

# Can ownership structure improve environmental performance in Chinese manufacturing firms?

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# Can ownership structure affect environmental performance in Chinese manufacturing firms? The moderating effect of financial performance

## Abstract

There is a growing debate on how should Chinese manufacturing firms improve their environmental performance (EP). In this paper, we analyze the impact of ownership structure (OS, including ownership property, SOP; ownership concentration, H5; shareholding ratio of the largest and second shareholders, FS; total proportion of stated-owned shares owned by top 10 shareholders, TOP10; proportion of independent directors accounting for all board members, ID) on EP with the consideration of the moderating effect of financial performance measured by net profit rate (NPR) through surveying 1605 firm-year observations. The findings present that the overall EP of Chinese manufacturing firms is relatively low (The average level is only 25.94% of the ideal maximum). Both SOP and H5 significantly improve EP (marginal effects within 8.20%~8.76% and 4.37%~4.44%, respectively), while the impacts of FS and TOP10 are both not significantly positive. Additionally, H5 significantly improves EP (8.90%~9.08%) when TOP10 is higher, and SOP significantly improves EP (10.01%~10.86%) when TOP10 is lower. Further, NPR negatively moderates the impact of FS on EP for the full sample and only positively moderates the impact of higher TOP10 on EP. However, the weak moderating effect of NPR also releases a positive signal that the level of EP is not dominated by financial performance. Accordingly, corporate EP may keep rising based on its prior trend instead of a major volatility in the coming period.

*Keywords: Ownership structure; Environmental performance; State-owned shares; Financial performance; Chinese manufacturing firm*

## Abbreviation

Ownership structure—OS; Environmental performance—EP; Financial performance—FP; Net profit rate—NPR; Corporate social responsibility—CSR; Environmental management capability—EMC

## 1. Introduction

The sustained and severe environmental pollution in China arouses the international concern on how to improve environmental performance (EP) of manufacturing firms because received wisdom indicates that the worsening natural environment is largely due to the less climate-friendly industrial operations, especially in manufacturing industry (Burress, 2005; Pinkse and Kolk, 2012). Prior studies have analyzed the particularity of Chinese manufacturing firms based on the comparison with Western firms, including the special feature in the corporate social responsibility (CSR). Overall, Chinese manufacturers present a distinctive governance structure and their top managers' code of conduct for environmental issues are different from the West. Specifically, large shareholders who are with the connection with government departments usually have a significant impact on critical decisions that are related to environmental management due to the widespread state-owned shares involved in Chinese manufacturers. In this case, top managers have a high degree of obedience to established rules or policies when organizing activities related to CSR (Smith et al., 1996; Liu, 2005; Li and Zhang, 2010). In this case, we wonder whether the ownership structure (OS) of manufacturing firms can affect the level of their EP in China's context.

This paper is motivated by the practical significance of environmental management in manufacturing industry for alleviating China's environmental pollution as well as the distinctive governance structure of Chinese manufacturers. A large number of historical data supports that China should explore the path for green manufacturing industry. For instance, in 2013, the amount of CO<sub>2</sub> emission in China reached 10 billion tons that exceeded the total of US and EU (Friedlingstein et al., 2014). Although many Chinese manufacturing firms have promised that they will actively fulfill environmental responsibility following environmental regulations, the findings from Whitcomb et al. (1998) and Shafer et al. (2007) presented that the business corruption triggered by the market economy mode has weakened large shareholders' social responsibility in some Chinese firms, which makes their decisions be more driven by commercial interests. Further, corporate governance mode (including the indicators related to board of directors,

1 ownership, top managers' feature) has been examined to link with environmental management (Walls et  
2 al., 2012; Kock and Min, 2016), and moreover, how OS can affect corporate environmental management  
3 mode is also analyzed in recent studies, e.g. Calza et al., 2016. Such analysis theoretically and practically  
4 support the power of shareholder as a driving force in corporate green development, while prior studies  
5 lacked the focus on what elements can motivate the governance mode or OS to play a better effect in  
6 green issues. As a rational economic participant, financial performance (FP) is always the primary target  
7 pursued by firms, and the level of such performance was also expected to reversely affect the actual  
8 contribution of governance mode or OS to firm development (Thomsen and Pedersen, 2000). The  
9 implication of the arrangement of OS indicates a relatively stable mode for daily operations. Enlightened  
10 by prior gaps on the link of corporate governance feature and environmental management, this paper  
11 will investigate to Chinese manufacturing firms, whether FP can motivate OS to improve EP? This work  
12 will help Chinese manufacturing industry to clarify whether excellent financial indicators can strengthen  
13 top managers' concern on environmental protection, thereby enriching the channel of green operations.  
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32 This paper will contribute to following fields. First, we theoretically analyze how corporate FP can  
33 moderate the impact of OS on EP. OS is a generalized concept that reflects how corporate internal share  
34 is distributed, and it can be described by multiple indicators, e.g. the fraction of shares owned by most  
35 significant shareholders and the fraction owned by top five shareholders (Demsetz and Villalonga, 2001).  
36 Although prior studies examined the impact of OS on CSR (Li et al., 2013; Meng et al., 2013), in more  
37 cases, OS was viewed as a moderating or mediating variable. Some other studies designed OS as an  
38 independent variable when analyzing the issue related to CSR or environmental issues (Li and Zhang,  
39 2010; Dam and Scholtens, 2013; Calza et al., 2016), while they have not further analyzed whether there  
40 are some elements that may optimize the effect of OS in improving such issue. Accordingly, this paper  
41 will enrich the interaction among OS, FP, and EP that is still ambiguous up to now, which will expand  
42 the perspective on what element can enhance the value of OS in green operations. Second, prior studies  
43 also examined the potential positive impact of corporate FP on EP because the growth of commercial  
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1 interests will provide a strong support for future environmental investment (Ruf et al., 2001; Clarkson et  
2 al., 2008; Al-Najjar and Anfimiadou, 2012), while these studies have not revealed the effect of elements  
3 that originally determine the level of corporate EP. The introduction of OS will enrich the following  
4 research route. Based on Jensen and Meckling (1976), Demsetz (1983), and Demsetz and Lehn (1985), this  
5 paper argues that OS always originally lead to the orientation of firm development, which suggests  
6 viewing it as a determinant when evaluating corporate performance. At least in China, the dominant  
7 effect of state-owned shares in manufacturing industry makes OS more fairly reflect corporate original  
8 willingness to operation activities. In the context of this special form of ownership, the analysis of how  
9 OS leading to corporate social issues will provide important implications to managers and government  
10 on how to guide green operations from the perspective of decision-making. Expectedly, empirical results  
11 of this paper will present what kind of OS can originally help to improve EP, which will provide policy  
12 implications for improving the OS that is with defects in green operations.  
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30 We organize the rest of this paper as follows. Section Two reviews prior literature and accordingly  
31 propose research hypotheses. Section Three introduces data, method, and variables, and then designs  
32 the measuring model. Section Four presents empirical results, including the analysis for the full sample,  
33 robustness test, and heterogeneity analysis grouped by the size of state-owned shares. Section Five  
34 discusses research implications. Section Six summarizes the conclusion, limitation, and future research.  
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## 42 **2. Literature review and hypotheses development**

### 43 *2.1. The role of social responsibility in Chinese state-owned firms*

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48 The higher proportion of state-owned shares in Chinese manufacturing firms indicates that corporate  
49 decisions usually involve government's willingness, also strengthening the effect of political intervention  
50 (Li and Zhang, 2010). Prior studies, e.g. Estrin and Perotin (1991) and Shleifer and Vishny (1997), have  
51 analyzed the general feature of state-owned firms. Specifically, such firm has the obligation to fulfill both  
52 political and economic responsibilities rather than only focus on profit-maximizing even if this process  
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1 will suffer the financial loss. Some studies also described Chinese state-owned firms as a public sector  
2 and argued that they should more focus on social responsibility and share interests with the public (Lu,  
3 2009; Gao, 2009). However, the opposing view emphasizes that no matter what kind of OS, the nature  
4 feature of firm is to create commercial interests. Therefore, what we need to advocate is the coordination  
5 between economic and social responsibilities rather than overemphasize the social role of state-owned  
6 firms. With the increase of private shares, the political intervention should be reduced. In fact, although  
7 the ownership property of some firms is state-owned, the principle of profit-maximizing may gradually  
8 weaken their social responsibility, which is mainly reflected in ignoring environmental management and  
9 social equality (Ip, 2009; Moon and Shen, 2010). Due to the primacy of commercial interests and the  
10 inherent conflict between FP and CSR, we argue that not well fulfilling social responsibility should not  
11 be completely viewed as an immoral behavior in some cases. Some innovative ways, e.g. the inter-firm  
12 collaboration for carbon emission reduction (Zhang and Wang, 2014), can help to spread the concept of  
13 CSR in China, and the central government is dedicated to achieve the win-win of corporate commercial  
14 value and social value with more improving measures developed, such as planning the green economy  
15 growth mode in “Thirteen Five-Year Plan” (2016-2020).

16 Accordingly, we further argue that in the context of market economy, Chinese government should  
17 fully respect the essence of firm and properly reduce the reliance on social contribution of state-owned  
18 firms. Instead, advocating all types of firms to jointly serve the society will relieve the potential negative  
19 impact of political intervention on the development of state-owned firms.

## 20 2.2. *The impact of OS on social responsibility of Chinese firms*

21 It still lacks high-quality studies on the impact of OS on social responsibility in Chinese firms probably  
22 due to the long-periodic data collection as well as complex firm features. Typically, Wang and Jin (2007)  
23 compared the pollutants control performance among Chinese manufacturing firms with diversified  
24 ownership properties, including the state-owned, collectively-owned, and privately-owned. They found  
25 that the sewage treatment performance of collectively-owned firms was much better than that of the  
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1 state-owned and privately-owned, and performance of the state-owned was the worst due to their lower  
2 operation efficiency and more bargaining power in environmental enforcement. However, [Gao \(2009\)](#)  
3 presented that Chinese state-owned firms more focus on social responsibility than the privately-owned  
4 due to the obvious profit-maximizing feature of the latter. From the perspective of environmental levies,  
5 [Maung et al. \(2016\)](#) presented that Chinese state-owned firms can potentially achieve better EP because  
6 most of them have established a close political connection with the central or local government, which  
7 will help to relieve the environmental management pressure. For a considerable number of Chinese  
8 firms, the primary motivation of large shareholders' focus on CSR is still to obtain commercial interests  
9 rather than improve the social or natural environment ([Zu and Song, 2009](#); [Rodrigue et al., 2013](#)). Judged  
10 by this, in most cases, only if they agree that social activities can bring expected FP (no matter directly or  
11 indirectly), they will actively organize related activities, including environmental management. Further,  
12 based on the Stakeholder Theory ([Ruf et al., 2001](#); [Cordeiro and Tewari, 2015](#)), this paper argues that the  
13 essence of fulfilling CSR is a kind of shareholders' investment on social issues that are expected to benefit  
14 to firms. In the long-run, if large shareholders agree with CSR, stakeholders' expectation to corporate  
15 outlook will be positive, which also reflects a kind of social value from the ownership.

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37 Up to now, there is still no unified conclusion on the relation between OS and social responsibility  
38 performance in Chinese firms, while the mainstream research perspective is that state-owned firms  
39 usually achieve better social responsibility performance no matter what original motivations their large  
40 shareholders have. Many Chinese state-owned firms have experienced OS reform, while the volatility of  
41 state-owned shares also triggers a change of CSR orientation to some extent ([Whitcomb et al., 1998](#); [Tam,](#)  
42 [2002](#); [Lu, 2009](#)). However, based on [Smith et al. \(1996\)](#), [Liu \(2005\)](#), and [Xun \(2013\)](#) that emphasized the  
43 effect of state-owned shares in guiding Chinese firms to fulfill social responsibilities, we can describe a  
44 picture that given the strong political power of the central government of China, no matter how large the  
45 proportion of state-owned shares is and how to distribute such share, social responsibility performance  
46 of state-owned firms is usually better than that of the non-state-owned. Further, through investigating  
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1 the annual report of Chinese listed manufacturing firms, this paper summarizes that the proportion of  
2 state-owned shares in some state-owned firms is less than 20%, while to some non-state-owned firms,  
3 such proportion is at a higher level, which suggests that only focusing on corporate ownership property  
4 (state-owned or not) may not help to fully reveal the impact of OS on social responsibility performance.  
5 Accordingly, this paper will further examine the impact of share-distribution, including ownership  
6 concentration, shareholding ratio of the largest and second shareholders, and proportion of state-owned  
7 shares, on EP based on prior studies that pointed out the aspects involved in OS (Demsetz and Lehn,  
8 1985; Sappington and Stiglitz, 1987; Li and Zhang, 2010), thereby proposing following hypotheses.

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10 Hypothesis 1a: The impact of corporate ownership property on EP is stronger than that of ownership  
11 concentration.

12 Hypothesis 1b: The impact of corporate ownership property on EP is stronger than that of the  
13 shareholding ratio of the largest and second shareholders.

14 Hypothesis 1c: The impact of corporate ownership property on EP is stronger than that of the  
15 proportion of state-owned shares.

16 Hypothesis 2: The higher proportion of state-owned shares will lead to a stronger impact of OS on EP.

### 17 2.3. *The impact mechanism of OS on EP under the moderating effect of FP*

18 According to Kagan et al. (2003) and Delmas and Blass (2010), corporate EP is mainly reflected in the  
19 improvement of surrounding natural environment, and improving EP usually requires the support from  
20 environmental management tools. In theory, OS can affect the orientation of corporate environmental  
21 management, while the process of improving natural environment also requires the incentive from FP.  
22 With more and more elements participating in corporate daily operations, the relation among OS, FP,  
23 and EP will present a diversity, and some studies have concluded that the relation between FP and EP is  
24 transforming to the bidirectional causality from unidirectional or non-causality (McWilliams and Siegel,  
25 2000; Orlitzky et al., 2003; Clarkson et al., 2008; Mishra and Suar, 2010; Clarkson et al., 2011; Al-Najjar  
26 and Anfimiadou, 2012). Further, some studies also examined the moderating effect of OS when



1 analyzing the issue related to environmental management. For instance, [Li et al. \(2013\)](#) presented that in  
2 Chinese state-owned firms, the moderating effect of OS between the impact of FP on EP is weaker than  
3 that in non-state-owned firms, while [Meng et al. \(2013\)](#) presented the opposite finding. Some studies  
4 examined the moderating effect of OS with the consideration that the impact of shareholders' decision  
5 on CSR largely depends on their identity and decision-making power, e.g. [Maung et al. \(2016\)](#). However,  
6 there are also studies viewing OS as an original determinant of fulfilling CSR because compared with the  
7 dynamic FP, OS is relatively stable even if the share-distribution may change within a certain period of  
8 time as well ([Wang and Jin, 2007](#); [Dam and Scholtens, 2013](#)). Integrating prior analysis and the feature of  
9 share-distribution in Chinese manufacturing firms, this paper arranges OS as an independent variable  
10 and describes the mechanism of FP moderating the impact of OS on EP as follows. Political intervention  
11 in environmental management makes that no matter the size of available resources within firms, large  
12 shareholders are always required to organize environmental activities. In this process, indicators related  
13 to FP will provide the fund support for developing such activity. According to [Qi et al. \(2014\)](#), when FP  
14 is considerable, its supporting effect can be described as the use of redundant resource to organize social  
15 activities. This case indicates that in a relatively stable share-distribution, FP may determine whether EP  
16 will reach the expected level ([Liu et al., 2010](#); [Zeng et al., 2011](#)). In other words, for one firm, the dynamic  
17 financial indicator will encourage the fixed OS to play diversified effects in environmental management,  
18 i.e. leading large shareholders to make changeable environmental decisions through available resources.  
19 Findings from [Wang et al. \(2011\)](#) and [Shin \(2012\)](#) further presented that large shareholders' goal-oriented  
20 leadership can always affect corporate comprehensive performance, and enhancing social responsibility  
21 leadership has become a global trend. In brief, we infer that large shareholders with a strong sense of  
22 social responsibility will usually present a forward-looking environmental insight based on the use of  
23 available resources rather than only engage in the short-run environmental programs. Accordingly, this  
24 paper argues that in theory, FP can moderate the impact of OS on EP.

25 Up to now, it lacks studies that examined such moderating effect of FP existing in Chinese firms. Some  
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1 supportive evidence presented that if separately analyzing the relation between OS and CSR as well as  
2 FP and CSR, higher state-owned shares or profitability will more positively affect social responsibility  
3 performance (Xu and Zeng, 2016). On the other hand, by the aid of financial or institutional tool, Chinese  
4 government is committed to compensate the loss of manufacturing firms resulted from environmental  
5 management as well (Chang et al., 2015), which helps to decrease corporate reliance on current FP when  
6 organizing environmental activities. However, through analyzing the historical data of annual reports of  
7 Chinese manufacturing firms, we find that compared with the size of their total assets, the intensity of  
8 policy support, e.g. tax return and fiscal subsidy, is still slight, and some firms are still in a state of  
9 financial deficit. Accordingly, this paper argues that the potential moderating effect of FP has not  
10 reached a high level, thereby proposing the following hypothesis.

25 Hypothesis 3: The moderating effect of FP between the impact of OS on EP is limited at present.

### 27 **3. Research methodology**

#### 30 *3.1. Data collection*

32 We used to examine the impact of EP on FP under the moderating effect of corporate environmental  
33 management capability (EMC) through surveying Chinese manufacturing firms (Liang and Liu, 2017).  
34 To ensure the continuity of research, this paper adopts the similar evaluation criterion to quantify the  
35 level of EP. Shanghai Stock Exchange has published nearly 3000 social responsibility reports of listed  
36 firms that involve almost all kinds of industrial sectors, and all reports have recorded how firms fulfilled  
37 their social responsibility. Chinese listed firms are obliged to yearly publish social responsibility reports  
38 and completely record the performance related to social issues, including the environmental  
39 management, community construction, customer service, supply-chain management, staff's career  
40 development. Some reports also further introduced corporate profile, operation mode, and even the  
41 distribution principle of shareholders' income. What needs to be noted is that CSR report is prepared by  
42 each listed firm, and it can also express corporate willingness to serve the society. Although few firms

1 published some negative information related to their social responsibility, almost all firms have declared  
2 that they are strictly following the law, policy, industrial operation criterion, and some international  
3 sustainable development guidelines, e.g. the Company Law, the Securities Law, the Tax Law, the  
4 Corporate Social Responsibility Report Guideline of China compiled by Chinese Academy of Social  
5 Sciences, and the Sustainability Reporting Guidelines compiled by Global Reporting Initiative, when  
6 organizing contents of CSR reports. Further, almost all listed firms have promised that they will  
7 truthfully and completely publish their social responsibility performance without any false or omitted  
8 information, and they will be responsible for all potential errors. According to the statement of these  
9 CSR reports, this paper argues that these firms have not obviously exaggerated their social responsibility  
10 performance with the credibility as well. Overall, following environmental activities have been  
11 published by most of CSR reports: environmental policy implementation, cleaner production programs,  
12 resources management, pollutants control, green supply-chain operations, environmental education,  
13 green community construction, and environmental strategy formulation. In fact, not all listed firms have  
14 continuously published annual social responsibility reports, and some only published 1 or 2 years.  
15 Through considering the availability and integrity of data of all analyzed variables, this paper collects  
16 1605 social responsibility reports of Chinese manufacturing firms, i.e. 1605 unique firm-year  
17 observations, involving CSR information from 2010 to 2016 (155 reports in 2010, 154 in 2011, 218 in 2012,  
18 239 in 2013, 238 in 2014, 259 in 2015, and 342 in 2016). Before 2010, only less than 10 reports were  
19 published in each year, so we have not considered these samples.

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47 With respect to the data source, following indicators are surveyed from CSR reports: the level of  
48 environmental activity, EMC, and whether firms publishing environmental performance based on the  
49 Sustainability Reporting Guidelines compiled by the Global Reporting Initiative (GRI3.1 version) or the  
50 Environment, Social and Governance Index compiled by the Stock Exchange of Hong Kong Exchange  
51 Ltd. (ESG). Following indicators are surveyed from corporate annual reports: corporate size, the number  
52 of staff, the size of R&D investment, whether annual reports have being audited by the international  
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1 accounting agency, diluted earnings per share, corporate growth, ratio of asset utilization, ownership  
2 concentration, shareholding ratio of the largest and second shareholders, ownership property, total  
3 proportion of stated-owned shares owned by top 10 shareholders, proportion of independent directors  
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5 accounting for all board members, and FP.  
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### 8 9 3.2. *Method and variables*

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11 This paper divides EP into the level of corporate environmental activity (actual behavior performance)  
12 and EMC (management performance). Prior studies on the Resource-based View argued that the  
13 management capability to environmental elements can help to improve commercial and social value of  
14 environmental activity (Barney, 1991; Teece et al., 1997; Lee et al., 2001), and once lack of such capability,  
15 EP may not be continuously improved. EMC was defined as a kind of the organizational capability in  
16 environmental management, also a kind of management tool used by large shareholders to reduce the  
17 negative effect of daily operations on the natural environment (Teece et al., 1997; Klassen and Whybark,  
18 1999; Melnyk et al., 2003; Lee and Klassen, 2008; Liu et al., 2010; Hofmann et al., 2012; Wong et al., 2012;  
19 20 Wong, 2013). Accordingly, this paper considers the level of both behavior and management performance  
21 in term of EP, which also enriches our prior study (Liang and Liu, 2017).  
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37 This paper applies the Content Analysis Method to evaluate both the level of corporate environmental  
38 activity and EMC. In the field of social science, we often need to quantify the value of non-quantitative  
39 indicators, and this method can be used to quantify the important information in documents, thereby  
40 rapidly determining the level of targeted variables based on the established evaluation criterion (Viney  
41 and brook, 1976; Wetbrook, 1976; Hsieh and Shannon, 2005). However, prior studies presented that the  
42 evaluation of non-quantitative variables will inevitably reflect researchers' subjective judgment, which  
43 may lead to a small deviation between estimated and true levels of variables (Downe-Wamboldt, 1992).  
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1 environmental activity and EMC. First, this paper surveys the level of environmental indicators included  
2 in GRI3.1 version to evaluate the environmental activity of our sample because this guideline provides a  
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5 universally applicable environmental evaluation criterion for global institutions, including all sizes of  
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7 firms, and this criterion fully takes into account shareholders' income and explains how to collect data of  
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9 each indicator as well. Additionally, GRI3.1 version is applied to evaluate the sustainable development  
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11 of global institutions from 2000 to 2011. Considering the CSR reports surveyed by this paper involve the  
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13 period from 2010 to 2016, we select GRI3.1 version rather than GRI4 version as the evaluation criterion.  
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15 Specifically, GRI3.1 version includes 30 environmental indicators that are divided into 9 categories, i.e.  
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17 17 core indicators (EN1-EN4, EN8, EN11-EN12, EN16-EN17, EN19-EN23, EN26-EN28) and 13 additional  
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19 indicators (EN5-EN7, EN9-EN10, EN13-EN15, EN18, EN24-EN25, EN29-EN30). The core indicator is  
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21 broadly applicable and valuable for most institutions while additional indicator only valuable for some  
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23 institutions. This paper renames each category of environmental activity as follows to clearly present  
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25 their contents: material consumption (EN1-EN2); energy-saving (EN3-EN7); water-saving (EN8-EN10);  
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27 biodiversity conservation (EN11-EN15); pollutants control (EN16-EN25); cleaner production  
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29 (EN26-EN27); environmental legitimacy (EN28); cleaner transportation (EN29); environmental  
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31 investment (EN30). According to CSR reports, we find that 5 firms have not well engaged in any  
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33 environmental activity, while all firms have a certain EMC. To avoid the score of their product being 0  
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35 that will hide the true effect of EMC, this paper defines 3 if a firm well engaged in one core indicator and  
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37 2 if well engaged in one additional indicator. Otherwise, it is 1. Then this paper adds the score of 30  
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39 indicators to present the level of corporate environmental activity. With respect to how to determine one  
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41 indicator has been well engaged in, GRI3.1 version has introduced the relation between each indicator  
42  
43 and environmental management. Accordingly, if a firm published data related to one indicator and then  
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45 explained its positive impact on the natural environment, we argue that this indicator has been well  
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47 engaged in. For instance, for EN5 (the saved-energy by saving and improving energy-efficiency), the  
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49 firm needs to simultaneously publish the total amount of annual saved-energy and explain how to  
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achieve energy-saving. If only publishing the data, we do not argue that it has been well engaged in.

With respect to the measurement of EMC, integrating Bowen et al. (2001), Clarkson et al. (2008), Sarkis et al. (2010), Hofmann et al. (2012), Wong et al. (2012), and Wong (2013), this paper judges whether the surveyed firms have following EMCs: professional environmental management system, e.g. ISO 14000; environmental values; environmental management department; short-run environmental programs; environmental strategy; advanced low-carbon technology; environmental cooperation with stakeholders; environmental performance incentives; environmental knowledge training for staff; green procurement agreement; environmental performance certification by independent agencies; voluntary participation in environmental activities organized by government or industry associations. This paper defines 1 if a firm has one capability and 0 otherwise, and then adds the score of each capability to present the overall level of EMC. Finally, this paper multiplies it and the score of environmental activity to quantify EP.

Independent variable: This paper designs corporate ownership property (SOP, non-state-owned=0; state-owned=1) as the first independent variable. Then, following Demsetz and Villalonga (2001) that proposed that OS is a generalized concept, subsequent studies, e.g. Dam and Scholtens (2013), Li et al. (2013), Peng and Yang (2014), and Li and Lu (2016), more focused on ownership concentration to present large shareholders' controlling capability, and this variable can be expressed as  $\ln [H5/(100-H5)]$  (H5). Additionally, based on Demsetz and Lehn (1985), Sappington and Stiglitz (1987), Baysinger et al. (1991), and Barnhart and Rosenstein (1998), this paper further designs following variables to reflect the effect of different types of shareholders: (1) the shareholding ratio of the largest and second shareholders (FS); (2) the proportion of state-owned shares owned by top 10 shareholders (TOP10).

Further, we consider the effect of independent director that is as the outsider to firm while is entitled to exercise the right to prevent large shareholders from damaging overall interests of firm (Armstrong et al., 2014). Patelli and Prencipe (2007) found that independent director can promote large shareholders to publish the information on corporate operations to the society, and this independent monitoring system will further normalize the effect of OS in improving corporate comprehensive performance. Accordingly,

1 this paper will examine whether the size of independent director can affect EP to present the monitoring  
2 duty of such director on current OS through the proportion of independent directors accounting for all  
3 board members (ID). Lack of the analysis of the effect of independent directors, it will be difficult to  
4 present whether the current operation of Chinese manufacturing firms is in the context of strict internal  
5 supervision. Further, the empirical results related to ID will also enlighten us whether the process of  
6 corporate environmental management strongly relies on the internal supervision mechanism.  
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14 Moderator variable: This paper designs the net profit rate (NPR) to reflect corporate FP. In reality, FP  
15 includes many indicators, e.g. ROE and ROA, while the profit growth within a certain period can more  
16 directly present the added monetary value created by diversified operation activities. Further, NPR can  
17 enhance shareholders' investment willingness and help to predict corporate outlook. Due to the close  
18 relation between NPR and corporate daily operations, this paper will examine its moderating effect.  
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27 Control variable: According to Griliches (1964), Trotman and Bradley (1981), Griliches (1986), Cho  
28 (1998), Hutchinson and Gul (2004), Clarkson et al. (2008), and Zeng et al. (2011), and prior studies on OS,  
29 shareholders' income, and competitiveness of Chinese firms (Zeng and Chen, 2006; Xu et al., 2006; Cao et  
30 al., 2007; Zhang and Liao, 2010), this paper designs following control variables that can potentially affect  
31 the level of OS, FP, and EP as well as their relations, to ensure that empirical results will truly present the  
32 effect of OS.  
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42 (1) Corporate size (SIZE). SIZE can originally determine whether the firms has the sufficient capability  
43 when organizing operation activities. Usually, larger-size firms can more easily get access to resources  
44 helpful to environmental management and have a stronger economic growth potential. (2) Number of  
45 staff (STAFF). STAFF presents corporate labor-input size, and larger-size staff will help firms to organize  
46 more commercial and social activities, thereby creating favorable conditions for the improvement of FP  
47 and EP. (3) The size of R&D investment (R&D). Prior studies presented the positive impact of R&D  
48 activity on both FP and EP, and focusing on new technology is a critical way to improve the outcome of  
49 environmental management. (4) Corporate listed age (AGE). Prior studies presented that the OS and  
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1 management mode of listed firms will change under the joint effects of internal and external available  
2 resources as well as shareholders' demand, e.g. the sharp volatility of share-distribution due to the entry  
3 of new shareholders. Accordingly, this paper argues that the orientation of decision-making in some  
4 firms will also change with the increase of listed age. This paper defines the age when firm being listed  
5 as 1, the next year as 2, and on the analogy of this. (5) Corporate pollution level (POLLUTION). Social  
6 responsibility that needs to be fulfilled is different between heavy-polluting and non-heavy-polluting  
7 firms. Some environmental activities more rely on heavy-polluting firms to organize, e.g. reducing GHG  
8 emission, which will lead to different environmental investments and expected EP in these two types of  
9 firms. According to the Environmental Information Disclosure Guidelines of Chinese Listed Company,  
10 this paper defines the heavy-polluting firm as 1 and the non-heavy-polluting as 0. (6) Corporate location  
11 (LOCATION). Overall, GDP, geographical condition, and marketization of provinces located in Eastern  
12 China are all more superior than that of other provinces, which requires Eastern firms to more actively  
13 fulfill environmental responsibility. This paper defines the Eastern firm as 1 and others as 0. (7) Whether  
14 organizing environmental activities following the GRI3.1 version or ESG (GRI/ESG). As GRI3.1 version  
15 introduces how to collect data related to environmental activity, and we find that CSR reports compiled  
16 following GRI3.1 version or ESG usually present a clear logic structure. At least, it can imply large  
17 shareholders' willingness for better EP. This paper defines 1 if a firm followed GRI3.1 version or ESG  
18 and 0 otherwise. (8) Whether employing international accounting agency to audit annual performance  
19 (IA). Cooperating with international accounting agency does not mean a high-quality annual report or  
20 better FP, while the global reputation of such accounting agency can help to reduce false information on  
21 corporate performance in annual reports. This paper defines 1 if a firm employed an international  
22 accounting agency, including Deloitte & Touche, Pricewaterhouse Coopers, Ernst & Young, and KMPG,  
23 and 0 otherwise. (9) Diluted earnings per share (DEPS). DEPS is the actual unit income that shareholders  
24 can obtain from corporate net profit, also a kind of optimization mode for primary earnings per share.  
25 The change of current DEPS will affect shareholders' investment willingness in the next phase, therefore



1 leading a new share-distribution or profit growth mode. (10) Corporate growth (GROWTH). Similar to  
 2 DEPS and NPR, GROWTH can affect shareholders' investment willingness and help to predict corporate  
 3 outlook as well. Additionally, GROWTH also presents corporate development potential to broader  
 4 stakeholders, e.g. consumers and suppliers, rather than only internal shareholders, which also implies a  
 5 broader profit growth space. (11) The ratio of asset utilization (AUR). Although there is no optimal AUR,  
 6 large shareholders usually avoid the excessively low AUR because it indicates resources waste. Higher  
 7 AUR can help to expand future environmental investment, therefore working on better EP.  
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10 Table 1 presents an overview of all variables, and standard deviation (S.D.) presents a relatively large  
 11 difference among firms as a whole. In theory, the total score of EP is 924, while Table 1 presents that the  
 12 highest score is 675 with the average of all samples only 239.64, which indicates that the EP of our  
 13 sample is relatively low. The data distribution of STAFF, R&D, AGE, GROWTH, and AUR presents the  
 14 obvious difference on corporate profile and outlook, while the average of GRI/ESG and IA presents that  
 15 only few firms have organized their environmental management and annual performance auditing  
 16 following international criteria. Further, the differences of OS and NPR are also obvious among firms.  
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19 **What needs to be noted is that this paper will not examine the interaction between ID and NPR because**  
 20 **although independent directors are closely related to the function of OS, they are not strictly within the**  
 21 **range of OS. Therefore, we only analyze the unique impact of ID on EP to present whether the size of**  
 22 **independent directors will affect the outcome of environmental management.**  
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35 **Table 1.** An overview of all variables (the raw data)  
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Variables	Definition	Min.	Max.	Mean	S.D.
EP	<i>The product of levels of environmental activity and EMC</i>	30.00	675.00	239.64	100.56
SIZE	<i>The logarithmic of annual total assets</i>	15.51	28.57	23.20	1.42
STAFF	<i>Total number of staff, including all parent and subsidiary firms</i>	28.00	294761.00	13679.26	30243.89
R&D	<i>The proportion of R&amp;D expenditure accounting for operating revenue</i>	0.00	20.25	1.99	2.42
AGE	<i>The time length of firm listing on the Shanghai Stock Exchange (year)</i>	1.00	27.00	13.28	5.47
POLLUTION	<i>Heavy-polluting firm=1; Non-heavy-polluting firm=0</i>	0.00	1.00	0.48	0.50
LOCATION	<i>Eastern province=1; Non-eastern province=0</i>	0.00	1.00	0.63	0.48

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**Table 1 (continued)**

Variables	Definition	Min.	Max.	Mean	S.D.
GRI/ESG	Organizing environmental activities following GRI3.1 version or ESG=1; otherwise=0	0.00	1.00	0.18	0.39
IA	Employing an international accounting agency to audit annual finance=1; otherwise=0	0.00	1.00	0.18	0.38
DEPS	A kind of performance metric used to gauge the quality of corporate earnings per share if all convertible securities are exercised.	-3.81	3.94	0.39	0.55
GROWTH	The annual growth rate of main business income	-58.41	416.31	9.79	26.92
AUR	The percentage of net assets accounting for total assets	-429.26	98.73	47.38	22.48
SOP	Ownership property (state-owned=1, non-state-owned=0)	0.00	1.00	0.75	0.43
H5	The concentration degree of shares owned by the top 5 shareholders	-2.11	4.86	0.31	0.84
FS	The shareholding ratio of the largest and second shareholders	1.00	750.09	18.74	40.84
TOP10	The proportion of state-owned shares owned by top10 shareholders	0.00	95.26	38.08	23.89
ID	The proportion of independent directors accounting for all board members	21.43	70.00	38.40	7.39
FP	Net profit rate, NPR	-136.98	367.46	8.39	20.20
SOP×NPR	N/A	-136.98	367.46	6.24	19.15
H5×NPR	N/A	-80.11	152.52	4.26	14.89
FS×NPR	N/A	-8278.12	4539.69	106.00	413.78
TOP10×NPR	N/A	-7026.84	18946.20	336.75	1016.10

### 3.3. Data processing and measuring model

Through the preliminary test for variables, this paper finds that the S.D. of some variables is large. Considering different measuring units among variables, this paper develops following processing of raw data to make their distribution more centralized. First, for variables that are non-dummy with all data greater than 0 (STAFF, FS, ID, AGE, and EP), this paper expresses them as the natural logarithm. Second, for variables that are non-dummy with some data equal or less than 0 (R&D, DEPS, GROWTH, AUR, TOP10, and NPR), this paper standardizes them to reduce negative interferences of few outliers on final empirical results (Amran et al., 2014; Garcia-Sanchez et al., 2014).

Based on the design of variables, this paper develops a full conceptual model to describe the research hypotheses as Fig. 1. To verify Hypothesis 3, this paper will examine the interaction of SOP and NPR, H5 and NPR, FS and NPR, and TOP10 and NPR to present the moderating effect of FP. To further enrich the analysis of the effect of state-owned shares, this paper divides TOP10 into 2 groups, i.e. higher and lower

than the average of all samples, and accordingly examine whether higher proportion of state-owned shares can strengthen the impact of OS on EP as well as the moderating effect of FP, thereby confirming the potential driving force of state-owned shares in environmental issues.

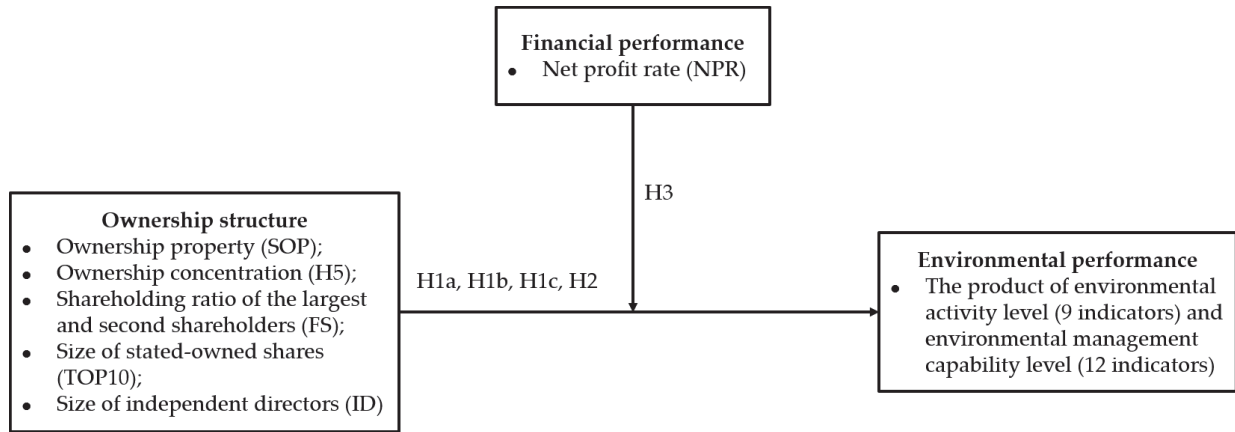


Fig. 1. The full conceptual model

Based on the full conceptual model, we need to examine whether our sample can present the overall situation of Chinese manufacturing firms. As the general OLS estimation model cannot well deal with the potential unobserved heterogeneity of panel data that is largely triggered by the time and individual difference, this paper compares the applicability of Fixed Effect Model and Random Effect Model. Through the Hausman test, we find that Random Effect Model is more applicable to both tests for full data and grouped data based on the size of state-owned shares (heterogeneity analysis). Specifically, all Random Effect tests have passed the significance level (“Prob>chi<sup>2</sup>”=0.0000), while all Fixed Effect tests have failed to pass the corresponding significance (“Prob>F”>0.05). This test supports that the findings of this paper can be extended to a broader range, i.e. helping to present the overall situation of Chinese manufacturing firms based on sampling survey. Accordingly, this paper designs the measuring model as Equation (1).

$$Y_{it} = \alpha + \beta_1 C_{it} + \beta_2 X_{it} + \beta_3 M_{it} + \beta_4 X_{it}M_{it} + \varepsilon_{it} \quad (1)$$

In Equation (1), we name  $X_{it}$  as the independent variable,  $M_{it}$  as the moderator variable,  $X_{it}M_{it}$  as the product of independent and moderator variables, and  $C_{it}$  as the control variable. Additionally,  $\alpha$  is the constant term, and  $\varepsilon_{it}$  is the random error term. Further, this paper decomposes Equation (1) into 4

models and then examine the impact of  $C_{it}$ ,  $C_{it} + X_{it}$ ,  $C_{it} + X_{it} + M_{it}$ , and  $C_{it} + X_{it} + M_{it} + X_{it}M_{it}$  on  $Y_{it}$ , respectively.

## 4. Empirical results

### 4.1. Correlation analysis

Table 2 presents that the firm with larger-size total assets, more staff, larger-size R&D investment, shorter listed age, heavy pollution, adopting GRI3.1 version or ESG, employing international accounting agency, or higher DEPS will usually achieve better EP, while the correlation between elements related to corporate outlook, e.g. GROWTH and AUR, and EP is weak. Further, the firm with the state-owned property, higher H5, smaller FS, or higher TOP10 will usually achieve better EP. Further, there is no significant positive correlation between the interaction of OS and NPR and EP, as well as NPR and EP. Following, this paper examines the causality between OS and EP to verify developed hypotheses.

### 4.2. Empirical results of full sample

Table 3 presents the impact of OS on EP under the joint effects of corporate profile, corporate outlook, and NPR with the method of Random Effect Model. The value of  $R^2$  indicates that with the increase of variables included in the measuring model, the marginal change of EP will be gradually better explained, also supporting that EP is usually simultaneously determined by multiple elements.

**Table 3.** Empirical results of full sample (N=1605)

Variables	Model 1	Model 2	Model 3	Model 4
Constant	4.6348*** (0.1469)	5.0748*** (0.2642)	5.0699*** (0.2614)	5.0449*** (0.2480)
SIZE	0.0021 (0.0084)	-0.0013 (0.0094)	-0.0004 (0.0092)	0.0002 (0.0093)
STAFF	0.0648*** (0.0072)	0.0651*** (0.0071)	0.0636*** (0.0070)	0.0636*** (0.0071)
R&D	0.0363*** (0.0072)	0.0395*** (0.0058)	0.0393*** (0.0058)	0.0417*** (0.0064)
AGE	0.0095 (0.0131)	0.0188 (0.0118)	0.0189 (0.0119)	0.0191 (0.0116)
POLLUTION	0.1180*** (0.0071)	0.1136*** (0.0078)	0.1136*** (0.0078)	0.1167*** (0.0072)
LOCATION	-0.0143 (0.0082)	-0.0109 (0.0071)	-0.0119 (0.0074)	-0.0105 (0.0075)
GRI/ESG	0.3418*** (0.0177)	0.3380*** (0.0169)	0.3382*** (0.0168)	0.3418*** (0.0191)
IA	0.0857*** (0.0254)	0.0647** (0.0270)	0.0645** (0.0269)	0.0615** (0.0253)
DEPS	-0.0052 (0.0117)	-0.0053 (0.0111)	-0.0034 (0.0109)	-0.0032 (0.0108)

Table 3 (continued)

Variables	Model 1	Model 2	Model 3	Model 4
GROWTH	0.0016 (0.0110)	0.0031 (0.0110)	0.0029 (0.0110)	0.0039 (0.0109)
AUR	0.0051 (0.0060)	0.0021 (0.0066)	0.0030 (0.0068)	0.0032 (0.0069)
SOP		0.0876* (0.0154)	0.0868* (0.0159)	0.0820* (0.0141)
H5		0.0439* (0.0134)	0.0444* (0.0134)	0.0437* (0.0140)
FS		0.0061 (0.0050)	0.0060 (0.0051)	0.0032 (0.0050)
TOP10		-0.0329* (0.0186)	-0.0326 (0.0187)	-0.0311 (0.0177)
ID		-0.1303* (0.0305)	-0.1308* (0.0307)	-0.1266* (0.0290)
NPR			-0.0057 (0.0030)	0.0681 (0.0313)
SOP×NPR				-0.0499 (0.0135)
H5×NPR				-0.0084 (0.0189)
FS×NPR				-0.0203* (0.0144)
TOP10×NPR				0.0469 (0.0226)
Time dummies	Include	Include	Include	Include
Firm dummies	Include	Include	Include	Include
Wald Chi <sup>2</sup>	392.30***	412.18***	412.24***	417.25***
D.W. statistics	2.0470	2.0440	2.0440	2.0480
Log likelihood	-788.4916	-779.9749	-779.8462	-777.4156
R <sup>2</sup>	0.1976	0.2061	0.2062	0.2086

Note: \*p≤0.10 (Two-tailed), \*\*p≤0.05 (Two-tailed), \*\*\*p≤0.01 (Two-tailed). Robust standard errors in parentheses are the cluster standard error at the year level.

Based on the Random Effect test, this paper further develops following tests to check the presence of heteroskedasticity and spatial as well as serial correlation. Specifically, the Lagrange Multiplier (LM) test is used to examine the heteroskedasticity of data, i.e. following  $LM = nR^2 \sim \chi^2(p - 1)$ . The LM test for each model supports that there is no heteroskedasticity within models, i.e. all values of  $nR^2$  are smaller than  $\chi^2(p - 1)$ . Further, as we often assume the disturbance terms of different individuals are mutually independent within the panel data, this paper estimates the cluster robust standard errors of variables within each model to present the spatial correlation of error terms of variables. As Table 3, cluster robust standard errors are small as a whole, which supports that the distribution of firm data at the year-level is not very dispersed, thereby further verifying the validity of sampling survey for this paper. Additionally,

1 this paper uses the D.W. statistics to present the serial correlation of variables within each model with  
2 the finding that all D.W. values are around 2, which supports that the residuals of variables obey normal  
3 distribution. Overall, the further test based on the Random Effect Model supports that the quality of  
4 collected data reaches a relatively high level.  
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10 In Table 3, STAFF, R&D, POLLUTION, GRI/ESG, and IA can all significantly improve EP no matter  
11 whether considering NPR or not (marginal effects are within 6.36%~6.51%, 3.63%~4.17%, 11.36%~11.80%,  
12 33.80%~34.18%, and 6.15%~8.57%, respectively). These results can jointly describe two facts that Chinese  
13 heavy-polluting firms more focus on the environmental management, and the size of internal available  
14 resources as well as internationalized management mode can also help to improve EP. If not considering  
15 the effect of NPR (Model 2 and Model 3), both SOP (8.20%~8.76%) and H5 (4.37%~4.44%) significantly  
16 improve EP, which supports the leading effect of political intervention and large shareholders' collective  
17 power in the environmental management, while FS and TOP10 do not significantly improve EP. The  
18 coefficients of Model 2 and Model 3 in Table 3 verify Hypothesis 1a to Hypothesis 1c, also presenting the  
19 primacy of corporate ownership property (state-owned or not) in environmental issues. Accordingly, we  
20 infer that even if the proportion of state-owned shares is lower in some state-owned firms, they will also  
21 actively engage in the environmental management because the state-owned power also leads to the  
22 widespread public concern on such firms. Additionally, ID significantly negatively affects EP. Prior  
23 studies presented that independent directors have the responsibility to independently and objectively  
24 evaluate corporate operations and restrain behaviors that will threaten shareholders' interests (Cotter et  
25 al., 1997; Kim, 1998; Tobe, 2000). According to the provision of China Securities Regulatory Commission,  
26 the proportion of independent directors in listed firms should be more than or equal to 1/3 of total board  
27 members. However, there are 232 firms whose ID is less than 1/3, accounting for 14.15% of our total  
28 sample, which indicates that the board structure of few firms is not in line with the policy requirement,  
29 also presenting that size of independent directors of Chinese manufacturing firms cannot help to well  
30 supervise environmental management as a whole. Overall, OS has presented a certain positive impact on  
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1 EP, and according to Baysinger et al. (1991), Barnhart and Rosenstein (1998), and Demsetz and Villalonga  
2 (2001) that presented a close relation among OS, available resources within firms, and operation modes,  
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4 we can infer that the potential impact of OS on EP is usually visually reflected in the effect of internal  
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6 available resources and operation process.  
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10 If considering the effect of NPR (Model 4), it only negatively moderates the effect of FS (-2.03%), which  
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12 indicates that a smaller difference between the largest and second shareholders' shareholding ratio will  
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14 strengthen the moderating effect of FP, also supporting the positive effect of balanced share-distribution  
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16 in the environmental management. Overall, the weak moderating effect of NPR also corresponds to the  
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18 result of correlation analysis that NPR hardly correlates with EP, with verifying Hypothesis 3. Through  
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20 analyzing the CSR reports this paper organizes, we find that to the same firm, its EP presents a certain  
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22 similarity in different years, while the annual NPR usually markedly changes. Accordingly, we infer that  
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24 the EP of Chinese manufacturing firms will remain stable in the coming period (The average score of EP  
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26 from 2010 to 2016 are 234.03, 240.77, 238.60, 239.43, 238.39, 239.97, and 243.11, respectively) no matter  
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28 what level of FP. Additionally, what needs to be noted is that the regression coefficients in Table 3 are  
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30 generally small (Maximum value is 0.3418), which indicates that corporate profile and other internal  
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32 elements have not markedly improved EP. At present, both administrative orders and public opinion are  
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34 largely leading to large shareholders' environmental management orientation, and such pressure can  
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36 also help to explain why some shareholders still lack the active environmental awareness (Zhang et al.,  
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38 2012). That is, they are more subject to commands rather than incentives from external stakeholders.  
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47 Further, this paper develops the robustness test to verify whether the volatility of collected data is  
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49 smooth through considering the time effect of variables. Specifically, we multiply independent variables,  
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51 the moderating variable, and the dependent variable with time (year) and then compare the regression  
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53 result with that in Table 3. We find that almost all regression coefficients obtained from the robustness  
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55 test are highly similar to results in Table 3, including the value of coefficients as well as their significance.  
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57 Following, this paper will develop the heterogeneity analysis based on the consideration of the level of  
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state-owned shares.

### 4.3. Empirical results of heterogeneity analysis

This paper divides TOP10 into 2 groups based on its average (38.08 as Table 1) to present the power of state-owned shares with the results as Table 4 and Table 5.

**Table 4.** The impact of OS on EP in the case of higher proportion of state-owned shares (N=968)

Variables	Model 1	Model 2	Model 3	Model 4
Constant	4.6623*** (0.2135)	4.9823*** (0.2689)	4.9665*** (0.2660)	4.8827*** (0.2458)
SIZE	0.0090 (0.0109)	-0.0013 (0.0138)	0.0013 (0.0137)	0.0010 (0.0142)
STAFF	0.0590*** (0.0076)	0.0582*** (0.0067)	0.0540*** (0.0068)	0.0577*** (0.0059)
R&D	0.0284* (0.0122)	0.0346** (0.0116)	0.0342** (0.0118)	0.0383** (0.0134)
AGE	-0.0372 (0.0137)	-0.0093 (0.0142)	-0.0090 (0.0141)	-0.0070 (0.0150)
POLLUTION	0.1267*** (0.0100)	0.1213*** (0.0119)	0.1219*** (0.0122)	0.1300*** (0.0113)
LOCATION	-0.0259 (0.0070)	-0.0287 (0.0065)	-0.0330 (0.0064)	-0.0296 (0.0072)
GRI/ESG	0.2873*** (0.0257)	0.2807*** (0.0223)	0.2824*** (0.0223)	0.2838*** (0.0230)
IA	0.0660* (0.0266)	0.0409 (0.0279)	0.0410 (0.0274)	0.0382 (0.0272)
DEPS	0.0032 (0.0155)	0.0046 (0.0151)	0.0087 (0.0150)	0.0053 (0.0159)
GROWTH	-0.0089 (0.0086)	-0.0079 (0.0091)	-0.0084 (0.0092)	-0.0055 (0.0090)
AUR	0.0069 (0.0129)	-0.0022 (0.0130)	0.0009 (0.0135)	-0.0018 (0.0141)
SOP		0.1877 (0.0777)	0.1896 (0.0776)	0.2405 (0.1600)
H5		0.0907*** (0.0075)	0.0908*** (0.0077)	0.0890*** (0.0086)
FS		0.0048 (0.0087)	0.0041 (0.0089)	0.0030 (0.0079)
TOP10		-0.0288 (0.0231)	-0.0264 (0.024)	-0.0343 (0.0234)
ID		-0.0992 (0.0389)	-0.1018 (0.0384)	-0.1011 (0.0351)
NPR			-0.0127 (0.0033)	-0.2290 (0.4822)
SOP×NPR				0.1961 (0.4952)
H5×NPR				-0.0295 (0.0335)
FS×NPR				-0.0158 (0.0187)
TOP10×NPR				0.1197** (0.0463)
Time dummies	Include	Include	Include	Include
Firm dummies	Include	Include	Include	Include
Wald Chi <sup>2</sup>	235.28***	253.63***	254.59***	261.62***
D.W. statistics	2.0880	2.0780	2.0760	2.0740
Log likelihood	-349.5494	-345.3520	-343.8573	-340.2584
R <sup>2</sup>	0.1975	0.2105	0.2114	0.2166



**Table 5.** The impact of OS on EP in the case of lower proportion of state-owned shares (N=637)

Variables	Model 1	Model 2	Model 3	Model 4
Constant	4.6969*** (0.1937)	5.1025*** (0.3199)	5.1059*** (0.3256)	5.1339*** (0.3474)
SIZE	-0.0086 (0.0072)	-0.0094 (0.0131)	-0.0097 (0.0139)	-0.0118 (0.0167)
STAFF	0.0731*** (0.0104)	0.0771*** (0.0110)	0.0792*** (0.0119)	0.0829*** (0.0144)
R&D	0.0445*** (0.0106)	0.0455*** (0.0101)	0.0459*** (0.0102)	0.0445*** (0.0093)
AGE	0.0413* (0.0226)	0.0334 (0.0212)	0.0336 (0.0213)	0.0330 (0.0204)
POLLUTION	0.1108*** (0.0104)	0.1156*** (0.0121)	0.1155*** (0.0122)	0.1140*** (0.0113)
LOCATION	0.0082 (0.0168)	0.0277 (0.0211)	0.0268 (0.0210)	0.0292 (0.0208)
GRI/ESG	0.4275*** (0.0826)	0.4297*** (0.0784)	0.4291*** (0.0785)	0.4217*** (0.0726)
IA	0.1338** (0.0359)	0.1123* (0.0370)	0.1110* (0.0365)	0.1137** (0.0391)
DEPS	-0.0299 (0.0233)	-0.0290 (0.0256)	-0.0337 (0.0249)	-0.0394* (0.0254)
GROWTH	0.0128 (0.0188)	0.0137 (0.0178)	0.0137 (0.018)	0.0130 (0.0176)
AUR	0.0016 (0.0083)	-0.0010 (0.0092)	-0.0026 (0.0097)	-0.0028 (0.0098)
SOP		0.1006** (0.0284)	0.1001** (0.0284)	0.1086** (0.0267)
H5		0.0178 (0.0318)	0.0168 (0.0324)	0.0168 (0.0327)
FS		0.0151 (0.0100)	0.0157 (0.0099)	0.0166 (0.0096)
TOP10		-0.0303 (0.0269)	-0.0285 (0.0273)	-0.0308 (0.0279)
ID		-0.1395 (0.1021)	-0.1426 (0.1020)	-0.1461 (0.0968)
NPR			0.0156 (0.0078)	-0.0002 (0.0539)
SOP×NPR				0.0588 (0.0336)
H5×NPR				-0.0085 (0.0293)
FS×NPR				0.0056 (0.0202)
TOP10×NPR				-0.0021 (0.0421)
Time dummies	Include	Include	Include	Include
Firm dummies	Include	Include	Include	Include
Wald Chi <sup>2</sup>	159.44***	169.56***	169.72***	169.96***
D.W. statistics	2.051	2.066	2.064	2.071
Log likelihood	-174.2256	-173.1351	-173.1303	-168.1253
R <sup>2</sup>	0.2033	0.2148	0.2152	0.2165

Based on the test of regression results in Table 4 and Table 5, this paper further checks the presence of heteroskedasticity and spatial as well as serial correlation for two sets of grouped data through the same processing method as the Subsection 4.2. We find that all of these tests also support the reliable quality of grouped data.

1 Table 4 presents that H5 significantly improves EP in the case of higher proportion of state-owned  
2 shares (marginal effects within 8.90%~9.08%), and only the impact of TOP10 has been significantly  
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4 positively moderated by NPR. However, when TOP10 is lower than the average, NPR cannot promote  
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6 any OS related variable to improve EP. This comparison supports that the power of state-owned shares  
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8 does not present a significant difference among firms. However, compared with the total sample, in  
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10 firms with a higher proportion of state-owned shares, the collective power of large shareholders (H5) is  
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12 stronger, which presents the leading effect of large shareholders under the control of state-owned shares.  
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14 Further, lower proportion of state-owned shares indicates more private or foreign shares, and in this case,  
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16 higher NPR may not directly promote the improvement of EP because these firms that are dominated by  
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18 private shares tend to give priority to commercial interests. This finding can verify Hypothesis 2, while  
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20 compared with corporate profile and available resources, the interaction between OS and FP has a little  
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22 impact on EP when the size of state-owned shares is higher. From another perspective, such relation also  
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24 implies a positive case that the positive effect of state-owned shares in environmental management may  
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26 remain stable in the coming period, and once FP significantly interacts with state-owned shares, it may  
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28 indicate that the leading effect of state-owned power will be weakened by dynamic financial indicators.  
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30 On the other hand, firms with higher proportion of state-owned shares mostly belong to the state-owned,  
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32 and in this case, the impact of SOP may be weakened, while when the proportion of state-owned shares  
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34 is lower, the existence of SOP itself will provide a strong guarantee for the creation of EP (marginal  
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36 effects within 10.01%~10.86%). Overall, there are some differences of empirical results between the full  
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38 sample and grouping tests, while they can jointly describe a trend that is state-owned power and large  
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40 shareholders always dominate the process of environmental management in manufacturing firms. In the  
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42 long-run, it suggests more focusing on large shareholders' environmental awareness because compared  
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44 with the state-owned power, the environmental behavior organized by some non-stated-owned  
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46 shareholders may be unstable, which will weaken the government role in environmental management.  
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## 60 **5. Research implications**

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### 5.1. Implication within theoretical perspectives

Empirical results present that FP has not well moderated the relation between OS and EP, while it can still improve the outcome of large shareholders' environmental management orientation to some extent. According to [Zeng et al. \(2011\)](#), [Qi et al. \(2014\)](#), and [Xu and Zeng \(2016\)](#), although there is no unified conclusion on the relation between FP and EP, FP is always designed as an indispensable element to support corporate environmental management because environmental investment strongly relies on this element. Based on our empirical results, this paper obtains following theoretical implications. First, due to the strong power of state-owned shares and political intervention, OS always originally affects the environmental management orientation of Chinese manufacturing firms. This paper agrees with the conceptual model of [Meng et al. \(2013\)](#) that OS can moderate the relation between FP and EP because some large shareholders organize the environmental activity based on the current profit. However, this opinion also implies that corporate environmental management orientation largely relies on the level of FP, which may weaken the impact of shareholders' management willingness. In this case, once FP is at a lower level, it will hinder the development of follow-up environmental management. This paper argues that protecting the natural environment is a responsibility that manufacturing firms must fulfill no matter what level of their FP. From this perspectives, our findings release a positive signal that the formation of environmental management orientation is not dominated by FP, which implies that such management is likely to remain stable instead of a major volatility. Accordingly, the conceptual model of this paper will strength the understanding on the original decisive impact of OS on CSR. Additionally, this paper expands the perspective on the environmental management mode of Chinese manufacturing firms and then suggests that large shareholders should enhance their environmental awareness.

Second, the  $R^2$  in Table 3 to Table 5 presents what extent all explanatory variables can describe the change of explained variable, and in the field of social science, the economic implication of variables can provide an important basis for the credibility of  $R^2$ , which suggests understanding the value of  $R^2$  based on the realistic context ([Pindyck and Rubinfeld, 2011](#)). Although this paper designs control variables as

1 comprehensively as possible to enhance the validity of conceptual model, the value of  $R^2$  is still low  
2 (Maximum value is only 0.2166). Further considering the measurement unit and regression coefficients  
3 related to OS, it supports that the impact of OS on EP is still limited in China's context. Some supportive  
4 studies, e.g. Li and Zhang (2010), Li et al. (2013), and Meng et al. (2013), also presented that a lower  $R^2$  on  
5 relations among OS, FP, and EP (or CSR performance) in China, while the potential reason still needs to  
6 be analyzed. Integrating prior studies, this paper finds that the process of environmental management in  
7 manufacturing firms is always affected by multiple elements, e.g. the share-distribution, production  
8 structure, available resources, large shareholders' environmental awareness, financing channel, political  
9 intervention, and other uncertain external contexts (Kagan et al., 2003; Melnyk et al., 2003; Montabon et  
10 al., 2007; Hatakeda et al., 2012; Meng et al., 2013). To Chinese manufacturing firms, political intervention,  
11 e.g. the mandatory environmental regulation and penalty, can usually directly affect their environmental  
12 management orientation, which will weaken the original effect of OS to some extent. In reality, no matter  
13 what proportion of state-owned shares is, the effect of such share will be always reflected in the process  
14 of corporate daily operations, while political intervention is a kind of behavior constraint from the  
15 government level. This case supports that environmental management orientation originated from large  
16 shareholders is always affected by political intervention as well. Based on above analysis, the  $R^2$  will be  
17 relatively low when the investigated elements are less related to political intervention in the field of  
18 environmental management in China's context.

## 45 *5.2. Implication within international perspectives*

47 An important finding of this paper is the driving effect of state-owned power in the environmental  
48 management of manufacturing firms. Accordingly, we will further discuss the difference of state-owned  
49 shares' effect in the environmental management between Chinese and Western firms. Prior studies have  
50 presented that the effect of both corporate OS and top managers' code of conduct in CSR are different in  
51 China and the West (Smith et al., 1996; Liu, 2005). Specifically, many Chinese manufacturing firms are  
52 state-owned or with a higher proportion of state-owned shares, while the share-distribution in the West  
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1 is relatively dispersed. It will make the power from large shareholders on Chinese manufacturing firms  
2 be stronger than that from the market while the West is opposite. Further, large shareholders of Chinese  
3 state-owned firms are usually more obedient to established procedure or rule, superiors' instruction, and  
4 political intervention when addressing important issues, while such shareholder of joint-venture firms  
5 more trusts their own professional knowledge or experience, which is similar with the West.  
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12 The above analysis on Chinese and Western firms can provide following implications. First, given the  
13 severe environmental crisis in China at present, the proper political intervention will help to coordinate  
14 the relation between environmental and commercial issues that is difficult to be addressed by the market  
15 power. This case implies that different from the West, the contribution of environmental management in  
16 Chinese manufacturing firms will be always under the joint regulations of state-owned power, political  
17 intervention, and large shareholders. Although the political intervention may weaken large shareholders'  
18 environmental proactivity ([González-Benito and González-Benito, 2006](#)), at least it will ensure the  
19 environmental cost of manufacturing firms to be within the control. For China that is in the period of  
20 economic transition, such action has a certain positive significance.  
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35 Second, the West has generally experienced a severe environmental pollution in the early of Industrial  
36 Revolution, while Chinese manufacturing industry is still addressing the transition of green operations.  
37 Such case and the feature of Western political system jointly trigger the limited impact of state-owned  
38 shares on environmental management in the West. Although our findings present a relatively stable  
39 impact of OS on EP, this paper argues that such positive significance can only indicate that in the context  
40 of China's economic transition, the proper political intervention will help to reverse corporate less  
41 climate-friendly operations. However, such mandatory intervention will also hinder the potential of  
42 corporate commercial growth, especially for state-owned firms. In contrast, environmental proactivity of  
43 Western firms and public supervision are both at a mature stage, and the effect of political intervention is  
44 more to provide incentives. Overall, given the difference of corporate development history, operation  
45 mode, social role, and large shareholders' code of conduct between China and the West, the stronger  
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1 state-owned power in environmental management has the uniqueness in China. No matter due to the  
2 enhancement of CSR consciousness or to meet policy requirements, state-owned power in environmental  
3 management has presented a positive trend. In the long-run, how to improve environmental proactivity  
4 of non-state-owned shareholders is an urgent issue to be addressed.  
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### 9 *5.3. Implication within managerial perspectives*

10 This paper also provides following managerial implications on how to improve large shareholders'  
11 environmental awareness. First, the average EP of manufacturing firms that are located in Non-eastern  
12 provinces (234.18) is markedly lower than that in the Eastern (242.78), while the average level of TOP10  
13 in these two regions is similar (37.69 vs 38.30). According to media coverage, the negative environmental  
14 information of manufacturing firms located in Non-eastern region is more than that in the Eastern,  
15 which indicates that the level of regional economy also affects the orientation of corporate environmental  
16 management (Eastern region is more developed than the Non-eastern). Additionally, the average NPR of  
17 manufacturing firms located in the Non-eastern (9.01) is higher than that in the Eastern (8.04), which  
18 implies that the former firms more focuses on commercial interests, thereby weakening the CSR to some  
19 extent. To improve it, Chinese government should strictly supervise the environmental management  
20 process of manufacturing firms located in the Non-eastern and motivate large shareholders to engage in  
21 pollutants control. Meanwhile, this paper infers that an important reason for lower EP of firms located in  
22 the Non-eastern is that due to the inferiority of geographical location, the environmental investment will  
23 markedly enhance corporate daily operation cost. Accordingly, the central and local government should  
24 jointly support their green operations, e.g. organizing the Industry-University-Research platform, special  
25 environmental fund, and new clean programs (Zhu et al., 2007; Yang and Feng, 2008). Further, the  
26 government should promptly optimize the size of fiscal support based on the volatility of corporate EP  
27 and FP, thereby establishing a dynamic and sustainable incentive mechanism. Second, we should realize  
28 that political intervention may be not an optimal approach to deal with environmental crisis in China  
29 because it cannot well address how to motivate large shareholders' environmental awareness. Although  
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1 corporate internal available resources and external contexts can also affect the outcome of environmental  
2 management, large shareholders' awareness is always a fundamental and irreplaceable driving force for  
3 improving EP, which indicates that large shareholders should agree that environmental management is a  
4 responsibility they must fulfill rather than only be subject to administrative orders (Fryxell and Lo, 2003;  
5 Zeng et al., 2011). Third, from the perspective of corporate internal supervision, Table 1 presents that the  
6 average size of ID (38.40) just exceeds the criterion set by the China Securities Regulatory Commission,  
7 which may restrict the monitoring duty of independent directors. On the one hand, for manufacturing  
8 firms, especially the listed firms, they should strictly abide by the regulation to arrange independent  
9 directors. On the other hand, independent directors should be endowed with more rights to supervise  
10 CSR issues, i.e. strengthening the status of environmental management in Chinese manufacturing firms  
11 through both internal and external supervisions.  
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27 In brief, it is necessary for Chinese government and large shareholders to be jointly committed to  
28 improve corporate environmental management system, and strengthen the environmental awareness of  
29 large shareholders as well as the monitoring duty of independent directors.  
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## 35 6. Conclusion

36 Through surveying Chinese manufacturing firms, this paper analyzes the impact of OS on EP under  
37 the moderating effect of FP (NPR) and further examines whether FP can a play better moderating effect  
38 when the firm is with higher proportion of state-owned shares through the Random Effect Model. The  
39 descriptive statistics present the relatively lower EP in Chinese manufacturing firms. Empirical results  
40 present that both SOP and H5 significantly improve EP, while the impact of FS and TOP10 are both not  
41 significantly positive, and the size of independent directors has not promoted the improvement of EP at  
42 present. Additionally, H5 significantly improves EP in the context of higher proportion of state-owned  
43 shares, and SOP significantly improves EP when the state-owned share is lower. Further, NPR slightly  
44 moderates the impact of OS on EP with findings that it negatively moderates the impact of FS on EP for  
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1 the full sample while only positively moderates the impact of higher TOP10 on EP. Overall, the findings  
2 of this paper present a relatively positive effect of OS in corporate environmental management, while  
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4 both the monitoring duty of independent directors and the moderating effect of FP are still weak. This  
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6 case indicates that even if the EP of Chinese manufacturing firms will not be significantly improved in  
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8 the short-run, at least it may present a stable rising trend.  
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12 This paper is not without limitations. First, although establishing the unified evaluation criterion can  
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14 help to fairly present the difference of EP among firms, the weight this paper sets inevitably reflects our  
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16 subjectivity. Specifically, although GRI3.1 version introduces that core indicators are valuable for most  
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18 institutions, we still cannot conclude that the importance of their weights is same to each firm due to the  
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20 difference of corporate basic features. In reality, large shareholders usually formulate future investment  
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22 plans for environmental management based on multiple considerations, which implies that the size of  
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24 such investment will always change. Therefore, a unified evaluation criterion may be difficult to present  
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26 the volatility of large shareholders' environmental awareness. Second, according to GRI3.1 version, few  
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28 additional indicators are not fully applicable to non-heavy-polluting firms. In this case, we infer that the  
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30 EP of non-heavy-polluting firms within our sample is markedly lower than that of the heavy-polluting,  
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32 and such inference is also supported by our calculated data (229.70 vs 250.48). Therefore, using a same  
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34 evaluation criterion may slightly weaken the real value of EP of non-heavy-polluting firms. Third,  
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36 although almost all CSR reports promise to truthfully and completely publish each kind of social  
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38 responsibility performance, they cannot record all related information in reality. Therefore, the EP this  
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40 paper measures may be lower than its true level, and the impact of OS on EP this paper examines may be  
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42 slightly different from the true state.  
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52 To work on these limitations, the following research should be further investigated. First, compared  
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54 with the data collected from CSR reports, data from field survey may provide more specific and targeted  
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56 information on corporate environmental management, which can help to design evaluation criterion that  
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58 is more in line with general features of Chinese manufacturing industry. Although such survey requires  
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1 much time and money input, the potential conclusion will be more helpful to improve the actual value of  
2 environmental management in firms. Second, in the context of facing the severe environmental crisis and  
3 huge international pressure, improving natural environment in China will make a great contribution to  
4 mitigate global climate change. However, it still lacks the high-quality research on the environmental  
5 management mode of Chinese manufacturing industry, especially the analysis of large shareholders'  
6 environmental responsibility. Accordingly, more perspectives need to be developed, e.g. analyzing the  
7 effect of political intervention on corporate environmental management. Third, as the above discussion  
8 on managerial implications in Subsection 5.3, large shareholders' environmental awareness is likely to  
9 more positively affect the level of EP in the long-run, which enlightens us to organize future research on  
10 corporate environmental management from the perspective of shareholders' psychological motivation,  
11 which will develop a dialogue that can help the environmental management to reach out a new related  
12 knowledge areas, i.e. environmental psychology. Prior studies on corporate environmental proactivity  
13 will provide some mature ideas for this expansion, and such work will reveal why EP is diversified  
14 among manufacturing firms from the perspective of shareholders' motivation.

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**Table 2.** Correlation coefficients (Spearman coefficients, N=1605)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
EP																					
SIZE	0.258**																				
STAFF	0.295**	0.713**																			
R&D	0.058*	-0.169**	-0.027																		
AGE	-0.113**	-0.009	-0.143**	-0.012																	
POLLUTION	0.103**	0.012	0.084**	-0.174**	0.041																
EDUCATION	0.028	0.082**	0.028	0.127**	0.008	-0.148**															
COR/ESG	0.399**	0.352**	0.285**	-0.047	-0.176**	-0.057**	0.114**														
LEIS	0.197**	0.381**	0.308**	-0.103**	-0.126**	0.010	0.169**	0.200**													
LEPS	0.045*	0.183**	0.130**	0.019	-0.113**	-0.067**	0.122**	0.126**	0.138**												
GROWTH	-0.023	-0.014	-0.014	-0.116**	-0.139**	-0.002	-0.010	-0.008	0.013	0.231**											
LABOR	-0.027	-0.332**	-0.195**	0.173**	-0.025	0.032	0.048*	-0.107**	0.016	0.134**	-0.046*										
SOP	0.088**	0.129**	0.010	-0.185**	0.014	0.073**	0.096**	0.035	0.103**	-0.016	-0.003	-0.039									
DEB	0.251**	0.398**	0.339**	-0.138**	-0.335**	0.054**	-0.040	0.299**	0.375**	0.157**	-0.045*	-0.024	0.201**								
ES	-0.063*	-0.062*	-0.078**	0.030	0.141**	0.064**	-0.079**	-0.134**	-0.173**	-0.055*	-0.058**	0.052*	0.143**	-0.113**							
OP10	0.147**	0.296**	0.164**	-0.217**	-0.126**	0.075**	0.043*	0.167**	0.188**	0.035	-0.026	-0.083**	0.691**	0.571**	0.195**						
OP	-0.004	0.055*	0.055*	-0.011	-0.056*	-0.018	-0.027	0.048*	0.010	0.010	0.002	-0.031	0.015	0.033	0.026	0.046*					
NPR	-0.002	-0.006	-0.156**	-0.011	-0.101**	-0.094**	0.101**	0.071**	0.080**	0.593**	0.112**	0.347**	-0.020	0.153**	-0.080**	0.046*	-0.008				
OP*NPR	-0.034	-0.013	-0.178**	-0.035	-0.051**	-0.124**	0.082**	0.053*	0.041	0.462**	0.083**	0.267**	-0.213**	0.083**	-0.070**	-0.063*	-0.011	0.833**			
OP15*NPR	-0.133**	-0.137**	-0.211**	-0.024	0.041	-0.065**	-0.026	-0.154**	-0.048*	0.137**	0.092**	0.157**	-0.074**	-0.218**	-0.003	-0.168**	-0.038	0.392**	0.447**		
OP20*NPR	0.010	0.024	-0.119**	-0.011	-0.104**	-0.094**	0.108**	0.097**	0.094**	0.531**	0.098**	0.293**	-0.038	0.184**	-0.255**	0.036	-0.002	0.907**	0.801**	0.331**	
OP10*NPR	-0.084**	-0.065**	-0.177**	-0.072**	0.102**	-0.106**	-0.058**	-0.095**	-0.067**	0.035	0.023	0.033	-0.090**	-0.177**	-0.001	-0.152**	-0.038	0.165**	0.505**	0.561**	0.193**

Note: \*p≤0.10 (Two-tailed), \*\*p≤0.05 (Two-tailed), \*\*\*p≤0.01 (Two-tailed).