Technological Forecasting & Social Change 184 (2022) 121990

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

journal homepage: www.elsevier.com/locate/techfore

Environmental performance and corporate innovation in China: The moderating impact of firm ownership

Farid Ullah [a], Ping Jiang [b], Ahmed A. Elamer [c,d,*], Andrews Owusu [e]

[a] School of Accounting, Xijing University, Xi'an City, Shaanxi Province, China
[b] School of International Trade and Economics, University of International Business and Economics, Beijing, China
[c] Brunel Business School, Brunel University London, Kingston Lane, Uxbridge, London UB8 3PH, UK
[d] Department of Accounting, Faculty of Commerce, Mansoura University, Mansoura, Egypt
[e] College of Business, Law and Social Sciences, Derby Business School, University of Derby, Kedleston Road, Derby, DE22 1GB, UK

ARTICLE INFO

Keywords:
Environmental performance
Corporate innovation
Institutional ownership
State ownership
China

ABSTRACT

In this study, we examine the impact of environmental performance on corporate innovation based on a sample of 11,014 Chinese A-share firm-year observations during the period from 2010 to 2017. Also, we investigate the moderating impact of firm ownership on the above relation. Our results suggest a significant positive association between environmental performance and corporate innovation. By analyzing the moderating effect of ownership structure, our findings suggest that institutional ownership strengthened the positive relation between environmental performance and corporate innovation, while state ownership played a partial role. Our findings are robust for using advanced techniques, such as reverse causality, omitted variable bias, two-stage least square, and propensity score matching. This study contributes to the literature by shedding light on the stakeholder and resource dependence perspectives on the relation between environmental performance and corporate innovation.

1. Introduction

In recent decades, governments, academic scholars, NGOs, and managers have devoted greater attention to the strategic implications of environmental performance (Attah-Boakye et al., 2020; Chen et al., 2022; Cui et al., 2022). Environmental actions include environmentally friendly technologies, recycling and CO2 and GHG emission reduction, may encourage investments in R&D that can create both process and product innovations (Bocquet et al., 2013; Ferreira et al., 2020; McWilliams and Siegel, 2001; Rodríguez et al., 2022; Skare and Porada-Rochon, 2022). Using the lens of resource-based view (RBV), this study investigates whether firms with higher levels of environmental performance are more likely to drive corporate innovation. Existing research finds that there is considerable variation in the level of firms' innovation (e.g., Brav et al., 2018; Chava, 2014; Flammer and Kacperczyk, 2016; Kim et al., 2019). For example, a strand of studies has analyzed the impact of corporate governance characteristics on corporate innovation. These characteristics include board independence (Balsmeier et al., 2017), analyst coverage (He and Tian, 2013), institutional ownership (Aghion et al., 2013; Rong et al., 2017), hedge fund activism (Brav et al., 2018), CEO attributes namely CEO overconfidence (Hirshleifer et al., 2012), pilot CEOs (Sunder et al., 2017), managerial foreign experience (Yuan and Wen, 2018), managerial conservatism (Lu and Wang, 2018), managerial ability (Chen et al., 2015), and firm characteristics (Bernstein, 2015; Chava et al., 2013; Jia and Tian, 2018). Also, Bocquet et al. (2013), Cegarra-Navarro et al. (2016) and Hadj (2020) find that corporate social responsibility has significant explanatory power for corporate innovation. Yet, many antecedents of innovation variation remain embryonic (Wang et al., 2021; Hameed et al., 2021). We extend this stream of literature and investigate whether there are systematic differences in the choice of corporate innovation based on environmental performance in the Chinese context.

The literature provides contrasting arguments for the association between environmental performance and corporate innovation. First, it is believed that environmentally related practices improve firms' efficiency of resource utilization, enabling firms to enhance their operational process, update the manufacturing technology, and adopt new materials, thereby inducing corporate innovation enhancement (Kim,

* Corresponding author at: Brunel Business School, Brunel University London, Kingston Lane, Uxbridge, London UB8 3PH, UK.
E-mail addresses: 20180224@xijing.edu.cn (F. Ullah), ping.jiang@uibe.edu.cn (P. Jiang), ahmed.elamer@brunel.ac.uk (A.A. Elamer), A.Owusu@derby.ac.uk (A. Owusu).

https://doi.org/10.1016/j.techfore.2022.121990
Received 22 January 2022; Received in revised form 24 July 2022; Accepted 24 August 2022
Available online 10 September 2022

2015; Shu et al., 2016). For example, Kim (2015) found that firms' environmental- and sustainable-related activities induce corporate innovation enhancement during the global financial crisis period. Second, it is argued that corporate environmentally related activities increase the cost of capital and weaken a firm's innovation capability (Carrión-Flores et al., 2013; Wagner, 2008). For example, Carrión-Flores et al. (2013) state that firms' participation in pollution reduction activities probably enhances environmental patents in the short run but decreases in the long run.

Moreover, besides the enormous contribution to the existing literature, the extant studies are subject to certain limitations, which further motivated us to examine the impact of environmental performance on corporate innovation. For example, Kim (2015) analyzed the relation between environmental and sustainable behaviors and firm innovation during financial crises. Their study differs from ours on the following ground. First, their study analyzes the aforementioned relation in UK-listed firms, where the institutional and governance structure is quite rich and strong. However, the literature (e.g., Jiang and Kim, 2015; Rong et al., 2017) in the Chinese context argues that Western theories and findings may not lead us to the same conclusion because China's legal, financial, social, and institutional environment entirely differs from developed markets. Second, Kim (2015) study measures corporate innovation by R&D expenditure, while recent scholars believe that R&D expenditure may not enhance innovation due to the possibility of inefficient management (Flammer and Kacperczyk, 2016; Rong et al., 2017; Yuan and Wen, 2018). They recommend that patent count be the most significant measure of corporate innovation. Third, Kim (2015) only considers the financial crisis period (2008–2009), where innovation might be low due to the slowdown of economic activities compared to the post-financial crisis period.

China offers an ideal setting for empirical research because its social objectives (environmental and climatic conditions) were seriously affected due to its emphasis on massive production in the early globalization period (Du et al., 2014; Shahab et al., 2018; Zheng and Kahn, 2013). China has recently shifted its focus toward building an environmentally friendly economy through its famous slogan of "*Harmonious Society*" and "*Greener GDP*" (see, 2009; Li et al., 2019). In particular, China has adopted different environmental laws, policies, and regulations (e.g., Environmental Protection Law and Paris Climate Change Agreement), aimed at improving environmental conditions, and has shown a serious inclination toward enhancing environmental performance. China in 2020 once more formally suggested a carbon peak and neutrality by 2030 and 2060, correspondingly (Lin and Ma, 2022).

As an improvement to Kim (2015) study, He and Shen (2019) have focused specifically on how the certification of environmental management system (EMS) to ISO 14001 affects corporate technological innovation across Chinese listed firms. Using a sample of 770 listed firms from 2005 to 2014 (i.e., 7670 firm-year observations), He and Shen (2019) most important finding is that EMS certification to ISO 14001 is positively and significantly related to corporate technological innovation proxied by patents. They further confirmed that internal resource management practices, including resource utilization, resource accumulation, and resource allocation play mediating roles through which environmental performance facilitates corporate innovation.

While He and Shen (2019) study is an important addition to the existing literature, a number of important issues remain unaddressed. First, He and Shen (2019) exclusively focused on the mere certification of EMS to ISO 14001 with less direct empirical evidence on the effect of the actual environmental performance measure on corporate innovation. This is important because the mere certification of EMS to ISO 14001 may not translate into a firm's environmental performance, in that, firms may be pressured to go for the certification of EMS to ISO 14001 but they may hide behind it and undertake activities that are not environmentally friendly. Therefore, in this study, we go beyond the mere certification of EMS to ISO 14001 and pay nuanced attention to the firm-level actual environmental performance measure to analyze the relation between environmental performance and corporate innovation. Second, a possible impediment in our understanding of the effect of environmental performance on corporate innovation is the channel through which environmental performance is related to corporate innovation. Even though He and Shen (2019) examined the mediating role of internal resource on the relation between the certification of EMS to ISO 14001 and corporate innovation, they disregarded the role that shareholders play in achieving environmental performance and the corresponding corporate innovation. This is important in view of the documented relation between ownership structure and environmental and social performance (Lau et al., 2016; Li et al., 2013; Dyck et al., 2019; Kim et al., 2019). Thus, we also attempt to investigate the role of ownership structure in explaining the relation between environmental performance and corporate innovation.

The preceding discussion suggests that the conditional effect of ownership structure on environmental performance and corporate innovation is an empirical question. Therefore, to investigate our research question, we employ two widely used databases, Rankins Rating (RKS) for environmental performance (Shahab et al., 2018, 2020) and China Stock Market and Accounting Research (CSMAR) for innovations, such as patent count (Yuan and Wen, 2018; Chi et al., 2019), and test the impact of environmental performance on corporate innovation from 2010 to 2017. In addition, we download ownership data from CSMAR to test its moderating role in explaining environmental performance-corporate innovation nexus. Our results show a significant positive association between environmental performance and corporate innovation. When we analyzed the moderating role of ownership structure, our findings suggest that institutional ownership strengthened the positive relation between environmental performance and corporate innovation, while state ownership played a partial role in the association between the two.

Our study contributes to the existing literature in several ways. First, we contribute to the extant literature by showing the differences between a mere certification of EMS to ISO 14001 and firm-level environmental performance captured by rating agencies. Specifically, this study adds to the literature on the determinants of innovation (Aghion et al., 2013; Balsmeier et al., 2017; Brav et al., 2018; Hirshleifer et al., 2012; Shu et al., 2016; Sunder et al., 2017; Yuan and Wen, 2018; He and Shen, 2019). To our knowledge, this is the first study to directly link firm-level environmental performance captured by rating agencies to corporate innovation measured in terms of patent count.

Second, we provide the first empirical test of the main prediction of a theory on the RBV (Wernerfelt, 1984; Hart, 1995; Russo and Fouts, 1997; Bocquet et al., 2013, 2019) that a competitive advantage through resources and capabilities, achieved by performing well in the environmental related issues, could be beneficial for corporate technological innovation.

Third, this study adds to the environmental performance literature. Even though a number of studies have been undertaken to analyze the impact of environmental performance on corporate outcomes (Chava, 2014; Flammer, 2015; Hassan, 2018; Klassen and McLaughlin, 1996; Shahab et al., 2018; Russo and Fouts, 1997), and more specifically, environmental related activities on corporate innovation (Kim, 2015; Wagner, 2008; Yang et al., 2019; He and Shen, 2019), we address the shortcomings of these studies to novelly elevate the literature.

Finally, despite several studies that have examined the impact of ownership structure measured in terms of institutional and state ownership on (1) environmental and social performance (Li et al., 2013; Jiang and Kim, 2015; Lau et al., 2016; Dyck et al., 2019; Kim et al., 2019), and (2) corporate innovation (Aghion et al., 2013; Rong et al., 2017; Fang et al., 2017), they have not always examined how the presence of ownership structure affect the relation between environmental performance and corporate innovation. In this regard, we investigate the impact of ownership structure measured in terms of institutional and state ownership on managerial/firm decisions in environmental related activities and the corresponding corporate

innovation. To our knowledge, this is the first study to provide direct empirical evidence on the combined effect of environmental performance and ownership structure on corporate innovation. Our results provide new insights into firms' technological innovation of the relation between environmental performance and ownership structure.

The remainder of the study is organized as follows. The second section discusses the contextual background, theoretical framework and hypotheses. Section 3 discusses the research methodology. Section 4 presents the empirical results, while Section 5 provides the conclusion and future research directions.

2. Background, theoretical framework and hypothesis development

2.1. Contextual background

Previous studies (e.g., Li et al., 2019; Yang et al., 2019; Zhang and Song, 2022; Zheng and Kahn, 2013) have discussed that, to achieve rapid economic growth, China has seriously compromised its environmental conditions and has caused many problems, such as air pollution, deterioration of the natural environment, and the wastage of resources. These problems have made environmental restoration an exceptionally important issue for the Chinese government due to emerging debates among the public, NGOs, and business communities at national and international levels. Therefore, to tackle the environmentally related issues, China has developed different institutions and regulations (e.g., State Environmental Protection Administration, Global Reporting Initiative guidelines, and Paris Climate Change Agreement) in different periods.

In particular, the environmental protection law was formulated by the Chinese government to reduce environmental problems, such as prevention and control of air and water pollution, protection of public health, and promotion of ecological civilization. This law was formulated in April 2014 and enforced on January 1, 2015. Environmental protection law welcomed different NGOs to initiate public interest lawsuits. Article 58 of this law permits social organizations to conduct legal proceedings against polluted organizations on behalf of the public. For example, based on Article 58, the two social organizations—Friend of Nature and Fujian Green Home—jointly filed a lawsuit against four mining operators by stating that their unauthorized stone-quarry creates ecological issues in Nanping city. The court accepted their complaint in January 2015, and nine months later, the court ordered these companies to pay the clean-up costs and the legal costs of these two organizations.[1] In addition, this new law fully authorized environmental protection bureaus to fine those companies involved in environmental violations. The Ministry of Ecology and Environment has tightened crackdown on environmental violations, and their official data showed 15.28 billion yuan fines in 2018 (3.14 billion yuan in 2014) for environmental violations.[2] However, besides their focus on environmental restoration, China remains among the largest carbon dioxide-emitting countries using unfriendly environmental resources (e.g., coal), which causes between 70 and 80 deaths out of 100,000 people per year.[3]

Dieppe et al. (2018)[4] stated that, in the next five to 10 years, China will almost become a market leader in the main areas of science and innovation. He further stated that China has become the second-largest economy after the US by spending 21 % (2 trillion dollars) of total R&D worldwide (18 % per year between 2010 and 2015) in 2015. Consequently, from an academic perspective, corporate innovation has received tremendous attention in recent times in all disciplines, including economics, finance, marketing, management, etc. He and Tian (2018) argued that the availability of patent data that specifically captures the country's or firm's innovation capabilities has made this topic more attractive recently.

Therefore, the current institutional background of China regarding the firm's environmental performance and corporate innovation makes our study more specific and timely in determining the association between environmental performance and corporate innovation in China and whether ownership structure plays any moderating role through which environmental performance affects corporate innovation.

2.2. Theoretical framework and research hypotheses

The role of environmentally responsible activities and their relation to various firm outcomes have usually been studied by employing the integration of multiple theoretical perspectives (Benlemlih et al., 2018; Flammer, 2015; Hillman and Keim, 2001). For example, Benlemlih et al. (2018) integrated multiple theories (agency, resource dependence, and stakeholder) and analyzed the impact of corporate environmental and social disclosure on firm risk. Similarly, Qiu et al. (2016) analyzed the relation between corporate environmental and social disclosure and firm performance by employing socio-political, legitimacy, resource-based, and voluntary disclosure theories. Moreover, since a single theory probably cannot explain a firm's engagement in different stakeholders' activities, the role of corporate social and environmental performance on different firm outcomes should be studied from multiple theoretical perspectives (Hillman and Keim, 2001; Chava, 2014; Flammer, 2015). Therefore, we integrate two prominent theories—stakeholder (Freeman, 1984; Flammer, 2015) and RBV (Wernerfelt, 1984; Russo and Fouts, 1997)—while analyzing the relation between environmental performance and corporate innovation.

Being an important stakeholder of the firm, environmentally related issues (environmental performance) have been predominantly discussed through stakeholder theory (Flammer, 2015; Freeman, 1984). Freeman (1984) argued that firms have close connections with various stakeholders that can be individuals or groups (e.g., employees, suppliers, creditors, customers, the environment, and society), which can affect and are affected by the firm business operations. Clarkson (1995) highlighted that stakeholders can be related to a firm either internally or from external sources, and, like shareholders, they also place some demands on a firm. The preceding empirical and theoretical literature (Clarkson, 1995) argued that firms must address the concerns of these stakeholders; otherwise, it will deteriorate shareholder value in the long run. Following the stakeholder's perspective, Wernerfelt (1984) introduced RBV by arguing that a firm's ability to outperform its competitor is due to their heterogeneous capabilities and resources. By following this theory, further studies elaborate that corporate resources can be divided into different categories, such as tangible (plant, equipment, and stocks of raw materials), intangible (reputation, technology, and human resources), and personnel resources (culture, training, employee attributes) (Grant, 1991; Russo and Fouts, 1997). Hart (1995) further extended the RBV and included firm environmental issues as an important indicator of comparative advantage. Moreover, Russo and Fouts (1997) expounded that environmental performance provides a comparative advantage to a firm compared to its competitor and maximizes firm value. Thus, firms may struggle to achieve higher level of innovation unless they have the policy, financial, and environmental resources necessary to successfully carry out innovation (Khan et al., 2020). Hence, Strategic environmental performance progressively seeks to build resources and capabilities, which can result in technological innovation (Bocquet et al., 2013, 2019).

Evidently, based on the above theoretical perspectives, few empirical studies have investigated the impact of environmental performance on

[1] http://www.chinadaily.com.cn/china/2015-05/15/content_20729260.htm.

[2] http://www.ecns.cn/news/society/2019-09-29/detail-ifzpknpx2080355.shtml.

[3] https://www.who.int/westernpacific/news/detail/02-05-2018-one-third-of-global-air-pollution-deaths-in-asia-pacific.

[4] https://www.weforum.org/agenda/2018/02/these-charts-show-how-china-is-becoming-an-innovation-superpower/.

various organizational outcomes, such as firm performance (Russo and Fouts, 1997), firm risk (Benlemlih et al., 2018), cost of capital (Chava, 2014), stock return (Klassen and McLaughlin, 1996), financial distress (Shahab et al., 2018). Noticeably, studies investigating the relation between environmentally related activities and corporate innovation remain scarce. Kim (2015) analyzed the impact of corporate environmental and sustainable behavior on innovation during the financial crisis period (2008–2009). He measured firm environmental and sustainable behavior by a dummy variable if a firm was included in the Carbon Disclosure Project and Dow and Jones Sustainability Index, and firm innovation by the total R&D expenditure. His empirical findings suggest that firm engagement in environmental activities enhances corporate innovation. Similarly, Yang et al. (2019) analyzed the impact of environmental strategy on corporate innovation capabilities in China. They measured environmental strategy using primary data, and they sent a questionnaire to the senior management through email to know how the management of the firm perceives environmentally related activities. However, for their dependent variable (innovation), they used secondary data by collecting the number of patents of those firms whose managers (126) responded to their email. Their empirical findings showed that the manager's perceived business and social pressure positively influenced proactive environmental strategies, which further enhanced the firm's innovative capabilities. However, this study has some limitations. First, Yang et al. (2019) considered primary (environmental strategy) and secondary (innovation) data at one time. The environmental strategy data was collected through a questionnaire to determine how managers perceive environmental strategy. However, we argue that managerial perception regarding environmentally related activities cannot be a proper measure for environmental performance because the latter (environmental performance) shows the actual steps taken to address this issue. Also, by conducting a cross-sectional study, Yang et al. (2019) final sample size was quite low (126 observations), thereby yielding a non-generalizable conclusion.

Of particular interest to this study is the research undertaken by He and Shen (2019) who analyzed the impact of ISO 14001 certification on corporate technological innovation across Chinese listed firms over the period 2005–2014. The authors document a positive association between ISO 14001 certification and total patent flow, implying that ISO 14001 certified firms significantly increase their patent applications than those uncertified and yet-to-certified firms. However, one significant limitation of He and Shen (2019) study is that they exclusively focused on the impact of the mere certification of EMS to ISO 14001 on corporate innovation in their analysis and disregarded the firm-level environmental performance measure. Not only does the certification not reflect the actual environmental performance, firms may also hide behind the certification and cover up environmental wrongdoing. Therefore, we extend He and Shen (2019) study by investigating the relation between environmental performance that captures firm-level environmental activities and technological innovation.

In light of the preceding discussion, one can argue that environmental related activities are more likely to increase corporate innovation. Therefore, drawing from the RBV, and given more consistent positive association between environmental related activities and corporate innovation, we would expect a positive relation between environmental performance and corporate innovation. Consequently, we propose our first hypothesis in an alternative form as follows:

Hypothesis 1. Environmental performance has a positive and significant relation with corporate innovation.

Next, we test hitherto the unexamined joint effect of environmental performance and ownership structure (i.e., proxied by institutional and state ownership) on corporate innovation. By holding a significant amount of other people's money, institutional investors are the most professional and active investors who can play an important role in protecting the shareholder's interest by efficiently and effectively monitoring firms' management (Cui et al., 2019; García-Sánchez et al., 2020; Hartzell and Starks, 2003; Jensen and Meckling, 1976). Institutional investors protect shareholders' interests and play a pivotal role in handling stakeholders' issues, especially firm environmental and social behaviors (Dyck et al., 2019; Kim et al., 2019). For example, Dyck et al. (2019) collected data from 41 countries and analyzed the relation between institutional ownership and firm environmental and social performance. They found that institutional ownership enhances firms' environmental and social performance, and this relation is more strengthened in those countries with strong community beliefs. Kim et al. (2019) investigated the impact of institutional investors on corporate environmental, social, and governance policies. By collecting the toxic release information data from 750 unique firms between 1994 and 2010, they found that institutional investors play an important role in significantly reducing corporate toxic release and enhancing corporate environmental and social performance. However, Jiang and Kim (2015) argued that institutional investors may not be able to influence corporate policies in China due to having a small proportion of share ownership.

In terms of corporate innovation, Aghion et al. (2013) analyzed the relation between institutional ownership and innovation in US-listed firms. They found that institutional ownership significantly positively affects firm innovation. Based on this idea, Rong et al. (2017) argue that, compared to the US, institutional ownership is quite low due to concentrated ownership in Chinese-listed firms. By investigating the impact of institutional ownership on firm innovation in China, they also found that institutional ownership enhances firm innovation. Similarly, Chi et al. (2019) divided institutional investors into three categories: mutual fund holding, grey institutional holding (insurance companies and pension funds), and qualified foreign institutional investors. They argued that mutual fund holdings are positively associated with firm innovation, while grey and qualified institutional holdings insignificantly affect firm innovation.

From these findings, we further extend the empirical literature regarding institutional investors and contend that institutional investors can play an important role in moderating the relation between environmental performance and corporate innovation. Following the arguments of preceding literature (Dyck et al., 2019; Kim et al., 2019; Rong et al., 2017), we conjecture that institutional investors protect the shareholder's interest (enhancing innovation activities) while effectively guarding the stakeholder's interest (maximize environmental performance). As in hypothesis 1, we would expect corporate innovation to be higher in firms with stronger environmental performance. If indeed environmental performance increases corporate innovation, then we would expect the relation to be strengthened in the presence of institutional shareholder monitoring. Therefore, we hypothesize that environmental performance has a stronger impact on innovation in a higher proportion of institutional shareholding firms. This leads to our second hypothesis in an alternative form as follows:

Hypothesis 2. The positive relation between environmental performance and corporate innovation is stronger for firms with higher institutional ownership.

In addition, state ownership is one of the key differences between Chinese and Western countries' firms (Jiang and Kim, 2015; Rong et al., 2017; Ullah et al., 2019; Yuan and Wen, 2018). Although, after the open-door policy, China underwent various state ownership reforms (i.e., the foundation of Shenzhen and Shanghai stock exchanges, split share reforms in 2005, etc.), most Chinese firms are owned by the state (Jiang and Kim, 2015; Ullah et al., 2019). Moreover, the preceding literature suggests that state-owned firms often focus on political targets and are more likely to engage in non-financial activities, such as reducing unemployment and enhancing corporate environmental and sustainable performance (Li and Zhang, 2010; Li et al., 2013; Marquis and Qian, 2014). For example, Lau et al. (2016) found that state ownership significantly positively affects corporate social performance. However, Rong et al. (2017) contended that state-owned firms in China file twice

less patent application and receive less citation than private firms. They further argued that CEOs' motive to enjoy a quiet life and less threat of being replaced due to less competition in state-owned firms might be one of the reasons for lower patent applications.

As the empirical literature in the Chinese context contends that state-owned firms are mostly focused on non-financial objectives, including corporate environmental performance (Li and Zhang, 2010; Li et al., 2013; Lau et al., 2016; Marquis and Qian, 2014), and are less engaged in innovation-related activities (Chen et al., 2015; Rong et al., 2017), we draw our inference from the preceding literature that states that firms' focus on environmental performance will ultimately lead to maximizing shareholders' return (Benlemlih et al., 2018; Chava, 2014; Flammer, 2015; Russo and Fouts, 1997), including corporate innovation (Flammer and Kacperczyk, 2016; Kim, 2015). We also argue that state-owned firms who are more likely to engage in environmental activities will have a greater comparative advantage to have higher corporate innovation than others. To the extent that environmental performance is more likely to increase corporate innovation and the fact that state-owned firms tended to engage in environmental activities to improve environmental and sustainable performance (Li and Zhang, 2010; Li et al., 2013; Marquis and Qian, 2014), we would expect the relation between environmental performance and corporate innovation to be more pronounced in firms with greater state ownership. Accordingly, our third hypothesis is stated in an alternative form as follows:

Hypothesis 3. State ownership strengthens the positive relation between environmental performance and corporate innovation.

3. Research design

3.1. Sample and data collection

To examine the nexus between environmental performance and corporate innovation, we obtained the data from 2010 to 2017 of A-share firms listed on the Shenzhen and Shanghai stock exchanges. We took the specific period because the data about our independent variable (environmental performance) was accessible from 2009 onward. Overall, we collected the data from two databases to check the above-mentioned relationship. First, by following the preceding literature (Lau et al., 2016; Shahab et al., 2018, 2020), the data regarding environmental performance were taken from the "HEXUN" website containing the Rankins Rating score (RKS) about the firm environmental and social performance. Second, the data about the rest of the variables, such as our dependent (innovation), controls, and moderating (institutional and state ownership) variables, were obtained from China Stock Market and Accounting Research (CSMAR). CSMAR is one of the most reliable databases in China and has been extensively used in previous studies (Jiang and Kim, 2015; Ullah et al., 2019; Yuan and Wen, 2018). After combining the two datasets, we excluded all the missing observations about our dependent, independent, and control variables. In addition, by following Yuan and Wen (2018), we also dropped financial sector firms (namely, banks, investment trust, and insurance companies, etc.) because the structure and function of these companies differed from other firms.[5] Finally, we winsorized all the relevant variables of interest at a 1 % level and attained a final sample of 11,014 observations between 2010 and 2017.

3.2. Environmental performance

RKS ratings contain the individual rating scores for various stakeholders' indicators, such as environment, corporate social responsibility, employee's responsibility, customer suppliers, and client responsibility. The range of these specific indicators is in a continuous form (from "0" to "100"), where "0" represents the lower or zero involvement of firms in the specific stakeholders' indicators, while "100" shows the higher involvement. Therefore, to measure environmental performance, we followed Shahab et al. (2020) and used the environment-specific ratings for environmental performance. Moreover, we noticed that most of the firms were uninvolved (84 %) in environmentally related activities. Therefore, to provide more robust findings, we used another proxy (used in propensity score matching and additional analyses) by creating a dummy variable that equals "1" if a firm RKS rating score exceeds zero in a particular year and "0" if vice versa.

3.3. Corporate innovation

The preceding literature (Flammer and Kacperczyk, 2016; Chi et al., 2019; He and Tian, 2013; Yuan and Wen, 2018) has consistently argued that, compared to innovation inputs, such as capital expenditure and R&D intensity, researchers should consider the actual output of innovation (the number of patent applications granted), as it shows broader and actual innovation-related activities. Therefore, by following their approach, we measured innovation using four different proxies. First, we collected the data and took one plus the natural logarithm of the total number of patent applications (invention, utility, and design) filed by a firm in a specific year. Second, we took the one plus natural logarithm of the total number of invention patent filed by a firm. These two were the main proxies used in the empirical analyses. Meanwhile, we also used an alternate proxy for corporate innovation to check the robustness of our results. For this alternate proxy, we followed Chi et al. (2019), and measured corporate innovation by one plus the natural logarithm of total utility patents. Besides these proxies for corporate innovation, the preceding literature (Flammer and Kacperczyk, 2016; Jia and Tian, 2018; Rong et al., 2017) also argued that patent citation might be a good proxy to measure corporate innovation. However, we could not use patent citation as an alternate proxy for corporate innovation because as per Yuan and Wen (2018) the patent citation data is not publically available in China.

3.4. Control variables

Following previous studies, we employed some control variables that were expected to affect corporate innovations. For example, Li et al. (2019) argued that innovation activities are risky and costly, therefore, the provision of incentives will encourage managers to align their interests with firm's long-term goals and will be able to make more effort in innovation. Hence, based on this argument, we take managerial ownership (the proportion of shares held by the managers of a firm) as our control variable. In addition, preceding literature (Balsmeier et al., 2017; Hirshleifer et al., 2012; Jensen and Meckling, 1976) highlighted that corporate governance specifically board of directors attributes plays an important role in protecting shareholder's interests and enhancing innovation-related activities. Thus, we used three variables regarding the board of director attributes namely board size (the total number of board of directors in a firm), board independence (the proportion of independent directors out of total directors in a firm), CEO duality (a dummy variable coded "1" if CEO is also the chairman of the board and "0" otherwise). Lastly, it has also been suggested by the preceding literature that firm-level characteristics variables play a significant role in determining corporate innovation. For example, Chen and Yang et al. (2019) stated that firm's innovative behaviors are constrained by financial conditions. A deficient debt-to-asset which shows the financial condition of a firm limits the investment intensity of innovation activities. Moreover, Balsmeier et al. (2017) found that as compared to small firms, large firms have more resources to innovate. Hence, based on these arguments, we used different firm characteristic variables namely return on assets (the income before extraordinary items divided by the book value of assets), leverage (the total debt divided by the total equity), firm size (the natural logarithm of firm total assets), cash ratio

[5] Please consult Table 1 for the final sample of the study.

(cash and cash equivalent divided by total assets), and firm age (the difference between the year t and the year when the firm was established).

3.5. Econometric model

By analyzing the impact of environmental performance on corporate innovation, we used the following baseline regression models with year- and industry-fixed effects.[6]

$$\mathrm{Ln}(1+\mathrm{invention})_{it} = b_0 + \beta_1 \mathrm{ENV.Per}_{it} + \beta_2 \mathrm{Controls}_{it} + \beta_3 \mathrm{Industry}_i + \beta_4 \mathrm{Year}_t + \varepsilon_{it} \quad (1)$$

$$\mathrm{Ln}(1+\mathrm{Patent})_{it} = b_0 + \beta_1 \mathrm{ENV.Per}_{it} + \beta_2 \mathrm{Controls}_{it} + \beta_3 \mathrm{Industry}_i + \beta_4 \mathrm{Year}_t + \varepsilon_{it} \quad (2)$$

$$\mathrm{Ln}(1+\mathrm{Utility})_{it} = b_0 + \beta_1 \mathrm{ENV.Per}_{it} + \beta_2 \mathrm{Controls}_{it} + \beta_3 \mathrm{Industry}_i + \beta_4 \mathrm{Year}_t + \varepsilon_{it} \quad (3)$$

The variable mentioned in the above equations has been explained in Sections 3.2, 3.3, and 3.4 respectively. The first and second equations are used in the main analysis while the third equation is used in robust analysis.

4. Empirical results

4.1. Summary statistics

Fig. 1 shows the graphical representation of the mean values of inventions and total (invention, utility, and design) patents filed by a firm over the period from 2010 to 2017. This graph indicates that there is a consistent increase in inventions and total patents during the sample period of the study where the lowest value is in 2010 while the highest value is in 2016.

Table 2 shows the summary statistics of the variables (dependent, independent, and control) used in our main regression analyses. This table contains the data regarding the total number of observations, mean, standard deviation, minimum, percentile (25th, 50th, and 75th), and maximum values. Consequently, in this table, we also show the raw data (not converted into natural logarithm) of innovation proxies to determine the mean value of the total number of patent applications filed by a firm in a particular year. The mean value of invention and total (invention, utility, and design) patents showed that, on average, each firm filed 14.09 and 34.07 inventions and total patent application, respectively. The mean value of these two proxies was slightly lower than that of Chi et al. (2019). However, we noticed that Chi et al. (2019) did not winsorize these two proxies data at the summary statistics table because the maximum value of both variables was quite large (almost similar to our pre-winsorization proxies).[7] To validate our argument, we took the natural log of both invention and total patents and found that our values were very close to the preceding studies (Chi et al., 2019; Fu, 2019). The mean value of the environmental performance score was 2.42, which parallels that of Shahab et al. (2020), who specifically used the environmental rating score while analyzing the relation between CEO attributes and environmental performance. Moreover, the mean value of environmental performance measured by a dummy variable showed that, on average, 16 % of firms reported environmentally related activities in China. This value corroborates that of Shahab et al. (2020).

The descriptive statistics about corporate governance variables showed that, in China, the managerial holding had 9 %, each firm had nearly 9 boards of directors in which 37 % were independent directors, while 29 % of CEOs were also chairman of the board. The mean value of the firm characteristics variables indicated that the average return on assets was 0.02 and a leverage of 38 %. The mean value of the natural logarithm of firm size was 21.86 with a 0.192 cash-to-asset ratio, and firm age was about 14 years. The mean value of our moderating variables (institutional and state ownership) showed that, on average, 6 % of the shares were held by institutional investors, while 32 % of the firms were owned by the state. These values parallel those of Chi et al. (2019) and Ullah et al. (2019).

In Table 3, we compare the mean values of corporate innovation between the firms that engaged in environmental activities and those that did not. In this table, we only dropped the missing values of environmental performance and corporate innovation, but we did not drop the missing values of control variables. The mean values of invention (total) patents were 26.789(63.056) for firms engaged in environmental activities and 11.629(28.261) for firms without environmental activities. The differences between both values were significant at 1 % level. This relation indicates that a firm's engagement in environmental activities brings more innovation than those without environmental activities.

Table 4 presents the results of the variance inflation factor (VIF) and correlations among innovation, environmental performance, and control variables. The largest value of VIF was 2.10, below the standard threshold of 10. Thus, it seems that our results might not be affected due to multicollinearity. The findings of the correlation columns in Table 3 indicated that environmental performance was positively and significantly associated with corporate innovation. Additionally, the results of the impact of control variables on corporate innovation parallel those of previous studies (e.g., Balsmeier et al., 2017; Chen et al., 2015; Yuan and Wen, 2018).

Table 1
Sample selection.
This table shows the final observations of the study over the period from 2010 to 2017 by excluding the firms in financial industries and missing observations of variables.

	Observations
Total observations of A-share listed firms from 2010 to 2017	11,483
Minus: Firms in financial industries	116
Minus: Missing observations	353
Final observations	11,014

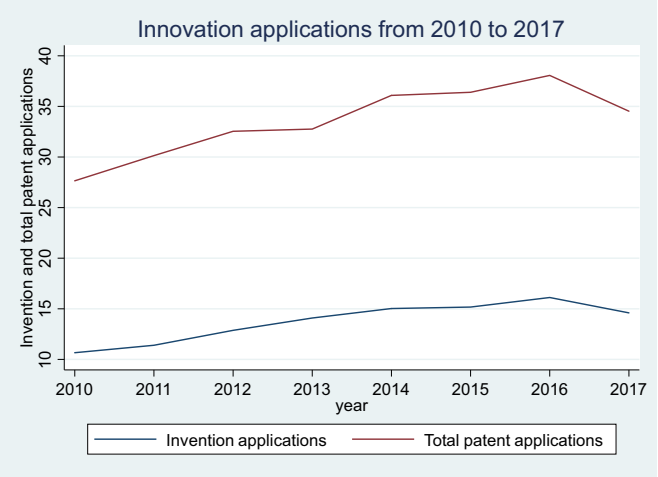

Fig. 1. Innovation applications.
This figure shows the average number of invention and total (including inventions, utility, and designs) patent applications filed by a firm during the sample period of the study.

[6] As invention and total patents are non-negative and discrete. Therefore, we also used Poisson and negative binomial regression. The results are presented in Table 8.

[7] For brevity, we have not reported the pre-winsorized values here. It can be available upon request.

Table 2
Descriptive statistics.

Variables	N	Mean	S.D	Min	P25	Median	P75	Max
INV_App	11,014	14.090	34.12	0	1	4	11	242
Patent_App	11,014	34.07	79.46	1	4	11	27	552
Ln(1 + Invention)	11,014	1.760	1.232	0	0.693	1.609	2.484	5.493
Ln(1 + Patent)	11,014	2.407	1.421	0	1.386	2.397	3.295	8.864
ENV_Per	11,014	2.421	5.938	0	0	0	0	30
ENV_Dummy	11,014	0.161	0.367	0	0	0	0	1
Mgt_Hold	11,014	0.0930	0.153	0	0	0.00600	0.124	0.587
Boardsize	11,014	8.654	1.637	5	7	9	9	15
Board_IND	11,014	0.373	0.0550	0	0.333	0.333	0.429	0.80
CEO_Duality	11,014	0.291	0.454	0	0	0	1	1
ROA	11,014	0.0290	0.0310	−0.140	0.0110	0.0260	0.0450	0.141
Leverage	11,014	0.383	0.206	0.052	0.214	0.365	0.533	1.380
Firmsize	11,014	21.86	1.230	18.997	20.98	21.66	22.48	26.466
Cash	11,014	0.192	0.153	0.006	0.0850	0.142	0.253	0.685
Firmage	11,014	13.98	5.253	0	10	14	18	26
Inst_Owner	11,014	0.0690	0.0630	0	0.0220	0.0520	0.0970	0.750
SOE	11,014	0.308	0.462	0	0	0	1	1

Table 3
Univariate analysis.

	Environmental activities = 1		*Environmental activities = 0*		*Differences*
	Observations	*Mean*	*Observations*	*Mean*	*T-value*
INV_App	1770	27.122	9244	11.513	−17.731***
Patent_App	1770	63.933	9244	28.303	−17.459***

Notes: This table reports univariate analysis of the dependent (innovation) based on independent variables (environmental performance). *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels (two-tailed). Please see Appendix A for descriptions of variables.

4.2. Regression results

Table 5 presents the empirical results of the pooled OLS regression models for the effect of environmental performance on corporate innovation. In columns 1 and 2, we checked the one-to-one association between environmental performance and corporate innovation with industry and year effects. In columns 3 and 4, we added control variables to further check the aforementioned relation.

Regarding our first hypothesis, the results of Columns 1 and 2 indicated that the coefficient and P-values of environmental performance and corporate innovation were positives 0.038 (0.040) and significant (P-values 0.000). These results support our first hypothesis about the positive relation between environmental performance and corporate innovation. Moreover, by adding control variables in Columns 3 and 4, our results parallel what we found in the first two columns (positive and significant). Thus, from the economic significance, it shows that a 1 % increase (decrease) in firm environmental performance can induce a 3 % or 4 % increase (decrease) in innovation-related activities of a firm. The previous studies (McWilliams and Siegel, 2001; Waddock and Graves, 1997) discussed that corporate environmental and social performance is significantly different across various industries due to the diverse product nature, social norms, and corporate settings. They further argued that the peer effect might be a reason to attract other firms to adopt parallel practices in similar industries. Based on this argument, in Columns 5 and 6, we further tested the aforementioned relation by double clustered (industry and year) effect. Here, the empirical findings also indicated that environmentally responsible firms were more likely to engage in innovation-related activities. Moreover, we also tried to add additional fixed effects such as provincial fixed effect and the results in Columns 7 and 8 were consistent with the previous findings.

Based on these findings, the policy implication of our study is that, on average, a firm's engagement in environmentally related activities is associated with better corporate innovation.

Overall, these findings follow stakeholder- and resource-based theoretical perspectives (Freeman, 1984; Flammer and Kacperczyk, 2016; Hart, 1995; Russo and Fouts, 1997), which argue that firms' engagement in environmentally related activities can be used as an important tool to enhance their reputations, trust, and performance. Consequently, the findings of our study further extend the preceding empirical literature (Balsmeier et al., 2017; Brav et al., 2018; Flammer and Kacperczyk, 2016; Sunder et al., 2017) by arguing that, besides reducing firm risk, financial constraints, and increasing firm performance, environmental performance can also be utilized as an important mechanism of enhancing corporate innovations. Moreover, the results regarding the impact of various control variables on corporate innovation corroborate those of previous studies (Lu and Wang, 2018; Rong et al., 2017; Yuan and Wen, 2018).

Table 4
VIF and correlation matrix.

Variables	VIF	1	2	3	4	5	6	7	8	9	10	11
1.Ln(1 + Invention)	–	1										
2.ENV_Per	1.12	0.155*	1									
3.Mgt_Hold	1.54	−0.044*	−0.132*	1								
4.Boardsize	1.45	0.102*	0.153*	−0.185*	1							
5.Board_IND	1.32	0.021*	−0.015*	0.113*	−0.454*	1						
6.CEO_Duality	1.38	−0.003	−0.078*	0.515*	−0.187*	0.117*	1					
7.ROA	1.30	0.063*	0.041*	0.146*	0.004	−0.031*	0.080*	1				
8.Leverage	2.10	0.127*	0.156*	−0.316*	0.199*	−0.015	−0.175*	−0.405*	1			
9.Firmsize	1.84	0.338*	0.311*	−0.329*	0.291*	0.017*	−0.194*	−0.094*	0.571*	1		
10.Cash	1.53	−0.055*	−0.079*	0.269*	−0.080*	0.005	0.144*	0.353*	−0.545*	−0.352*	1	
11.Firmage	1.13	0.058*	0.021*	−0.199*	0.076*	−0.043*	−0.116*	−0.098*	0.236*	0.253*	−0.265*	1
Observations	11,014											

Notes: * Statistically significant at the 0.10 level.

Table 5
Regression results for the impact of environmental performance on corporate innovation.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables	*Ln(1 + Invention)*	*Ln(1 + Patent)*	*Ln(1 + Invention)*	*Ln(1 + Patent)*	*Ln(1 + Invention)*	*Ln(1 + Patent)*	*Ln(1 + Invention)*	*Ln(1 + Patent)*
ENV_Per	0.038***	0.040***	0.011***	0.012***	0.011***	0.012***	0.013***	0.014***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Mgt_Hold			0.266***	0.459***	0.266***	0.459***	0.193**	0.378***
			[0.002]	[0.000]	[0.002]	[0.000]	[0.023]	[0.000]
Boardsize			0.031***	0.017	0.031***	0.017*	0.031***	0.017*
			[0.001]	[0.101]	[0.000]	[0.091]	[0.000]	[0.081]
Board_IND			0.528**	0.633**	0.528**	0.633***	0.462**	0.641**
			[0.022]	[0.018]	[0.011]	[0.005]	[0.043]	[0.016]
CEO_Duality			0.090***	0.099***	0.090***	0.099**	0.075***	0.082***
			[0.001]	[0.002]	[0.007]	[0.023]	[0.005]	[0.009]
ROA			2.840***	3.258***	2.840***	3.258***	2.706***	2.897***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Leverage			−0.023	0.096	−0.023	0.096	0.013	0.103
			[0.775]	[0.315]	[0.781]	[0.359]	[0.865]	[0.279]
Firmsize			0.412***	0.438***	0.412***	0.438***	0.409***	0.449***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Cash			0.325***	0.352***	0.325***	0.352***	0.297***	0.373***
			[0.000]	[0.001]	[0.003]	[0.008]	[0.001]	[0.000]
Firmage			−0.007***	−0.012***	−0.007***	−0.012***	−0.006***	−0.011***
			[0.001]	[0.000]	[0.001]	[0.000]	[0.005]	[0.000]
Industry effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial effect	No	No	No	No	No	No	Yes	Yes
Observations	11,014	11,014	11,014	11,014	11,014	11,014	11,014	11,014
R-squared	0.061	0.060	0.185	0.164	0.185	0.164	0.211	0.192

Notes: *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels. Please see Appendix A for descriptions of variables. Industry and year effects have been controlled in the analysis. P-values are reported in brackets.

4.3. Robustness check

We further conducted additional tests to analyze the robustness of our test. Table 6 shows the detailed results of our additional analyses. In this table, we used different proxies for environmental performance and corporate innovation. First, we measured environmental performance by two proxies: (a) a dummy variable code "1" if a firm is engaged in environmental activities and "0" if vice versa (b). We followed Shahab et al. (2018) and measured environmental performance using corporate social responsibility ratings (ranges from 0 to 100). The data regarding corporate social performance were also obtained from RKS ratings. Second, for measuring corporate innovation, we followed Chi et al. (2019) and Fu (2019) and measured corporate innovation by natural logarithm of 1 plus utility patents. In Table 6, the empirical results of environmental performance measured by dummy show a positive and significant relation with both proxies of corporate innovation. The coefficient values of these two columns are positive (0.124, 0.095) and significant (0.000), indicating that a 1 % increase in environmentally related activities leads to the enhancement of corporate utility and design innovation by 12 % and 9 %, respectively. Similarly, Columns 3 and 4 results also show a positive and significant relation between sustainable performance and corporate innovation. Overall, these results parallel our preceding findings relating to our main hypothesis about the positive association between environmental performance and corporate innovation.

Moreover, environmental protection system (EMS) certifications like ISO14001 are getting much attention around the world and are expected to play a significant role in enhancing corporate environmental performance (Aravind and Christmann, 2011; Boiral and Henri, 2012). However, preceding studies provide contrasting findings regarding its contribution to improving firm performance and other corporate outcomes. For example, Arocena et al. (2021) argued that ISO14001 certifications have a positive and significant relation with firm performance. On the other hand, He et al. (2015) collected the data from Chinese firms and found an insignificant relation between ISO14001 and firm performance. Thus, an important indicator of improving corporate environmental performance, in Table 6, we use ISO14001 as a robust proxy to analyze the impact of corporate environmental performance on corporate innovation. We collected the data ISO14001 from CSMAR and measured it with a dummy variable coded "1" if a firm has ISO14001 certification and "0" if vice versa.[8] The empirical findings columns 6 and 7 indicate that ISO14001 has a positive and significant relation with corporate innovation.

We also used Poisson and negative binomial regression to address the issue that invention and total (invention, utility, and design) patents are non-negative and discrete. Here, for corporate innovation, instead of log values, we used two proxies' namely the total number of invention patents and the number of overall patents including invention, utility, and design patents file by a firm in a specific year. The empirical findings of both models in Table 7 indicate that environmental performance positively and significantly impacts the innovation-related activities of a firm. Thus, these findings also validate our first hypothesis.

4.4. Endogeneity

So far, although the empirical evidence of the regression results indicates that environmental performance is positively associated with corporate innovation, we cannot finally conclude about the above-mentioned relation due to endogeneity bias. Therefore, to address the endogeneity issue and to provide a more robust conclusion, we further used different other techniques, such as reverse causality, omitted variable bias, two stages least square (2SLS), and propensity score matching.

4.4.1. Omitted variable and change analyses

To address the concern of reverse causality, we took the dependent variable (corporate innovation) at forward lag (in columns 1 and 2 of Table 8) and again checked the impact of environmental performance on corporate innovation. The empirical findings in Table 8 also support our first hypothesis by showing that environmental performance significantly positively affects corporate innovation at a 1 % level of

[8] We deleted the firm-year observations for which the data was not available.

Table 6
Alternate proxies.
This table reports the regression results about the association between environmental performance and corporate innovation by using additional proxies. Please see Appendix A for descriptions of variables. Industry and year effects were controlled in the analysis. P-values are reported in brackets.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables	*Ln(1 + Invention)*	*Ln(1 + Patent)*	*Ln(1 + Invention)*	*Ln(1 + Patent)*	*Ln(1 + Utility)*	*Ln(1 + Invention)*	*Ln(1 + Patent)*
ENV_Dummy	0.158***	0.171***					
	[0.000]	[0.000]					
Social_Per			0.004***	0.005***			
			[0.000]	[0.000]			
ENV_Per					0.012***		
					[0.000]		
ISO_14,001						0.146***	0.195***
						[0.000]	[0.000]
Mgt_Hold	0.268***	0.460***	0.264***	0.456***	0.389***	0.182**	0.383***
	[0.002]	[0.000]	[0.002]	[0.000]	[0.000]	[0.046]	[0.000]
Boardsize	0.031***	0.016	0.030***	0.016	−0.003	0.032***	0.016
	[0.001]	[0.107]	[0.001]	[0.118]	[0.769]	[0.001]	[0.115]
Board_IND	0.522**	0.627**	0.517**	0.621**	0.336	0.575**	0.599**
	[0.024]	[0.020]	[0.025]	[0.021]	[0.223]	[0.016]	[0.030]
CEO_Duality	0.090***	0.099***	0.091***	0.099***	0.021	0.090***	0.091***
	[0.001]	[0.002]	[0.001]	[0.002]	[0.524]	[0.001]	[0.005]
ROA	2.831***	3.249***	2.119***	2.440***	0.450	2.671***	2.913***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.341]	[0.000]	[0.000]
Leverage	−0.024	0.095	−0.008	0.114	0.432***	−0.034	0.069
	[0.765]	[0.322]	[0.920]	[0.235]	[0.000]	[0.680]	[0.478]
Firmsize	0.415***	0.440***	0.408***	0.432***	0.343***	0.440***	0.479***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Cash	0.321***	0.348***	0.303***	0.329***	0.451***	0.310***	0.357***
	[0.000]	[0.001]	[0.001]	[0.002]	[0.000]	[0.001]	[0.001]
Firmage	−0.008***	−0.012***	−0.008***	−0.012***	−0.018***	−0.010***	−0.015***
	[0.001]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]
Industry effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,014	11,014	11,014	11,014	11,014	10,414	10,414
R-squared	0.185	0.164	0.185	0.164	0.147	0.190	0.173

Notes: *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels. Please see Appendix A for descriptions of variables. Industry and year effects have been controlled in the analysis. P-values are reported in brackets.

Table 7
Poisson and negative binomial regression results.

Variables	*Poisson*		*Negative Binomial*	
	(1)	*(2)*	*(3)*	*(4)*
	INV_App	*Patent_App*	*INV_App*	*Patent_App*
ENV_Per	0.011***	0.008***	0.012***	0.007***
	[0.000]	[0.007]	[0.000]	[0.003]
Mgt_Hold	0.786***	0.831***	0.407***	0.473***
	[0.000]	[0.000]	[0.001]	[0.000]
Boardsize	0.062***	0.039***	0.028*	0.004
	[0.000]	[0.004]	[0.053]	[0.735]
Board_IND	0.883**	0.717*	0.511	0.892**
	[0.011]	[0.057]	[0.154]	[0.013]
CEO_Duality	0.102**	0.135***	0.079**	0.096**
	[0.023]	[0.003]	[0.044]	[0.011]
ROA	3.751***	4.830***	3.974***	4.579***
	[0.000]	[0.000]	[0.000]	[0.000]
Leverage	0.032	0.195	0.101	0.342***
	[0.813]	[0.153]	[0.424]	[0.004]
Firmsize	0.658***	0.632***	0.603***	0.556***
	[0.000]	[0.000]	[0.000]	[0.000]
Cash	0.411**	0.360**	0.529***	0.370***
	[0.016]	[0.016]	[0.000]	[0.004]
Firmage	−0.006	−0.006	−0.013***	−0.011***
	[0.117]	[0.157]	[0.000]	[0.001]
Industry effect	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes
Observations	11,014	11,014	11,014	11,014
R-squared	0.375	0.379	0.056	0.048

Note: *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels.

significance.

Moreover, following previous studies (Chi et al., 2019; Rong et al., 2017; Yuan and Wen, 2018), to minimize the problem of omitted variable bias, we added some additional control variables, which were shown to significantly affect corporate innovation. These variables included largest shareholder (the proportion of shares held by the largest shareholder of a firm), director meeting (the total number of meetings by the board of directors in a year), asset turnover (the ratio of book value of firm total revenue divided by total assets), and sale growth (the proportion of change in firm sale in year t). The results of Table 8 Columns 3 and 4 show that environmental performance still significantly positively affected corporate innovation after adding these variables.

4.4.2. *Instrumental variable*

We employed 2SLS to mitigate the issue of potential endogeneity. Although 2SLS is an effective technique for more robust findings, the problem with its use is to find relevant instrumental variables that can affect our independent variable (environmental performance) but have no relation with the dependent variable (innovation). However, previous studies (McWilliams and Siegel, 2001; Waddock and Graves, 1997) have shown that the peer effect may lead other firms to adopt parallel practices in similar industries. In addition, they argued that corporate environmental and social performance have significant variations across industries due to the diverse product nature, monitoring settings, and social norms. Following this approach, Cai et al. (2011), and Shahab et al. (2018) used the industry average of environmental performance as an instrumental variable for environmental performance. Therefore, by analyzing the impact of environmental performance on corporate innovation, we followed the related approach and used industry average environmental performance as our instrumental variable. While using

Table 8
Reverse causality and omitted variables bias.

Variables	Reverse causality		Omitted variable bias	
	(1)	(2)	(3)	(4)
	f.Ln(1 + Invention)	f.Ln(1 + Patent)	Ln(1 + Invention)	Ln(1 + Patent)
ENV_Per	0.011***	0.014***	0.011***	0.012***
	[0.000]	[0.000]	[0.000]	[0.000]
Mgt_Hold	0.336***	0.491***	0.279***	0.500***
	[0.001]	[0.000]	[0.001]	[0.000]
Boardsize	0.034***	0.015	0.028***	0.013
	[0.001]	[0.169]	[0.002]	[0.186]
Board_IND	0.621**	0.996***	0.545**	0.614**
	[0.021]	[0.001]	[0.018]	[0.022]
CEO_Duality	0.090***	0.084**	0.092***	0.099***
	[0.004]	[0.020]	[0.001]	[0.002]
ROA	4.118***	5.160***	2.688***	2.620***
	[0.000]	[0.000]	[0.000]	[0.000]
Leverage	0.046	0.178	−0.065	0.002
	[0.620]	[0.105]	[0.432]	[0.987]
Firmsize	0.448***	0.472***	0.424***	0.446***
	[0.000]	[0.000]	[0.000]	[0.000]
Cash	0.306***	0.340***	0.352***	0.380***
	[0.003]	[0.004]	[0.000]	[0.000]
Firmage	−0.007***	−0.010***	−0.009***	−0.013***
	[0.008]	[0.001]	[0.000]	[0.000]
Large_SHR			−0.003***	−0.001
			[0.000]	[0.462]
Dir_Meeting			−0.003	−0.006*
			[0.303]	[0.085]
Asset_T			0.158***	0.346***
			[0.003]	[0.000]
Sale_Growth			−2.531	−6.393*
			[0.380]	[0.060]
Industry effect	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes
Observations	8392	8392	11,014	11,014
R-squared	0.201	0.186	0.188	0.168

Note: *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels.

2SLS, the empirical findings of the second stage regression in Table 9 indicated that environmental performance and corporate innovation are significantly positively related. Moreover, regarding the validity of the instrumental variable, the Wald F value of our instrumental variable (22.45) exceeded the standard threshold (10), indicating that our instrumental variable is relevant and has a stronger effect on environmental performance.

4.4.3. PSM

We used the PSM technique to alleviate the potential endogeneity concerns that can occur due to reverse causality and the self-selection effect. The summary statistics table of our study shows that nearly 16 % of the firms are engaged in environmentally related activities. Therefore, by employing PSM, we used the second proxy in which we measured environmental performance by a dummy ("1" if a firm is involved in environmentally related activities and "0" if vice versa). While using the approach, we took all the control variables of our main regression model (managers holding, board size, board independence, CEO duality, ROA, leverage, firm size, cash ratio, and firm age). We followed radius matching technique and used a logit model to identify the propensity score-matched control sample within a caliper width of 0.1 for each treated firm. From Table 10, Panel A, all logit models passed the balance test, ensuring that matching is satisfactory. In Table 10, Columns 1 and 2, Panel B, we re-estimated Model 1 while using the treatment and control sample. The findings showed that environmental performance is positively and significantly associated with corporate innovation. These results further strengthen our argument that environmental performance spurs corporate innovation.

Table 9
Endogeneity check.

Variables	(1)	(2)	(3)
	First stage	Second stage (2SLS)	
	ENV_Per	Ln(1 + Invention)	Ln(1 + Patent)
Mean_ENV_Per	1.119***		
	[0.000]		
ENV_Per		0.270***	0.338***
		[0.000]	[0.000]
Mgt_Hold	−2.669***	0.514***	0.830***
	[0.000]	[0.001]	[0.000]
Boardsize	0.355***	0.004	−0.037
	[0.000]	[0.836]	[0.102]
Board_IND	5.883***	0.294	−0.042
	[0.000]	[0.479]	[0.934]
CEO_Duality	0.020	0.080*	0.095*
	[0.873]	[0.054]	[0.064]
ROA	22.355***	−0.286	−0.877
	[0.000]	[0.776]	[0.473]
Leverage	3.268***	0.413***	0.424**
	[0.000]	[0.008]	[0.027]
Firmsize	−1.072***	−0.592***	−0.535***
	[0.000]	[0.000]	[0.000]
Cash	−2.884***	1.155***	1.257***
	[0.000]	[0.000]	[0.000]
Firmage	0.054***	−0.017***	−0.026***
	[0.000]	[0.000]	[0.000]
Industry effect	Yes	Yes	Yes
Year effect	Yes	Yes	Yes
Observations	11,014	11,014	11,014
R-squared	0.133	0.317	0.391
Un_Iden_Test			
K-P rk LM stat		67.38	67.38
P-value		0.000	0.000
Weak_Iden_ Test			
C-D Wald F stat		96.32	96.32
S-Y ID 10 % value		16.38	16.38

Note: *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels.

4.4.4. Entropy balancing

We also used entropy balancing method to further alleviate potential endogeneity bias.[9] We first divide the sample into two groups: treatment and control groups. The treatment group *(ENV_Dummy = 1)* contains firm-year observations having *ENV_Per > 0*, whereas the control group *(ENV_Dummy = 0)* consists of firm-year observations having *ENV_Per = 0*. In Table 11, Panel A (before entropy balancing) and Panel B (after entropy balancing, we followed Hainmueller and Xu (2013) to converge the mean, variance, and skewness of all covariates in the treatment and control groups. In Table 11, Panel C, we again re-estimate the regression results reported in Table 5 based on treated balance. The empirical findings suggested that there is a positive and signification relation between environmental performance and corporate innovation. Hence, our findings are robust to potential endogeneity bias.

4.5. The moderating role of institutional and state ownership

In this section, to test our second and third hypotheses, we empirically analyzed how ownership structure (institutional and state ownership) moderates the relation between environmental performance and corporate innovation. Based on previous studies (Lin and Fu, 2017; Ullah et al., 2019), we measured institutional investors by the proportion of shares held by different institutional investors (e.g., mutual funds, insurance companies, qualified foreign institutional investors, trust shareholding). Second, we measured state ownership by a dummy variable coded "1" if a firm is owned by the state and "0" otherwise.

Table 12 shows the empirical results regarding the moderating role of institutional ownership. In support of our second hypothesis, in the

[9] We are thankful to the anonymous reviewer for this suggestion.

Table 10
PSM results for the impact of environmental performance on corporate innovation.

Panel A: Results of covariate balance checks

Variables	Mean		P values
	ENV_Dummy = 1	*ENV_Dummy = 0*	
Mgt_Hold	0.045	0.044	0.710
Boardsize	9.248	9.177	0.248
Board_IND	0.370	0.368	0.277
CEO_Duality	0.210	0.200	0.479
ROA	0.033	0.033	0.575
Leverage	0.451	0.451	0.975
Firmsize	22.689	22.699	0.826
Cash	0.171	0.167	0.417
Firmage	14.295	14.423	0.459

Panel B: Regression results using the PSM method.

Variables	*(1)*	*(2)*
	Ln(1 + Invention)	*Ln(1 + Patent)*
ENV_Dummy	0.155***	0.169***
	[0.000]	[0.000]
Mgt_Hold	0.271***	0.476***
	[0.002]	[0.000]
Boardsize	0.030***	0.016
	[0.001]	[0.126]
Board_IND	0.510**	0.628**
	[0.028]	[0.020]
CEO_Duality	0.087***	0.091***
	[0.001]	[0.004]
ROA	2.925***	3.377***
	[0.000]	[0.000]
Leverage	−0.036	0.079
	[0.652]	[0.409]
L.Firmsize	0.416***	0.441***
	[0.000]	[0.000]
Cash	0.310***	0.336***
	[0.001]	[0.002]
Firmage	−0.007***	−0.012***
	[0.001]	[0.000]
Industry effect	Yes	Yes
Year effect	Yes	Yes
Observations	10,942	10,942
R-squared	0.183	0.162

Note: *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels.

first and second columns, we found that institutional ownership strengthens the relation between environmental performance and corporate innovation because the results are significant at a 5 % level. Moreover, to check the robustness of our results, we also used double clustered OLS,[10] reverse causality, and omitted variable bias techniques. Our results from Columns 3 to 8 are consistent with our previous findings. Overall, these findings support our second hypothesis. Previous studies (Dyck et al., 2019; Kim et al., 2019; Rong et al., 2017) have shown that institutional investors are professional investors who can play an important role in protecting shareholders' and stakeholders' interests. Consequently, particularly in China, although institutional investors remain in the minority, besides their prime responsibility (to maximize the profit of their client), they are also actively involved in improving corporate governance activities and maximizing shareholder wealth (Firth et al., 2016; Lin and Fu, 2017; Rong et al., 2017). Therefore, based on these recommendations and our empirical findings, the policy implication of our study could be that environmentally responsible firms will be more able to enhance innovation if there is a higher proportion of institutional investors.

Moreover, regarding the moderating role of state ownership, we found that state ownership positively and significantly moderates the relation between environmental performance and corporate innovation (measured through the natural log of 1 plus total number invention applications filed by a firm in a specific year). However, we noticed that state ownership plays no role in moderating the above-mentioned relation while using the natural log of 1 plus total number patent applications filed by a firm in a specific year as a proxy for corporate innovation. Moreover, to check the robustness of our results, we followed similar procedure and used double clustered OLS, reverse causality, and omitted variable bias techniques as shown in Table 13. Here, we also found consistent results. These findings partially support our third hypothesis. However, studies (Li et al., 2013; Lau et al., 2016; Marquis and Qian, 2014) have highlighted that a state-owned firm's prior focus is to fulfill the non-financial objective. This means that, rather than achieving their own interest (profit), their prime objective is to contribute to the community. However, based on our findings, we argue that non-financial objectives might be a priority for state-owned firms, but it might be possible that such activities will provide them with an opportunity and comparative advantage to enhance innovation in the long run.

4.6. Additional tests

Preceding studies (Du et al., 2014; Li et al., 2019; Shahab et al., 2018) have highlighted that, by achieving rapid economic growth, China has seriously compromised its environmental responsibilities and has caused many problems, such as air pollution, deterioration of natural habitats, and the wastage of resources. Moreover, besides the national level crisis mentioned above, it is also highlighted that industries engaged in pollution-related activities reduce firm value and enhance their financial constraints (Chang et al., 2015; Xiao and Wang, 2020). Based on these findings, we test that how firms operating in heavily polluted industries moderate the relation between environmental performance and corporate innovation. To define heavily polluted firms, we followed the administrative measures issue by the Chinese Ministry of Environmental Protection and empirical studies namely Chang et al. (2015) and Xiao and Wang (2020). We measured heavily polluted firms (*High_Polluted*) through a dummy variable equals "1" if a firm operates in any of eight categories namely mining, metal and non-metal, textile and clothing, biomedicine, petrochemical, food and beverages, water-electricity-gas and pulp-paper-printing, and "0" if vice versa. The results in Table 14 Columns 1 indicated that firms that operate in heavily polluted industries negatively moderate the relation between environmental performance and corporate innovation. The afore-mentioned relation is also negative but insignificant in Column 2.

In addition, China's focus on rapid economic growth have made environmental restoration an exceptionally important issue for the Chinese government due to emerging debates among the public, NGOs, and business communities at national and international levels. Therefore, an environmental protection law with stricter legislation was enacted in 2014 to further improve environmental performance. As per this law, it is the responsibility of individuals and organizations to protect the environment. In addition, in this law, several punishments have been mentioned for individuals, organizations, and local governments for environmental misconduct.[11] Based on the above discussions, we tested how environmental protection law moderates environmental performance and corporate innovation in its post period. We developed a dummy variable (*Post_EPL*) equals "1" if the firm year is greater than or equal to 2015 and "0" otherwise. The empirical findings in Table 14 columns 3 and 4 indicate that there is an insignificant relation between environmental performance and corporate innovation after the

[10] Given the significant differences in environmental activities across industries, we apply double clustered OLS on industry and year for robustness purpose.

[11] http://www.gov.cn/zhengce/2014-04/25/content_26664 34.htm.

Table 11
Entropy balancing.

Panel A: Before entropy balancing

Variables	*Treatment group (ENV_Dummy = 1)*			*Control group (ENV_Dummy = 0)*		
	Mean	*Variance*	*Skewness*	*Mean*	*Variance*	*Skewness*
Mgt_Hold	0.045	0.011	2.889	0.101	0.025	1.638
Boardsize	9.263	3.477	0.944	8.538	2.442	0.453
Board_IND	0.370	0.003	1.964	0.373	0.003	1.489
CEO_Duality	0.209	0.165	1.427	0.306	0.212	0.837
ROA	0.033	0.001	0.530	0.028	0.001	0.068
Leverage	0.451	0.039	−0.127	0.369	0.042	0.540
Firmsize	22.7	1.987	0.525	21.69	1.261	1.104
Cash	0.171	0.016	1.508	0.196	0.024	1.402
Firmage	14.29	24.52	0.235	13.92	28.17	0.105

Panel B: After entropy balancing

Variables	*Treatment group (ENV_Dummy = 1)*			*Control group (ENV_Dummy = 0)*		
	Mean	*Variance*	*Skewness*	*Mean*	*Variance*	*Skewness*
Mgt_Hold	0.045	0.011	2.889	0.046	0.010	3.009
Boardsize	9.263	3.477	0.944	9.262	3.716	0.850
Board_IND	0.370	0.003	1.964	0.370	0.003	2.126
CEO_Duality	0.209	0.165	1.427	0.210	0.166	1.423
ROA	0.033	0.001	0.530	0.033	0.001	0.889
Leverage	0.451	0.039	−0.127	0.451	0.045	0.128
Firmsize	22.7	1.987	0.525	22.7	2.532	0.710
Cash	0.171	0.016	1.508	0.171	0.019	1.64
Firmage	14.29	24.52	0.235	14.29	28.4	−0.001

Panel C: Entropy balancing regression results

Variables	*(1)*	*(2)*
	Ln(1 + Invention)	*Ln(1 + Patent)*
ENV_Dummy	0.109***	0.127***
	[0.006]	[0.005]
Mgt_Hold	0.549***	0.710***
	[0.004]	[0.001]
Boardsize	0.047***	0.034**
	[0.000]	[0.020]
Board_IND	0.609*	0.771*
	[0.097]	[0.062]
CEO_Duality	0.172***	0.195***
	[0.001]	[0.000]
ROA	2.247***	3.521***
	[0.002]	[0.000]
Leverage	−0.225	−0.037
	[0.105]	[0.811]
Firmsize	0.522***	0.541***
	[0.000]	[0.000]
Cash	0.002	0.200
	[0.993]	[0.292]
Firmage	−0.009**	−0.013***
	[0.022]	[0.005]
Industry effect	Yes	Yes
Year effect	Yes	Yes
Observations	11,014	11,014
R-squared	0.288	0.263

Note: *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels.

implementation of environmental protection law.

It has been documented in the literature that China exhibits substantial regional variation in intellectual property right protection (IPRP) which can significantly affect various corporate outcomes including corporate innovation (Ang et al., 2014; Fang et al., 2017; Huang et al., 2017). Thus, we followed these studies and checked how provincial IPRP affects the association between environmental performance and corporate innovation. We collected the province-level IPRP data from China Regional Intellectual Property Rights (CRIPR) Index Report. However, we had to drop the environmental performance and corporate innovation data from 2010 to 2012 because the data regarding provincial level IPRP index was available from 2013 to 2017. To test the moderating role of IPRP, we divided the IPRP index into two categories by assigning a value of "1" if a province mean value of the IPRP index is greater than the overall mean value of the IPRP index and "0" if vice versa. The empirical findings in columns 5 and 6 suggest that the positive relation between environmental performance and corporate innovation is more pronounced in firms located in higher IPRP provinces.

5. Conclusion and future research directors

The impact of environmental performance on corporate innovation

Table 12
Moderating effect of institutional ownership.

Variables	Fixed effect		Clustered regression		Reverse causality		Omitted variable bias	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Ln(1 + Invention)	Ln(1 + Patent)	Ln(1 + Invention)	Ln(1 + Patent)	f.Ln(1 + Invention)	f.Ln(1 + Patent)	Ln(1 + Invention)	Ln(1 + Patent)
ENV_Per	0.006*	0.006*	0.006	0.006	0.005	0.005	0.006*	0.006*
	[0.072]	[0.092]	[0.114]	[0.159]	[0.135]	[0.205]	[0.071]	[0.096]
Inst_Owner	1.234***	0.867***	1.234***	0.867***	1.502***	0.906***	1.207***	1.041***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
ENV_Per*Inst_Owner	0.079**	0.088**	0.079**	0.088***	0.081**	0.127***	0.075**	0.084**
	[0.016]	[0.017]	[0.028]	[0.006]	[0.021]	[0.000]	[0.022]	[0.021]
Mgt_Hold	0.306***	0.487***	0.306***	0.487***	0.387***	0.526***	0.325***	0.540***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Boardsize	0.032***	0.017*	0.032***	0.017*	0.035***	0.016	0.029***	0.014
	[0.000]	[0.089]	[0.000]	[0.086]	[0.001]	[0.157]	[0.001]	[0.156]
Board_IND	0.522**	0.626**	0.522**	0.626***	0.600**	0.974***	0.527**	0.597**
	[0.024]	[0.020]	[0.013]	[0.005]	[0.026]	[0.001]	[0.022]	[0.026]
CEO_Duality	0.084***	0.094***	0.084***	0.094**	0.080**	0.076**	0.085***	0.093***
	[0.002]	[0.003]	[0.008]	[0.024]	[0.011]	[0.036]	[0.002]	[0.003]
ROA	2.173***	2.755***	2.173***	2.755***	3.219***	4.503***	1.998***	2.004***
	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Leverage	−0.033	0.088	−0.033	0.088	0.028	0.165	−0.074	−0.007
	[0.680]	[0.357]	[0.699]	[0.410]	[0.762]	[0.132]	[0.370]	[0.944]
Firmsize	0.402***	0.431***	0.402***	0.431***	0.437***	0.466***	0.413***	0.436***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Cash	0.335***	0.359***	0.335***	0.359***	0.328***	0.350***	0.351***	0.378***
	[0.000]	[0.001]	[0.001]	[0.006]	[0.002]	[0.003]	[0.000]	[0.001]
Firmage	−0.008***	−0.013***	−0.008***	−0.013***	−0.008***	−0.011***	−0.010***	−0.014***
	[0.000]	[0.000]	[0.001]	[0.000]	[0.002]	[0.000]	[0.000]	[0.000]
Large_SHR							−0.002***	0.000
							[0.004]	[0.774]
Dir_Meeting							−0.004	−0.007**
							[0.168]	[0.049]
Asset_T							0.172***	0.357***
							[0.001]	[0.000]
Sale_Growth							−4.221	−7.853**
							[0.144]	[0.021]
Industry effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,014	11,014	11,014	11,014	8392	8392	11,014	11,014
R-squared	0.190	0.166	0.190	0.166	0.207	0.189	0.191	0.170

Note: *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels.

was explored in this study. Based on previous studies (Chava, 2014; Freeman, 1984; Flammer and Kacperczyk, 2016; Russo and Fouts, 1997), we contended that a firm's emphasis on environmentally related activities will provide them with an opportunity and comparative advantage to enhance their reputations, and trust that can ultimately help them to foster innovation. Moreover, we argue that the positive association between environmental performance and corporate innovation will be more pronounced in the presence of higher institutional and state ownership.

By collecting data of A-share-listed firms from 2010 to 2017, the findings of the study showed that environmental performance significantly positively affected corporate innovation. To test the robustness of our findings, we found similar results using omitted variable bias, reverse causality, 2SLS, and PSM techniques. Moreover, we also found that institutional ownership strengthened the positive relation between environmental performance and corporate innovation, while state ownership played a partial role in the above-mentioned relation. Based on these findings, we recommend that Chinese firms should pay considerable attention to environmentally related activities, as it will help to attain stakeholders' demands while providing opportunity and comparative advantage to maximize shareholders' wealth.

Finally, although we tried our best to determine the unexplored relation (particularly in China) between environmental performance and corporate innovation, we believe that our study has certain limitations that should be addressed in the future. First, in this study, we did not use patent citation data, as it was difficult to obtain during the study period. However, we recommend that future studies also consider the citation proxy for corporate innovation. Second, corporate innovation is an interesting topic in the recent literature. Therefore, we recommend that further studies regarding the antecedents and consequences of corporate innovation should be conducted in the future.

Data availability statement

Data available on request from the authors.

Funding statement

This research was funded by the “Funds for High-Level Talents of Xijing University (2019)”, Grant/Award Number: XJ19B02; and “The Fundamental Research Funds for the Central Universities” in UIBE, grant number: CXTD12-01.

Ethics approval statement

This article does not contain any studies with human participants or animals performed by any of the authors.

CRediT authorship contribution statement

Farid Ullah: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing - original draft, Visualization. **Ping Jiang:** Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft, Visualization, Supervision, Project

Table 13
Moderating effect of State ownership.

Variables	*Fixed effect*		*Clustered regression*		*Reverse causality*		*Omitted variable bias*	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
	Ln(1 + Invention)	*Ln(1 + Patent)*	*Ln(1 + Invention)*	*Ln(1 + Patent)*	*f.Ln(1 + Invention)*	*f.Ln(1 + Patent)*	*Ln(1 + Invention)*	*Ln(1 + Patent)*
ENV_Per	0.006**	0.010***	0.006***	0.010***	0.004	0.012***	0.006**	0.010***
	[0.028]	[0.002]	[0.007]	[0.000]	[0.169]	[0.000]	[0.046]	[0.002]
SOE	0.094***	−0.024	0.094***	−0.024	0.093***	−0.007	0.111***	−0.039
	[0.001]	[0.471]	[0.002]	[0.469]	[0.007]	[0.849]	[0.000]	[0.263]
ENV_Per SOE*	0.009**	0.004	0.009**	0.004	0.013***	0.005	0.009**	0.004
	[0.037]	[0.400]	[0.027]	[0.244]	[0.005]	[0.327]	[0.024]	[0.399]
Mgt_Hold	0.309***	0.444***	0.309***	0.444***	0.379***	0.485***	0.326***	0.480***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Boardsize	0.027***	0.017*	0.027***	0.017*	0.029***	0.015	0.023**	0.015
	[0.003]	[0.090]	[0.000]	[0.086]	[0.004]	[0.176]	[0.011]	[0.150]
Board_IND	0.471**	0.641**	0.471**	0.641***	0.562**	0.993***	0.483**	0.629**
	[0.042]	[0.017]	[0.022]	[0.004]	[0.038]	[0.001]	[0.036]	[0.020]
CEO_Duality	0.101***	0.097***	0.101***	0.097**	0.100***	0.083**	0.104***	0.095***
	[0.000]	[0.002]	[0.004]	[0.030]	[0.002]	[0.021]	[0.000]	[0.003]
ROA	3.000***	3.238***	3.000***	3.238***	4.318***	5.170***	2.905***	2.574***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Leverage	−0.047	0.107	−0.047	0.107	0.025	0.184*	−0.097	0.018
	[0.560]	[0.267]	[0.572]	[0.321]	[0.794]	[0.098]	[0.241]	[0.853]
Firmsize	0.406***	0.438***	0.406***	0.438***	0.440***	0.471***	0.417***	0.447***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Cash	0.312***	0.355***	0.312***	0.355***	0.291***	0.338***	0.340***	0.384***
	[0.001]	[0.001]	[0.004]	[0.007]	[0.005]	[0.004]	[0.000]	[0.000]
Firmage	−0.009***	−0.012***	−0.009***	−0.012***	−0.008***	−0.010***	−0.011***	−0.013***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.002]	[0.002]	[0.000]	[0.000]
Large_SHR							−0.004***	−0.001
							[0.000]	[0.539]
Dir_Meeting							−0.002	−0.007*
							[0.581]	[0.068]
Asset_T							0.157***	0.347***
							[0.003]	[0.000]
Sale_Growth							−2.317	−6.477*
							[0.422]	[0.057]
Industry effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,014	11,014	11,014	11,014	8392	8392	11,014	11,014
R-squared	0.187	0.164	0.187	0.164	0.202	0.186	0.189	0.168

Note: *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels.

Table 14
Additional analyses.

Variables	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
	Ln(1 + Invention)	*Ln(1 + Patent)*	*Ln(1 + Invention)*	*Ln(1 + Patent)*	*Ln(1 + Invention)*	*Ln(1 + Patent)*
ENV_Per	0.016***	0.013***	0.010***	0.011***	−0.422**	−0.680***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.016]	[0.004]
High_Polluted	−0.199***	−0.423***				
	[0.000]	[0.000]				
ENV_Per High_Polluted*	−0.009**	−0.002				
	[0.024]	[0.678]				
Post_EPL			0.212***	0.190***		
			[0.000]	[0.002]		
*ENV_Per *Post_EPL*			0.006	0.004		
			[0.228]	[0.490]		
IPRP_High					−0.011	−0.043
					[0.921]	[0.725]
*ENV_Per *IPRP_High*					0.103*	0.109*
					[0.071]	[0.094]
Mgt_Hold	0.257***	0.445***	0.267***	0.459***	0.345***	0.587***
	[0.003]	[0.000]	[0.002]	[0.000]	[0.001]	[0.000]
Boardsize	0.032***	0.018*	0.031***	0.017*	0.043***	0.036***
	[0.000]	[0.070]	[0.000]	[0.099]	[0.000]	[0.004]
Board_IND	0.453**	0.497*	0.533**	0.636**	0.943***	1.063***
	[0.047]	[0.059]	[0.021]	[0.018]	[0.001]	[0.001]
CEO_Duality	0.086***	0.090***	0.089***	0.098***	0.032	0.033
	[0.001]	[0.004]	[0.001]	[0.002]	[0.352]	[0.396]
ROA	3.126***	3.834***	2.855***	3.267***	3.284***	3.594***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

(*continued on next page*)

Table 14 (*continued*)

Variables	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
	Ln(1 + Invention)	*Ln(1 + Patent)*	*Ln(1 + Invention)*	*Ln(1 + Patent)*	*Ln(1 + Invention)*	*Ln(1 + Patent)*
Leverage	−0.029	0.091	−0.023	0.095	0.018	0.113
	[0.716]	[0.333]	[0.770]	[0.317]	[0.856]	[0.318]
Firmsize	0.414***	0.442***	0.412***	0.438***	0.424***	0.457***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Cash	0.275***	0.261**	0.318***	0.348***	0.423***	0.433***
	[0.003]	[0.013]	[0.001]	[0.001]	[0.001]	[0.003]
Firmage	−0.007***	−0.011***	−0.007***	−0.012***	−0.004	−0.009***
	[0.003]	[0.000]	[0.001]	[0.000]	[0.192]	[0.006]
Industry effect	Yes	Yes	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,014	11,014	11,014	11,014	7561	7561
R-squared	0.193	0.183	0.186	0.164	0.181	0.168

Note: *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels.

administration. **Ahmed A Elamer:** Writing- Reviewing and Editing. **Andrews Owusu:** Writing- Reviewing and Editing.

Declaration of competing interest

The authors declared no potential conflicts of interest.

Data availability

Data will be made available on request.

Appendix A. Variable definition

Variables	Definition
Dependent variables	
INV_App	The total number of invention patents filed by a firm in year t.
Patent_App	The total number of patents including invention, utility, and design applications filed by a firm in year t.
Ln(1+ Invention)	The natural log of 1 plus the total number of invention patents filed by a firm in year t.
Ln(1+ Patent)	The natural log of 1 plus the total patents including invention, design, and utility filed by a firm in year t.
Ln(1 + Utility)	The natural log of 1 plus the total number of utility patents filed by a firm in year t.
Independent variables	
ENV_Per	The *HEXUN RKS-ratings score* on environmental performance which ranges from '0' to '100' where '0' represents lower environmental rating score of a firm in a given year and so on.
ENV_Dummy	Dummy variable equal to '1' if a firm has disclosed environmental performance in a given year and '0' otherwise.
Social_Per	The *HEXUN RKS-ratings score* on firm social performance which ranges from '0' to '100' where '0' shows a lower sustainable rating score of a firm in a given year and so on.
ISO_14,001	Dummy variable equal to '1' if a firm ISO14001 certification and '0' if vice versa.
Other variables	
Mgt_Own	The proportion of shares held by the managers out of total shares.
Boardsize	The total number of board of directors.
Board_IND	The proportion of independent directors out of total directors.
CEO_Duality	Dummy variable equals to '1' if CEO is also Chairman of the board and '0' otherwise.
ROA	The earnings before interest and taxes by total assets.
Leverage	Total debt divided by total assets.
Firmsize	Natural logarithm of a firm's total assets.
Cash	The ratio of cash and cash equivalent divided by total assets.
Firmage	The year that has been elapsed since a firm foundation
Large_SHR	The proportion of shares held by the largest shareholders out of total shares.
Dir_Meetings	The total number of annual meetings held by the board of directors.
Inst_Owner	The proportion of shares held by institutional investors out of total shares.
Asset_T	The ratio of the book value of firm total revenue divided by total assets.
Sale_Growth	The proportion of change in firm sales in year t.
SOE	Dummy variable equal to '1' if a firm is owned by the state and '0' otherwise

References

Aghion, P., Van Reenen, J., Zingales, L., 2013. Innovation and institutional ownership. Am. Econ. Rev. 103 (1), 277–304.

Ang, J.S., Cheng, Y., Wu, C., 2014. Does enforcement of intellectual property rights matter in China? Evidence from financing and investment choices in the high-tech industry. Rev. Econ. Stat. 96 (2), 332–348.

Aravind, D., Christmann, P., 2011. Decoupling of standard implementation from certification: does quality of ISO 14001 implementation affect facilities' environmental performance? Bus. Ethics Q. 21 (1), 73–102.

Arocena, P., Orcos, R., Zouaghi, F., 2021. The impact of ISO 14001 on firm environmental and economic performance: the moderating role of size and environmental awareness. Bus. Strateg. Environ. 30 (2), 955–967.

Attah-Boakye, R., Adams, K., Kimani, D., Ullah, S., 2020. The impact of board gender diversity and national culture on corporate innovation: a multi-country analysis of

multinational corporations operating in emerging economies. Technol. Forecast. Soc. Chang. 161, 120247.
Balsmeier, B., Fleming, L., Manso, G., 2017. Independent boards and innovation. J. Financ. Econ. 123 (3), 536–557.
Benlemlih, M., Shaukat, A., Qiu, Y., Trojanowski, G., 2018. Environmental and social disclosures and firm risk. J. Bus. Ethics 152 (3), 613–626.
Bernstein, S., 2015. Does going public affect innovation? J. Financ. 70 (4), 1365–1403.
Bocquet, R., Le Bas, C., Mothe, C., Poussing, N., 2013. Are firms with different CSR profiles equally innovative? Empirical analysis with survey data. Eur. Manag. J. 31 (6), 642–654.
Bocquet, R., Le Bas, C., Mothe, C., Poussing, N., 2019. Strategic CSR for innovation in SMEs: does diversity matter? Long Range Plan. 52 (6), 101913.
Boiral, O., Henri, J.F., 2012. Modelling the impact of ISO 14001 on environmental performance: a comparative approach. J. Environ. Manag. 99, 84–97.
Brav, A., Jiang, W., Ma, S., Tian, X., 2018. How does hedge fund activism reshape corporate innovation? J. Financ. Econ. 130 (2), 237–264.
Cai, Y., Jo, H., Pan, C., 2011. Vice or virtue? The impact of corporate social responsibility on executive compensation. J. Bus. Ethics 104 (2), 159–173.
Carrión-Flores, C.E., Innes, R., Sam, A.G., 2013. Do voluntary pollution reduction programs (VPRs) spur or deter environmental innovation? Evidence from 33/50. J. Environ. Econ. Manag. 66 (3), 444–459.
Cegarra-Navarro, J.G., Reverte, C., Gómez-Melero, E., Wensley, A.K., 2016. Linking social and economic responsibilities with financial performance: The role of innovation. Eur. Manag. J. 34 (5), 530–539.
Chang, L., Li, W., Lu, X., 2015. Government engagement, environmental policy, and environmental performance: evidence from the most polluting chinese listed firms. Bus. Strateg. Environ. 24 (1), 1–19.
Chava, S., 2014. Environmental externalities and cost of capital. Manag. Sci. 60 (9), 2223–2247.
Chava, S., Oettl, A., Subramanian, A., Subramanian, K.V., 2013. Banking deregulation and innovation. J. Financ. Econ. 109 (3), 759–774.
Chen, C., Gu, J., Luo, R., 2022. Corporate innovation and R&D expenditure disclosures. Technol. Forecast. Soc. Chang. 174, 121230.
Chen, Y., Podolski, E.J., Veeraraghavan, M., 2015. Does managerial ability facilitate corporate innovative success? J. Empir. Financ. 34, 313–326.
Chi, J., Liao, J., Yang, J., 2019. Institutional stock ownership and firm innovation: Evidence from China. J. Multinatl. Financ. Manag. 50, 44–57.
Clarkson, M.E., 1995. A stakeholder framework for analyzing and evaluating corporate social performance. Acad. Manag. Rev. 20 (1), 92–117.
Cui, J., Dai, J., Wang, Z., Zhao, X., 2022. Does environmental regulation induce green Innovation? A panel study of chinese listed firms. Technol. Forecast. Soc. Chang. 176, 121492.
Cui, Y., Zhang, Y., Guo, J., Hu, H., Meng, H., 2019. Top management team knowledge heterogeneity, ownership structure and financial performance: evidence from chinese IT listed companies. Technol. Forecast. Soc. Chang. 140, 14–21.
Dieppe, A., Gilhooly, R., Han, J., Korhonen, I., Lodge, D., 2018. The transition of China to sustainable growth–implications for the global economy and the euro area, 206. ECB Occasional Paper.
Du, X., Jian, W., Zeng, Q., Du, Y., 2014. Corporate environmental responsibility in polluting industries: does religion matter? J. Bus. Ethics 124 (3), 485–507.
Dyck, A., Lins, K.V., Roth, L., Wagner, H.F., 2019. Do institutional investors drive corporate social responsibility? International evidence. J. Financ. Econ. 131 (3), 693–714.
Fang, L.H., Lerner, J., Wu, C., 2017. Intellectual property rights protection, ownership, and innovation: evidence from China. Rev. Financ. Stud. 30 (7), 2446–2477.
Ferreira, J.J., Fernandes, C.I., Ferreira, F.A., 2020. Technology transfer, climate change mitigation, and environmental patent impact on sustainability and economic growth: a comparison of european countries. Technol. Forecast. Soc. Chang. 150, 119770.
Firth, M., Gao, J., Shen, J., Zhang, Y., 2016. Institutional stock ownership and firms' cash dividend policies: evidence from China. J. Bank. Financ. 65, 91–107.
Flammer, C., 2015. Does corporate social responsibility lead to superior financial performance? A regression discontinuity approach. Manag. Sci. 61 (11), 2549–2568.
Flammer, C., Kacperczyk, A., 2016. The impact of stakeholder orientation on innovation: evidence from a natural experiment. Manag. Sci. 62 (7), 1982–2001.
Freeman, R.E., 1984. Strategic management: A stakeholder approach. Pittman, Boston, MA.
Fu, Y., 2019. Independent directors, CEO career concerns, and firm innovation: evidence from China. N. Am. J. Econ. Financ. 50, 101037.
García-Sánchez, I.M., Aibar-Guzmán, C., Aibar-Guzmán, B., 2020. The effect of institutional ownership and ownership dispersion on eco-innovation. Technol. Forecast. Soc. Chang. 158, 120173.
Grant, R.M., 1991. The resource-based theory of competitive advantage: implications for strategy formulation. Calif. Manag. Rev. 33 (3), 114–135.
Hadj, T.B., 2020. Effects of corporate social responsibility towards stakeholders and environmental management on responsible innovation and competitiveness. J. Clean. Prod. 250, 119490.
Hainmueller, J., Xu, Y., 2013. Ebalance: a stata package for entropy balancing. J. Stat. Softw. 54 (7), 1–18.
Hameed, W.U., Nisar, Q.A., Wu, H.C., 2021. Relationships between external knowledge, internal innovation, firms' open innovation performance, service innovation and business performance in the Pakistani hotel industry. Int. J. Hosp. Manag. 92.
Hart, S.L., 1995. A natural-resource-based view of the firm. Acad. Manag. Rev. 20 (4), 986–1014.
Hartzell, J.C., Starks, L.T., 2003. Institutional investors and executive compensation. J. Financ. 58 (6), 2351–2374.
Hassan, O.A., 2018. The impact of voluntary environmental disclosure on firm value: does organizational visibility play a mediation role? Bus. Strateg. Environ. 27 (8), 1569–1582.
He, J., Tian, X., 2013. The dark side of analyst coverage: the case of innovation. J. Financ. Econ. 109 (3), 856–878.
He, J., Tian, X., 2018. Finance and corporate innovation: a survey. Asia Pac. J. Financ. Stud. 47 (2), 165–212.
He, W., Shen, R., 2019. ISO 14001 certification and corporate technological innovation: evidence from chinese firms. J. Bus. Ethics 158 (1), 97–117.
He, W., Liu, C., Lu, J., Cao, J., 2015. Impacts of ISO 14001 adoption on firm performance: evidence from China. China Econ. Rev. 32, 43–56.
Hillman, A.J., Keim, G.D., 2001. Shareholder value, stakeholder management, and social issues: what's the bottom line? Strateg. Manag. J. 22 (2), 125–139.
Hirshleifer, D., Low, A., Teoh, S.H., 2012. Are overconfident CEOs better innovators? J. Financ. 67 (4), 1457–1498.
Huang, K.G.L., Geng, X., Wang, H., 2017. Institutional regime shift in intellectual property rights and innovation strategies of firms in China. Organ. Sci. 28 (2), 355–377.
Jensen, M.C., Meckling, W.H., 1976. Theory of the firm: managerial behavior, agency costs and ownership structure. J. Financ. Econ. 3 (4), 305–360.
Jia, N., Tian, X., 2018. Accessibility and materialization of firm innovation. J. Corp. Finan. 48, 515–541.
Jiang, F., Kim, K.A., 2015. Corporate governance in China: a modern perspective. J. Corp. Finan. 32, 190–216.
Khan, Z., Hussain, M., Shahbaz, M., Yang, S., Jiao, Z., 2020. Natural resource abundance, technological innovation, and human capital nexus with financial development: a case study of China. Resour. Policy 65, 101585.
Kim, I., Wan, H., Wang, B., Yang, T., 2019. Institutional investors and corporate environmental, social, and governance policies: evidence from toxics release data. Manag. Sci. 65 (10), 4451–4949.
Kim, Y., 2015. Environmental, sustainable behaviors and innovation of firms during the financial crisis. Bus. Strateg. Environ. 24 (1), 58–72.
Klassen, R.D., McLaughlin, C.P., 1996. The impact of environmental management on firm performance. Manag. Sci. 42 (8), 1199–1214.
Lau, C., Lu, Y., Liang, Q., 2016. Corporate social responsibility in China: a corporate governance approach. J. Bus. Ethics 136 (1), 73–87.
Li, J.J., Massa, M., Zhang, H., Zhang, J., 2019. Air pollution, behavioral bias, and the disposition effect in China. J. Financ. Econ. 142 (2), 641–673.
Li, Q., Luo, W., Wang, Y., Wu, L., 2013. Firm performance, corporate ownership, and corporate social responsibility disclosure in China. Bus. EthicsEur. Rev. 22 (2), 159–173.
Li, W., Zhang, R., 2010. Corporate social responsibility, ownership structure, and political interference: evidence from China. J. Bus. Ethics 96 (4), 631–645.
Lin, B., Ma, R., 2022. Green technology innovations, urban innovation environment and CO2 emission reduction in China: fresh evidence from a partially linear functional-coefficient panel model. Technol. Forecast. Soc. Chang. 176, 121434.
Lin, Y.R., Fu, X.M., 2017. Does institutional ownership influence firm performance? Evidence from China. Int. Rev. Econ. Financ. 49, 17–57.
Lu, J., Wang, W., 2018. Managerial conservatism, board independence and corporate innovation. J. Corp. Finan. 48, 1–16.
Marquis, C., Qian, C., 2014. Corporate social responsibility reporting in China: symbol or substance? Organ. Sci. 25 (1), 127–148.
McWilliams, A., Siegel, D., 2001. Corporate social responsibility: a theory of the firm perspective. Acad. Manag. Rev. 26 (1), 117–127.
Qiu, Y., Shaukat, A., Tharyan, R., 2016. Environmental and social disclosures: link with corporate financial performance. Br. Account. Rev. 48 (1), 102–116.
Rodríguez, A., Hernández, V., Nieto, M.J., 2022. International and domestic external knowledge in the innovation performance of firms from transition economies: the role of institutions. Technol. Forecast. Soc. Chang. 176, 121442.
Rong, Z., Wu, X., Boeing, P., 2017. The effect of institutional ownership on firm innovation: evidence from chinese listed firms. Res. Policy 46 (9), 1533–1551.
Russo, M.V., Fouts, P.A., 1997. A resource-based perspective on corporate environmental performance and profitability. Acad. Manag. J. 40 (3), 534–559.
See, G., 2009. Harmonious society and chinese CSR: is there really a link? J. Bus. Ethics 89, 1–22.
Shahab, Y., Ntim, C.G., Chen, Y., Ullah, F., Li, H.X., Ye, Z., 2020. Chief executive officer attributes, sustainable performance, environmental performance, and environmental reporting: new insights from upper echelons perspective. Bus. Strateg. Environ. 29 (1), 1–16.
Shahab, Y., Ntim, C.G., Chengang, Y., Ullah, F., Fosu, S., 2018. Environmental policy, environmental performance, and financial distress in China: do top management team characteristics matter? Bus. Strateg. Environ. 27 (8), 1635–1652.
Shu, C., Zhou, K.Z., Xiao, Y., Gao, S., 2016. How green management influences product innovation in China: the role of institutional benefits. J. Bus. Ethics 133 (3), 471–485.
Skare, M., Porada-Rochon, M., 2022. The role of innovation in sustainable growth: a dynamic panel study on micro and macro levels 1990–2019. Technol. Forecast. Soc. Chang. 175, 121337.
Sunder, J., Sunder, S.V., Zhang, J., 2017. Pilot CEOs and corporate innovation. J. Financ. Econ. 123 (1), 209–224.
Ullah, F., Jiang, P., Shahab, Y., Li, H.X., Xu, L., 2019. Block ownership and CEO compensation: does board gender diversity matter? Appl. Econ. 1–15.
Waddock, S.A., Graves, S.B., 1997. The corporate social performance–financial performance link. Strateg. Manag. J. 18 (4), 303–319.
Wagner, M., 2008. Empirical influence of environmental management on innovation: evidence from Europe. Ecol. Econ. 66 (2–3), 392–402.

Wang, K.H., Umar, M., Akram, R., Caglar, E., 2021. Is technological innovation making world" Greener"? An evidence from changing growth story of China. Technol. Forecast. Soc. Change 165, 120516.
Wernerfelt, B., 1984. A resource-based view of the firm. Strateg. Manag. J. 5 (2), 171–180.
Xiao, H., Wang, K., 2020. Does environmental labeling exacerbate heavily polluting firms' financial constraints? Evidence from China. China J. Account. Res. 13 (2), 147–174.
Yang, D., Wang, A.X., Zhou, K.Z., Jiang, W., 2019. Environmental strategy, institutional force, and innovation capability: a managerial cognition perspective. J. Bus. Ethics 159 (4), 1147–1161.
Yuan, R., Wen, W., 2018. Managerial foreign experience and corporate innovation. J. Corp. Finan. 48, 752–770.
Zhang, Y., Song, Y., 2022. Tax rebates, technological innovation and sustainable development: evidence from chinese micro-level data. Technol. Forecast. Soc. Chang. 176, 121481.
Zheng, S., Kahn, M.E., 2013. Understanding China's urban pollution dynamics. J. Econ. Lit. 51 (3), 731–772.

Farid Ullah (PhD, Xijing University) is an Assistant Professor of Finance at University of International Business and Economics (UIBE) - School of International Trade and Economics. His research interests focus on Environmental Policy, Environmental Performance, gender diversity and innovation, performance measurement and management. He has published extensively in a number of internationally recognised journals, such as Business Strategy and the Environment and Applied Economics Letters and International Review of Financial Analysis, among others.

Ping Jiang (PhD, City University of Hong Kong) is a Professor of Finance at University of International Business and Economics (UIBE) - School of International Trade and Economics. Ping Jiang currently works at the Department of Finance, University of International Business and Economics. Ping does research in Business Ethics and Financial Economics.

Ahmed A. Elamer (PhD, University of Huddersfield) is a Senior Lecturer in Accounting at Brunel University London. His research interests focus on narrative disclosure, social and environmental accounting, and corporate governance. He has published extensively in several internationally recognised journals, such as the Journal of Business Ethics, Accounting Forum, Business & Society, Business Strategy and the Environment, Expert Systems with Applications, Sustainability Accounting, Management and Policy Journal, among others.

Andrews Owusu (PhD, Robert Gordon University) is an Associate Professor in Accounting at Derby Business School, University of Derby. His research interests focus on the performance consequences of corporate governance changes, auditing and earnings management. He has published extensively in several internationally recognised journals, such as the Journal of Business Ethics, Review of Quantitative Finance and Accounting, International Journal of Finance and Economics, and Energy Policy.