find high incidence of CEO duality among China listed firms.

Keywords: Corporate Governance; Innovation; China.
JEL Classification: M21 Business Economics; G30 Corporate Finance and Governance; F23 Multinational Firms • International Business.

1. Introduction

We investigate and quantify the relationship between corporate governance and corporate innovation for China's listed firms. We hope to further strengthen the current comprehension of corporate innovation antecedents, at the intersection on new and exciting areas of research such corporate governance of Chinese firms and EMNCs' activity.

[1] Business School, University of International Business and Economics (UIBE), Beijing, China, Email: yacinesitayeb@outlook.com
[2] Business School, University of International Business and Economics (UIBE), Beijing, China, Email: yechengang@uibe.edu.cn
[3] Business School, University of International Business and Economics (UIBE), Beijing, China, Email: m_ozguven@yahoo.com

Although a significant number of studies tried to analyzed the influence of governance on company performance and value, a shift in recent years has seen growing interest in regards to the influence of governance mechanisms on innovation decisions taken by top management teams (Tribo, Berrone, & Surroca, 2007; Belloc, 2011; Balsmeier, Buchwald, & Stiebale, 2014; Tsao, Lin, & Chen, 2015). These authors and others' empirical work argue that innovation efforts and results depend on factors that are influenced by corporate governance, such as ownership structure, shareholder identity or the functioning of the board of directors.

Even considering that the recently published studies grasp the potential direct effect of CG mechanisms on corporate innovation, questions remain on whether they are context specific results, and on which corporate governance element has the most significant influence - thus leaving plenty to explore. Most of the above cited studies have been conducted in Western and developed market economies, while this study sets out to analyze Chinese firms in China, a country where the transition to a market economy has not been completed yet. Moreover, questions that have since emerged on the issue of how to define and quantify corporate innovation are here tackled. By reviewing the existing literature, different trends emerge, with results that have so far not achieved universal consensus in both the academic and professional worlds. In the past innovation has been defined as either R&D expense as a percentage of total sales (Park, 2018), R&D staff as a share of the total company employees (Rui, 2016), or lastly by considering the patent applications made by a firm within a specified timeframe (Prodan, 2005). In accordance with the most recent literature, these measures are now deemed inadequate, and an innovation study considering only "successful innovation" quantified by the number of patents granted was needed and is here presented.

Last but not least, a study advancing the understanding of Chinese corporate governance practices could represent a welcome contribution to the existing slim body of literature on the subject, given the increasing attention that has been dedicated to China's economic growth and the country's recent economic and legislative reforms. Many studies on China suffer shortcomings such as applying Western theories and concepts to explain Chinese empirical findings, misunderstanding or not being aware of important regulatory issues (be it legal, financial and institutional environments, business customs and practices in China), or simply being outdated studies.

Agency and resource-dependence theories will be examined to deduct the extent of the effect or lack of thereof on corporate innovation when it comes to China listed firms.

Top managers are some of the main influencers of CG and are believed to exert a large influence on the paths and outcomes of firm innovation. This can be achieved by building and managing an innovation culture, nurturing such culture, rewarding innovative initiatives, and drawing policies that foster innovation (Chatman & Sandra E., 2003; Frambach & Schillewaert, 2002). Previous literature on innovation suggests that in the environment of China, CG may be a determining factor of firm innovation.

CG can be classified into internal and external (Yang, Chi, & Young, 2011). This paper considers internal governance as it often has a direct and strong influence on company strategies and performance. Such internal governance mechanisms include ownership, board of directors' composition, and CEO duality. A characterizing element of the study is the fact that we analyze internal governance mechanisms of Chinese companies. Many companies are still owned and controlled by the state or central governments. By the end of 2009, about half of the publicly listed companies were owned by governments (Yang, Chi, & Young, 2011) and many of them had local or state government as the major shareholders (Liu, 2006). Second, a publicly listed firm is required to maintain certain proportion of outside directors on the board. This requirement may affect the power distribution among board members and between board and top management teams. Third, a firm may also maintain a supervisory board whose chairman is often the secretary of communist party in the organization and has power to influence firm policies such as human resources policies. As a result, the CEO-Chairman duality in state-owned firms may play a more important role in affecting the discretion of top management teams and subsequently a firm's behavior and strategy (Yang, Chi, & Young, 2011).

The effects of CG on innovation in the Chinese context are important to study because of China's spectacular economic development; although in the past there has been strong criticism by Western media for lack of an effective system of corporate governance (Shi & Weisert, 2002; Dahya, Karbhari, Xiao, & Yang, 2003; Clarke, 2003). In response to investors' criticism, the Securities Regulatory Commission of China (CSRC) issued several regulations and recommendations on the corporate

governance of Chinese listed companies: an important one is the corporate governance code for listed companies in China (2007). Following the regulation and recommendation issued by the CSRC, there is evidence that Chinese companies are actively improving their corporate governance practices, by establishing independent boards and hiring competent members of the financial and industrial sector with experience (Li, Byard, & Weintrop, 2006). This is a highly dynamic field of study, with existing literature on the subject becoming obsolete rapidly, especially when considering the English language literature dedicated to the Chinese context.

In the following chapters a review of the literature is presented, followed by the description of the research methodology, a presentation and discussion of the results, and policy recommendations.

2. Literature review

2.1 China's Stock Exchanges

Founded 100 years ago, China's stock exchange is the second largest in the world following the U.S. stock exchange (Jingyi, 2019). China's first stock exchange opened within the 1860s in Shanghai. While it closed for 41 years, in 1990 the Shanghai stock market opened again and private investors bought shares of state-owned businesses at the time.

The market is considered to be thinly traded as only 7 percent of China's population owns stocks. Since participation is so low, a small share of wealthy investors owns 80 percent of tradable shares (Das, 2019). The Chinese state encourages investment as a part of its economic reform. A healthy stock exchange will fund innovative smaller companies and boost China's economic development, and can provide an alternative to bank debt.

Unlike the U.S. stock market, China's stock exchange doesn't indicate the health of China's economy. The entire value of each stock traded on its exchanges is smaller than a third of its economic output, as measured by gross domestic product. In China, only 20 percent of household wealth is within the stock exchange .

There are two exchanges in mainland China. The Shanghai and Shenzhen exchanges were opened by the Chinese government in 1990 as way of modernizing China's economy and to help SOEs raise funds and improve their performance (Ding et al. 2007).

The Hong Kong stock market is being integrated into the Chinese exchanges, starting in November 2014, the Chinese government linked it with the Shanghai exchange Shanghai-Hong Kong Connect Program, and then added Shenzhen in late 2016 (Lau, Moe, Bei, & Liu, 2014).

2.1.1 Shanghai Stock Exchange

The Shanghai Stock Exchange was founded on November, 26th 1990 and began its operations on December, 19th 1990. The Shanghai Stock Exchange is the largest stock market in mainland China in terms of the number of listed firms, total market value, and tradable market value.

It has 1,561 listed firms and operates as a non-profit organization directly administered by the China Securities and Regulators Commission (CSRC). According to the World Federation of Exchanges (WFE), the Shanghai Stock Exchange ranked fourth in the world for market capitalization at US$4.0 trillion as of late 2018 (World Federation of Exchanges, 2019).

2.1.2 Shenzhen Stock Exchange

The Shenzhen Stock Exchange was also created in 1990, and boasts a market capitalization of US$2.5 trillion as of 2019 which makes it the fourth largest in Asia, and ninth largest in the world.

With 2,268 listed firms, its focus differs from the Shanghai Stock Exchange, as ever since its inception it has mainly focused on developing small and medium sized enterprises. It hosts the SME Board since 2004, and the ChiNext market since 2009, which could be considered as being very similar to the Nasdaq as it hosts high-tech & high-growth start-ups (Jeffries, 2010). The Shenzhen Stock Exchange is also under direct management of the CSRC since 1997 (China Securities Regulatory Commission, 2008). Table 01.

Shanghai and Shenzhen Stock Exchanges Differences by Sector.

Sector	Shanghai	Shenzhen

Manufacturing	28%	60%
Financial	32%	7.2%
Mining	Less than 3%	15%
Transportation	5.1%	Less than 3%
Real Estate	Less than 3%	4.9%
Utilities	4.5%	Less than 3%
Retail and Wholesale	Less than 3%	3.3%

Source: Amadeo, K.; Boyle, M.J., 2020

2.1.3 The China Securities Regulatory Commission – CSRC

The China Securities Regulatory Commission is the national regulatory body tasked with overseeing the securities and futures markets of China. Formed in 1998, it reports directly to China's State Council, and is the functional equivalent of the Securities and Exchange Commission (SEC) of the U.S. It includes 36 regulatory bureaus covering different geographic regions of the country, as well as two supervisory bureaus at China's Shanghai and Shenzhen stock exchanges.

The CSRC has one appointed chairman, four vice appointed chairmen, one secretary of the Disciplinary Inspection Commission and three assistants to the chairman. It has also setup a public offering (for IPOs) review committee constituted of professionals and invited experts from outside the committee in accordance with Article 14 of the Securities Law of the PRC.

Its functions can be resumed under three key areas:

i) Define and issue policies, laws and regulations concerning markets in securities and futures contracts.

ii) Oversee the issuing, trading, custody and settlement of equity shares, bonds, and investment funds

iii) Supervise listings, trading and settlements of future contracts, futures exchanges as well as securities and future firms.

Among the many important tasks, the CSRC has accomplished over the course of the years, one that stands tall among many is certainly the issuance of the code of corporate governance in 2004, or also the requirement for listed firms to include independent directors in their boards in 2007.

The style of the CSRC's policies follows the American and Hong Kong models. The American model influenced the code of corporate governance issued by CSRC (Walter & Fraser, 2011), while the Hong Kong model influenced the company law and securities law introduced in 1993 and 1998 respectively.

2.1.4 Shares structure

Following the split share reform of 2005, in China's stock markets we find that now the public has access to a variety of share classes, with differences in access that are set in accordance to their currency of trading and the limits imposed on the nationality of the investors. The different types of shares in circulation and their characteristics are resumed in table 02 according to their official classification.

Table 02.

China's Stock Markets Shares Classification.

Share Class	Country of Incorporation	Country of Listing	Trading Currency	Available to Mainland Chinese Investors	Available to Other Investors
A Share	People's Republic of China (PRC)	China	CNY	Yes	Yes under QFII/RQFII/ Stock Connect programs
B Share	PRC	China	USD (Shanghai) HKD (Shenzhen)	Yes (under condition they possess the appropriate currency accounts)	Yes

H Share	PRC	Hong Kong SAR	HKD	Yes, if QDII approved or under Stock Connect programs	Yes
Red Chip	Non-PRC	Hong Kong SAR	HKD	Yes, if QDII approved or under Stock Connect programs	Yes
P Chip	Non-PRC	Hong Kong SAR	HKD	Yes, if QDII approved or under Stock Connect programs	Yes
S Chip	Non-PRC	Singapore	Singapore	Yes, if QDII approved	Yes
N Share	Non-PRC	United States	United States	Yes, if QDII approved	Yes

Source: FTSE Russell, 2019

The current shares classification is the results of a lengthy and arduous reform process that the CSRC under request of China's State Council initiated in 1999 and achieved in 2005. The primary stated objective of this reform, coinciding with the desire to reform SOEs administration in the country, was to offer increased protection to public and minority investors.

This reform has been regarded as milestone that can set the way for the future privatization of SOEs (Shu, 2008).

2.2 Corporate governance

Agency theory has been used as the core theory in studies on corporate governance and corporate performance (Colarossi, Giorgino, Steri, & Viviani, 2008; Shakir, 2009; Sami, Wang, & Zhou, 2011; Tariq & Abbas, 2013; Gupta & Sharma, 2014; Dian, 2014). The main objective of the theory is to reduce or minimize agency costs incurred by the principals, by controlling the behavior of the agents through the internal control mechanisms of the company, and to align the interests of owners and agents. In a modern and generally Western context, a firm has dispersed minority shareholders who cannot exert direct control, and instead assign their decision-making rights to a board of directors and professional managers as their agents (Donaldson & Davis, 1991). In turn the agents are expected to run the firm in the best interest of the shareholders; studies on whether this is applicable to the Chinese context are lacking.

Recently scholars have criticized the under-socialized premises of agency theory (Lubatkin, Lane, Collin, & Very, 2007; Zahra, Hayton, Neubaum, Dibrell, & Craig, 2008), arguing that both large shareholders and managers exist in a socially situated context in which their behavior is inevitably influenced by the social relationship between them (Westphal & Zajac, 2013).

On the other hand, a competing theory, stewardship theory has been proposed as an appropriate theoretical perspective to analyze the social relationships and ties between large shareholders and managers (Sundaramurthy & Lewis, 2003), especially in China, where collectivistic cultures are common (Earley, 1989; Michailova & Hutchings, 2006). Stewardship theory states that managers, when left to their own choices, will act as responsible stewards of the assets they control. Advocates of this theory propone that given a choice between self-serving behavior and pro-organizational behavior, a steward (manager) will place higher regard on cooperation rather than defection. Stewards, according to this theory, are therefore assumed to be collectivists, pro-organizational, and trustworthy (Davis, Schoorman, & Donaldson, 1997).

2.2.1 Corporate governance in China

An important debate continues to grow over the impact of standard governance mechanisms on firm performance in China (Peng, 2004; Tsui, Nifadkar, & Ou, 2007). Standard monitoring and interest alignment mechanisms assume of self-orientation (Davids & Marquis, 2005) and market maturity (Young, Peng, Ahlstrom, Bruton, & Jiang, 2008), which may not be an appropriate fit for economies characterized by relationship-based contexts and underdeveloped market institutions (Sundaramurthy & Lewis, 2003).

Scholars have started to embrace a "context matters" perspective regarding the corporate governance literature, and one such example is the recommendation to leverage an institution-based view by incorporating institutional factors to better understand the contextual nature of corporate governance issues in China (Haxhi & Aguilera, 2016; Meyer & Peng, 2016). The institution-based view not only focuses on how institutions affect firm behavior, but also how changes in such institutions over time affect firm strategic choices and performance (Meyer & Peng, 2016). The inclusion of a temporal dimension by this theory allows the exploration for a dynamic institution-based view (Banalieva, Eddleston, & Zellweger, 2015) which would find fertile ground for analysis in the Chinese context.

While it is true that agency theory constitutes the underpinning of most of corporate governance literature, we should also consider if standard corporate governance mechanisms that are largely based on agency theory prescriptions do play a role in China, and if so, to what extent. We should also remember that China is considered a "hybrid" between central planning and market competition (Allen, Qian, & Qian, 2018), and between relationship-based and rule-based contexts (Luen, Lau, & Young, 2013).

The progressive and frequent introduction of market reforms in China are impactful as they alter the institutional framework that will ultimately improve all product, capital, and labor markets. These can be considered external governance mechanisms improvements, and they will in turn improve internal governance mechanisms by emphasizing arm's length monitoring, which may reduce agency costs and ultimately help firm performance (Peng, 2003). Corporate governance in China has experienced continuous reforms over the past 4 decades, and they can all be categorized into three stages (Jiang & Kim, 2015).

Table 03.

Three stages of institutional transitions of corporate governance in China.

	Key events	Implications
Stage 1 1980–1989	- Enterprise reform; privatization of SOEs. - Introduction of SOE law to clarify property rights and to implement incentive contracts (1988).	- Ownership and control problems still constrained the effectiveness of the incentive contracts between the government and the management. - The need for a basic corporate governance framework emerged.
Stage 2 1990–1999	- Launch of Shanghai and Shenzhen Stock Exchanges. - Launch of the Company Law (1993) and the Security Law (1999).	- Structural changes such as the formation of board of directors, the supervisory board, and mandatory annual shareholder meetings were introduced. - The establishment of a modern enterprise system sped up.
Stage 3 2000-present	- Revision of corporate laws (e.g., company law, accounting law, securities law). - Accession to the World Trade Organization (2001). - Introduction of the Code of Corporate Governance of Listed Companies (2002). - The 2005 non-tradable share reform.	- Improvements in the quality of disclosures and transparency. - Convergence to international standards (e.g., rules about having independent directors on the board).

Sources: (Liang, Renneboog, & Sun, 2016; Tenev & Zhang, 2002; Yang, Chi, & Young, 2011)

The more notable reforms in terms of internal governance mechanisms, included mandating board independence to increase monitoring power of corporate boards and reforming executive pay to align managerial interests with those of shareholders.

Unfortunately, some difficulties have been attributed to the implementation of such a governance model in China. The first being that standard internal governance mechanisms assume effective external governance mechanisms, such as strong shareholder protection and competitive product and labor markets (Young, Peng, Ahlstrom, Bruton, & Jiang, 2008). In China these conditions are

not completely met yet, and consequently the execution of standard governance structures may prove to be problematic (Allen, Qian, & Qian, 2005). The second difficulty would be the key assumptions of standard governance mechanisms in regards to self-interested agents and goal-oriented conflicts may not hold in contexts characterized by relationship-based regimes (Bruce, Buck, & Main, 2005; Luen, Lau, & Young, 2013). The cardinal role of guanxi (connections) in helping firms secure much needed resources and overcome institutional disadvantages has been highlighted by multiple studies (Park & Luo, 2001).

The literature on China is therefore mixed in the overall effects of standard corporate governance mechanisms on firm performance. While some studies do indeed report that "good" governance mechanisms make a difference in firm performance (Bai, Liu, Lu, Song, & Zhang, 2004), other studies simply fail to do so (Peng, 2004). The reasons behind such inconclusive evidence could be many, with failure to recognize "context" as key, as well as the high dynamisms of the institutional environment in China. An additional reason attributed by scholars is the need to derive corporate governance theory from China, for Chinese firms, and potentially other emerging economies' firms as well.

2.3 Corporate innovation

Innovation has been claimed to be the main driver for economic development by Schumpeter in his two best known books (1934, 1942). It can be defined as "the introduction of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (OECD, 2005).

The concept can be measured in two ways according to the literature; the most utilized method being the consideration of inputs (such as expenses on research & development, as a percentage of a company's total sales, or by the number of people involved in research & development activities as a percentage of the company's total employees) and outputs (the result of the innovative activity measured as the number of patents registered or in process of registration by the company) (Asensio-López, Cabeza-García, & González-Álvarez, 2019).

Over the past few years there has been a growing academic interest in the influence of governance mechanisms on innovation decisions taken by management teams (Tribo, Berrone, & Surroca, 2007; Belloc, 2011; Tsao, Lin, & Chen, 2015; Balsmeier, Buchwald, & Stiebale, 2014). This growing body of research argues that innovation factors, and thus in part innovation results, depend on elements that are influenced by corporate governance, such as the functioning of the board of directors, shareholder identity, CEO duality, foreign investors, or ownership structure.

To arrive at the current state of the literature, many theoretical iterations have occurred. Starting with Schumpeter's early work (Schumpeter J., 1934), sometimes simply referred to as "Schumpeter Mark I", where the key innovative players were the individual entrepreneurs with a series of new and small firms contributing to a process of "creative destruction". This hypothesis was however reviewed by Schumpeter himself with his work referred to as "Schumpeter Mark II" (Schumpeter J., 1942). This updated model was instead characterized by "creative accumulation" in which established firms with monopolistic power are the driving forces of the innovation process.

Such hypotheses spurred a large number of studies investigating the effects of market structures on innovation (Kamien & Schwartz, 1975; Cohen & Levin, 1989), but with inconclusive results. Aghion et al. (2005) based on cross-section industry data pointed out how the Schumpeterian hypotheses failed when conducting empirical research, as they both overlooked the degree of competition changes as a result of successful innovation, which in turn changes the competitive pressure to innovate, therefore creating an endogeneity problem.

The research that followed strived to develop models that took into account the two-way relationship between market-structures and firm's innovation activity, by using for example game-theory to model the interaction between incumbents and potential entrants. This strand of research starting in the late 70s brought significant theoretical developments that can be resumed with the auction model (Gilbert & Newbery, 1982) and the patent race model (Loury, 1979; Reinganum, 1983).

The literature on innovation seemed unable to explain the mixed results of the empirical studies up to that point, which led to a tentative to explain that the nature of competition differs between sectors' technological trajectories by using the distinction between competition in the market and competition for the market (Ahn, 2002; Malerba, 2004). Nevertheless, even when focusing on just one

individual sector, the theoretical and empirical studies were failing to explain why firms with similar external conditions would show vastly different innovation performances (Fagerberg & Mowery, 2005).

These continuous unsuccessful efforts of both theoretical predictions and empirical outcomes caused a shift from considering firms merely as players in a multi-actor economic game which wasn't adequately sufficient to understand firms' innovation performance, to relating firm's innovation activity to their organizational characteristics. A change of point of view from outside the firm to inside the firm was then enacted. New strands of research emerged, looking at the structure of the firms according to an evolutionary theory, and to their management teams' strategies and corporate governance. It started to be clear how the tendency of previous economic research to ignore differences between firms in corporate structure and governance was contributing to the inconclusiveness of the studies.

Although the focus of the research seems to have since shifted in the right direction by looking inside firms to explain corporate innovation, a well-defined or generally widely accepted theory of the innovative firms is still missing, as we still do not have a single and coherent conceptual framework for understanding the phenomenon of corporate technological innovation at the firm level (Lazonick, 2003).

It is possible to identify some main dimensions of corporate governance that are currently recognized as being relevant to innovation such as corporate ownership structure, corporate finance, and labor (Belloc, 2011). This shift has also been credited with creating a distinction between traditional economics of innovation which treats firms as if they were alike and considers innovation as a direct consequence of profit-maximizing behavior (Nelson, 1993) and the new and developing literature on corporate governance and innovation.

One such example is the organizational control theory proposed by Lazonick (Lazonick & Prencipe, 2005). This theory focuses on the organizational conditions at the base of the dynamics of the innovation process, and affirms that an enterprise must achieve three social conditions to be able to innovate: the first being strategic control, second being organizational integration; third being financial commitment.

Since the pioneering contribution of Schumpeter, followed by the game-theoretical literature and its traditionally minded studies that yielded inconclusive results leaving large parts of the picture unexplained, and treating the firm as a black box where internal structure, contracts and government modes are not even considered, we have arrived to a recent literature that is heterogenous and dynamic. Corporate governance for firm's performance, and more recently for firm's innovation, is finally being recognized. A paradigm shift where innovation is not seen as the result of technological determinism in a context of profit-maximizing firms, but as the result of individual investment decisions on innovative projects shaped by corporate governance systems is emerging (Belloc, 2011).

The delay is somewhat surprising if we consider that within the concept of corporate governance itself lies the implication that it may affect innovation, as corporate governance involves all the companies' management bodies with decision making powers and the distribution of powers amongst them (Fama & Jensen, 1983). Yet, despite these facts and the fact that corporate governance analysis started decades ago (Warren & Goodstein, 1991), there had been up until recently much fewer research studies conducted on the relationship between corporate governance and innovation, than on the relationship between corporate governance and business performance (Shah, Butt, & Saeed, 2011). The number drops even lower when considering non-Western markets or firms.

Some attempts have been made to confirm the relevance that research gives to the relationship between corporate governance and innovation, and even determine an evolution and clear trend in its direction. Among these, the cataloguing work by Gonzales-Bustos et al. (Gonzales-Bustos & Hernández-Lara, 2016) identifies the first publication in this field dates to 1991, although with only a handful of publications (less than 10) in the following decade. It was not until 2004 that the tendency began to change with the study of the relationship between corporate governance and innovation beginning to acquire interest at an academic level. Most of the papers in this field, 78.2%, were published in the last nine years and almost exclusively concentrated on analyzing companies in North America and England thus leaving a significant gap in the literature when it comes Asian markets, or in this case China.

3. Methodology

3.1 Measurement of the dependent variable

Table 04.

Summary of the independent variables used in model

Independent Variables	Measurement	Reference
CEO Duality	Coded as a dummy variable with a value of 0 if the CEO and Chairman of the Board are different persons; alternatively, coded as 1 is the CEO and Chairman are the same person.	Rechner & Dalton, 1991; Mallette & Fowler, 1992; Yang, Chi, & Young, 2011; Tribo, Berrone, & Surroca, 2007
Board Size	The number of directors sitting on the board of directors according to the company's annual disclosure report.	Yermack (1996); Eisenberg et al. (1998); Hillman & Dalziel, 2003
Board Independence	Calculated as a ratio by dividing the number of independent directors by the total number of directors on the board. Transformed in log because of high skewness and kurtosis.	Fama & Jensen, 1983; Williamson, 1983; IMA., 2009

3.2 Measurement of the dependent variable

Reviewing the existing literature, it will be possible to find different papers that when studying corporate innovation, chose to define it by utilizing either R&D expenses as a percentage of total sales, R&D staff as a share of the total company employees, or lastly by considering the patent applications made by a firm within a specified timeframe.

In accordance with the recent literature, the authors feel that studying innovation by considering R&D expenses could generate misleading results as many firms could have a cyclical budgeting method towards innovation, or even just use creative accounting methods when reporting their R&D budgets.

The same applies for the share of the workforce considered as R&D staff, as misleading results could be generated thanks to firms' mis-categorizing their employees' function, managers manipulating roles in their reporting to meet quotas, or simply because of inefficient firms with overstaffed R&D departments. The last possibility of considering patent applications has also come to be seen as questionable at best in the recent literature. This is due to phenomena such as patent bidding and simply patent "troll" firms.

For the purpose of this study, the dependent variable will only consider successful patent applications and grants obtained within China by Chinese firms. The exclusion of patents obtained overseas is done in order to ensure any selection bias, and to smooth any potential patent awarding discrepancies that we might encounter if we were to consider patents obtained in other countries, as every country could have different patent classification and grant standards.

3.3 Sample profile and data collection

This study employs a dataset consisting of the totality of Chinese firms listed on the Shanghai and Shenzhen stock markets.

The secondary data was collected through a multi-step approach from the Chinese Research Data Services Platform (CNRDS) which catalogues the official patent data released by the State Intellectual Property Office (SIPO), and the China Stock Market & Accounting Database (CSMAR), a comprehensive research-oriented database that contains financial and governance information of China's listed firms.

The collected dataset of all China's listed firms includes 3,337 firms with a total 13,182 firm-year observations ranging from the year 2010 to 2019. It was edited following the Adams et al. (2019)

framework for handling data: we do not winsorize, trim or alter the data in any way, and we exclude firms-year observations with missing data.

We analyse the impact of corporate governance on corporate innovation in China. To do so, the corporate governance components of CEO duality, as well as the size and independence of the board of directors are used. From the authors' perspective, there may be signs of corporate governance impact on innovation. Nevertheless, considering the scarce available literature on the subject when it comes to China, and how relatively young the Chinese stock market and corporate governance code of conduct is, an analysis is needed to confirm or deny the abundant anecdotal evidence we find on the subject and to quantify it as well.

3.4 Instrumentation and analysis standards

The obtained data has been subjected to the most prominent tests such as reliability analysis, correlation analysis and hierarchical regression to test the relationship between independent and dependent variables.

Robustness tests and tests for endogeneity have also been conducted, together with tests for collinearity and heteroskedasticity, and a few basic tests such as standard deviation, mode, and median. Significance of test results are reported in the three ways suggested by Coolican (1990), and all probabilities reported are based on two-tailed tests.

4. Results

The data has been subjected to the most prominent tests such as reliability analysis, correlation analysis and hierarchical regression to test the relationship between independent and dependent variables. Robustness tests and tests for endogeneity have also been conducted, together with tests for collinearity and heteroskedasticity.

Significance of test results are reported in the three ways suggested by Coolican (1990), and all probabilities reported are based on two-tailed tests.

The regressions performed are here preceded by summary statistics and pairwise correlation matrix to give an overview of the data features and the relationships between the variables.

4.1 Descriptive statistics

Table 5 presents the descriptive statistics for our sample's dependent and independent variables. Two variables, patents and board independence, which were transformed to their natural logarithm because of their irregular distribution and kurtosis, are here included in both transformed and non-transformed form.

Table 05.

Sample descriptive statistics.

Variable	N	Mean	Median	Std. Dev.	Min.	Max.
Patents	13182	43.11	10.00	174.84	1	4434
lnPatents	13182	2.41	2.30	1.48	0	8.4
Board Size	13182	8.42	9.00	1.56	4	18
CEO Duality	13182	0.47	0.00	0.50	0	1
Num. of Independent Directors	13182	3.11	3.00	0.51	1	8
Board Independence	13182	0.38	0.33	0.05	0.18	0.75
lnBoard Independence	13182	-0.99	-1.10	0.14	-1.7	-0.29

With a sample of 13,182 firm-year observations, the mean value of our response variable is 43.11, with a maximum recorded value of 4434 patents. We notice that the average board size is 8.42 board members of which 3.11 directors are independent on average; and CEO duality's mean is 0.47.

4.2 Correlation analysis

We first perform a correlation analysis, allowing us to evaluate the relationship's strength between our independent and dependent variables. Our correlation analysis produces some interesting results. As we can see from table 6 we find several variables correlated with our response variable, with the highest level of significance.

Table 06.

Sample correlation matrix.

Variables	*ln*Patents	Board Size	CEO Duality	*ln*Board Independence
*ln*Patents	1.00			
Board Size	0.059*** (0.000)	1.00		
CEO Duality	-0.110*** (0.000)	-0.052*** (0.000)	1.00	
*ln*Board Independence	0.029*** (0.001)	-0.555*** (0.000)	-0.019** (0.029)	1.00

4.3 Multicollinearity analysis

A multicollinearity analysis was performed using the variance inflation factor (VIF) for this study's predictor variables. According to the literature, a variable having a VIF value greater than 10 should merit further investigation; while tolerance being defined as 1/VIF is used to check the degree of collinearity. If the tolerance value results to be lower than 0.1, then it is comparable to a VIF of 10, which could mean that the variable in question can be regarded as a linear combination of other independent variables (Fox & Monette, 1992).

Table 7 presents the collinearity diagnostics, with results that clear our variables from any collinearity concerns.

Table 07.

Sample collinearity diagnostics.

Variable	VIF	SQRT VIF	Tolerance	R-Squared
Board Size	1.47	1.21	0.6826	0.3174
CEO Duality	1.01	1.00	0.9938	0.0062
Board Independence	1.45	1.21	0.6882	0.3118
Mean VIF	1.23			
Observations	13,182			

4.4 Regression model specification

Considering that our dataset is a panel data set, the standard test is the pooled OLS model's framework with a basic regression:

Eq. (01) $yit = x'it\beta + \alpha i + \varepsilon it$

With y indicating the dependent variable, I each individual firm, β the intercept, and εit the error term with t being the year. Based on our theoretical model, the equations of this study are as follows:

Eq. (02) Innovation = $\beta 0$ + $\beta 1$ Board Size + $\mu 0$

Eq. (03) Innovation = $\beta 0$ + $\beta 1$ CEO Duality + $\mu 0$

Eq. (04) Innovation = $\beta 0$ + $\beta 1$ Board Independence + $\mu 0$

Considering the possibility of group specific random effects, the Hausman test was performed in order to determine the most appropriate model to be used for the regression analysis. The models are:

Eq. (05) Fixed effects model: $yit = x'it\beta + \alpha i + \varepsilon it$

Eq. (06) Random effects model: $yit = x'it\beta + \alpha + \mu i + \varepsilon it$

Where y indicates the dependent variable, i each individual firm, and β the intercept, and εit the error term with t being the year. The fixed effects model illustrates the fixed individual effects, while the random effects model includes a group of specific random elements, which allow the unobservable effects to be randomly distributed in the cross-sectional unit (C. & Trivedi, 2009).

Table 08.
Hausman & overidentifying restrictions test results.

Variable	Test results	Appropriate model decision
*ln*Board Independence	Prob>chi2 = 0.03 chi2(2) = 0.8644	Random Effects
CEO Duality	Prob>chi2 = 0.0473 chi2(2) = 3.93	Fixed Effects
Board Size	Prob>chi2 = 0.0011 chi2(2) = 10.62	Fixed Effects

In addition to the Hausman test, an additional test for overidentifying restrictions (i.e., orthogonality conditions) has been performed for every model to confirm the Hausman test results, through postestimation analysis in Stata via the command "xtoverid" by Schaffer, Stillman, & Baum (2007). This test considers that when compared to fixed effects, random effects' estimator uses the traditional orthogonality conditions that the regressors are uncorrelated with group-specific error "u_i".

This implies that these additional orthogonality conditions are overidentifying restrictions. We used a technique implemented by Arellano (1993) and Wooldridge (2002) in which a random effects equation is re-estimated augmented with additional variables consisting of the original regressors transformed into form of deviations from mean. Untabulated test for overidentifying restrictions results were consistent with the Hausman test results reported here.

4.5 Regression analyses

After clearing multicollinearity concerns for our chosen predictive variables, and determining the most appropriate models, we can supplement our correlation analysis with regression analyses.

The regressions allows us to tackle the research questions of this paper, notably whether corporate governance affects innovativeness of China listed firm.

Table 9 presents the linear and multiple regression results for our sample. Results for postestimation tests conducted by the researcher such as endogeneity and robustness tests are also included at the bottom of the table.

Table 09.
Regression results.

	Model 1	Model 2	Model 3	Model 4
		lnPatents		
*ln*Board Independence	0.217** (0.081)			0.306** (0.104)
CEO Duality		-0.258*** (0.023)		-0.253*** (0.023)
Board Size			0.008 (0.007)	0.021* (0.009)
Constant	2.492*** (0.084)	2.535*** (0.013)	2.343*** (0.066)	2.657*** (0.089)
Observations	13182	13182	13182	13182
F		117.7	1.144	42.31
Prob > F	0.007	0.000	0.285	0.000
F Test		8.470	8.442	8.384
Wald chi2	7.051			
Endogeneity Test	No Endogenous Regressors 0.0000	No Endogenous Regressors 0.0000	No Endogenous Regressors 0.0000	No Endogenous Regressors 0.0000
Robustness Test	Robust	Robust	Robust	Robust

Standard errors in parentheses
* p < 0.05, ** p < 0.01, *** p < 0.001

5. Discussion and conclusion

This study set out to examine the effect of corporate governance on corporate innovation for China's listed firms, a research area still largely unexplored in Western academic literature.

Differently from previous studies conducted on innovation performance, we adhere to the call for the measurement of only successful innovation that has recently emerged in innovation literature.

Our sample consisted of 3,337 total firms and 13,182 firm-year observations ranging from the year 2010 to 2019. By utilizing regression models appropriate for a longitudinal study, testing for multicollinearity, endogeneity and robustness, and transforming key variables in order to avoid manipulating the data, we are able to gain an insight on the effects of corporate governance's effects on innovation. We find that board independence and CEO Duality are the most important predictors of corporate innovation.

Parsing our descriptive statistics, we notice how most firms have a preference for assigning the CEO and chairman of the board positions to the same person, thus creating CEO duality.

We notice the overall vital role played by the independent directors, and how boards are generally not large in our sample, suggesting that Chinese listed firms prefer smaller boards. This choice could generate benefits such as speed and efficiency in strategy decision making for example. We link the importance of board independence's predictive significance with the recent reform introduced by the China Securities Regulatory Commission requiring that a third of board directors be independent directors for firms listed in the country's stock exchanges. While the decision was surely taken with the aim to address one of the most important problems affecting the Chinese financial market by strengthening shareholders' protection, especially minority shareholders, it seems that it brings added benefits to the corporate governance of Chinese firms as it can foster innovation.

The necessity of a corporate governance theory by China and for China, is now more evident than ever. Future research could focus on utilizing Chinese data to test the existing theories of corporate governance across industries and across academic fields such as marketing and finance.

We have seen from our findings how the majority of firms present instances of CEO duality, and future research could investigate the different other areas of the firm that CEO duality could affect, and to what extent. Future research could venture deeper and study how CEO characteristics such as age, tenure, remuneration package and previous experience affect the outcomes of the firms.

Additionally, the differences between the CEOs and board members that are shareholders and those that are not could be studied, and the results of their respective firms compared. Such research could help determine whether including shares in the compensation packages of top executives produces any significant differences in performance; the best guess would be that it does improve performance, but we so far lack quantifiable results borne out of empirical research when it comes to China listed firms.

We studied listed firms in the Chinese stock markets, leaving a large number of non-listed firms that have not been included for which it would be interesting to conduct a dedicated study. Other types of studies such as a comparison between state-owned enterprises, family firms, SMEs and fully independent private firms could also be considered.

5.1 Policy and managerial recommendations

From a policy perspective, the decision to require a third of all board members be independent directors is certainly a good one, at least in terms of contributions to firms' innovation endeavors. We therefore recommend the continuation and encouragement of this policy, that in the long term will generate increasingly positive results. A second aspect that board independence can affect is shareholders' protection and trust in the top management teams, which brings us to our second recommendation. The authors feel that in order to address the concerns in regard to shareholder protection, and silence the criticism directed towards the Chinese listed firms by foreign investors, an

update of the company and contract law is due. It has been mentioned multiple times in the specialized press that the CSRC's next endeavor would be to undertake such reforms, and we believe they'll increase confidence in the country's listed firms and propel both the Shanghai and Shenzhen stock markets to new heights.

From a managerial perspective, we would like to recommend a renewed focus on innovation. By this we mean that innovation should no longer come second to profits and other accounting measures such as returns on sales or investments which would demonstrate short-term focus, and should instead place innovation as a cardinal element to the company, as it will exponentially contribute to the company's future success. According to the findings of this study, we also recommend to look at innovation capability not merely in terms of R&D staff and budget allocation, as these can be considered as outdated and superficial measurements. The CEO and directors of the board should take it upon themselves to create and foster a culture of innovation within the ranks, that promotes employees intrapreneurial spirit and risk propensity. Essentially, we recommend to the top management to "live in the future" and to focus on integrating good and efficient corporate governance practices with the world of tomorrow.

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