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

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ABSTRACT

There is a growing debate on how should Chinese manufacturing firms improve their environmental performance (EP). This paper analyzes the impact of ownership structure (OS, including state 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 considering the moderating effect of financial performance measured by net profit rate (NPR) through 1605 firm-year observations. The findings present that the overall EP of Chinese manufacturers is relatively low (The average level is only 25.94% out of the ideal maximum). Both SOP and H5 can significantly improve EP (marginal effects within 8.20%–8.76% and 4.37%–4.44%, respectively), but the impacts of FS, TOP10, and ID are all not significantly positive. Additionally, H5 significantly improves EP (8.90%–9.08%) when TOP10 is higher than its sample average, and SOP significantly improves EP (10.01%–10.86%) when TOP10 is lower than such average. Further, NPR significantly negatively moderates the impact of FS on EP for the full sample and only positively moderates the impact of higher TOP10 on EP. Empirical results enlighten that some OS-related indicators can steadily contribute to EP, and the weak moderating effect of NPR also presents a positive phenomenon that 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.

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 the manufacturing sector (Burress, 2005; Pinkse and Kolk, 2012). Prior studies analyzed the particularity of Chinese manufacturing firms based on the comparison with Western firms, including the special feature in the corporate social responsibility (CSR). On the whole, 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 link with government departments usually have a significant impact on important decisions related to environmental issues 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 CSR activities (Smith et al., 1996; Liu, 2005; Li and Zhang, 2010). Therefore, 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 sectors for mitigating 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 paths for green manufacturing industry. For instance, the amount of CO_2 emission

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

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in China reached 10 billion tons in 2013 that has 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, findings from Whitcomb et al. (1998) and Shafer et al. (2007) presented that business corruptions caused by the market economy weakened large shareholders' social responsibility in some Chinese firms, which makes their decisions be more driven by commercial interests. Further, corporate governance mode, e.g. indicators related to board of directors, ownership, and top managers' feature, has been linked with environmental management (Walls et al., 2012; Kock and Min, 2016), and moreover, how OS can affect the mode of corporate environmental management has been also analyzed in recent studies, e.g. Calza et al. (2016). Such analysis theoretically and practically support the power of shareholder as a driver for corporate green operations, but prior studies lacked a focus on what elements can motivate governance mode or OS to play a more critical effect in environmental issues. As a rational economic participant, financial performance (FP) is always the primary target pursued by firms, and the level of such performance is also expected to reversely affect the actual contribution of governance mode or OS to firm development (Thomsen and Pedersen, 2000). The implication of OS arrangement indicates a stable mode in daily operations. Enlightened by prior gaps on the link of corporate governance feature and environmental management, this paper will investigate to Chinese manufacturing firms, whether FP can motivate OS to improve EP? This work will help Chinese manufacturers to clarify whether excellent financial indicators can strengthen top managers' concerns on environmental issues, thereby enriching the channel of green operations.

This paper is expected to contribute to following aspects. First, we theoretically analyze how corporate FP can moderate the impact of OS on EP. OS is a generalized concept that reflects how corporate internal shares are distributed, and it can be described by multiple indicators, e.g. the fraction of shares owned by their major shareholders (Demsetz and Villalonga, 2001). Although prior studies examined the impact of OS on CSR (Li et al., 2013; Meng et al., 2013), OS was designed as a moderating or mediating variable in more cases. Prior studies also designed OS as an independent variable when analyzing issues related to CSR or environmental management (Li and Zhang, 2010; Dam and Scholtens, 2013; Calza et al., 2016), but they have not further analyzed whether there are some elements that may optimize the effect of OS in improving such issue. Accordingly, this paper will enrich the interaction among OS, FP, and EP that is still ambiguous by now, which will expand the perspective on what element can enhance the value of OS in green operations. Second, some studies also analyzed the impact of FP on EP based on a consideration that commercial interests may provide a strong support for the future environmental investment (Ruf et al., 2001; Clarkson et al., 2008; Al-Najjar and Anfimiadou, 2012), but these studies did not revealed the effect of elements that the originally determine the level of corporate EP. Therefore, the introduction of OS will enrich the following research route. Based on Jensen and Meckling (1976), Demsetz (1983), and Demsetz and Lehn (1985), this paper argues that OS always leads to the orientation of firm development, which suggests OS to be viewed as a determinant when evaluating corporate performance. In China, the dominant role of state-owned shares in manufacturing sectors can make OS more fairly reflect corporate original willingness to operation activities. In the context of this special form of ownership, the analysis on how OS leads to CSR will provide important implications for managers and government when they organize green operations from the perspective of initial decision-makings. Expectedly, this paper will present what kind of OS can originally help to improve EP, which will also provide policy implications for improving OS that is with defects in green operations.

We organize the rest of this paper as follows. Section Two reviews prior literature and accordingly propose research hypotheses. Section Three introduces data, method, variables, and measuring model. Section Four presents empirical results, including the analysis for the full sample, robustness test, and heterogeneity analysis that is grouped by the size of state-owned shares. Section Five discusses research implications. Section Six summarizes the conclusion, limitation, and future research.

2. Literature review and hypotheses development

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

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

Accordingly, we argue that in the context of market economy, Chinese government should respect the essence of firm and properly reduce the reliance on social role of state-owned firms. Instead, advocating all types of firms to serve the society will mitigate the potential negative impact of political intervention on the development of state-owned firms.

2.2. The impact of OS on social responsibility in Chinese firms

It still lacks high-quality studies on the impact of OS on social responsibility in Chinese firms probably due to the long-periodic data collection as well as complex firm features. Typically, Wang and Jin (2007) compared pollutants control performance among Chinese manufacturing firms that are with diversified ownership properties, including the state-owned, collectively-owned, and privately-owned. They found that collectively-owned firms' sewage treatment performance was much better than the state-owned and privately-owned, and the performance of state-owned firms was the worst due to their lower operation efficiency and more

bargaining power in environmental enforcement. However, Gao (2009) found that Chinese state-owned firms often more focus on social issues than the privately-owned due to an obvious profit-maximizing feature of the latter. From the perspective of environmental levies, Maung et al. (2016) presented that Chinese state-owned firms can potentially achieve better EP because most of them have established a close political connection with the central or local government, which will help to mitigate their environmental pressure. For a considerable number of Chinese firms, a primary motivation of large shareholders' focus on CSR is to obtain commercial interests rather than improve their social or natural environment (Zu and Song, 2009; Rodrigue et al., 2013). Judged by this, in most cases, only if they agree that social issues can bring the expected FP (no matter directly or indirectly), they will actively organize related activities, including environmental management. Further, based on the Stakeholder Theory (Ruf et al., 2001; Cordeiro and Tewari, 2015), this paper argues that the essence of fulfilling CSR is a kind of shareholders' investment on social issues that are expected to be beneficial to firms. In the long-term, if large shareholders highly agree with CSR, stakeholders' expectation to corporate outlook will be positive, which also reflects a kind of social value originated from the ownership.

There is still no unified conclusion on the relation between OS and social responsibility performance in Chinese firms, but the mainstream research finding is that state-owned firms usually achieve better social responsibility performance no matter what initial motivations their large shareholders have. Many Chinese state-owned firms have experienced OS reform, but the change of state-owned shares also leads to diversified CSR orientations (Whitcomb et al., 1998; Tam, 2002; Lu, 2009). However, based on Smith et al. (1996), Liu (2005), and Xun (2013) that jointly emphasized the effect of state-owned shares in guiding Chinese firms to fulfill social responsibility, we can describe a picture that given a strong political power of the Central Government of China, no matter how large the proportion of state-owned shares is and how to distribute these shares, social responsibility performance of state-owned firms is often better than other firms. Further, through investigating the annual report of Chinese listed manufacturing firms, we summarize that the proportion of state-owned shares in some state-owned firms is less than 20%, but to some non-state-owned firms, such proportion is at a higher level, which suggests that only focusing on ownership property (state-owned or not) may not fully reveal the impact of OS on social responsibility performance. Besides ownership property, this paper will also examine the impact of share-distribution, i.e. ownership concentration, shareholding ratio of the largest and second shareholders, and proportion of state-owned shares, on EP based on prior studies that discussed indicators involved in OS (Demsetz and Lehn, 1985; Sappington and Stiglitz, 1987; Li and Zhang, 2010). Integrating these studies, we predict that the leading effect of ownership property in social responsibility of Chinese firms is usually stronger than that of other OS indicators, thereby proposing following hypotheses.

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

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

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

Hypothesis 2. Higher proportion of state-owned shares leads to a more positive impact of OS on EP.

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

According to Kagan et al. (2003) and Delmas and Blass (2010), corporate EP is mainly reflected in the improvement of surrounding natural environment, and improving EP usually requires the support from environmental management tools. In practice, OS can affect the orientation of corporate environmental management, but the process of improving natural environment also requires incentives from FP. With more and more elements participating in corporate daily operations, the relation among OS, FP, and EP will present a diversity, and some studies concluded that the relation between FP and EP is transforming to the bidirectional causality from unidirectional or non-causality (McWilliams and Siegel, 2000; Orlitzky et al., 2003; Clarkson et al., 2008, 2011; Mishra and Suar, 2010; Al-Najjar and Anfimiadou, 2012). Further, some studies examined the moderating effect of OS in environmental issues. For instance, Li et al. (2013) presented that the moderating effect of OS between the impact of FP on EP in Chinese state-owned firms is weaker than that in the non-state-owned, but Meng et al. (2013) found the opposite finding. Some studies examined the moderating effect of OS with the consideration that the impact of shareholders' decision on CSR largely depends on their identity and decision-making power, e.g. Maung et al. (2016). However, there are also some studies designing OS as an original determinant of fulfilling CSR because compared with dynamic FP, OS is relatively stable even if there will be a volatility of share-distribution in the coming period (Wang and Jin, 2007; Dam and Scholtens, 2013). Through integrating prior analysis and share-distribution features in Chinese manufacturing firms, this paper arranges OS as an independent variable and then describes the mechanism of FP moderating the impact of OS on EP as follows. Political intervention in environmental management makes that whatever the size of available resources in firms, large shareholders are often required to organize environmental management. In this process, indicators related to FP will provide the fund support for developing such activity. Based on Qi et al. (2014), when FP is considerable, its supporting effect can be described as using redundant resource to organize social activities. This case indicates that in the context of relatively stable share-distribution, FP may determine whether EP will reach the expected level (Liu et al., 2010; Zeng et al., 2011). In other words, for one firm, dynamic financial indicators will encourage the fixed OS to play diversified effects in environmental issues, i.e. leading large shareholders to make changeable environmental decisions by the aid of available resources. Wang et al. (2011) and Shin (2012) further found that large shareholders' goal-oriented leadership can always affect corporate comprehensive performance, and improving social responsibility leadership has become a global trend. In brief, we infer that large shareholders with strong senses of social responsibility will usually present a forward-looking environmental insight based on the use of available resources rather than only engage in short-term environmental programs. Accordingly, this paper argues that in theory, FP can moderate the impact of OS on EP.

By now, it lacks studies that examined such moderating effect of FP existing in Chinese firms. Some supportive evidence presented that if separately analyzing the relation between OS and CSR as well as FP and CSR, higher state-owned shares and profitability will more positively affect social responsibility performance (Xu and Zeng, 2016). On the other hand, by the aid of financial or institutional tool, Chinese government is committed to compensate the loss of manufacturing firms resulted from environmental management as well (Chang et al., 2015), which helps to decrease corporate reliance on current FP when organizing environmental activities. However, through analyzing the historical data of annual

reports of Chinese manufacturing firms, we find that compared with the size of their total assets, the intensity of policy support, e.g. tax return and fiscal subsidy, is slighter, and some firms are still in a state of financial deficit. Accordingly, this paper argues that the potential moderating effect of FP has not reached a high level, thereby proposing the following Hypothesis.

Hypothesis 3. The positive moderating effect of FP between the impact of OS on EP is limited.

3. Research methodology

3.1. Data collection

We used to examine the impact of EP on FP under the moderating effect of corporate environmental management capability (EMC) through surveying Chinese manufacturing firms (Liang and Liu, 2017). To ensure the continuity of research, this paper adopts a similar evaluation criterion to quantify the level of EP. Shanghai Stock Exchange has published nearly 3000 social responsibility reports of listed firms that involve almost all kinds of industrial sectors, and all reports have recorded how firms fulfilled their social responsibility. Chinese listed firms are obliged to yearly publish social responsibility reports and faithfully record performance related to social issues, including environmental management, community construction, customer service, supply-chain management, staff's career development. Some reports also introduced corporate profile, operation mode, and distribution principle of shareholders' income. What needs to be noted is that CSR report is prepared by each listed firm and reflects corporate willingness to serve the society. Although few firms have published negative information on their social responsibility, almost all firms declared that when organizing CSR reports, they are strictly following the law, policy, industrial criterion, and some international sustainable development guidelines, e.g. the Company Law, the Securities Law, the Tax Law, Corporate Social Responsibility Report Guideline of China complied by Chinese Academy of Social Sciences, and Sustainability Reporting Guidelines compiled by Global Reporting Initiative. Further, almost all listed firms promised that they have faithfully and completely published their social responsibility performance without any false or omitted information, and they will be responsible for potential errors. According to the statement of these CSR reports, we argue that these firms have not obviously exaggerated their social responsibility performance with the credibility as well. Overall, following environmental activities are published by most of CSR reports: environmental policy implementation, cleaner production program, resources management, pollutants control, operations of sustainable supply-chain, environmental education, green community construction, and environmental strategy formulation. In fact, not all firms have yearly published annual social responsibility reports, and some only did this work for 1 or 2 years. Through considering the availability and integrity of data of all analyzed variables, this paper collects 1605 social responsibility reports of Chinese manufacturing firms, i.e. 1605 unique firm-year observations, involving CSR information from 2010 to 2016 (155 reports in 2010, 154 in 2011, 218 in 2012, 239 in 2013, 238 in 2014, 259 in 2015, and 342 in 2016). As before 2010, only less than 10 reports were published in each year, we have not considered these samples.

With respect to the data source, following indicators are surveyed from CSR reports: environmental activity, EMC, and whether firms publishing environmental performance following the Sustainability Reporting Guidelines compiled by the Global Reporting Initiative (GRI3.1 version) or the Environment, Social and Governance Index compiled by the Stock Exchange of Hong Kong Exchange Ltd. (ESG). Following indicators are surveyed from corporate annual reports: corporate size, the number of staff, the size of R&D investment, whether annual reports having been audited by the international accounting agency, diluted earnings per share, corporate growth, ratio of asset utilization, ownership concentration, the shareholding ratio of the largest and second shareholders, ownership property, total proportion of stated-owned shares owned by top 10 shareholders, the proportion of independent directors accounting for all board members, and FP. Other data are collected from corporate official website, e.g. listed age.

3.2. Method and variables

This paper divides EP into the level of corporate environmental activity (behavior-related performance) and EMC (management-related performance). Prior studies on the Resource-based View argued that the management capability to environmental elements can help to improve commercial and social value of environmental activity (Barney, 1991; Teece et al., 1997; Lee et al., 2001), and once lack of such capability, EP may not be continuously improved. EMC was defined as a kind of the organizational capability in environmental management, also a kind of management tool used by large shareholders to mitigate the negative impact of daily operations on the natural environment (Teece et al., 1997; Klassen and Whybark, 1999; Melnyk et al., 2003; Lee and Klassen, 2008; Liu et al., 2010; Hofmann et al., 2012; Wong et al., 2012; Wong, 2013). Accordingly, this paper considers the level of both behavior and management performance in term of EP, which also enriches our prior study (Liang and Liu, 2017).

This paper applies the Content Analysis Method to evaluate both the level of corporate environmental activity and EMC. In the field of social science, we usually need to quantify the level of non-quantitative indicators, and when documents do not involve enough data, this method can help to visually present the level of targeted variables based on the established evaluation criterion (Viney and Westbrook, 1976; Westbrook, 1976; Hsieh and Shannon, 2005). However, Downe-Wamboldt (1992) argued that evaluating non-quantitative variables will inevitably reflect researchers' subjective judgment, which may lead to a small deviation between estimated and true levels of variables. Following, we provide an overview of all variables.

Dependent variable: EP is designed as the dependent variable that is multiplied by the score of environmental activity and EMC. First, this paper surveys the level of environmental indicators involved in GRI3.1 version to evaluate the environmental activity of our sample because this guideline provides a universally applicable environmental evaluation criterion for global institutions, including all sizes of firms, with fully taking into account shareholders' income and explaining how to collect data for each indicator as well. Additionally, GRI3.1 version is used to evaluate the sustainable development of global institutions from 2000 to 2011. As CSR reports surveyed by this paper involve the period from 2010 to 2016, we select GRI3.1 version rather than GRI4 version as the evaluation criterion. Specifically, GRI3.1 version includes 30 environmental indicators that were divided into 9 categories, i.e. 17 core indicators (EN1-EN4, EN8, EN11-EN12, EN16-EN17, EN19-EN23, EN26-EN28) and 13 additional indicators (EN5-EN7, EN9-EN10, EN13-EN15, EN18, EN24-EN25, EN29-EN30). The core indicator is broadly applicable and valuable for most institutions but additional indicator only valuable for some institutions. This paper renames each category of environmental activity as follows to clearly present their contents: materials consumption (EN1-EN2); energy-saving (EN3-EN7); water-saving (EN8-EN10); biodiversity conservation (EN11-EN15); pollutants control (EN16-EN25); cleaner

products and services (EN26-EN27); environmental legitimacy (EN28); cleaner logistics (EN29); environmental investment (EN30). Within our all CSR reports, only 5 ones have not recorded any environmental activity, but all reports introduced a certain amount of EMCs. To avoid the score of their product being 0 that hides the true effect of EMC, this paper defines 3 if a firm well engaged in one core indicator and 2 if well engaged in one additional indicator in a year. Otherwise, it is 1. Then this paper adds the score of 30 indicators to present the level of environmental activity. With respect to how to determine one indicator has been well engaged in or not, GRI3.1 version has introduced the relation between each indicator and environmental management. Accordingly, if a firm published data related to one indicator and then explained its positive impact on the natural environment, this paper argues that this indicator has been well engaged in. For instance, for EN5 (the saved-energy through improving energy-efficiency), the firm needs to simultaneously publish the total amount of annual saved-energy and explain how to achieve energy-saving. If only publishing the data, it is not considered to be 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 department; short-term environmental programs; environmental strategy; leading low-carbon technology; environmental cooperation with stakeholders; environmental performance incentives; environmental knowledge training for staff; green procurement; environmental performance certified by independent agencies; voluntary participation in environmental protection activities organized by governments or industry associations. This paper defines 1 if a firm has one kind of capability in a year 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: The ownership property of firms (SOP, non-state-owned = 0; state-owned = 1) is designed 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), focused more on ownership concentration (H5) to present large shareholders' controlling capability, and this variable can be expressed as Ln [H5/(100-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 role 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 but 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 directors 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, this paper will examine whether the size of independent director can affect EP to present the monitoring duty of such director in current OS through the proportion of independent directors accounting for all board members (ID). Lack of analysis of the effect of independent directors, it will be difficult to present whether the current operation of Chinese manufacturing firms is in a state of strict internal supervision. Further, the empirical results related to ID will also enlighten us whether the process of environmental management strongly relies on the internal supervision mechanism.

Moderator variable: This paper designs the net profit rate (NPR) to reflect corporate FP. In reality, FP includes many indicators, e.g. ROE and ROA, but the profit growth in a certain period can more directly present the added monetary value created by diversified operation activities. Further, NPR can enhance shareholders' investment willingness and thus help to predict corporate outlook. Due to a close relation between NPR and corporate daily operations, this paper will examine its moderating effect.

Control variable: Based on Griliches (1964), Trotman and Bradley (1981), Griliches (1986), Cho (1998), Hutchinson and Gul (2004), Clarkson et al. (2008), and Zeng et al. (2011) as well as prior studies on OS, shareholders' income, and competitiveness of Chinese firms (Xu et al., 2006; Zeng and Chen, 2006; Cao et al., 2007; Zhang and Liao, 2010), this paper designs following control variables that can potentially affect the level of OS, FP, and EP as well as their relations, to ensure that empirical results will truly present the effect of OS.

(1) Corporate size (SIZE). SIZE can originally determine whether the firm has sufficient capabilities to organize operation activities. Usually, larger-size firms can more easily get access to resources helpful to environmental management and have a greater economic growth potential. (2) Number of staff (STAFF). STAFF presents the size of labor-input in firms, and larger-size staff will promote firms to organize more commercial and social activities, thereby creating favorable conditions for the improvement of FP and EP. (3) The size of R&D investment (R&D). Prior studies presented the positive impact of R&D activity on FP and EP, and focusing on new technology is a critical approach to improve the outcome of environmental management. (4) Corporate listed age (AGE). Prior studies presented that OS and management mode of listed firms will be changeable under joint effects of internal and external available resources as well as shareholders' demand, e.g. the sharp volatility of share-distribution due to the entry of new shareholders. Accordingly, this paper argues that the decision-making orientation of some firms will also change with the increase of listed age. This paper defines the age when firm being listed as 1, the next year as 2, and on the analogy of this. (5) Corporate pollution level (POLLUTION). Social responsibility that needs to be fulfilled is often different between heavy-polluting and non-heavy-polluting firms. Some environmental activities more rely on heavy-polluting firms to organize, e.g. reducing GHG emissions, which will lead to different environmental investments and expected EP in these two types of firms. According to the Environmental Information Disclosure Guidelines of Chinese Listed Company, this paper defines the heavy-polluting firm as 1 and non-heavy-polluting as 0. (6) Corporate location (LOCATION). Overall, GDP, geographical condition, and marketization of provinces located in Eastern China are more superior than that of other provinces, which requires Eastern firms to more proactively fulfill their environmental responsibilities. This paper defines the Eastern firm as 1 and others as 0. (7) Whether organizing environmental activities following the GRI3.1 version or ESG (GRI/ESG). As GRI3.1 version introduces how to collect data related to environmental activity, and we find that CSR reports compiled following GRI3.1 version or ESG usually present a clear logic structure. At least, it can imply large shareholders' willingness for better EP. This paper defines 1 if a firm followed GRI3.1 version or ESG and 0 otherwise. (8) Whether employing international accounting agency to audit annual performance (IA). Cooperating with international accounting agencies does

not mean a high-quality annual report or better FP, but the global reputation of such agency can help to decrease the false information on corporate performance in annual report. This paper defines 1 if a firm employed an international accounting agency, including the Deloitte & Touche, Pricewaterhouse Coopers, Ernst & Young, and KMPG, and 0 otherwise. (9) Diluted earnings per share (DEPS). DEPS is the actual unit income that shareholders can obtain from corporate net profit, also a kind of optimization mode for primary earnings per share. The volatility of DEPS will affect shareholders' investment willingness in the next phase, thereby leading a new share-distribution or profit growth mode. (10) Corporate growth (GROWTH). Similar to DEPS and NPR, GROWTH can affect shareholders' investment willingness and help to predict corporate outlook as well. Additionally, higher GROWTH also presents corporate development potential to broader stakeholders, e.g. consumers and suppliers, rather than only internal shareholders, which also implies a broader profit growth space. (11) The ratio of asset utilization (AUR). Although there is no optimal AUR, large shareholders usually avoid the excessively low AUR because it indicates resources waste. Higher AUR can help to expand the future environmental investment, thereby working on better EP.

Table 1 presents an overview of all variables, and standard deviation (S.D.) presents a relatively large difference among firms. In theory, the total score of EP is 924, but Table 1 presents that the highest score is 675 with the average of all samples only 239.64, which indicates that EP of our sample is low. The data distribution of STAFF, R&D, AGE, GROWTH, and AUR presents an obvious difference on corporate profile and outlook, but the average of GRI/ESG and IA presents that only few firms have organized the environmental management and annual performance auditing following international criteria. Further, the differences of OS and NPR are also obvious among firms. What needs to be noted is that we will not examine the interaction between ID and NPR because although independent director is closely related to the function of OS, the lower proportion of their actual shareholding (usually less than 1%) makes their opinions on environmental management less likely to be affected by commercial indicators. Accordingly, we only examine the unique impact of ID on EP.

3.3. Data processing and measuring model

Through a preliminary test for variables, this paper finds that the S.D. of some variables is large. Due to different measuring units among variables, we develop following processing for the 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), we express them as their 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), we standardize them to decrease 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, we 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 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 then examine whether higher proportion of state-owned shares strengthens the impact of OS on EP and the moderating effect of FP, thereby confirming the potential driving force of state-owned shares in environmental management.

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 caused by the time and individual difference, this paper compares the applicability of Fixed Effect test and Random Effect test. Through the Hausman test, we find that Random Effect test is more applicable to both tests for full data and grouped data based on the size of state-owned shares (heterogeneity analysis). Specifically, the result of Hausman test supports the better applicability of Random Effect test, i.e. all values of Prob > chi^2 greater than 0.05 (in Table 3, Table 4, and Table 5). Additionally, all Random Effect tests have passed the significance level ("Prob > chi^2" = 0.0000), but all Fixed Effect tests have failed to pass the corresponding significance of each measuring model ("Prob > F">0.05). Table 3, Table 4, and Table 5 present all necessary test results for each model to visually support which test method

Table 1
The overview of all variables (the raw data, n = 1605).

Variables	Definition	Min.	Max.	Mean	S.D.
EP	*The product of levels of environmental activity and EMC*	30.00	675.00	239.64	100.56
SIZE	*The logarithmic of annual total assets*	19.20	28.57	23.22	1.40
STAFF	*Total number of staff, including all parent and subsidiary firms*	28.00	294761.00	13679.26	30243.89
R&D	*The proportion of R&D expenditure accounting for operating revenue (%)*	0.00	20.25	1.99	2.42
AGE	*The time length of firm listing in the Shanghai Stock Exchange (year)*	1.00	27.00	13.28	5.47
POLLUTION	*Non-heavy-polluting firm=0; Heavy-polluting firm=1*	0.00	1.00	0.48	0.50
LOCATION	*Non-eastern province=0; Eastern province=1*	0.00	1.00	0.63	0.48
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	*State ownership property (non-state-owned=0, state-owned=1)*	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 owed 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

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																
LOCATION	0.028	0.082***	0.028	0.127***	0.008	−0.148***															
GRI/ESG	0.399***	0.352***	0.285***	−0.047*	−0.176***	−0.057**	0.114***														
IA	0.197***	0.381***	0.308***	−0.103***	−0.126***	0.010	0.169***	0.200***													
DEPS	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***											
AUR	−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									
H5	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***								
FS	−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***							
TOP10	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***						
ID	−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				
SOP × 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***			
H5 × 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***		
FS × 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***	
TOP10 × 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).

should be developed to analyze the practical implication of our data. The result of Hausman test further supports that our findings can be extended to a broader range, i.e. helping to present the overall situation of Chinese manufacturing firms based on the 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, α is the constant term, and ε_{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 firms 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 usually achieve better EP, but the correlation between the element related to corporate outlook, i.e. GROWTH and AUR, and EP is weak. Further, firms with state-owned property, higher H5, smaller FS, or higher TOP10 are usually with better EP, and there is no significant positive correlation between the interaction of OS and NPR and EP as well as NPR and EP. Following, we will examine 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 joint effects of corporate profile, corporate outlook, and NPR through the Random Effect test. The value of R^2 indicates that with the rise of variables involved 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.

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 R^2 in LM test is the result when the square of error term is arranged as the dependent variable (Explanatory variables remain unchanged), and $(p-1)$ is the degree of freedom of regression equation. Table 3, Table 4, and Table 5 will also present the result of LM test for each measuring model that can support 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 will also estimate the cluster robust standard errors of variables for 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 of this paper. Additionally, this paper uses the D.W. statistics to present the serial correlation of variables within each model with the finding that all D.W. values are around 2, which supports that residuals of variables obey a normal distribution. Overall, the further test based on the Random Effect test supports that the quality of collected data reaches a relatively high level.

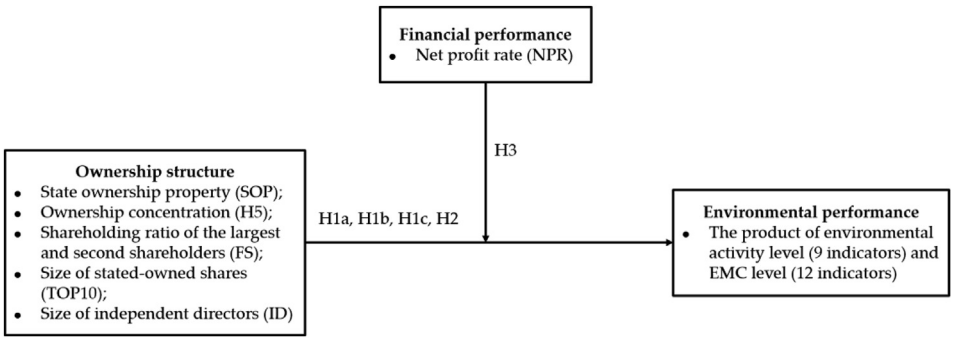

Fig. 1. The full conceptual model.

Table 3
Empirical results for the 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)
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 dummy	Include	Include	Include	Include
Firm dummy	Include	Include	Include	Include
Wald Chi²	392.30***	412.18***	412.24***	417.25***
Hausman test	Prob > chi² = 0.2971 (accept Random Effect test)	Prob > chi² = 0.2515 (accept Random Effect test)	Prob > chi² = 0.2491 (accept Random Effect test)	Prob > chi² = 0.2470 (accept Random Effect test)
Random Effect test	Prob > chi² = 0.0000 (accept)	Prob > chi² = 0.0000 (accept)	Prob > chi² = 0.0000 (accept)	Prob > chi² = 0.0000 (accept)
Fixed Effect test	Prob > F = 0.2973 (not accept)	Prob > F = 0.2515 (not accept)	Prob > F = 0.2492 (not accept)	Prob > F = 0.2470 (not accept)
LM test	$nR^2 = 7.87 < \chi^2_{0.05}(p\text{-}1) = 18.31$	$nR^2 = 13.71 < \chi^2_{0.05}(p\text{-}1) = 25.00$	$nR^2 = 14.22 < \chi^2_{0.05}(p\text{-}1) = 26.30$	$nR^2 = 19.73 < \chi^2_{0.05}(p\text{-}1) = 31.41$
D.W. statistics	2.045	2.043	2.042	2.046
Log likelihood	−788.4916	−779.9749	−779.8462	−777.4156
R^2	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. The note for Tables 4 and 5 is same as Table 3.

In Table 3, STAFF, R&D, POLLUTION, GRI/ESG, and IA can all significantly improve EP no matter whether considering NPR or not (marginal effects are within 6.36%–6.51%, 3.63%–4.17%, 11.36%–11.80%, 33.80%–34.18%, and 6.15%–8.57%, respectively). These results can jointly describe two facts that Chinese heavy-polluting firms more focus on environmental issues, and the size of internal available resources as well as internationalized management mode can also help to improve EP. If not considering the effect of NPR (Model 2 and Model 3), both SOP (8.20%–8.76%) and H5 (4.37%–4.44%) significantly improve EP, which supports the leading effect of political intervention and large shareholders' collective efforts in the environmental management, but FS and TOP10 do not significantly improve EP. Coefficients of Model 2 and Model 3 in Table 3 verify Hypothesis 1a to Hypothesis 1c, also presenting the primacy of corporate ownership property (state-owned or not) in environmental issues. Accordingly, we infer that even if the proportion of state-owned shares is lower in some state-owned firms, they will also actively engage in environmental management because the state-owned power also leads to a widespread public concern on such firm. Additionally, ID significantly negatively affects EP. Prior studies argued that independent directors have a duty to independently and objectively evaluate corporate daily operations and restrain behaviors that will threaten shareholders' interests (Cotter et al., 1997; Kim, 1998; Tobe, 2000). According to the provision of China Securities Regulatory Commission, the proportion of independent directors in listed firms should be more than or equal to 1/3 of total board members. However, there are 232 samples (firm-year observation) whose ID is less than 1/3,

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 dummy	Include	Include	Include	Include
Firm dummy	Include	Include	Include	Include
Wald Chi²	235.28***	253.63***	254.59***	261.62***
Hausman test	Prob > chi² = 0.8832 (accept Random Effect test)	Prob > chi² = 0.9202 (accept Random Effect test)	Prob > chi² = 0.9193 (accept Random Effect test)	Prob > chi² = 0.9250 (accept Random Effect test)
Random Effect test	Prob > chi² = 0.0000 (accept)	Prob > chi² = 0.0000 (accept)	Prob > chi² = 0.0000 (accept)	Prob > chi² = 0.0000 (accept)
Fixed Effect test	Prob > F = 0.8840 (not accept)	Prob > F = 0.9208 (not accept)	Prob > F = 0.9199 (not accept)	Prob > F = 0.9256 (not accept)
LM test	$nR^2 = 10.03 < \chi^2_{0.05}(p\text{-}1) = 18.31$	$nR^2 = 16.91 < \chi^2_{0.05}(p\text{-}1) = 25.00$	$nR^2 = 17.78 < \chi^2_{0.05}(p\text{-}1) = 26.30$	$nR^2 = 25.50 < \chi^2_{0.05}(p\text{-}1) = 31.41$
D.W. statistics	2.094	2.083	2.081	2.074
Log likelihood	−349.5494	−345.3520	−343.8573	−340.2584
R^2	0.1975	0.2105	0.2114	0.2166

accounting for 14.15% of total sample, which indicates that the board structure of few firms is not in line with policy requirements, also presenting that the size of independent directors of Chinese manufacturing firms well supervised environmental management as a whole. Overall, some OS indicators have presented a certain positive impact on EP, and according to Baysinger et al. (1991), Barnhart and Rosenstein (1998), and Demsetz and Villalonga (2001) that found a close relation among OS, available resources in firms, and operation modes, we infer that the potential impact of OS on EP is usually visually reflected in the effect of internal available resources and operation process.

When considering the effect of NPR (Model 4), it only significantly negatively moderates the effect of FS (−2.03%), which indicates that the smaller difference between the largest and second shareholders' shareholding ratio will strengthen the moderating effect of FP, also supporting the positive effect of balanced share-distribution in environmental management. Overall, the weak moderating effect of NPR also corresponds to the result of correlation analysis that NPR usually hardly correlates with EP, thereby verifying Hypothesis 3. Through analyzing CSR reports this paper organizes, we find that to the same firm, its EP presents a certain similarity in different years, but its annual NPR usually markedly changes. Accordingly, we infer that EP of Chinese manufacturing firms will remain stable in the coming period (The average score of EP from 2010 to 2016 are 234.03, 240.77, 238.60, 239.43, 238.39, 239.97, and 243.11, respectively) no matter what level of FP. Additionally, the regression coefficients in Table 3 are generally small (Maximum value is 0.3418), which indicates that corporate profile and other internal elements did not markedly improve EP. At present, both administrative order and public opinion are largely leading to large shareholders' environmental management orientation, and these pressure can further help to explain why some shareholders still lack the active environmental awareness (Zhang et al., 2012). That is, they are more subject to commands rather than incentives from external stakeholders.

Further, this paper develops the robustness test to examine whether the volatility of collected data is smooth through considering the time effect of variables. Specifically, we multiply independent variables, the moderating variable, and the dependent variable with time (year), and then compare the regression result with that in Table 3. We find that almost all regression coefficients obtained from the robustness test are highly similar to results in Table 3, including the value of coefficients as well as their significance. Following, this paper will develop the heterogeneity analysis based on the consideration of the level of state-owned shares.

4.3. Empirical results of heterogeneity test

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 results in Tables 4 and 5.

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

Table 4 presents that H5 significantly improves EP in the case of higher proportion of state-owned shares (marginal effects within 8.90%–9.08%), and only the impact of TOP10 is significantly positively moderated by NPR. However, when TOP10 is lower than the average, NPR cannot promote any variable related to OS to improve EP. This comparison supports that the power of state-owned shares does not present a significant difference among firms. However, compared with full sample, the collective efforts of large

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 dummy	Include	Include	Include	Include
Firm dummy	Include	Include	Include	Include
Wald Chi²	159.44***	169.56***	169.72***	169.96***
Hausman test	Prob > chi² = 0.2587 (accept Random Effect test)	Prob > chi² = 0.3405 (accept Random Effect test)	Prob > chi² = 0.3342 (accept Random Effect test)	Prob > chi² = 0.3635 (accept Random Effect test)
Random Effect test	Prob > chi² = 0.0000 (accept)	Prob > chi² = 0.0000 (accept)	Prob > chi² = 0.0000 (accept)	Prob > chi² = 0.0000 (accept)
Fixed Effect test	Prob > F = 0.2588 (not accept)	Prob > F = 0.3412 (not accept)	Prob > F = 0.3348 (not accept)	Prob > F = 0.3643 (not accept)
LM test	$nR^2 = 15.52 < \chi^2_{0.05}(p\text{-}1) = 18.31$	$nR^2 = 20.52 < \chi^2_{0.05}(p\text{-}1) = 25.00$	$nR^2 = 21.15 < \chi^2_{0.05}(p\text{-}1) = 26.30$	$nR^2 = 29.43 < \chi^2_{0.05}(p\text{-}1) = 31.41$
D.W. statistics	2.055	2.071	2.070	2.076
Log likelihood	−174.2256	−173.1351	−173.1303	−168.1253
R^2	0.2033	0.2148	0.2152	0.2165

shareholders (H5) of firms with a higher proportion of state-owned shares is stronger, which can present the leading effect of large shareholders under the control of state-owned shares. Further, lower proportion of state-owned shares indicates more private or foreign shares, and in this case, higher NPR may not directly promote the improvement of EP because these firms that are dominated by the private share tend to give priority to commercial interests. This finding can verify Hypothesis 2, but compared with corporate profile and available resources, the interaction between OS and FP has a less impact on EP when the size of state-owned shares is higher. From another perspective, such relation also implies a positive phenomenon that the positive effect of state-owned shares in environmental management may remain stable in the coming period, and once FP significantly interacts with state-owned shares, it may indicate that the leading effect of state-owned power will be weakened by dynamic financial indicators. On the other hand, firms with higher proportion of state-owned shares mostly belong to the state-owned, and in this case, the impact of SOP may be weakened, but when the proportion of state-owned shares is lower, the existence of SOP itself will provide a stronger guarantee for improving EP (marginal effects within 10.01%–10.86%). Overall, there are some differences of empirical results between full sample and grouping tests, but they jointly describe a trend that is state-owned power and large shareholders always dominate the process of environmental management in Chinese manufacturing firms. In the long-term, it suggests more focusing on large shareholders' environmental awareness because compared with the state-owned power, environmental activities organized by some non-stated-owned shareholders may be unstable, which will weaken the government role in environmental management.

5. Research implications

5.1. Implications within theoretical perspectives

Empirical results present that FP has not well moderated the relation between OS and EP, but 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 usually 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 in Chinese manufacturing firms, OS always originally affects environmental management orientation. We agree with the conceptual model of Meng et al. (2013) that OS can moderate the relation between FP and EP because some large shareholders organize environmental activities 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 subsequent environmental activities. This paper argues that protecting the natural environment is a responsibility that manufacturing firms must fulfill no matter what level of FP. From this perspective, our findings release a positive signal that the establishment of environmental management orientation is not dominated by FP, which implies that such management mode 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, Table 4, and Table 5 presents what extent all explanatory variables 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 realistic contexts (Pindyck and Rubinfeld, 2011). Although this paper designs control variables as comprehensively as possible to enhance the validity of conceptual model, the value of R^2 is still low (Maximum value is only 0.2166). Further considering the measurement unit and regression coefficients related to OS, it supports that the impact of OS on EP in still limited in China's context. Some supportive studies, e.g. Li and Zhang (2010), Li et al. (2013), and Meng et al. (2013), also presented a lower R^2 on the relation among OS, FP, and EP (or CSR performance) in China, but the potential reason still needs to be analyzed. Integrating prior studies, this paper finds that the process of environmental management in manufacturing firms is always affected by multiple elements, e.g. share-distribution, available resources, production structure, large shareholders' environmental awareness, political intervention, financing channel, and other uncertain external contexts (Kagan et al., 2003; Melnyk et al., 2003; Montabon et al., 2007; Hatakeda et al., 2012; Meng et al., 2013). To Chinese manufacturing firms, political intervention, e.g. the mandatory environmental regulation and penalty, can usually directly affect their environmental management orientation, which will weaken the original effect of OS to some extent. In reality, no matter what proportion of state-owned shares is, the effect of such share will be always reflected in the process of corporate daily operations, but political intervention is a kind of behavior constraint from the level of government, which supports the strong impact of political intervention on environmental management orientation as well. Based on above analysis, the R^2 will be relatively low when the investigated elements are less related to political intervention in the field of environmental management in China's context.

5.2. Implications within international perspectives

An important finding of this paper is the driving effect of state-owned power in the environmental management of manufacturing firms. Accordingly, we will further discuss the difference of state-owned shares' effect in environmental management between Chinese and Western firms. Prior studies indicated that the effect of both corporate OS and top managers' code of conduct in CSR are different in China and the West (Smith et al., 1996; Liu, 2005). Specifically, many Chinese manufacturing firms are state-owned or with a higher proportion of state-owned shares, but the share-distribution in the West is relatively dispersed. It will make the power from large shareholders on Chinese manufacturing firms be stronger than that from the market but the West is opposite. Further, large shareholders of Chinese state-owned firms are more obedient to established procedures or rules, superiors' instructions, and policy guidance when addressing important issues, but such shareholder in the joint-venture firms more trusts their own professional knowledge or experience, which is similar to the West.

The above analysis on Chinese and Western firms can provide following implications. First, given the severe environmental crisis in China currently, the proper political intervention will help to coordinate the relation between environmental and commercial issues that is difficult to be addressed by the market power. This case implies that different from the West, the contribution of environmental management in Chinese manufacturing firms will be always under the joint regulations of state-owned power, political intervention, and large shareholders. Although the political intervention may weaken large shareholders' environmental proactivity (González-Benito and González-Benito, 2006), it will ensure environmental cost of manufacturing firms to be within the control at least. For China that is in the period of economic transition, such action has a certain positive significance.

Second, the West has generally experienced a severe environmental pollution in the early of Industrial Revolution, but Chinese manufacturing sectors are still addressing the transition of green operations. Such case and features of Western political system jointly trigger a limited impact of state-owned shares on environmental management in the West. Although our findings indicate a relatively stable impact of OS on EP, this paper argues that such positive significance can only indicate that in the context of China's economic transition, proper political intervention will help to reverse the less climate-friendly operations in firms. However, such mandatory intervention will also hinder the potential of corporate commercial growth, especially for state-owned firms. In contrast, both environmental proactivity of Western firms and public supervision are at a mature stage, and the effect of political intervention is more to provide incentives. Overall, given the difference of corporate development history, operation mode, social role, and large shareholders' code of conduct between China and the West, a stronger state-owned power in environmental management has the uniqueness in China. No matter due to the improvement of CSR awareness or to meet policy requirements, state-owned power in environmental issues has presented a decisive role. Accordingly, how to improve non-state-owned shareholders' environmental proactivity is an urgent issue to be addressed.

5.3. Implications within managerial perspectives

This paper also provides following managerial implications on how to improve large shareholders' environmental awareness. First, the average EP of manufacturing firms that are located in Non-eastern provinces (234.18) is markedly lower than that in the Eastern (242.78), but the average level of TOP10 in these two regions is similar (37.69 vs 38.30). According to media coverage, the negative environmental information from manufacturing firms located in Non-eastern regions is more than that in the Eastern, which indicates that the level of regional economy also affects the orientation of corporate environmental management (Eastern region is more developed than the Non-eastern). Additionally, the average NPR of manufacturers located in the Non-eastern (9.01) is higher than that in the Eastern (8.04), which implies that former firms more focuses on commercial interests, thereby weakening their CSR to some extent. To improve it, Chinese government should strictly supervise the process of environmental management in manufacturing firms located in Non-eastern regions and then motivate large shareholders to engage in pollutants control. Meanwhile, this paper infers that an important reason for lower EP of firms located in the Non-eastern is that due to the inferiority of geographical location, the environmental investment will markedly enhance corporate daily operation cost. Accordingly, the central and local government should jointly support their green operations, e.g. organizing the Industry-University-Research platform, special environmental fund, and new cleaner programs (Zhu et al., 2007; Yang and Feng, 2008). Further, the government should promptly optimize the size of fiscal support based on the volatility of corporate EP and FP, thereby establishing a dynamic and sustainable incentive mechanism. Second, we should realize that political intervention may be not an optimal approach to deal with environmental crisis in China because it cannot well address how to

motivate large shareholders' environmental awareness. Although corporate internal available resources and external contexts can also affect the outcome of environmental management, large shareholders' awareness is always a fundamental and irreplaceable driving force for improving EP, which indicates that large shareholders should agree that environmental management is the responsibility they must fulfill rather than only be subject to administrative orders (Fryxell and Lo, 2003; Zeng et al., 2011). Third, from the perspective of corporate internal supervision, Table 1 presents that the average size of ID (38.40) is only a little higher than the criterion set by the China Securities Regulatory Commission, which may restrict the monitoring duty of independent directors. On one hand, manufacturing firms, especially the listed firms, should strictly abide by the regulation to arrange their independent directors. On the other hand, independent directors should be endowed with more rights to supervise CSR issues, i.e. improving the state of environmental management through both internal and external supervisions.

In summary, it is essential for Chinese government and large shareholders to be jointly committed to improve corporate environmental management system, and strengthen the environmental awareness of large shareholders as well as the monitoring duty of independent directors.

6. Conclusion

Through surveying Chinese manufacturing firms, this paper analyzes the impact of OS on EP under the moderating effect of FP (NPR) and further examines whether FP can a play better moderating effect when there is a higher proportion of state-owned shares in firms through the Random Effect test. The descriptive statistics present the relatively lower EP in Chinese manufacturing firms. Empirical results indicate that both SOP and H5 significantly improve EP, but the impact of FS and TOP10 are both not significantly positive, and the size of independent directors has not promoted the improvement of EP at present. Additionally, H5 significantly improves EP in the context of higher proportion of state-owned shares, and SOP significantly improves EP when such share is lower. Further, NPR slightly moderates the impact of OS on EP. It significantly negatively moderates the impact of FS on EP for the full sample but only positively moderates the impact of higher TOP10 on EP. Overall, findings of this paper present a relatively positive effect of OS in corporate environmental management, but both the monitoring duty of independent directors and the moderating effect of FP are still weak. This case indicates that even if the EP of Chinese manufacturing firms will not be significantly improved in the short-term, at least it may remain a stable rising trend.

This paper is not without limitations. First, although establishing the unified evaluation criterion can help to fairly present the difference of EP among firms, the weight this paper sets inevitably reflects our subjectivity. Specifically, although GRI3.1 version introduces that core indicators are valuable for most institutions, we still cannot conclude that the importance of their weights is same to each firm due to the difference of corporate basic features. In reality, large shareholders usually formulate future investment plans for environmental management based on multiple considerations, which implies that the size of such investment will always change. Therefore, a unified evaluation criterion may be difficult to present the volatility of large shareholders' environmental awareness. Second, according to GRI3.1 version, some additional indicators are not fully applicable to non-heavy-polluting firms. In this case, we infer that the EP of non-heavy-polluting firms within our sample is markedly lower than that of the heavy-polluting, and such inference is also supported by our calculated data (229.70 vs 250.48). Therefore, using a same evaluation criterion may slightly underestimate the real value of EP in non-heavy-polluting firms. Third, almost all CSR reports promise to faithfully and completely publish each kind of social responsibility performance, but they cannot record all related information in reality. Therefore, the EP we measure may be lower than its true level, and the impact of OS on EP this paper examines may be slightly different from the true state.

To work on these limitations, the following research should be further investigated. First, compared with the data collected from CSR reports, data from field survey may provide more specific and targeted information on corporate environmental management, which can help to design evaluation criterion that is more in line with the general feature of Chinese manufacturing sectors. Although such survey requires much time and money input, the potential conclusion will be more helpful to improve the actual value of environmental management in firms. Second, in the context of facing the severe environmental crisis and huge international pressure, improving the natural environment in China will make a great contribution to mitigate global climate change. However, it still lacks the high-quality research on the environmental management mode of Chinese manufacturers, especially the analysis on shareholders' environmental responsibility. Accordingly, more perspectives need to be developed, e.g. analyzing the effect of political intervention on corporate environmental issues. Third, as above discussion on managerial implications in Subsection 5.3, large shareholders' environmental awareness is likely to more positively affect the level of EP in the long-term, which enlightens us to organize future research on corporate environmental management from the perspective of shareholders' psychology, which will lead to a dialogue that helps environmental management to reach out a new related knowledge areas, i.e. environmental psychology. Prior studies on corporate environmental proactivity will provide some mature ideas for this expansion, and such work will reveal why EP presents the diversity among manufacturers from the perspective of large shareholders' motivation.

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