"Greenwashing" or "Helping": ESG Performance and Chinese Firm Total Factor Productivity

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ABSTRACT: As the market economy has continued to develop, businesses have consistently prioritized profits, excessively emphasizing income and financial gains while neglecting ecological conservation and financial fraud. Consequently, the phenomenon of "greenwashing" has emerged. How to prevent this "greenwashing" phenomenon while pursuing economic benefits and enabling high-quality business development has become a focal point. Therefore, this paper analyzes whether the ESG (Environmental, Social, and Governance) performance of listed companies has an impact on the enhancement of the Total Factor Productivity (TFP) of enterprises. This study aims to explore how companies, while striving to maximize economic interests, can more proactively undertake environmental protection and social responsibility, thereby promoting the green transformation of enterprises. Using A-share listed companies from 2012 to 2022 as the sample, through an empirical examination of the correlation between the ESG performance of listed companies in China and the TFP of enterprises, the following conclusions are drawn: (1) ESG performance significantly promotes the TFP of enterprises, indicating that higher ESG performance corresponds to higher TFP; (2) Through intermediary effect tests, it is found that corporate reputation plays a role in enhancing the TFP of enterprises. That is, through good ESG performance, a company's reputation is improved, thereby leading to higher TFP; (3) Heterogeneity analysis demonstrates that the impact of good ESG performance on the enhancement of TFP is more significant in large-scale enterprises and state-owned enterprises.

KEYWORDS: ESG performance；Total Factor Productivity (TFP)；Corporate reputation

1. Introduction

Globally, issues concerning Corporate Social Responsibility (CSR) and Environmental, Social, and Governance (ESG) in sustainable development have garnered widespread attention. This attention originates not only from academia but also from governments, investors, media, and the general public. With shifts in policy orientation across the globe, more and more countries and regions are encouraging companies to fulfill their social and environmental responsibilities. ESG disclosure has become an integral part of a company's daily operations. For instance, the United Nations Sustainable Development Goals (SDGs) present a global consensus that demands active engagement from companies in addressing social and environmental issues. This is reflected in legislative and regulatory frameworks in numerous countries, offering policy support for corporate sustainability [1]. The proliferation of ESG disclosure is not merely a compliance requirement but has profound implications on business operations and investment decisions. Previous studies indicate that ESG disclosure aids in enhancing a company's reputation, reducing investment risks, and attracting more socially responsible investors [2]. This transformative shift is not confined to traditional CSR realms but encompasses operational performance closely associated with Total Factor Productivity (TFP). This paper's focal point is the relationship between ESG performance and TFP, with corporate reputation as the mediating variable. TFP is a crucial metric for assessing a company's performance, considering the comprehensive efficiency of multiple production factors[3,4]. The impact of ESG performance on TFP might be conveyed through various channels, with corporate reputation being a vital intermediary

mechanism. However, current research on how ESG performance affects TFP remains limited, especially in exploring mediating mechanisms [5]. This study aims to bridge this knowledge gap by delving into how ESG performance influences TFP through corporate reputation, providing practical guidance for corporate decision-makers, investors, and policymakers.

In recent years, more studies have started to focus on the relationship between ESG performance and TFP. In [6], the authors found a positive correlation between high ESG performance and higher TFP. They suggested that enhancing ESG performance might reduce environmental and social risks, enhance corporate reputation, and consequently affect TFP. Similarly, the research findings of [7] also indicate that companies with strong ESG performance exhibit higher TFP. However, these studies, while providing evidence, have certain limitations. Primarily, existing research often leans towards qualitative analysis or employs small samples, lacking large-scale quantitative analysis. This might limit the universality and robustness of the conclusions. Moreover, although some studies suggest that ESG performance may influence TFP through reputation channels, in-depth research into related mediating mechanisms remains relatively limited [8].

The innovative aspects of this study design will encompass several areas. Firstly, we aim to conduct comprehensive quantitative analysis using a large-scale dataset to address the deficiencies in current research [9]. This will contribute to a more comprehensive understanding of the relationship between ESG performance and TFP. Secondly, we will extensively investigate how ESG performance influences TFP through corporate reputation, exploring the details and pathways of the mediating mechanism. Finally, we will employ various methods, including robustness checks and heterogeneity analysis, to validate the robustness and universality of the research results, thereby enhancing the credibility of the study [10]. In summary, this paper aims to fill the research gap regarding the relationship between ESG performance and TFP, explore its mechanisms, and offer practical guidance for corporate decision-making and policy formulation. Through this research, we anticipate better comprehension of the connection between ESG and corporate operational performance, providing further insights for sustainable economic development.

2. Literature Review and Research Hypotheses

2.1. ESG Performance and Total Factor Productivity

According to the theory of information asymmetry, investors often require a substantial amount of relevant information to make decisions. In situations of severe information asymmetry, investors might make erroneous

decisions, thereby reducing the allocation efficiency of the capital market. This leads to high-quality companies finding it challenging to obtain substantial funding for innovative activities, while less efficient companies can continue to acquire funds for less efficient production models. In [11], the authors demonstrated that the ESG rating of listed companies can reflect a company's level of corporate governance and effectively indicate the quality of information disclosure. There exists a significant positive correlation between these two aspects. Additionally, higher levels of corporate governance can effectively reduce situations where management sacrifices the company's long-term interests for personal gains due to agency problems and significantly curb the interests' encroachment by major shareholders [11–13]. By fully disclosing relevant information, companies enable investors to better understand their developmental status, facilitating the movement of capital in the capital market toward high-quality companies. Consequently, this enhances the ESG rating of listed companies, enabling companies to obtain more substantial resources for production activities, thereby increasing the total factor productivity of enterprises [14].

From a stakeholder theory perspective, if a company demonstrates excellent ESG performance, it can gain the trust of various stakeholders, thereby fostering the improvement of relationships among groups of stakeholders such as shareholders, employees, consumers, creditors, and the media. This leads to additional funding sources for external investments and internal research and development. Firstly, internal research and development, as a driving force for technological progress, enables companies to increase their knowledge reserves, optimize the combination of production factors, improve and upgrade production technology to enhance production efficiency. Additionally, research and development can help companies achieve technological innovation, providing new impetus for company development. Secondly, regarding external investments, limited resources can be invested in more efficient projects, thereby reducing the risk of resource misallocation and increasing total factor productivity [15]. Based on this, the following hypothesis is proposed:

H1: ESG performance contributes to enhancing the total factor productivity of enterprises.

2.2. ESG Performance, Corporate Reputation, and Total Factor Productivity

In the 1970s, signal transmission theory, stemming from information asymmetry theory, became a focal point for many scholars. Signal transmission theory is employed to alleviate information asymmetry. It posits that companies should timely disclose relevant internal information to enable outsiders to better understand the

company's actual operational status, thereby reducing information asymmetry. Moreover, to acquire external resources more effectively, internal personnel actively disclose information about the company to convey the company's operational situation to the external environment. Companies often use signals such as profits and incentives as financial indicators, while in the current scenario, ESG reports, non-financial indicator disclosures, have become an aspect that investors particularly focus on. Therefore, actively engaging in ESG disclosure essentially informs the market that the company considers the interests of various stakeholders during its operations, maintaining a positive stakeholder relationship, thus enabling the acquisition of more external resources [16–18].

Compared to companies that do not undertake social responsibility, socially responsible companies can transmit positive information about their good operational management to the outside world, thereby gaining the trust of more stakeholder groups, aiding the establishment of higher social reputation for the company [19]. Furthermore, corporate reputation is an intangible asset that allows companies to obtain capital from the outside, thereby alleviating the financing constraints of the company. Simultaneously, it increases the probability of attracting high-quality talents, which are crucial elements for company growth and also ensure the investment in human resources [19,20].

Hence, the following hypothesis is formulated:

H2: Corporate reputation acts as a mediator in the impact of ESG performance on the total factor productivity of enterprises.

3. Research Methods

3.1. Sample Selection

This study primarily investigates the impact of ESG performance of A-share listed companies on the total factor productivity of enterprises. Data were collected and organized through the Guotai An (CSMAR) database and the Wind Information (WIND) database. Using the Huazheng ESG rating data, the study period was set from 2012 to 2022, considering the availability of other key research variables. The data selection followed these criteria: (1) ST and *ST companies were removed; (2) companies from the financial and insurance industries were excluded; (3) samples with missing values were eliminated, resulting in an observed sample of 5993. To mitigate the influence of outliers on empirical results, a 1% winsorization was applied to continuous variables.

3.2. Variable Definitions

Dependent Variable: The total factor productivity (TFP) of enterprises was measured using methods such as OP,

LP, OLS, etc. The study used the [21] and [22] methods to measure TFP through the LP method.

Explanatory Variable: The explanatory variable in this study is ESG performance. The study constructed the Huazheng ESG rating index by referencing mainstream ESG rating systems both domestically and internationally. Each indicator's applicability was deliberated to exclude unsuitable or unattainable data. Based on the rating criteria, ESG ratings were divided into 8 levels, from low to high: C, CC, CCC, B, BB, BBB, A, AA, and these ratings were used as the explanatory variable to measure a company's ESG performance.

Mediating Variable: After consulting relevant literature on corporate reputation, various foreign methods for measuring corporate reputation were examined, such as the "Most Admired Companies in America," "Global Most Admired Companies," and "Reputation Index" published by Fortune magazine. However, due to differences in cultural aspects between the East and the West, these methods might not be suitable for research on Chinese companies. Hence, building upon the work in [23], this study measured corporate reputation using intangible asset data.

Control Variables: Existing data suggests that factors such as company size, financial status, debt-paying ability, profitability, and corporate governance all impact the improvement of total factor productivity. Hence, referring to the methods of reference [24], the following control variables were selected: (1) Company Size (Size), (2) Company Age (Age), (3) Debt-to-Asset Ratio (Lev), (4) Return on Assets (ROA), (5) Fixed Asset Ratio (Fixed), (6) Company Growth (Growth), (7) Company Market Value (TobinQ), (8) Management Shareholding Ratio (Mshare), (9) Equity Concentration (Top10), and (10) Independent Director Ratio (Outdir). Definitions for related variables are detailed in Table 1.

3.3. Model design

To examine the impact of ESG performance on total factor productivity and explore the relationship between ESG performance, corporate reputation, and total factor productivity, a fixed-effects model based on the mediation effect testing method proposed [25] is established. To test the impact of ESG performance on overall factor productivity, the following model is designed:

$$TFP_{it}=\alpha_0+\alpha_1 ESG_{it}+\sum \alpha_j Controls_{it} + u_i+\lambda_t+\varepsilon_{it} \quad （1）$$

1. This model aims to investigate how ESG performance affects total factor productivity by considering various control variables.

2. Using corporate reputation as the dependent variable, the model aims to investigate the influence of ESG

performance on corporate reputation. The model is represented as:

$$Rep_{it} = \beta_0 + \beta_1 ESG_{it} + \sum \beta_j Controls_{it} + u_i + \lambda_t + \varepsilon_{it} \quad (2)$$

This model examines the impact of ESG performance on corporate reputation, incorporating control variables.

3. Incorporating both ESG performance and corporate reputation, this model examines whether corporate reputation mediates the relationship between ESG and total factor productivity:

$$TFP_{it} = \gamma_0 + \gamma_1 ESG_{it} + \gamma_2 Rep_{it} + \sum \gamma_j Controls_{it} + u_i + \lambda_t + \varepsilon_{it} \quad (3)$$

This model investigates the potential mediation effect of corporate reputation in the relationship between ESG and total factor productivity.

Here, I represents the enterprise, t represents the year, **Controls represents** the control variables, u_i represents individual fixed effects, λ_t **represents time fixed effects**, **and** ε_{it} represents the random disturbance term.

Table 1. Variable definition explanations

Variable type	Variable Names:	variable symbol	variable definition
Dependent Variable	High-Quality Development of Enterprises	TFP	Measurement of Total Factor Productivity using the LP method
Independent Variable	Enterprise ESG Performance	ESG	Assignment of values from 1-8 based on the Huazheng ESG rating from low to high
Mediating Variable	Corporate Reputation	Rep	Natural logarithm of Intangible Asset Net Value
Control Variable	Company Size	Size	Natural logarithm of Total Assets of the enterprise
	Company Age	Age	Age of the enterprise from its establishment to the specific period
	Asset-Liability Ratio	LEV	Total Liabilities to Total Assets ratio of the enterprise
	Asset Yield/Asset Profitability Ratio	ROA	Net Profit to Total Assets ratio
	Fixed Asset Ratio	Fixed	Net Fixed Assets to Total Assets ratio
	Company Growth Potential	Growth	Growth in Total Assets of the enterprise
	Company Market Value	TobinQ	Market Value to Total Assets ratio
	Management Holding Percentage	Mshare	Quantity of Management-held Shares to Total Shares
	Equity Concentration	Top10	Sum of the shareholding proportion of the top 10 shareholders of the enterprise
	Proportion of Independent Directors	Outdir	Proportion of Independent Directors among the total number of Board Members

Table 2: Descriptive statistics of variables

Variable name	Sample size	Mean value	Standard deviation	Minimum value	Maximum value
TFP	5993	8.634	1.115	4.706	13
ESG1	5993	3.965	1.162	1	8
Size	5993	22.608	1.313	18.524	28.293
Lev	5993	0.493	0.207	0.01	1.957
ROA	5993	0.03	0.075	-0.894	0.517
Cashflow	5993	0.047	0.078	-0.556	0.661
FIXED	5993	0.225	0.177	0	0.929
Growth	5993	0.276	2.175	-0.985	87.484
Indep	5993	0.374	0.059	0.167	0.714
Top10	5993	0.534	0.152	0.106	0.952
TobinQ	5993	2.025	2.16	0.674	76.82
Age	5993	3.058	0.244	1.946	3.761
Mshare	5993	0.036	0.111	0	1.694
Rep	5993	18.935	1.877	7.458	24.398

4. Analysis of empirical results

4.1. Descriptive Statistics

Descriptive statistical analysis, as depicted in Table 2, provides an overview of the collected data. This study gathered a total of 5993 valid samples, encompassing 14 variables. Among these variables, the total factor productivity (TFP) ranges from a minimum of 4.706 to a maximum of 13, with a standard deviation of 1.115. These values indicate significant differences in development across various industries in China.

The ESG performance (ESG1) of companies varies substantially, ranging from a minimum of 1 to a maximum of 8, with an average value of 3.965 and a standard deviation of 1.162. This highlights the considerable diversity in ESG performance among different companies.

Regarding corporate reputation (Rep), the average value is 18.935 with a standard deviation of 1.877. These figures illustrate significant differences in reputation among different enterprises. Such variability among the samples enhances the effectiveness of the empirical model analysis. The differences between samples enable more

comprehensive matching in regression analysis, resulting in more credible and robust outcomes.

4.2. Correlation Analysis

The correlation analysis reveals significant relationships among the variables. From Table 3, it is evident that the correlation coefficient between ESG and total factor productivity is 0.276. This indicates a substantial positive association between ESG performance and total factor productivity, and the research findings are statistically significant at the 1% level. This result provides initial support for hypothesis H1, suggesting that ESG performance significantly enhances total factor productivity.

Furthermore, the analysis shows a strong correlation between corporate reputation and ESG performance, with a correlation coefficient of 0.153. Additionally, the correlation coefficient between corporate reputation and total factor productivity stands at 0.361, both achieving statistical significance at the 1% level. These results suggest that ESG performance elevates total factor productivity through the enhancement of corporate reputation, thereby providing preliminary validation for hypothesis H2.

Table 3: Correlation analysis of variables

Variables	TFP	ESG1	Size	Lev	ROA	Cashflow	FIXED	Growth	Indep	Top10	TobinQ	Age	Mshare	Reput
(1) TFP	1.000													
(2) ESG1	0.276***	1.000												
(3) Size	0.737***	0.312***	1.000											
(4) Lev	0.361***	0.044***	0.415***	1.000										
(5) ROA	0.179***	0.189***	0.086***	0.357***	1.000									
(6) Cashflow	0.100***	0.047***	0.040***	0.205***	0.405***	1.000								
(7) FIXED	0.197***	0.050***	-0.004	-0.017	0.041***	0.232***	1.000							
(8) Growth	0.038***	0.041***	0.010	0.014	0.070***	0.006	-0.026*	1.000						
(9) Indep	0.016	0.096***	0.038***	0.000	0.036**	0.040***	-0.034*	0.004	1.000					
(10) Top10	0.273***	0.084***	0.333***	0.083***	0.133***	0.085***	0.031*	0.048***	-0.036*	1.000				
(11) TobinQ	0.301***	0.122***	0.391***	0.209***	0.013	0.018	0.074***	-0.011	0.029*	0.124***	1.000			
(12) Age	0.101***	0.095***	0.130***	0.060***	0.089***	-0.045***	-0.126***	0.023	0.040***	-0.019	0.026*	1.000		
(13) Mshare	-0.022	-0.008	0.088***	0.139***	0.099***	0.059***	-0.121***	0.053***	-0.003	0.006	0.007	-0.176***	1.000	
(14) Rep	0.361***	0.153***	0.560***	0.105***	0.075***	0.116***	0.220***	-0.026*	0.005	0.153***	-0.212***	-0.004	-0.027*	1.000

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

Table 4: Variance Inflation Factor (VIF) Test

Variables	VIF	1/VIF
Size	1.78	0.561
Lev	1.54	0.65
ROA	1.32	0.759
ESG1	1.22	0.82
Age	1.17	0.855
Top10	1.15	0.87
TobinQ	1.1	0.909
Mshare	1.07	0.933
FIXED	1.05	0.949
Indep	1.02	0.982
Growth	1.00	0.998

In order to accurately mitigate the interference of multicollinearity among the variables, a VIF test was conducted. The analysis results, as presented in Table 4, reveal that all variables have VIF values less than 5. This indicates that there is no evidence of multicollinearity among the variables. Hence, the selection of variables is reasonable, and the analytical data results possess a higher level of reliability.

4.3. Hausman Test

Prior to conducting regression analysis, a Hausman test was employed to determine whether a fixed effects model or a random effects model should be selected. The test results, as displayed in Table 5, indicate that the test statistics for each variable are less than 0.01. This signifies that for this research, a fixed effects model is more suitable compared to a random effects model.

4.4. Baseline Regression Analysis

Following the research approach, a baseline regression was conducted to explore the relationship between a company's ESG performance and Total Factor Productivity (TFP). The results of the model are presented in Table 6. Model (1) includes Total Factor Productivity (TFP) and Company ESG1 performance alone, while Model (2) incorporates Total Factor Productivity (TFP), Company ESG1 performance, and control variables.

The analysis indicates that the value of ESG1 in Model (1) is 0.0454, and in Model (2), it stands at 0.0484. Both values are statistically significant at the 1% level, indicating a positive impact of a company's ESG performance on its Total Factor Productivity. In other words, as a company's ESG performance improves, its Total Factor Productivity tends to increase.

Table 5: Hausman Test

variable	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
ESG1	0.008	0.011	-0.004	0.001
Size	0.525	0.562	-0.037	0.006
Lev	0.276	0.333	-0.057	0.014
ROA	1.46	1.548	-0.088	0.009
FIXED	-1.076	-1.018	-0.058	0.023
Growth	0.001	0.001	0.001	0.001
Indep	0.167	0.127	0.04	0.03
Top10	0.04	0.045	-0.005	0.023
TobinQ	0.004	0.004	0	0.001
Age	0.608	0.252	0.355	0.104
Mshare	0.351	0.281	0.07	0.032

b = Consistent under H0 and Ha; obtained from xtreg.

B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

Test of H0: Difference in coefficients not systematic

chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 333.59

Prob > chi2 = 0.0000

Model (1) has an adjusted R-squared of 0.107, whereas Model (2), which includes control variables, exhibits an adjusted R-squared of 0.275. The higher adjusted R-squared in Model (2) compared to Model (1) suggests that the inclusion of control variables enhances the model's fit.

Table 6: Baseline Regression Results

	TFP	TFP
	(1)	(2)
ESG1	0.0454***	0.0484***
	(4.9122)	(6.3509)
Lev		1.0163***
		(18.1972)
ROA		2.1160***
		(20.5147)
FIXED		-1.2914***
		(-17.2327)
Growth		-0.0000
		(-0.9690)
Indep		0.0791
		(0.5050)
Top10		0.8605***
		(11.7103)
TobinQ		-0.0148***
		(-9.1943)
Age		1.2318***
		(36.8100)
Mshare		0.4258***
		(4.0982)
cons	8.3609***	3.9117***
	(225.0124)	(29.0693)
N	5993	5993
adj. R2	0.107	0.275

4.5. Mediation Analysis

The results of the mediation effect for company reputation are depicted in Table 7. Model (1) represents the regression model between the dependent variable and independent variable along with control variables in the absence of Reputation. Model (2) includes the regression model of the independent variable, control variables, and Reputation. Lastly, Model (3) displays the regression model between the dependent variable and independent variable after adding control variables and Reputation.

The regression outcomes reveal a significant impact of a company's ESG performance on the enhancement of Total Factor Productivity under the mediation effect of company reputation. Both Model (1) and Model (3) exhibit significant results for ESG performance at a 1% confidence level. Specifically, when a company's ESG1 performance increases by 1 unit, it leads to a 0.0471 unit increase in high-quality development for the enterprise. In Model (2), the mediator variable, company Reputation, shows a significant positive correlation with ESG ratings at a 1% level. This signifies the transmission role of company reputation between ESG ratings, indicating that an improvement in ESG performance enhances company reputation, further boosting Total Factor Productivity.

Table 7: Company Reputation Mediation Effect

	TFP	Rep	TFP
	(1)	(2)	(3)
ESG1	0.047***	0.070***	0.043***
	(6.07)	(4.05)	(5.50)
Rep			0.070***
			(10.12)
Lev	0.903***	0.667***	0.856***
	(14.16)	(4.75)	(13.55)
ROA	1.891***	0.067	1.887***
	(17.65)	(0.28)	(17.82)
FIXED	-1.027***	0.441**	-1.058***
	(-12.16)	(2.37)	(-12.67)
Growth	0.020***	0.004	0.020***
	(7.18)	(0.63)	(7.17)
Indep	0.175	-0.905**	0.239
	(1.05)	(-2.47)	(1.45)
Top10	0.849***	1.406***	0.750***
	(10.47)	(7.87)	(9.29)
TobinQ	-0.033***	-0.029***	-0.031***
	(-7.92)	(-3.18)	(-7.51)
Age	1.197***	-0.446	1.228***
	(5.64)	(-0.95)	(5.86)
Mshare	0.313***	1.023***	0.241**
	(2.79)	(4.14)	(2.17)
Y			0.070***
			(10.12)
cons	4.191***	18.230***	2.910***
	(6.50)	(12.83)	(4.48)
N	4783	4783	4783
R2	0.405	0.207	0.419
adj. R2	0.318	0.091	0.334

t statistics in parentheses

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

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4.6. Robustness Tests

4.6.1 Replacing the Dependent Variable

To test the robustness of the model, the dependent and independent variables were replaced. In the previous basic regression analysis, the ESG ratings from Huazheng were assigned numerical values according to their order. For robustness testing, following the methodology from previous research by [26] and [27], a reassignment of the Huazheng ESG ratings was done. Publicly available data indicate that these ratings can be categorized into three levels: A-rated companies are ESG performance leaders, B-rated companies represent average ESG performance, and C-rated companies lag behind. In this context, the ESG2 variable was assigned values according to these definitions to replace ESG1. Additionally, the alternative measurement methods for the dependent variable, Total Factor Productivity, were considered. Robustness testing included using the OP method, OLS method, and fixed-effect method to reevaluate Total Factor Productivity and use these new measurements as dependent variables.

In Table 8, Model (1) represents the replacement of the explanatory variable ESG1 with ESG2. Models (2), (3), and (4) represent the results of regressions using OLS, fixed-effect, and OP methods with different measurements of the dependent variable. The results show that ESG performance remains highly significant in all models at a 1% significance level. This consistency in results suggests that the model is robust.

4.6.2 Instrumental Variable

The baseline regression results indicate that the better the ESG performance, the stronger the positive effect on enhancing a company's total factor productivity. However, this result could also be due to the fact that companies with higher total factor productivity are more willing to actively improve their own ESG rating, potentially leading to a two-way causal endogeneity issue. To address this potential endogeneity issue, this paper employs lagged ESG performance and the industry average ESG performance as instrumental variables in a two-stage least squares regression. In the first-stage regression of the two-stage least squares method, the study uses the firm's ESG performance as the explained variable, the lagged ESG performance, and industry average ESG performance as explanatory variables, alongside the control variables From Model (1), controlling for industry and time effects in a least squares regression. In the second stage, the study employs the total factor productivity measured by the OP and LP methods as the explained variables and ESG performance as the explanatory variable for regression.

Table 8: Replacing the Dependent Variable

	TFP_LP (1)	TFP_OLS (2)	TFP_FE (3)	TFP_OP (4)
ESG1		0.0709***	0.0770***	0.0191***
		(8.4224)	(8.8641)	(2.6220)
ESG2	0.1248***			
	(7.0238)			
Lev	1.2301***	1.2503***	1.3103***	0.7495***
	(19.9518)	(20.2767)	(20.6031)	(14.0487)
ROA	2.3734***	2.3542***	2.4035***	1.9902***
	(20.8115)	(20.6719)	(20.4631)	(20.1982)
FIXED	-0.2301***	-0.2165***	-0.0589	-1.0492***
	(-2.7761)	(-2.6171)	(-0.6898)	(-14.6566)
Growth	-0.0001*	-0.0001*	-0.0001**	-0.0000
	(-1.8598)	(-1.9281)	(-2.0534)	(-0.7751)
Indep	-0.0789	-0.1321	-0.1822	0.2694*
	(-0.4559)	(-0.7635)	(-1.0210)	(1.8001)
Top10	1.2332***	1.2340***	1.3121***	0.6541***
	(15.1693)	(15.2100)	(15.6809)	(9.3184)
TobinQ	-0.0180***	-0.0182***	-0.0190***	-0.0123***
	(-10.1472)	(-10.2735)	(-10.3803)	(-8.0163)
Age	1.6894***	1.6823***	1.7672***	1.0993***
	(45.5806)	(45.5339)	(46.3758)	(34.3910)
Mshare	0.2287**	0.2391**	0.2112*	0.3907***
	(1.9898)	(2.0845)	(1.7849)	(3.9369)
cons	4.5909***	4.5490***	4.7424***	2.8117***
	(30.8029)	(30.6185)	(30.9489)	(21.8732)
N	5878	5878	5878	5878
adj. *R*²	0.299	0.301	0.305	0.225

The regression results are presented in Table 9. It can be observed that in the first stage of Table 9, the regression coefficients of L.ESG and IndESG are both significantly greater than 0 at the 1% significance level. This indicates a high correlation between these two instrumental variables and the explanatory variables. The results of the weak instrumental variable test and over-identification test also demonstrate the effectiveness of the instrumental variable selection in this study. Looking at columns (2) and (3) of Table 9, the regression coefficients for ESG are 0.101 and 0.185, both significant at the 1% level. This demonstrates that, even after using instrumental variables to address potential endogeneity issues in the two-stage least squares regression, the conclusions of this study still hold, affirming that a strong ESG performance in companies can contribute to increased total factor productivity.

Table 9: Results of Instrumental Variable Regression

	First ESG (1)	Second TFP_OP (2)	Second TFP_LP (3)
ESG		0.101***	0.185***
		(17.47)	(26.61)
L.ESG	0.774***		
	(145.65)		
IndESG	0.066***		
	(3.94)		
Control	YES	YES	YES
YEAR	YES	YES	YES
INDUSTRy	YES	YES	YES
_cons	0.924***	5.125***	6.580***
	(7.64)	(71.22)	(76.07)
N	5878	5878	5878
adj. R2	0.614	0.484	0.552

4.6.3 Controlling for Individual Effects

To further address estimation biases caused by endogeneity, this study undertook regression analysis controlling for individual effects. Table 10 provides regression results simultaneously controlling for individual, industry, and yearly effects. From Table 10, it is observed that after controlling for individual effects, the coefficients for ESG are 0.0629, 0.0654, 0.1142, and 0.1194, all significant at the 1% level. This indicates that strong ESG performance in companies can enhance total factor productivity and affirms the prior research conclusion even after addressing potential endogeneity by controlling for individual effects.

4.6.4 Sample Selection Issue

This paper employs the Heckman two-stage regression to address potential sample selection issues. In the first stage Probit regression, the dependent variable DESG is a dummy variable. When ESG is greater than the mean, DESG is 1; when ESG is less than the mean, DESG is 0. The exogenous instrument variable remains the industry average of ESG performance (IndESG). The choice of the industry average of ESG performance as an exogenous instrument variable is because a company's ESG performance can be influenced by industry ESG performance, especially the industry environment, social responsibility awareness, and corporate governance, which can affect a company's ESG performance. Other control variables remain consistent with Model (1). The inverse Mill's ratio is calculated from the first-stage regression results, and it is included in the model for the second-stage regression. The regression results, as shown in the second column and third column of Table 11, demonstrate that the ESG regression coefficients for both OP and LP measures of total factor productivity are significant at the 1% level. This indicates that even after employing Heckman's two-stage regression to overcome potential sample selection issues, the study's conclusion remains valid, demonstrating the robustness of the research findings.

Table 10: Results of Regression Controlling for Individual Effects

variable	(1) TFP_OP	(2) TFP_OP	(3) TFP_LP	(4) TFP_LP
ESG	0.0629***	0.0654***	0.1142***	0.1194***
	(15.22)	(16.12)	(23.60)	(24.98)
Control	YES	YES	YES	YES
YEAR	NO	YES	NO	YES
INDUSTRY	NO	YES	NO	YES
FIRM	NO	YES	NO	YES
_cons	4.8033***	4.8910***	6.4325***	6.4697***
	(105.99)	(80.20)	(121.30)	(90.03)
N	5878	5878	5878	5878
Adj. R2	0.4488	0.5001	0.5426	0.5793
F	1713.11	526.8621	2495.51	725.0600

Table 11: Heckman Two-Stage Regression Results

variable DESG	(1) TFP_OP	(2) TFP_LP	(3)
ESG		0. 0796*** (19. 53)	0. 1436*** (29. 47)
IndESG	0. 0935** (2. 08)		
imr		1. 6762*** (10. 77)	2. 1807*** (11. 72)
Control	YES	YES	YES
YEAR	YES	YES	YES
INDUSTRY	YES	YES	YES
_cons	0. 9302*** (2. 76)	4. 6803*** (71. 93)	6. 2011*** (79. 72)
N	5787	5878	5878
Adj. R2		0. 4869	0. 5559
F		524. 3927	691. 3780

4.7. Further Research

4.7.1 Analysis Based on Scale Heterogeneity

Larger companies tend to hold leading positions within their industries due to their robust risk resilience and extensive funding sources, providing a secure foundation for the full realization of ESG's role. This subsequently aids companies in alleviating financing constraints and increasing research and development investments, thus enhancing total factor productivity. Accordingly, this study anticipates that the positive impact of excellent ESG performance on the total factor productivity of large-scale enterprises will be greater than that on small and medium-sized enterprises (SMEs). Therefore, In [28, 29], papers measures company size using the natural logarithm of total assets and groups the sample based on the mean of this indicator. Companies larger than the mean are categorized as large-scale enterprises, while those smaller than the mean are classified as SMEs. Subsequently, group regression and inter-group coefficient difference tests are conducted based on Model (1). Columns (1) and (2) in Table 12 provide the results of the group regression, showing that while the ESG coefficients in both sample groups are significantly positive, the regression coefficients in the large-scale enterprise sample (0.0744 and 0.1291) are higher than those in the SME sample (0.0095 and 0.0398). Moreover, the inter-group coefficient difference test also indicates significance at the 1% level, confirming the hypothesis that excellent ESG performance has a greater positive impact on the total factor productivity of large-scale enterprises compared to SMEs.

4.7.2 Heterogeneity Analysis Based on Property Rights

For state-owned enterprises, they possess stronger talent and technological advantages and tend to have easier access to funding sources during financing.

Consequently, state-owned enterprises' research and development investments often enjoy more robust financial support, contributing to an improved total factor productivity. In this scenario, state-owned enterprises are better positioned to leverage the advantages of excellent ESG performance, translating it into impetus for increased research and development investments to enhance total factor productivity. Therefore, this study expects that excellent ESG performance has a greater positive impact on the total factor productivity of state-owned enterprises compared to non-state-owned enterprises.

Table 12: Heterogeneity Test Results Based on Scale

variable	(1) TFP_OP	(2) TFP_OP	(3) TFP_LP	(4) TFP_LP
ESG	0. 0744*** (12. 95)	0. 0095* (1. 90)	0. 1291*** (19. 83)	0. 0398*** (7. 26)
Control	YES	YES	YES	YES
YEAR	YES	YES	YES	YES
INDUSTRY	YES	YES	YES	YES
_cons	5. 4618*** (51. 23)	5. 6829*** (85. 13)	7. 8087*** (64. 67)	7. 4120*** (101. 60)
N	5787	5878	5787	5878
Adj. R2	0. 3843	0. 2829	0. 4481	0. 3346
F	150. 8827	121. 3907	195. 9741	154. 4751

Coefficient difference test between groups
Chi2(1) = 71. 15
Prob>Chi2 = 0. 0000
Chi2(1) = 106. 61
Prob>Chi2 = 0. 0000

To test the heterogeneous effects of ESG performance on the improvement of total factor productivity for state-owned and non-state-owned enterprises, this study uses a dummy variable based on the ownership nature. State-owned enterprises are represented as 1, while non-state-owned enterprises are represented as 0. Group regression is conducted based on Model (1), and inter-group coefficient difference tests are performed. Columns (3) and (4) in Table 13 present the regression results for the sub-samples of state-owned and non-state-owned enterprises.

The regression coefficients for ESG in state-owned enterprise results are 0.1072 and 0.1721, both significant at the 1% level. In the non-state-owned enterprise results, the ESG coefficients are 0.0527 and 0.1084, also significant at the 1% level. While both are significantly positive at the 1% level, the regression coefficient for state-owned enterprises is higher than that for non-state-owned

Table 13: Heterogeneity Test Results Based on Property Rights

variable	(1) TFP_OP	(2) TFP_OP	(3) TFP_LP	(4) TFP_LP
ESG	0. 1072***	0. 0527***	0. 1721***	0. 1084***
	(14. 51)	(10. 74)	(19. 56)	(18. 58)
Lev	1. 3074***	1. 4923***	1. 7763***	2. 2212***
	(23. 99)	(45. 49)	(27. 39)	(56. 92)
Control	YES	YES	YES	YES
YEAR	YES	YES	YES	YES
INDUSTRY	YES	YES	YES	YES
_cons	4. 8553***	5. 1079***	6. 6820***	6. 6744***
	(41. 67)	(68. 11)	(48. 18)	(74. 81)
N	4564	5878	4564	5878
Adj. R2	0. 5018	0. 4409	0. 5588	0. 5040
F	184. 4533	289. 8876	231. 6766	373. 3346

enterprises. Moreover, the inter-group coefficient difference test is significant at the 1% level, indicating that excellent ESG performance has a more substantial positive effect on the total factor productivity of state-owned enterprises compared to non-state-owned enterprises.

5. Conclusion and Enlightenment

5.1. Research Conclusions

This study focuses on A-share listed companies from 2012 to 2022, utilizing the Huazheng rating index to measure corporate ESG performance and validating the correlation between ESG performance and total factor productivity of listed companies. The main conclusions drawn from this research are as follows:

ESG Performance and Total Factor Productivity: ESG performance significantly enhances a company's total factor productivity. This implies that higher ESG performance correlates with increased total factor productivity.

Effect of Corporate Reputation: Empirical analysis demonstrates that a company's reputation significantly influences the enhancement of its total factor productivity. This indicates that improving a company's reputation through good ESG performance further elevates its total factor productivity. Furthermore, these conclusions remain robust after various sensitivity tests such as altering the computation method of the explained variable, alternative assignment methods for explanatory variables, implementing instrumental variable methods to alleviate potential endogeneity issues, and utilizing the Heckman two-stage method to correct sample selection biases.

Heterogeneity Analysis: The research shows that the impact of good ESG performance on enhancing total factor productivity is more pronounced in large-scale enterprises and state-owned enterprises.

5.2. Policy Insights

Based on the conclusions drawn in the previous sections, the paper proposes policy recommendations in the following areas:

Policy Formation: Governments should expedite the formulation of laws and regulations governing corporate ESG performance to establish a robust institutional framework, directing policies to steer companies toward high-quality development. This includes fostering environmentally friendly practices and preventing inadequate or untimely disclosures, thus discouraging unethical behaviors born from insufficient information, such as illegal waste disposal or opportunistic practices.

Enhanced Regulatory Oversight: Regulatory authorities should intensify their focus on corporate ESG performance by implementing stricter laws, establishing robust regulatory mechanisms, and employing more robust measures to maintain market order. Introducing third-party audit mechanisms for comprehensive assessment and evaluation of a company's ESG performance would ensure its quality and credibility.

Balanced Perspective on ESG Performance: Companies should adopt a balanced perspective on the unique role of ESG performance. They should invest efforts into achieving a win-win scenario in terms of economic and social benefits based on their specific circumstances. Acknowledging the necessity of improving ESG performance for sustainable development, companies can align economic and social benefits, promoting organizational legitimacy for their high-quality development.

This research provides practical policy implications to promote sustainable business practices and organizational growth.

Conflict of Interest

The authors declare no conflict of interest.

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