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THE MODERATING EFFECT OF ENVIRONMENTAL PROTECTION SUBSIDIES ON THE RELATIONSHIP BETWEEN ENVIRONMENTAL REGULATION AND CHINESE LISTED ENTERPRISE PERFORMANCE

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Abstract

China has accelerated its transition toward green development through the implementation of stringent environmental regulations, placing increasing pressure on enterprises to comply. These enterprises often face the challenge in balancing short-term profitability with long-term sustainability objectives. Notably, state-owned enterprises and non-state-owned enterprises exhibit differential responses to such regulations due to variations in ownership structures. This study examines the impact of environmental regulations on enterprises performance among Chinese-listed manufacturing enterprises and explores the moderating role of environmental protection subsidies. Utilising panel data from 143 listed manufacturing firms in China between 2010 and 2023, the study employs Tobin's Q as the proxy for dependent variable to assess enterprise performance, with environmental regulation as the independent variable and environmental protection subsidies as the moderating variable. The empirical findings indicate that environmental regulation significantly and positively influences enterprise performance, with stricter regulations associated with higher market valuations. Moreover, environmental protection subsidies showed a significant positive moderating effect, mitigating the financial burden of regulatory compliance. This moderating effect is more pronounced among state-owned enterprises, likely due to their stronger alignment with governmental priorities and enhanced access to policy resources. The study contributes theoretically by examining how institutional pressures and incentive mechanisms jointly influence enterprise performance in emerging economies. Practically, the findings offer valuable insights for policymakers aiming to design effective environmental policies and for business leaders and investors seeking to integrate environmental responsibility with financial performance.

Keywords: Environmental regulation, Enterprise performance, Environmental protection subsidies, China

INTRODUCTION

The world is confronting increasingly severe environmental challenges that threaten ecological stability and human health (World Health Organization, 2023). Environmental degradation exacerbates climate change through the rapid increase in greenhouse gas (GHG) emission. This contributes to extreme events such as heatwaves, wildfires, floods, tropical storms, and hurricanes. These events are increasing in scale, frequency, and intensity and increase substantial economic and social losses (Sarabdeen et al., 2024).

The ongoing global economic transformation and industrial expansion continue to intensify environmental pressures. Manufacturing and industrial activities generate large amounts of emissions through the burning of fossil fuels to produce goods such as cement, iron, steel, electronics, plastics, and textiles. In addition, mining, construction, and other industrial processes release substantial greenhouse gases, further contributing to climate change (United Nations, n.d.)

This issue is particularly pronounced in China, which has undergone rapid economic transformation and large-scale industrialisation over the past decade. While this growth has positioned China as the world's second-largest economy, it has also resulted in severe environmental degradation (Senz, 2025). For instance, persistent haze pollution highlights the severity of China's environmental issues, which negatively impacts the climate, environmental, and public health (Hao et al., 2021). As the world's largest manufacturing economy and the largest contributor to global greenhouse gas emissions (World Bank Group, 2022), China faces substantial environmental pressures arising from industrial emissions, energy-intensive production, and vehicle exhaust.

In response to these challenges, China has implemented a range of environmental regulatory policies to promote green and low-carbon transformation and reduce industrial pollution. The key legislation including the Environmental Protection Law of the People's Republic of China; Air Pollution Prevention and Control Law of the People's Republic of China; Water Pollution Prevention and Control Law of the People's Republic of China, have accelerated its transition toward a green development strategy through stricter environmental regulations, enhanced monitoring, and stringent enforcement and penalties for polluting enterprises (Cao et al., 2024; Zhao et al., 2016).

From the perspective of enterprises, environmental regulation presents a dual effect, both costs and opportunities. On one hand, it increases production and compliance costs, which adversely affect enterprises' performance (Zhang et al., 2023). Enterprises may face penalties, such as production halts and reputational damage for non-compliance. For example, Yingde Wanyang Energy Saving and Environmental Protection Technology Co., Ltd. was fined RMB170,000 for exceeding the wastewater emission (ammonia nitrogen) standards (Yingde Municipal People's Government, 2025). Wang et al. (2021) showed that in industries with high elasticity of market demand, such as cement, firms often struggle to pass compliance costs onto consumer, further weaken firms' performance in China.

From the lens of institutional theory, firms respond to the environmental regulation to seek legitimacy among stakeholders, including government, customers, and public. Firms incentivised to comply with environmental regulation to avoid penalties and reputational losses. However, compliance with environmental regulations requires substantial investment in green technologies, pollutant control infrastructure and monitoring systems (Du & Li., 2020), which impose financial burdens on enterprises by increasing production and capital costs (Zhang et al., 2023). Chang et al. (2021) explained that the nature of public good and the externality of environmental protection rise to the potential imbalance between pollution cost of enterprises and governance benefits.

Despite these challenges, a growing body of literature highlights the long-term strategic benefits of environmental regulation. The Porter Hypotheses posits that well-designed environmental regulations can stimulate innovations, improve resources efficiency, and enhance firms' competitiveness. Empirical evidence demonstrated in the studies such as Deng & Li (2020) and Hong et al. (2024) support this view. They show that stricter environmental regulations have a long-lasting and gradual positive impact on firm productivity and value, especially high-polluting businesses. Wang and Sun (2022) also show that enterprises adopting green innovation in response to environmental regulation, the effect is further strengthened among firms with strong ESG performance Similarly, Ortas et al. (2015) find that enterprises with higher ESG scores have greater access to external financing, which allow them to improve their production technologies and service quality, thereby enhancing their competitiveness.

Government recognising the high investment and operational cost associated with sustainability practices, a series of targeted environmental measures, including environmental protection subsidies such as funding for emissions reduction equipment, pollution abatement projects, green credits and tax incentives, to ease the burden of enterprises and to promote sustainable development. For example, substantial environmental protection subsidies are provided for new energy vehicles and solar energy industries (Jiang & Xu, 2023). These subsidies not only encourage enterprises to invest in green technologies but also help reduce the costs of

green products, thereby promoting their widespread adoption (Shao & Chen, 2022). Additionally, the construction of green industrial parks has been vigorously promoted. These parks centralize resources, facilitate the sharing of green technologies and experiences, and improve the overall efficiency of green industries (Zeng et al., 2021). These initiatives have contributed to a reduction in domestic carbon emissions and supported China's commitment to lowering carbon emissions per unit of GDP by 60% -65% by 2030 and has also witnessed a slowdown in the growth rate of total carbon emissions (Lai et al., 2022).

Environmental protection subsidies also play a key role in stimulating green innovation by providing financial support and encouraging firms to invest in sustainable technologies. Studies have shown that subsidies promote green innovation and indirectly improve firm performance through innovation effects (Zhang et al., 2023). Furthermore, the environmental regulations such as carbon trading system and pollution taxes, encourage enterprises to internalize environmental costs and innovate in energy-saving and emission reduction (Deng & Li, 2020).

However, the overall impacts of environmental regulations on enterprises performance in China remained inconclusive. While institutional pressure increases compliance costs and may reduce profitability, the Porter Hypothesis suggests that environmental regulation pressure can enhance competitiveness through innovation and efficiency gains (Baloch et al., 2021). This mixed evidence highlights the need to examine into how environmental regulation affects enterprises performance in China, particularly the moderating effect of environmental protection subsidies.

Moreover, the effects of environmental regulation and subsidies may vary across ownership structures. State-owned enterprises (SOEs) typically have better access to government subsidies due to stronger political connections and institutional support (Han et al., 2024; Li et al., 2019). In contrast, non-state-owned enterprises (NSOEs) often face greater barriers in accessing such support, despite being eligible for environmental protection subsidies (Bai et al., 2019; Deng & Li, 2020). As a result, SOEs are better positioned to benefit from government environmental policies (Hong et al., 2024; Tang et al., 2020).

Existing literature presents inconclusive findings on the relationship between environmental regulation, environmental protection subsidies, and enterprises performances. Studies such as Du and Li (2020), Chang et al. (2021), and Zhang et al. (2023) found a negative impacts of environmental regulation on enterprise performances as environmental regulation may raise production costs. Contradictorily, studies such as Deng and Li (2020), Hong et al. (2024), and Wang and Sun (2022) found that environmental regulation can stimulate innovation and efficiency, which ultimately enhance enterprise performances. Additionally, limited studies have examined the moderating effect of environmental protection subsidies, particularly in differentiating between SOEs and NSOEs.

Therefore, this study aims to examine the impact of environmental regulations on the performance of Chinese-listed manufacturing enterprises, explore the moderating role of environmental protection subsidies in this relationship, and further analyze how these impacts difference between SOEs and NSOEs. The findings of this study provide deeper insights for policymakers in formulating effective environmental regulations and to encourage enterprises to sustain their commitment to environmental governance.

This paper is organised as follows. Next section presents the theoretical and empirical review and hypotheses development. Section 3 presents research design and methodology, followed by findings and discussions in Section 4. Section 5 concludes the paper with implications and limitations of the study.

LITERATURE REVIEW AND HYPOTHESIS FORMULATION

Theoretical Review

This study adopts two theories, namely institutional theory and the Porter Hypotheses, to explain the relationship between environmental regulation, environmental protection subsidies, and enterprises performance.

According to institutional theory, the institutional environment is primarily divided into formal institutions (such as laws and regulations, policy standards) and informal institutions (such as social norms, public expectations), which jointly influence corporate behavior (DiMaggio & Powell, 1983). Enterprises adapt to the institutional environment through legitimacy and resource dependency mechanisms. In China, the institutional pressures faced by enterprises are concentrated in two aspects: legitimacy adaptation strategies, and resource dependency with institutional arbitrage. In terms of legitimacy adaptation strategies, enterprises make compliance investments, such as forcing investments in pollution control equipment (such as desulfurization and denitrification devices in the steel industry) or participating in green industrial parks to obtain policy legitimacy. Although such behaviors increase short-term costs, they avoid administrative penalties and enhance social reputation (Javeed et al., 2021). Yu et al. (2019) found that Chinese manufacturing enterprises reduce emission intensity and improve production efficiency through carbon capture technology.

The Porter Hypothesis, proposed by Porter and Linde (1995), posits that well-designed environmental regulations can enhance enterprise's competitiveness rather than hinder it. This hypothesis points out that while the government environmental regulations impose pressure on enterprises, they also serve as a catalyst for innovation, encouraging technological improvement, process optimisation, and the adoption of environmentally friendly practices (Ying et al., 2022). Porter and Linde (1995) argue that the benefits brought by technological innovations often outweigh the initial costs of compliance. Enterprises subject to environmental regulations can offset these costs through improved efficiency and resource utilisation, mitigate the negative impacts of externalities, and enhance performance (Porter & Linde, 1995). In addition, green technologies can improve production processes and optimize supply chain management, enabling enterprises to produce more products or provide more services with the same resource input, thus lowering the cost per unit of product. Leuz and Oberholzer-Gee (2006) explain that the environmental regulation stimulates efficiency of an enterprise, this offsets the cost of complying with the environmental restrictions. The strict environmental regulation policies enhance enterprise image and reputation and improve their competitiveness in the market. Studies such as Weche Gelübcke and Stoever (2016), based on the Porter Hypothesis, reveal that environmental regulations enhance innovation efficiency within German enterprises, which helps mitigate their negative impact on firms' short-term economic performance. Chen et al. (2022) found that environmental regulatory policies can strengthen the commitment of private enterprises to fulfill social responsibility, thereby promoting firm performance and further validating the Porter Hypothesis.

Empirical review of environmental regulation and enterprise performance

Past studies have showed the impacts of environmental regulation on enterprises performance. Chai et al. (2020) examined the impacts of environmental regulation on corporate performance among the Chinese A-share listed companies from 2012 to 2017. They found that the environmental regulations improved enterprise performance by obviating heavily polluting firms through cost-improving effects, improving regional air quality. Similarly, Chen et al. (2023) employed evolutionary game model theory and the DID model to analyse changes in pollution intensity before and after the implementation of environmental regulatory policies. They found that government intervention significantly reduced water and air pollution emissions. Enterprises achieved these emission reduction targets by increasing their use of clean energy and installing

pollution control equipment, which promotes sustainable development and enhances long-term performance.

On the other hand, Zou and Zhang (2022) investigate the impacts of environmental regulatory in driving green development among pollution-intensive industries in China during 2005-2017. They applied entropy method to integrate existing environmental regulatory system into three types of environmental regulations (command-and-control, market-based, and voluntary) and explored non-linear effects of them on green total factor productivity (GTFP). Zou and Zhang (2022) measured environmental regulation with the total investment per unit of GDP. They found that the effect of command-and-control environmental regulation on GTFP is a significant inverted U-shape curve, but it is too strict and increasingly less effective. However, the market incentive and voluntary environmental regulations appear as positive U-shape curves, and their proper enhancement is breakthrough for future green development. Additionally, Hu et al. (2021) explain that environmental information disclosure, as a tool for government intervention, guides enterprises to increase their investment in environmental protection, promotes green innovation, and enables sustainable development of enterprises, which is beneficial for the long-term development of enterprise performance.

The findings of López-Gamero et al. (2010), Hu et al. (2021), and Wu et al. (2023) are consistent with previous studies, where environmental regulations have a significant positive impact on enterprises financial performance. Enterprises that actively respond to environmental regulations can better achieve environmental investment, save energy, reduce pollution control costs, thereby conveying a good reputation to stakeholders, attracting social investment, and transforming environmental regulatory pressure into a driving force to improve enterprises performance.

However, some studies found contradictory findings. Greenstone et al. (2012) examine the impact of environmental regulations on the manufacturing industry in the United States. The results showed that excessive environmental regulations increases firm costs, impose additional production burden, and weaken their competitiveness, leading to a deterioration in enterprise performance. According to Deng and Li (2020), environmental regulations require companies to invest more funds in pollution control, which increases their costs. Environmental technology companies are unable to adapt to strict environmental regulations, resulting in low market competitiveness and adverse effects on their performance. But, Zhang et al. (2023) examine the relationship between environmental regulations and manufacturing enterprise performance revealed that, in the short term, environmental regulations lead to cost increases and negatively impact corporate performance. However, in the long term, environmental regulations can stimulate technological innovation and improve corporate performance.

In summary, the impact of environmental regulations on enterprise performance is inconclusive in the existing literature. Some studies demonstrated that environmental regulation could enhance enterprise performance through innovation and promoting industry transformation. In contrast, other studies showed the negative effects of environmental regulation on cost and performance due to increased compliance burdens. However, this study argues that environmental regulations encourage enterprises to improve efficiency, adopt greener technologies, and achieve sustainable competitive, thereby improving business performance. Therefore, this study proposes that:

H1: Environmental regulation has a significant positive impact on enterprise performance.

Empirical review on environmental protection subsidies, environmental regulation and enterprise performance

The relationship between environmental protection subsidies, environmental regulation and enterprise performance has been examined in the literature. Yi et al. (2020) examine the relationship between environmental regulations (measured by the level of investment in

environmental regulations in each province), environmental protection subsidies (obtained by enterprises from government research and development subsidies related to green innovation), and manufacturing green innovation efficiency (measured by number of domestic invention patents and sales revenue of a new product in enterprises). The results indicate that firms often encounter insufficient research and development (R&D) funding and increased technological risks when developing green innovation and environmental protection technologies in response to environmental regulation requirements. The government therefore eases the burden on firms by providing environmental protection subsidies, enabling them to successfully achieve their environmental goals.

Han (2021) demonstrates that the government is continuously strengthening the requirements of environmental regulations and increasing support for the development of pollution-intensive enterprises. They explore the relationship between environmental regulations (measured by the investment in industrial pollution control products produced by units in different regions) and environmental protection subsidies (information on environmental protection subsidies disclosed in the annual reports of listed companies). The findings showed that the strict environmental regulations are accompanied with higher levels of environmental protection subsidies, stimulating enterprises to increase investment in environmental protection. This practice ease short-term operational pressures and promoting long-term green transition. Xue et al. (2023) found the same findings for oil and gas companies. Studies such as Pei and Pei (2022), Du et al. (2023), Shao and Chen (2022), and Yuan and Zheng (2017) found the similar findings where environmental protection subsidies not only directly increase the capital holding of enterprises for environmental responsibility but also realize clean production through strengthening green technology innovation, thus reducing environmental pollution and improving enterprise environmental performance.

Although environmental protection subsidies can be promotional, some studies have highlighted that excessive or misallocated subsidies can lead to a mismatch of resources, inefficient innovation, and reduced firm performance. Jia et al. (2021) found that large-scale subsidies may lead to resource misallocation among high-tech firms, as some firms use funds for inputs that do not directly generate innovation, thereby reducing overall productivity and enterprise performance. Liu et al. (2025) added that while green subsidies stimulate investment in innovation, but it shows limited direct impact on innovation outputs. Wu and Qu (2021) explained that technology-intensive firms are capable in achieving high innovation performance even without subsidies. The subsidies may not always a pre-requisite for innovation.

In summary, the literature presents mixed evidence on the role of environmental protection subsidies in the relationship between environmental regulation and enterprises performance. Some studies, such as Jia et al., 2021, argue that excessive or poorly allocated subsidies may lead to resource misallocation and reduce enterprises productivity. However, other studies suggest that environmental protection subsidies can reduce firms' compliance pressure under environmental regulation (Yi et al., 2020; Han, 2021), thereby improving firm performance and sustainability. We posit that environmental protection subsidies alleviate the financial burden associated with compliance with environmental regulations and improve enterprises performance. Therefore, the following hypothesis is developed:

H2: Environmental protection subsidies significantly moderate the relationship between environmental regulation and enterprise performance.

Empirical review on the differences of SOEs and NSOEs in facing environmental regulations

The effect of environmental regulation on SOEs and NSOEs has been widely documented in the literature. Wang et al. (2022) empirically analyse differences in environmental performance between SOEs and privately-owned enterprises (POEs) for Chinese-listed companies. They found that SOEs perform better in meeting government-mandated environmental targets compared to

POEs. This is because SOEs, being government-controlled, tend to comply more effectively with environmental regulations, adopt more proactive environmental strategies, and better complying with emission standards under environmental regulations. Similarly, Huang et al. (2020) showed that SOEs are more actively declare and pay pollution discharge fees and increase investment in pollution control facilities.

Deng and Li (2020) investigated that SOEs leverage their political connections to access policy information promptly and adjust more effectively to environmental regulations, thereby maintaining more stable performance. In contrast, NSOEs, which lack strong government ties, face stricter enforcement, weaker risk resilience, and limited access to policy transmission and coordination mechanisms. As a result, they tend to respond to environmental regulations untimely or less effectively, leading to more volatile enterprise performance. Likewise, Sam and Zhang (2020) argued that SOEs maintain closer relationships with the government compared to NSOEs. Under environmental regulatory pressure, NSOEs are therefore more vulnerable to policy impacts.

At global level, Benoit (2019) provides qualitative evidence that governments, as shareholder of SOEs, can directly influence managerial decision, provide strategic guidance, and promote the implementation of low-carbon transformation capabilities in SOEs. Contradictorily, NSOEs are not directly controlled by the government and therefore receive less direct intervention and policy guidance. Zhao et al. (2024) further showed that SOEs are controlled by the government, which maintains substantial political control and acts as the policy maker, enabling it to balance economic interests. The separation between ownership and control, benefit from more effective corporate governance and perform in complying environmental regulations.

Based on the above discussion, we argue that SOEs outperform NSOEs under environmental regulation due to faster policy response, stronger resource access and more effective governance. This enables better compliance and stable performance. Therefore, this study proposes that:

H3: The moderating effect of environmental protection subsidies on the relationship between environmental regulation and enterprise performance is stronger for SOEs than NSOEs.

RESEARCH METHODS

Data and sample

The sample of this study consists of Chinese-listed manufacturing enterprises for the period of 2010-2023. The examination period is selected because the environmental protection subsidies for enterprises meeting the emission standards were introduced in 2010. After excluding enterprises with missing data on key variables (e.g., environmental protection subsidies and environmental protection investment), as well as those were delisted, had negative assets, and were suspended from trading, the sample comprises 143 enterprises listed on the Shanghai Stock Exchange in China, with 42 SOEs and 101 NSOEs

The data related to environmental regulation and government environmental subsidies are extract from statistical year books published by the Chinese government. The data on net income, total assets, total equity, enterprise market capitalisation, total liabilities, operating cash flow and revenue for corporate performance are obtained from Datastream and annual reports of the listed enterprises. All variables are winsorised at the 1st and 99th percentiles.

Regression model

Model 1 examines the relationship between environmental regulation and enterprise performance. The dependent variable is enterprise performance, which is proxied by Tobin’s Q. We do not consider accounting-based indicators such as ROA and ROE, which only capture past financial performance based on internal data, Tobin's Q incorporates market-based information by comparing the market value of a firm's assets to their replacement cost. As highlighted by Kabajeh

et al. (2012), while ROA and ROE are valuable profitability ratios, they are limited by historical cost accounting and fail to reflect investors' perceptions or future growth potential. Tobin's Q, by contrast, accounts for external valuation, making it a more comprehensive and forward-looking measure of firm performance, particularly in studies concerned with market reactions or investment behaviors under policy influences such as environmental subsidies or regulation.

$$EnterprisePerformance_{it} = \alpha_{it} + EnvReg_{it} + Xs_{it} + \varepsilon_{it} \quad (1)$$

The $EnterprisePerformance_{it}$ is therefore the Tobin's Q of enterprise *i* at year *t* ($Tobin'sQ_{it}$). The $Tobin'sQ_{it}$ is measured as the ratio of market value to asset replacement cost of enterprise *i* at year *t* (Wang et al., 2024). The independent variable is environmental regulation ($EnvReg_{it}$), which designed to control and limit the production behavior of enterprises including restrictions on pollution emissions, environmental taxes and fees, and ecological compensation (Zou & Zhang 2022). The $EnvReg_{it}$ is measured as the ratio of environmental protection investment to GDP of enterprise *i* at year *t*.

Xs_{it} are the control variables comprising of $FinLev_{it}$ (Enterprise's financial leverage, measured as the ratio of total debt to total assets of enterprise *i* at year *t*), OCF_{it} (Operating cash flow, the ratio of net operating cash flow to total assets of enterprise *i* at year *t*), and $Size_{it}$ (the size of the enterprises, natural logarithm of total assets of enterprise *i* at year *t*). Finally, $\varepsilon_{i,t}$ is the error term capturing unobserved factors. Year effect, industry effect, and regional effect are controlled in the model.

$$EnterprisePerformance_{it} = \alpha_{it} + EnvReg_{it} + EPS_{it} + Interaction_{it} + Xs_{it} + \varepsilon_{it} \quad (2)$$

Model 2 further investigates the moderating effect of EPS_{it} on the relationship between environmental regulation and enterprise performance. Followed Pei and Pei (2022), the EPS_{it} is environmental protection subsidies measured as natural logarithm of amount of environmental protection subsidies received of enterprises *i* at year *t*. An interaction term, $EnvReg_{it} \times EPS_{it}$, is included in the model. We expect the coefficient of the interaction term to be positive, indicating that higher environmental protection subsidies enhance the impact of environmental regulation on enterprises performance.

$$EnterprisePerformance_{it} = \alpha_{it} + EnvReg_{it} + EPS_{it} + Interaction_{it} + Xs_{it} + Dummy + \varepsilon_{it} \quad (3)$$

To further capture the heterogeneity in ownership structure, this study disaggregates the sample into SOEs and NSOEs. A dummy variable in model 3 will take a value of one if the enterprise is SOEs and zero otherwise.

RESULTS AND DISCUSSION

Descriptive Statistics

Table 1 presents the descriptive statistics for the variables included in this study.

Table 1. Descriptive Statistics

Variables	Obs	Min	Max	Mean	Stdev
$Tobin'sQ_{it}$	2002	0.623	19.270	3.048	7.902
$EnvReg_{it}$	2002	0.000	16.717	1.648	9.681
EPS_{it}	2002	0.000	14.871	9.711	2.037
OCF_{it}	2002	4.378	17.123	11.944	1.562
$FinLev_{it}$	2002	0.001	5.987	0.115	0.276
$Size_{it}$	2002	19.251	29.298	22.677	1.473

Note: *$EnvReg_{it}$=Environmental regulation; EPS_{it}=Environmental protection subsidies; OCF_{it}=Operating cash flow; $FinLev_{it}$=Financial leverage; $Size_{it}$=Enterprise size;* Obs is number of observables; Min refers to minimum; Max refers to maximum; Stdev is the standard deviation

The minimum value of *$Tobin'sQ_{it}$* is 0.623 and the maximum value is 19.2705, with a mean of 3.048. This suggests that, on average, these enterprises have a strong growth opportunities and favorable market expectations during the period from 2010 to 2023, and the market value of these enterprises is higher than their replacement cost. *$EnvReg_{it}$* has a mean value of 1.648, indicating the average level of environmental regulation exposure among the enterprises. The mean value of *EPS_{it}* is 9.711, indicating the average level of environmental protection subsidies received by the enterprises. The standard deviation of 2.037 indicates that there is a difference in the amount of environmental protection subsidies obtained across enterprises. Regarding control variables, the means of *OCF_{it}* is 11.944, *$FinLev_{it}$* is 0.115, and *$Size_{it}$* is 22.677.

Table 2 shows the correlations among the variables. We observed that environmental regulations (*$EnvReg_{it}$*) and environmental protection subsidies (*EPS_{it}*) positively correlated with enterprise performance. This suggests that stricter environmental regulation and greater environmental protection subsidies do enhance enterprises' performance.

Table 2.Correlations

Variables	**1**	**2**	**3**	**4**	**5**	**6**
1. $Tobin'sQ_{it}$	1.000					
2. $EnvReg_{it}$	0.096	1.000				
3. EPS_{it}	0.512	0.234	1.000			
4. OCF_{it}	0.041	0.016	0.024	1.000		
5. $FinLev_{it}$	0.064	0.082	0.056	–0.329	1.000	
6. $Size_{it}$	0.070	0.031	0.023	–0.189	0.650	1.000

Note: $EnvReg_{it}$=Environmental regulation; EPS_{it}=Environmental protection subsidies; OCF_{it}=Operating cash flow; $FinLev_{it}$=Financial leverage; $Size_{it}$ =Enterprise size

We find that *OCF_{it}*, *$FinLev_{it}$*, and *$Size_{it}$*, also positively correlated with enterprises performance. Soet et al. (2018) show that a higher operating cash flow means that the enterprise has sufficient cash to meet short-term financial needs and unexpected expenditures, which enhances its flexibility, thus enabling it to better capitalise on market opportunities and improve business performance. Furthermore, according to Modigliani and Miller (1963), high financial leverage reduces agency problems and increases profitability by enabling managers to enjoy tax advantages and use resources more effectively. The positive correlation between enterprise size and enterprise performance is supported by the study of Laitinen and Kadak (2018). They explain that the larger the scale of enterprises, the more resources, the better the performance of enterprises.

Moreover, the variance inflation factors (VIF) for all variables range from 1.26 to 2.50, and the tolerance values range from 0.40 to 0.79, indicating no multicollinearity issues exists.

The impacts of environmental regulations on enterprises performance

Table 3.The regression results of the impacts of environmental regulation on enterprises performance

DV= *$Tobin'sQ_{it}$*	**(1)**	**(2)**	**(3)**	**(4)**
$EnvReg_{it}$	0.130	0.157***	0.027**	0.023***
	(1.784)	(2.769)	(2.206)	(3.105)
$FinLev_{it}$	0.310***	0.130**	0.010***	0.005*

	(21.389)	(2.012)	(2.588)	(1.787)
OCF_{it}	-0.083	0.018	0.001	0.004
	(-1.354)	(0.473)	(0.729)	(1.100)
$Size_{it}$	0.091**	0.233***	0.028**	0.084
	(2.167)	(5.634)	(2.328)	(0.158)
Constant	13.879***	13.766***	14.087***	14.068***
	(27.380)	(28.071)	(27.772)	(18.808)
Year dummies	No	Yes	No	Yes
Industry dummies	No	No	Yes	Yes
Regional Dummies	No	No	Yes	Yes
R-square (R^2)	0.412	0.414	0.754	0.755
Obs	2002	2002	2002	2002

*Note: $EnvReg_{it}$=Environmental regulation; OCF_{it}=Operating cash flow; $FinLev_{it}$=Financial leverage; $Size_{it}$=Enterprise size; *,** and *** indicate significance at 10%, 5% and 1% level, respectively. The figure in parentheses is t-statistics.*

Table 3 presents the regression results of the model. We find that the results are consistent across all regression models, with $EnvReg_{it}$ exhibiting a statistically significant positive relationship with enterprises performance ($Tobin'sQ_{it}$), supporting Hypothesis 1. Enterprises subject to stricter environmental regulation tend to experience higher enterprises valuations, as measured by Tobin's Q. This result is consistent with previous studies by Chai et al. (2020), Cai et al. (2020), and Wu et al. (2023), who also found that environmental regulation contributes positively to enterprises performance.

This result can be attributed to several reasons. First, environmental regulations provide enterprises with a competitive advantage by encouraging them to adopt cleaner technologies and processes. For example, SANY Group's compliance with environmental regulations has led to significant improvements in enterprise performance, as reported in its 2024 ESG Report (Sany Group, 2024). By strengthening green manufacturing systems, investing in pollution control system, green, and enhancing energy efficiency, the enterprise reduced environmental risk and operating cost, while improving overall efficiency. These efforts enhanced its brand reputation and investor confidence, which in turn strengthens market recognition and competitiveness. In addition, Xie et al. (2017) find that environmental regulation enhance coal enterprises' performance in China. Environmental regulation can increase the motivation of enterprises to make a green transition by encouraging the proactive replacement of cleaner equipment and technologies, thereby reducing carbon emissions (Liu et al., 2018; Lu et al., 2019). Moreover, environmental regulation also influences consumer trust through increased media attention, which raises public scrutiny and encourages firms to consciously fulfill their environmental responsibilities (Zhang et al., 2014). This is supported by institutional theory, when enterprises face regulatory pressures, they tend to make compliance investments, such as forcing investments in pollution control equipment (such as desulfurization and denitrification devices in the steel industry) or participating in green industrial parks to gain policy legitimacy. These actions help enterprises avoid administrative penalties, enhance social reputation, and ultimately enhance enterprise performance (Javeed et al., 2021). Hence, this supports our Hypothesis 1.

In terms of control variables, the effects are consistent with our expectations, except OCF_{it}. Both $FinLev_{it}$ and $Size_{it}$ play significant roles in influencing enterprises' performance. Enterprises with higher leverage can benefit from lower borrowing costs, which enables them to obtain more funds for investment and expansion. This allows enterprises to achieve greater scale of investment and production capacity without increasing their own capital, thereby improving their profitability and operational performance (Ibrahim & Isiaka, 2020). Meanwhile, larger enterprises can enjoy cost reductions and efficiency gains due to economies of scale (Hernández et al., 2020). For example, in

the manufacturing industry, large-scale production lowers the costs per unit and enhances production efficiency (Bayat et al., 2021).

The moderating effects of environmental protection subsidies on the relationship between environmental regulations and enterprises performance under ownership heterogeneity

Table 4.Analysis of ownership heterogeneity

DV: *Tobin'sQ$_{it}$*			
		SOEs	**NSOEs**
	(1)	**（2）**	**（3）**
EnvReg$_{it}$	3.566*	1.536***	0.012**
	(1.833)	(3.370)	(2.263)
EPS$_{it}$	0.277	1.487***	0.021
	(0.253)	(7.605)	(1.038）
*EnvReg$_{it}$*EPS$_{it}$*	0.023*	4.135***	0.017***
	(1.759)	(7.607)	(5.279）
FinLev$_{it}$	0.0005	–0.098***	0.033**
	(0.307)	(-3.474)	(2.342)
OCF$_{it}$	0.010	0.329***	0.003
	(0.148)	(6.461)	(0.388）
Size$_{it}$	0.658	0.124	0.018
	(0.229)	(0.845)	(0.556)
Constant	0.408	0.830***	16.003***
	(0.375)	(2.402)	(131.237）
Year Dummies	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes
Regional Dummies	Yes	Yes	Yes
R-square (R^2)	0.786	0.755	0.755
Obs	2002	2002	2002

*Note: EnvReg$_{it}$=Environmental regulation; EPS$_{it}$=Environmental protection subsidies; OCF$_{it}$=Operating cash flow; FinLev$_{it}$=Financial leverage; Size$_{it}$=Enterprise size * indicates significance at 10% level. The figure in parentheses is t-statistic*

Table 4 shows the results of the moderating effect of environmental protection subsidies on the relationship between environmental regulations and enterprises performance under ownership heterogeneity. The interaction term *EnvReg$_{it}$*EPS$_{it}$* in Model 1 shows a significant positive relationship with enterprise performance. Thus, supports Hypothesis 2. This suggests higher environmental protection subsidies may amplify the positive impacts of environmental regulations on enterprises performances. Environmental protection subsidies act as an important government tool for incentivising enterprise to participate in environmental governance to reduce the marginal cost of enterprises' environmental governance, provides financial relief that supports enterprises' environmental efforts (Yu et al., 2020). For example, environmental protection subsidies such as tax reductions, cash compensation, and credit preferences can encourage enterprises to increase investment in environmental protection, improve environmental quality, and reduce financial pressure, while simultaneously maintaining or enhancing their market competitiveness (Liang et al., 2022). On the other hand, environmental protection subsidies also promote green transformation and technological innovation, thus enhancing the positive impact of environmental regulation on enterprises' performance (Albitar et al., 2023). These subsidies offer financial support and policy guidance that help enterprises update outdated equipment, processes, and production methods, increase pollution control and emission reduction, and realize green production and

sustainable development (Zuo & Lin, 2022). Moreover, environmental protection subsidies can be served as funding for research and development (R&D), lowering the cost of green transformation (Cao et al., 2024) and fostering innovation in green technologies of enterprises (Zhao et al., 2022). Thus, environmental protection subsidies play a significant moderating role in the relationship between environmental regulation and enterprises performance.

This aligns with the Porter Hypothesis. According to the Porter Hypothesis, well-designed environmental policies can offset enterprises' compliance costs through the "innovation offset effect", and environmental protection subsidies, as an important component of policy tools, can strengthen this effect by reducing the upfront investment threshold for enterprises' green transition (Porter & Linde, 1995). For instance, when enterprises receive R&D subsidies to upgrade pollution treatment technologies, they not only meet environmental regulatory requirements but may also enhance production efficiency through technological spillover effects, forming an environment-economy win-win situation (Ambec & Lanoie, 2008).

Due to the significant differences in the internal governance of SOEs and NSOEs in China, there are differences in their awareness of pollution control and environmental protection action power in response to different environmental regulation policies. These differences, in turn, lead to variations in their enterprises. This study further examines whether the moderating effect of environmental protection subsidies on the relationship between environmental regulation and enterprise performance is stronger for SOEs or NSOEs.

The results in Model 2 and 3 presents ownership heterogeneity among enterprises. The findings suggest that environmental regulation has a stronger and more significant positive effect on the performance of SOEs compared to NSOEs. Additionally, the interaction term $EnvReg_{it}*EPS_{it}$ in both models shows a significant positive relationship with enterprise performance, with stronger effects observed for SOEs than for NSOEs. Therefore, these results support Hypothesis 3.

The main reason for this situation is China's special national conditions, in which the Chinese government requires SOEs to fulfill their social responsibilities more consciously than NSOEs, and in the context of political promotion incentives for executives in Chinese SOEs (Wang et al., 2024), executives' green innovation effects through internal control mechanisms and environmental subsidies play a role in improving enterprise performance (Pei & Pei, 2022; Wang et al., 2022). In addition, media attention is higher for SOEs compared to NSOEs (Luo et al., 2023). Therefore, environmental regulations have a greater impact on SOEs. In contrast, the Chinese government does not impose a high degree of mandatory requirements on NSOEs, and these enterprises rely more on their own intrinsic motivation in environmental governance. Therefore, environmental regulations and environmental protection subsidies have a greater impact on the performance of SOEs than NSOEs. This is supported by the institutional theory, SOEs are more sensitive to government expectations in meeting environmental goals. They seek legitimacy by aligning closely with government policies.

Furthermore, the inefficiency in environmental subsidy allocation between SOEs and NSOEs stems from three key factors. First, NSOEs face stricter eligibility criteria for subsidies, often requiring complex compliance documentation and technical certifications that disproportionately burden smaller enterprises. For example, applications may require detailed emission reduction plans or green technology adoption reports, which NSOEs with limited administrative capacity may struggle to prepare the reports (Li et al., 2022). Second, bureaucratic inefficiencies contribute a bias towards SOEs in subsidy allocation. Local governments often prioritise SOEs in subsidy disbursement due to stronger political connections (Cai et al., 2016). Third, the smaller scale of NSOEs' limits their access to subsidies, as many programs impose minimum investment thresholds or require economies of scale (e.g., large-scale equipment upgrades) that NSOEs cannot meet (Wan & Sheng, 2022). These factors create a subsidy gap between SOEs and NSOEs.

Robustness test

Table 5. Results of Robustness test

DV	***ROE$_{it}$***	***ROA$_{it}$***
EnvReg$_{it}$	0.315***	0.376***
	(6.462)	(17.924)
FinLev$_{it}$	0.240*	0.376***
	(1.759)	(17.924)
OCF$_{it}$	0.022	0.081
	(1.219)	(1.574)
Size$_{it}$	0.195***	0.349***
	(7.381)	(2.213)
Constant	0.268**	11.728***
	(2.057)	(137.310)
Year Dummies	Yes	Yes
Industry Dummies	Yes	Yes
Regional Dummies	Yes	Yes
Obs	2002	2002

*Note: EnvReg$_{it}$=Environmental regulation; EPS$_{it}$=Environmental protection subsidies; OCF$_{it}$=Operating cash flow; FinLev$_{it}$=Financial leverage; Size$_{it}$=Enterprise size * indicates significance at 10% level. The figure in parentheses is t-statistic*

Table 5 shows the results of the robustness test. This study replaces *Tobin'sQ$_{it}$* with *ROE$_{it}$* and *ROA$_{it}$* as alternative measures of firm performance. The result aligns with the findings of the original results where environmental regulation significantly and positively affected enterprises performance. This shows the model developed is robust.

CONCLUSION, IMPLICATIONS AND LIMITATION OF THE STUDY

This study examines the impact of environmental regulation on enterprise performance, with the environmental protection subsidies as a moderating factor among the Chinese-listed enterprises. The findings suggest that environmental regulations have a significant positive impact on enterprise performance. The stricter the environmental regulations, the higher the valuation of the enterprises. Furthermore, environmental protection subsidies significantly and positively moderate the relationship between environmental regulation and enterprise performance, with stronger effects observed in SOEs compared to NSOEs. In the context of China's institutional environment, SOEs are expected to fulfill their social responsibilities more actively than NSOEs. In addition, SOEs are typically larger and have stronger industrial integration platforms and capital operation capabilities. Therefore, the industrial development green fund or public-private-partnership green project fund set up by large groups are more favor SOEs participation, providing them with greater access to green financing and project opportunities. Therefore, environmental regulations have a greater impact on SOEs. These findings are supported by the Porter Hypothesis and institutional theory.

This study fills the literature gaps by providing evidence-based findings on the impacts of environmental regulation. In the context of global climate change and its growing environmental and economic consequences, this study offers theoretical insights into enterprises responses to government policies, particularly in addressing global climate-related challenges. The investigation on the environmental protection subsidies and the heterogeneity between SOEs and NSOEs highlights how ownership structure shapes enterprises' responses to environmental regulations, demonstrating the sensitivity of enterprises with different ownership structure to government policies. Several practical implications of the study are derived from the findings of this study. First,

government may improve the existing environmental regulation policies by recognising the different ownership structure. The "one-size-fits-all" policies may not evenly apply to SOEs and NSOEs. To improve the participation of NSOEs in combating the climate-related issues in China, a more tailored policy should be developed. Next, environmental protection subsidies serve as an effective complementary policy tool that help enterprises strengthen their compliance with environmental regulations. Government should continue to utilise this subsidy to support enterprises with lower capabilities.

There are several limitations of this study. Firstly, this study does not consider the heterogeneous impacts of environmental regulation across different regions. For example, cities such as Shanghai, Beijing, Guangzhou, and Shenzhen have different environmental regulation policies and subsidy scheme, which may lead to variation in their impacts on enterprise performance. Therefore, future study is recommended to examine the heterogeneity of regional to better understand the impact of environmental regulations and subsidy policies on enterprise performance in different local policy context. Secondly, this study focused solely on manufacturing sector. However, other industries, such as logistics and services, also contribute significantly to environmental pollution through carbon emissions, noise pollution, and resource consumption. Further studies could expand the sample to include other environmentally polluting industries to enhance generalizability of the findings. Thirdly, this study primarily examines the relationship between environmental regulation and enterprise performance. Future studies could incorporate additional outcome variables, such as enterprises carbon performance or disclosure environmental regulation, to provide a more comprehensive understanding of regulatory impacts. This may help investors and policymakers to better align their decision making with strategic objectives. Fourth, examining the effects of environmental regulations on small and medium-sized enterprises (SMEs) and unlisted enterprises is crucial. Compared to listed manufacturing enterprises, SMEs and unlisted enterprises face tighter financial constraints, limited access to green financing, and higher compliance costs. Examining how these enterprises respond to environmental regulations provide more complete understanding of policy effectiveness across types of enterprise, such as subsidies, technology adoption, or participation in green niches markets.

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