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The Moderating Role of Economic Policy Uncertainty in the Relationship between State Ownership and Environmental Performance

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Abstract

With increasing global attention to corporate environmental performance, this study examines whether state ownership contributes to variations in firms' environmental outcomes. It further investigates whether economic policy uncertainty (EPU) moderates the relationship between state ownership and environmental performance. Using panel data from Chinese listed firms during 2018–2022, this study employs a fixed-effects (FE) model for the main analysis, with alternative dependent variables and feasible generalized least squares (FGLS) regressions for robustness tests. The empirical results reveal that state ownership is negatively associated with environmental performance, and that higher levels of EPU intensify this negative relationship. By integrating stakeholder theory and real options theory, this study provides new empirical evidence on how external policy uncertainty influences environmental behavior across ownership structures. It is the first to incorporate EPU into the analysis of environmental strategies of state-owned enterprises, demonstrating that EPU amplifies the strategic delay effect of state-owned enterprises (SOEs) and exacerbates their environmental performance disadvantages. These findings uncover the compounded effects of policy uncertainty and state ownership on environmental outcomes during the COVID-19 pandemic, offering valuable insights for achieving green recovery in the post-pandemic era.

Keywords: Economic Policy Uncertainty, State Ownership, Environmental Performance, Stakeholder Theory, Real Options Theory

Introduction

Since the major revision of China's *Environmental Protection Law* in 2015 and China formal accession to the *Paris Climate Agreement* in the following year, the "green signal" within the market has been significantly strengthened, exerting a directional influence on the environmental strategies of listed companies (Shahab et al., 2023; Zhou et al., 2021). However, the *Global Environmental Performance Index* report jointly released in 2018

indicated that a substantial gap remains between the world's current progress and the established environmental protection goals, reinforcing the notion that "high-emission enterprises should pay for their ecological debts" (Luo et al., 2019). As the world's largest manufacturing cluster, China is home to tens of thousands of manufacturing enterprises that have contributed to national economic growth but have also caused significant environmental pollution (Di et al., 2017).

The environmental administrative penalty intensity imposed by the Chinese government provides insights into recent trends in the environmental performance of Chinese firms, as the level of administrative penalties serves as a "barometer" reflecting the interaction between corporate environmental practices and regulatory pressure (Ding, 2025). In 2020, affected by the COVID-19 pandemic, China's Ministry of Ecology and Environment issued 126,000 administrative penalty decisions totaling RMB 8.24 billion (≈USD 1.15 billion). In 2021, both figures increased to 133,000 cases and RMB 11.69 billion (≈USD 1.63 billion), before declining steadily from 2022 onward, reaching 56,000 cases and RMB 4.61 billion (≈USD 0.64 billion) by 2024 (Ministry of Ecology and Environment, 2025). This trend suggests that relying solely on market self-regulation is insufficient to achieve an environmentally friendly economy; a strong external impetus is essential (Shahab et al., 2023). State ownership, in this regard, act as a "green bridge" between the government and the market (Liu et al., 2024). Moreover, amid rising uncertainty and intensifying climate risks, capital markets have placed increasing emphasis on firms' environmental performance (Wu et al., 2024).

Although corporate environmental performance has attracted increasing attention, debates remain regarding how internal governance mechanisms shape such outcomes. A number of scholars contend that SOEs tend to demonstrate superior environmental performance by increasing environmental protection expenditures, alleviating financing constraints, promoting green innovation, and disclosing environmental information (Acar et al., 2021; Lai et al., 2025; Liu et al., 2024). In contrast, others contend that SOEs perform poorly in terms of environmental outcomes, as government-controlled enterprises may prioritize political or social objectives over environmental sustainability, or because political intervention weakens environmental governance (Karim et al., 2021; Li & Zhang, 2010). This inconsistency suggests the presence of moderating factors influencing the ownership–environment nexus.

To address this gap, this study adopts stakeholder theory and real-options theory as its foundational conceptual frameworks. Stakeholder theory posits that national policies impose constraints on the structure and behavior of corporate governance, which may, in turn, influence firm performance (Feils et al., 2018). Additionally, the state can participate in enterprises through ownership, forming mixed-ownership state-owned enterprises, where corporate social responsibility can be implemented and play a role (Lee, 2023; Silva & Medeiros, 2021). Therefore, this study posits that the state is one of the stakeholders in a company, influencing environmental performance through restrictions and participation. zzMoreover, from the perspective of real options theory, the moderating role of EPU can be further understood. Real options theory posits that under conditions of high uncertainty, firms tend to adopt a "wait-and-see" attitude and postpone investment decisions (Ipsmiller et al., 2019). However, state-owned enterprises (SOEs), driven by socio-political objectives, differ from non-state-owned enterprises (non-SOEs) in their sensitivity to EPU. Consequently,

SOEs and non-SOEs may adopt distinct environmental investment strategies when confronted with EPU.

Building on stakeholder theory and real options theory, this study proposes that state ownership influences firms' environmental performance, while economic policy uncertainty moderates this relationship. To empirically analyze the research question, a fixed effects model was employed, and robustness tests were conducted by substituting the dependent variable and using the FGLS model. The results reveal that state ownership significantly reduces firms' environmental performance, and that EPU strengthens the negative relationship between state ownership and environmental performance. By integrating stakeholder theory and real options theory, this research provides new empirical evidence on how external policy uncertainty affects firms' environmental performance under different ownership structures, offering theoretical and policy implications for promoting sustainable corporate governance. Furthermore, this study is the first to incorporate EPU into the analysis of the environmental behavior of state-owned enterprises. The findings indicate that higher levels of EPU lead SOEs to postpone green investment, thereby exacerbating their environmental performance disadvantage. This finding reveals a cross-level mechanism through which macroeconomic policy fluctuations influence environmental outcomes through differences in ownership. Meanwhile, this study examines the combined effect of policy uncertainty and state ownership on corporate environmental performance during the pandemic, providing academic support for a post-pandemic green recovery. Finally, the empirical findings can be translated into investment strategies, as under periods of rising EPU, underweighting pollution-intensive firms with high state ownership may help mitigate environmental compliance risks.

Literature Review and Research Hypothesis

State 0wnership and Environmental Performance

Operating under a socialist system, China features significant state ownership in corporate equity. This study examines how environmentally responsible state-controlled enterprises are compared to their non-state-controlled counterparts. Research by Lai et al. (2025), analyzing Chinese companies from 2009-2021, reveals that state capital involvement substantially boosts corporate spending on environmental initiatives, improves environmental performance metrics, and elevates ESG ratings. Notably, when state shareholders divest, environmental performance tends to deteriorate. Additionally, Liu et al. (2024), utilizing extensive data from China's A-share market, establish that joint state ownership markedly improves corporate environmental outcomes by easing financial constraints, fostering green technology innovation, and enhancing industry-wide green total factor productivity. Similarly, Acar et al. (2021) using observations from 72 countries, concluded that higher state ownership is associated with greater environmental information disclosure. Conversely, Karim et al. (2021) report that, in a cross-country sample of 576 publicly traded companies from Malaysia and Pakistan, greater government ownership is associated with weaker environmental performance. In the same vein, Li & Zhang (2010), in their study of 692 Chinese listed companies, argue that political intervention constrains the fulfillment of corporate social responsibility in SOEs, leading to weaker performance compared with their non-state-owned counterparts.

Enterprises constitute a vital component of the national or societal economy, and the government plays a pivotal role in promoting corporate engagement in social and environmental initiatives (Wirba, 2023). In some countries, corporate social activities are primarily initiated by the private sector, whereas in China, sustainable activities are mainly driven by the government (Xu & Zeng, 2016). In addition, following the current practice of enterprises and the prospect of future enterprise development, Stakeholder Theory would be increasingly adaptable to corporate governance (Stoelhorst & Vishwanathan, 2024). The state can participate in enterprises through ownership, forming mixed-ownership state-owned enterprises, where corporate social responsibility can be implemented and play a role (Lee, 2023; Stoelhorst & Vishwanathan, 2024). Therefore, based on existing research, this study posits that state ownership correlates highly with environmental performance and proposes the following hypothesis:
H1: State ownership has a significant impact on the environmental performance of Chinese enterprises.

The Moderating Variable EPU
Previous studies have examined the relationship between EPU and environmental performance, revealing that the direction of EPU's impact varies depending on the measurement approach and contextual setting. Specifically, Vural-Yavas (2020) and Wu et al. (2024), based on samples of Chinese A-share firms and European companies respectively, found that an increase in EPU significantly improves ESG environmental scores or performance in emissions and resource utilization. In contrast, Benlemlih & Yavaş (2024), using corporate CO_2 emissions data from 23 countries, as well as Su et al. (2022), employing a macro-level panel covering 137 countries, consistently and robustly reported that higher EPU leads to a decline in environmental performance.

From Real Options Theory, Myers (1977) posited that real options are related to uncertain environments, and their value affects corporate investment decisions, valuation and financing choices when facing strategic choices. According to a World Bank report on standards and code compliance, the resources of the CSRC do not show the same progress in market growth. Meanwhile, the shortcomings in the legal framework, including the low level of sanctions that may be imposed for certain misconduct, have limited the authorities' ability to conduct an effective enforcement program (World Bank, 2017). In particular, the registration system for securities issuance is implemented in the Chinese securities market, while the corresponding regulations are constantly being improved. These conditions would increase the economic policy uncertainty and further moderate the relationship between state ownership and environmental performance. Therefore, the following hypothesis is proposed:
H2: EPU significantly moderates the effect of state ownership on environmental performance.

Research Design
Data Source and Sampling Strategy
This research centers on A-share firms listed on the Shanghai and Shenzhen stock exchanges, drawing on 2018–2022 data. After omitting ST stocks, financial institutions, and observations with incomplete records, the dataset comprises 2,553 unique companies (12,765 firm-year observations). Furthermore, the observations are classified into 76 industries. The study employs secondary data for empirical analysis. Specifically, data on state ownership and control variables are obtained from the CSMAR database and companies' annual reports,

while environmental performance indicators are sourced from the WIND database. The EPU is measured using the China Economic Policy Uncertainty Index constructed by Huang and Luk (2020).

Selection of Variables

The dependent variable of this study is environmental performance. This study employed data from the WIND database, consistent with Chen et al. (2023) and Chen & Xie (2022). Moreover, the environmental dimension comprises eight components: energy and climate change, water resources, materials and waste management, emissions, wastewater, biodiversity impacts, green building, and green finance. The specific method for evaluating environmental performance involves scoring each item within the aforementioned dimensions, applying weights, and aggregating the results to obtain a final score ranging from 0 to 10. In addition, the independent variable of this study is state ownership. The state ownership was a proxy for the percentage of shares held by the state (Shao, 2019). Moreover, the moderating variable of this study is EPU, regarding the measurement of economic policy uncertainty, several studies have adopted the EPU Index developed by Baker et al. (2016) at Stanford University and the University of Chicago. While this study uses the method by Huang & Luk (2020), the method using ten mainland Chinese newspapers shows a higher journal coverage and authority compared to Baker et al. (2016).

This study incorporates five control variables. Supervisory board size (SupNo) is measured as the natural logarithm of the number of supervisory board members, following the approach of Chen & Al-Najjar, (2012) and Lin (2019). The independent directors (IndepDire) is defined as the ratio of independent directors to the total number of directors, adopting the measurement used by Chen & Al-Najjar, (2012) and Lin (2019). Board meeting (BMeet) is proxied by the annual number of board meetings, in line with Hussain et al. (2018) and Ghazali (2020). The impact of the COVID-19 pandemic (Covid19) is captured by a dummy variable, coded as 1 for years affected by COVID-19 and 0 otherwise, consistent with Pozzoli et al. (2022). Firm size (lnsize) is measured as the natural logarithm of total assets at year-end, following the standard applied by Naciti (2019).

Regression Models

To more rigorously uncover the underlying mechanism linking state ownership, EPU, and environmental performance, this study employs a FE model to analyze their relationship. To ensure the robustness of the findings, alternative measurements of the core variables are adopted (for instance, replacing the environmental performance measure from the Wind database with that from the Huazheng database), and further validation is conducted using the FGLS regression. Based on the above design, the following baseline econometric model is constructed:

Model 1: Effect of state ownership on environmental performance:

$$\mathrm{Envir}_{it} = \beta_0 + \beta_1 \mathrm{StaOwn}_{it} + \beta_2 \mathrm{Controls}_{it} + \varepsilon_{it}$$

Model 2: There is a moderation effect of EPU between state ownership and environmental performance.

$$\mathrm{Envir}_{it} = \beta_0 + \beta_1 \mathrm{StaOwn}_{it} + \beta_2 (\mathrm{StaOwn}_{it} \times \mathrm{EPU}_{it}) + \beta_3 \mathrm{Control}_{it} + \varepsilon_{it}$$

Data Analysis and Results

Overview of Descriptive Statistics

To explore how state ownership and EPU shape environmental perfomance, Table 4.1 first summarises the data. On average, sample firms score only 1.61 on environmental performance (Envir, SD = 1.85), revealing both low attainment and wide dispersion. State ownership (StaOwn) averages 2.2 % (SD = 0.085). Further examination of the raw data for the period 2019–2022 reveals that state-owned enterprises account for 13.9% of the sample firms, while the remaining 86.1% are privately owned enterprises. Finally, the mean value of the EPU is 4.976 with a standard deviation of 0.132, reflecting relative stability over the observation period.

Accordingly, Table 4.1 reports the Pearson correlation coefficients among the variables and their significance levels. The preliminary results indicate that environmental performance (Envir) is significantly and positively correlated with key explanatory variables, including state ownership (StaOwn) and economic policy uncertainty (EPU). Specifically, the correlation coefficients with state ownership, supervisory board, EPU, and firm size are 0.032, 0.115, 0.113, and 0.388, respectively (all $p < 0.05$). Notably, with the exception of the proportion of independent directors and the COVID-19 dummy variable, environmental performance exhibits statistically significant correlations with all other independent variables. In addition, all absolute values of the correlation coefficients are below 0.7, suggesting that multicollinearity is not a serious concern among the independent variables in the model (Bravo-Urquiza & Moreno-Ureba, 2021).

Table 4.1
Descriptive Statistics and Correlations

	Envir	StaOwn	EPU	SupNo	IndepD~e	BMeet	Covid19	lnsize
Envir	1.000							
StaOwn	0.032***	1.000						
EPU	0.113***	-0.048***	1.000					
SupNo	0.115***	0.172***	-0.017*	1.000				
IndepDire	0.005	-0.053***	0.015*	-0.084***	1.000			
BMeet	0.108***	0.055***	-0.037***	0.047***	0.037***	1.000		
Covid19	-0.003	-0.032***	-0.200***	-0.003	0.002	0.006	1.000	
lnsize	0.388***	0.154***	0.062***	0.280***	0.015*	0.309***	0.029***	1.000
Mean	1.61	0.022	4.976	1.228	0.378	9.692	0.4	22.638
SD	1.846	0.085	0.132	0.237	0.054	3.856	0.49	1.36

Regression Results

This study explores how state ownership relates to environmental performance. To select the most suitable estimation strategy, this study conducted a Hausman specification test, which yielded a statistic of 16.206 (p=0.013). Because the p-value falls below the conventional threshold, we reject the null hypothesis and adopt a FE model rather than a Random Effects model. According to the results in Table 4.2, at the 1% significance levels, the result support that state ownership significantly and negatively affects the firm's environmental performance, with coefficient values of -0.566.

Table 4.2
Regression Results

Envir	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
StaOwn	-0.566	0.21	-2.70	0.007	-0.978	-0.155	***
SupNo	-0.109	0.187	-0.58	0.56	-0.476	0.258	
IndepDire	-0.117	0.413	-0.28	0.776	-0.926	0.692	
BMeet	-0.017	0.005	-3.63	0.000	-0.026	-0.008	***
Covid19	-0.071	0.02	-3.60	0.000	-0.109	-0.032	***
lnsize	0.694	0.055	12.51	0.000	0.585	0.803	***
Constant	-13.722	1.285	-10.67	0.000	-16.242	-11.201	***
Mean dependent var	1.610		SD dependent var		1.846		
R-squared	0.031		Number of obs		12765		
F-test	27.884		Prob > F		0.000		

**** p<.01, ** p<.05, * p<.1*

Moderating Result

This study also established a panel regression model to identify the moderating effect of EPU on the relationship between state ownership and environmental performance. In Table 4.3, this study observes a significantly negative impact of state ownership on environmental performance (β = -0. 367*). Thus, the coefficient of the interaction term (StaOwn × lnEPU) shows that the moderating variable EPU intensifies the negative impact of state ownership on environmental performance.

Table 4.3
Regression results

Envir	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
StaOwn	-0.367	0.221	-1.66	0.097	-0.8	0.067	*
EPULUK	1.275	0.103	12.41	0.000	1.073	1.476	***
SupNo	0.041	0.184	0.22	0.825	-0.32	0.402	
IndepDire	-0.304	0.403	-0.75	0.451	-1.094	0.486	
BMeet	-0.01	0.005	-2.09	0.036	-0.019	-0.001	**
Covid19	0.022	0.019	1.19	0.232	-0.014	0.058	
lnsize	0.45	0.053	8.48	0.000	0.346	0.555	***
StaOwn×EPU	-2.957	1.401	-2.11	.035	-5.705	-0.209	**
Constant	-14.775	1.25	-11.82	0.000	-17.225	-12.324	***
Mean dependent var	1.610		SD dependent var		1.846		
R-squared	0.054		Number of obs		12765		
F-test	37.162		Prob > F		0.000		

**** p<.01, ** p<.05, * p<.1*

Robustness Check

This study also implements the alternative dependent variable and FGLS regression methodology to analyze the relevant variables, and the principal results align strongly with those of the FE regression. This robustness examination substantiates the reliability and validity of the study's findings. Specifically, this study replaces the environmental performance (EHuaZ) with data from the Huazheng database. The results indicate that state ownership exerts a negative effect on environmental performance (β = -4.4631***). Similarly, in the FGLS regression model, the coefficient of state ownership on environmental performance is -0.7691, which is statistically significant at the 0.01 level.

Table 4.4
Robustness check

	(1) EHuaZ	(2) FGLS
StaOwn	-4.4631***	-0.7691***
	(0.8949)	(0.1180)
SupNo	-0.0984	0.1384***
	(0.8027)	(0.0377)
IndepDire	-0.7402	-0.3909***
	(1.8838)	(0.1453)
BMeet	-0.0821***	-0.0038*
	(0.0207)	(0.0021)
Covid19	-0.3636***	-0.0714***
	(0.0903)	(0.0156)
lnsize	1.5548***	0.5407***
	(0.2279)	(0.0064)
_cons	27.8522***	-10.7642***
	(5.2343)	(0.1437)
N	12765	12765
adj. R^2	0.0114	-

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Discussion

Based on the empirical findings, this study systematically elucidates the intrinsic relationships among state ownership, economic policy uncertainty (EPU), and environmental performance. The following sections provide a detailed analysis of the two core research findings and compare them with existing literature to highlight their theoretical contributions and practical implications.

H1: State ownership has a significant impact on the environmental performance of Chinese enterprises.

The study finds that state ownership significantly reduces corporate environmental performance. This can be attributed to the significant impact of the COVID-19 pandemic on China's economy during the period from 2018 to 2022, as well as the incomplete economic recovery post-pandemic. China government prioritizes rapid economic growth to restore the economy and help millions of people escape poverty. State-owned enterprises may be more focused on achieving economic targets, sometimes at the expense of environmental considerations. Additionally, state-owned enterprises may receive government subsidies or

support, which could reduce the urgency of adopting environmentally sustainable practices. This support may create a buffer against the financial consequences of environmental non-compliance. The findings further support stakeholder theory, indicating that corporate decision-making is influenced by relevant stakeholders such as government agencies. Moreover, this finding aligns with the results of Karim et al. (2021) and Li and Zhang (2010). Thus, our findings support H1.

H2: EPU significantly moderates the effect of state ownership on environmental performance. Another finding of this study indicates that state ownership reduces firms' environmental performance, and that EPU amplifies this negative effect. This may be because EPU could lead state-owned enterprises to adopt a more conservative approach in decision-making, tending to minimize risk exposure. Such conservatism may be reflected in decreased investment in environmental projects or the adoption of more cautious strategies in environmental policy implementation, ultimately resulting in negative changes in environmental outcomes. In situations of high EPU, state-owned enterprises are more likely to adopt a "wait option" strategy. This is because once they invest in purchasing environmental protection equipment or engaging in green technology research and development, there is a risk of incurring unrecoverable costs. As a result, SOEs are more inclined to await clear policy directives before making such investments. Therefore, based on the analysis results of Model 2, Hypothesis 2 is supported.

Conclusions

This study employs a fixed effects model to analyze Models 1 and 2 and conducts robustness checks using an alternative dependent variable and the FGLS method. The analysis is based on five years of data (2018–2022) to examine the relationship between state ownership and environmental performance among Chinese listed companies across the COVID-19 period. Furthermore, using EPU as a moderating variable, the study investigates whether the relationship between state ownership and environmental performance is moderated. The results indicate that state ownership is negatively associated with environmental performance, and the moderating variable EPU further strengthens the negative effect of state ownership on environmental performance. This study is the first to incorporate EPU into the analysis of state-owned enterprises' environmental performance. It finds that EPU amplifies the delayed effects of SOEs' environmental strategies, thereby exacerbating their environmental performance disadvantages. This finding reveals how macro-level policy fluctuations are transmitted to environmental outcomes through micro-level ownership differences, filling a research gap regarding cross-level mechanisms from macro policy to firm behavior. Moreover, by covering both the pandemic and post-pandemic periods, this study identifies—for the first time—the compounded effects of policy uncertainty and state ownership on corporate environmental performance during the pandemic, providing academic evidence on how to achieve green recovery in the post-pandemic era. Furthermore, the empirical findings can be translated into quantitative investment strategies. During periods of rising EPU indices, such as during pandemics or trade wars, underweighting firms with high state ownership and a history of pollution intensity—such as locally state-controlled steel and coal-power companies—can help mitigate potential risks from environmental compliance premiums. Finally, in terms of corporate governance, environmental performance can be incorporated into the performance evaluation of executives in state-owned enterprises, and environmental accountability mechanisms can be established.

Additionally, specialized audits of pollution emissions in state-owned enterprises should be strengthened. These measures facilitate effective supervision of corporate environmental performance, particularly during periods of heightened risk.

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