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Original Research

Does ESG Disclosure Improve Green Innovation Performance of New Energy Enterprises? Evidence from China

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Abstract

Utilizing data from Chinese A-share new energy listed companies spanning 2010 to 2022, this study empirically investigates the impact of ESG disclosure on the green innovation performance of new energy firms. The findings reveal that ESG disclosure significantly enhances green innovation performance, with these results remaining robust across various tests. Mechanism analysis indicates that ESG disclosure primarily facilitates green innovation by mitigating corporate financing constraints and improving the quality of internal control. The heterogeneity analysis further demonstrates that the positive effect of ESG disclosure on green innovation is more pronounced in high-tech industries, firms with high institutional investor attention, and firms located in eastern China. This research provides a foundation for further refinement of the ESG disclosure system and offers strategic insights for new energy enterprises aiming to boost their innovation performance.

Keywords: ESG disclosure, green innovation performance, new energy enterprises, financing constraints, quality of internal controls

Introduction

Currently, the world faces resource depletion, environmental pollution, and climate change, making sustainable development urgent and challenging on a global scale. Governments and the public increasingly emphasize green environmental protection and actively promote the research, application, and dissemination of green innovative technologies. As primary drivers of economic development, new energy enterprises are pivotal in advancing green innovation. The green innovation performance of these enterprises is crucial for their sustainable development and significantly influences the broader green transformation of the economic system. Consequently, enhancing green innovation performance is a vital concern for new energy enterprises to achieve sustainable development.

To address these issues, the United Nations Principles for Responsible Investment (UN-PRI) introduced ESG criteria, with European institutional

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investors pioneering the adoption of ESG indicators and considering corporate ESG performance as a crucial factor in investment decisions. ESG disclosure involves the systematic and comprehensive reporting of non-financial performance, including environmental and social responsibilities, as well as the effectiveness of corporate governance. This practice highlights the sustainable development capabilities of enterprises. By providing key information to both internal and external stakeholders, ESG disclosure offers specific and actionable guidance for green development and serves as a vital tool for implementing sustainable development strategies. However, ESG disclosure in China's capital market commenced late and remains in its nascent stage [1]. The development of ESG investment in China has been impeded by issues such as low transparency, poor standardization, and weak comparability of ESG information disclosed by enterprises, along with the limited and delayed access to information for investors [2].

From the perspective of existing research, few studies have focused on the ESG performance of new energy enterprises. The available studies predominantly examine the impact of ESG performance on corporate finance and are largely qualitative [3], with only a limited number employing quantitative methods. Furthermore, the assessment of corporate green innovation performance is typically based on singular metrics, such as the number of green patent applications [4, 5]. This raises the question: what are the economic consequences of ESG disclosure, and does it affect the green innovation performance of new energy enterprises? Investigating this issue could facilitate the enhancement of ESG disclosure levels among new energy enterprises and subsequently improve their green innovation performance.

Technological innovation within an enterprise is characterized by multi-input and multi-output activities, making its production function complex and difficult to ascertain. Therefore, employing Data Envelopment Analysis (DEA) is a more suitable approach to measure an enterprise's innovation performance. DEA, established by Charnes et al. (1978) [6], is an efficiency evaluation method based on the concept of "relative efficiency evaluation." Depending on different premise assumptions, DEA can be divided into the CCR model [7] and the BCC model [8]. The CCR model evaluates the relative efficiency of decision-making units (DMUs) under constant returns to scale, while the BCC model does so under variable returns to scale. The traditional CCR model, assuming fixed returns to scale, measures comprehensive efficiency as an integration of pure technical efficiency and scale efficiency. Pure technical efficiency, influenced by factors such as management and technology, reflects the production efficiency of input factors when the DMU operates at an optimal scale, significantly impacting the enterprise's overall efficiency. Given that green innovation activities typically necessitate technical inputs and enhancements, with minimal disruption from non-technical factors, and emphasize core production processes like technological innovation and resource utilization efficiency, pure technical efficiency more directly reflects an enterprise's performance in these areas.

Based on the above analysis, we collected data from Chinese A-share new energy listed companies from 2010 to 2022 and used DEA to calculate pure technical efficiency as a proxy for firms' green innovation performance. This allowed us to empirically test the impact of ESG disclosure on green innovation performance. Our study may contribute in three ways: first, it enriches the research on the economic consequences of ESG disclosure by empirically demonstrating its positive effect on green innovation in new energy enterprises, thus supporting the importance of ESG information disclosure. Second, it expands the research on factors influencing corporate green innovation performance, an area less studied compared to financial performance. By focusing on new energy enterprises, we provide evidence on the role of ESG disclosure in innovation performance, offering insights into its influencing factors. Third, through mechanism tests, we show that ESG disclosure enhances green innovation performance by reducing financing constraints and improving internal control quality, offering pathways for improving green innovation in new energy enterprises. Additionally, this paper provides motivation for developing a unified, standardized ESG information disclosure system at national and regional levels, offering empirical references for other economies in the early stages of ESG development.

Research Hypothesis

(1) ESG disclosure, financing constraints, green innovation performance:

ESG disclosure enhances green innovation performance by easing financing constraints for new energy enterprises. Green innovation requires high investment, involves high risk, and has long cycles, along with significant environmental externalities. Hence, enterprises need long-term and stable financial support for green innovation activities.

Firstly, financial institutions and investors often increase risk premiums due to information asymmetry, raising financing costs for enterprises. Active ESG disclosure allows enterprises to demonstrate strong performance in environmental protection, social responsibility, and governance [9], thus reducing risk premiums. Good environmental performance shows excellent management in resource utilization and pollution control, reducing legal and operational risks. Strong social performance indicates good management of employee welfare, community relations, and product liability, lowering reputational risks. A robust governance structure reflects high transparency, board independence, and shareholder protection, decreasing management risk and agency costs. Lower risk

premiums enable firms to secure financing at reduced costs, freeing up more capital for green innovation.

Secondly, signaling theory indicates that when financial and non-financial information of enterprises converges, the transmitted information is of higher quality. ESG disclosure improves corporate transparency and alleviates information asymmetry between enterprises and stakeholders [10]. This enables investors and financial institutions to better understand operational risks and future value, expanding green grants and green credit [11]. Enhanced environmental awareness and sustainable development concepts make investors focus more on ESG performance when making investment decisions. For new energy enterprises, ESG disclosure is crucial for regulatory review of refinancing [12]. It simplifies information access for investors and reduces investment decision risks and adverse selection, thereby increasing exogenous financing and supporting green innovation.

Finally, governments and regulators increasingly focus on ESG performance and have introduced policies to encourage green innovation. Positive ESG disclosure helps firms comply with policies and gain government support, such as tax incentives and financial subsidies [13], providing financial incentives for green innovation.

Therefore, ESG disclosure facilitates access to external financial support, such as bank loans and government subsidies, which alleviates the financing constraints faced by enterprises in their green innovation efforts. This reduction in innovation costs incentivizes firms to engage in technological innovation activities, thereby gradually enhancing the output and quality of their innovations and boosting their green innovation performance.

(2) ESG disclosure, quality of internal controls, green innovation performance:

ESG disclosure bolsters corporate green innovation performance by fortifying the quality of internal controls. It functions not merely as a tool for external communication but also as a catalyst for enhancing the level of internal controls. Mandating companies to systematically evaluate and report on their environmental, social, and governance performance, ESG disclosure compels them to establish comprehensive internal control processes to ensure that all disclosures are compliant, accurate, and reliable [14]. This compliance check not only enhances the legal compliance of enterprises but also fortifies the standardization and systematization of internal control.

Firstly, ESG disclosure necessitates companies to systematically identify and assess environmental risks, compelling them to establish robust risk management systems. This ensures that companies can identify and respond to potential issues promptly, thereby enhancing preventive measures within internal controls [15]. A robust internal control risk assessment system aids companies in identifying, evaluating, and managing risks encountered during the green innovation process, enabling the adoption of suitable preventive measures. This mitigates unforeseen risks associated with the development and application of green technologies, thereby reducing the costs of green innovation risks.

Secondly, the reinforcement of internal controls enables enterprises to allocate and utilize resources more effectively. Rigorous budget control and cost management ensure the judicious allocation of resources to the most valuable green innovation projects, enhancing resource utilization efficiency and reducing wastage, thereby providing ample financial and resource support for green innovation. Through scientific resource allocation, enterprises can concentrate on overcoming critical technological challenges and promoting the research, development, and application of green technologies. A robust internal control system can also augment an enterprise's data management capability. Accurate data collection and analysis enable an enterprise to better comprehend its ESG performance and identify areas for improvement. These data not only assist enterprises in making informed decisions but also provide robust support for green innovation. For example, by analyzing environmental data, companies can identify the potential for energy saving and emission reduction and develop corresponding green technologies and products.

Finally, ESG disclosure also attracts more attention from the capital market, forcing firms to establish effective incentive mechanisms for green innovation in response to market concerns [16]. Through performance evaluation and reward systems, companies can motivate employees to propose and implement green innovation programs, while ensuring that incentives are fair and transparent to enhance employees' motivation to innovate. The improvement of the internal control system also helps enterprises to establish a mechanism for continuous improvement and learning. Through internal control feedback mechanisms such as internal auditing and performance evaluation, enterprises can identify problems in the process of green innovation in a timely manner, which helps them summarize their experiences, optimize the innovation process, and improve the ability and level of green innovation.

Therefore, ESG disclosure prompts enterprises to strengthen their internal controls to ensure the accuracy and transparency of information by requiring them to disclose their environmental, social, and governance practices and performance in detail. This strict internal control not only improves the enterprise's risk management, resource allocation, and data processing capabilities, but also optimizes the enterprise's innovation environment, motivates employees to actively participate in green innovation, and promotes technological advancement, thus facilitating the enhancement of the enterprise's green innovation performance level.

Based on the above analysis, we propose the following hypothesis:

Hypothesis: Effective ESG disclosure enhances green innovation performance in new energy firms.

Material and Methods

Data Sources and Sample Selection

We select China's A-share listed companies from 2010 to 2022 as the research sample. The data are processed as follows: (1) excluding *ST, ST, and PT firms; (2) removing samples with missing essential data; and (3) all the continuous variables were winsorized at the 1% and 99% levels. Ultimately, we obtain 133 firms with 784 valid observations. The ESG data utilized in this study are sourced from Sino-Securities Index Information Service (Shanghai) Co. Ltd., while the financial and corporate governance data are obtained from the CSMAR database.

The Dependent Variable (VRS)

The dependent variable is the enterprise green innovation performance (VRS). To evaluate this, we employ the pure technical efficiency (VRS) measure, assessing 133 new energy enterprises as decision-making units. Utilizing the CCR model within the DEA framework, we quantify the input and output efficiency of enterprise green innovation. This model assumes constant returns to scale for DMUs, thereby measuring total efficiency as a composite reflection of both pure technical efficiency and scale efficiency. The selection of input and output indicators is detailed in Table 1.

The Independent Variable (ESG)

Following the study by Yan et al. (2024) [17], we selected SNSI ESG as the explanatory variable to assess the level of ESG disclosure. This choice is based on the comprehensiveness of the SNSI ESG evaluation system, which aligns with international ESG principles, reflects the current state of disclosure and corporate characteristics in China, and is widely used. SNSI ESG scores range from 0 to 100, with higher scores indicating better ESG performance. To prevent regression coefficients from being too small to retain economic significance and to ensure ease of interpretation, the independent variables are divided by 100.

Table 1. Green innovation performance evaluation index system for new energy enterprises.

DEA Parameter	Index
Input Module	Percentage of R&D personnel
	R&D investment intensity
	Number of patent applications
	Patent applications per R&D staff member
Output Module	Average number of patents filed for R&D funding
	Assets and liabilities ratio
	Operating income growth rate
	Cost and Expense Margin

The Control Variables

To mitigate the impact of omitted variable bias and enhance the robustness of our model, we include several control variables that may influence the explanatory variables. These controls include firm size (Size), year of establishment (FirmAge), cash flow ratio (Cashflow), board size (Board), percentage of independent directors (Indep), percentage of shareholding by the largest shareholder (Top1), CEO duality (Dual), and financial leverage (FL).

Model Design

We employ a fixed-effects regression model that controls for individual, year, and industry-specific effects to examine the impact of ESG disclosure on green innovation performance. The model Equation is presented in (1):

$$VRS_{i,t} = \alpha_0 + \alpha_1 ESG_{i,t} + \alpha_2 control + \sum Firm + \sum Year + \sum Ind + \varepsilon_{i,t} \quad (1)$$

In Equation (1), i denotes the firm, t denotes time, $VRS_{i,t}$ represents green innovation performance, and $ESG_{i,t}$ represents corporate ESG disclosure. ∑Firm denotes firm-specific fixed effects, ∑Year denotes year fixed effects, ∑Ind denotes industry fixed effects, and ε represents a perturbation term that varies across firms and over time.

Results and Discussion

Descriptive Statistics

Table 2 presents the descriptive statistics results. The explanatory variable VRS has a maximum value of 1 and a minimum value of 0.497, indicating a significant disparity in the green innovation performance of the sample firms. The mean VRS is 0.782, with a standard deviation of 0.098, suggesting a generally high level of green innovation performance. The independent variable ESG has a maximum value of 0.070 and a minimum value of 0.010, highlighting a notable difference in ESG disclosure levels among the sample firms. The mean ESG is 0.044, with a standard deviation of 0.011, indicating that the overall level of disclosure among the sample firms is low.

Benchmark Regression

Table 3 illustrates the impact of ESG disclosure on the green innovation performance of new energy companies. Column (1) employs a fixed-effects

Table 2. Results of descriptive statistics.

Variables	mean	sd	min	max	p50	N
VRS	0.782	0.098	0.497	1.000	0.786	784
ESG	0.044	0.011	0.010	0.070	0.040	784
Size	23.200	1.250	20.470	26.670	23.040	784
FirmAge	2.885	0.310	2.079	3.497	2.890	784
Cashflow	0.045	0.057	-0.111	0.201	0.046	784
FL	1.304	1.065	-0.695	8.774	1.064	784
Board	2.122	0.178	1.609	2.639	2.197	784
Indep	37.330	4.862	33.330	50.000	33.330	784
Top1	31.630	13.800	8.087	65.750	29.940	784
Dual	0.361	0.481	0.000	1.000	0.000	784

regression model controlling for individual and year effects. Column (2) incorporates industry fixed effects in addition to the controls in column (1). Column (3) further adds control variables to the model in column (2). The regression results are significantly positive at the 1% level across all models, indicating that ESG disclosure substantially enhances the green innovation performance of new energy companies.

Robustness Tests

We use various methods to test the robustness of the benchmark model, with results presented in Table 4. First, we include province fixed effects. Although the benchmark regression model controls for individual, time, and industry fixed effects, as well as multiple firm-level control variables, unobservable factors might still influence the results. Thus, we further control for province fixed effects to minimize interference from omitted variables that vary by province. As shown in column (1), the regression coefficients are positive and significant at the 1% level, indicating that the baseline regression results remain robust after adding province fixed effects. Second, we add industry and year interaction fixed effects. Given that the green innovation of firms within the same industry may be influenced by industry factors such as macro policies over different cycles, we control for industry-year interaction fixed effects to mitigate the impact of time-varying industry-level macro factors. The results, shown in column (2), reveal positive regression coefficients significant at the 10% level, indicating that the benchmark regression results remain robust after adding industry-year fixed effects. Third, we replace the measure of explanatory variables. We conduct a robustness test by reclassifying the SNSI ESG ratings into nine grades (C, CC, CCC, B, BB, BBB, A, AA, AAA) and assigning values from 1 to 9, with ESG = 1 for a rating of C and ESG = 9 for a rating of AAA. The magnitude of the ESG assignments represents the quality of ESG disclosure. The regression results in column (3) show positive coefficients significant at the 1% level, indicating robust results.

Mechanism Tests

Benchmark regression and robustness test results indicate that ESG disclosure enhances the green innovation performance of new energy enterprises. Next, we will explore the specific pathways through which ESG disclosure affects green innovation performance, focusing on mitigating financing constraints and improving internal control quality. To examine the mediating roles of financing constraints (WW) and internal control quality (IC) in the impact of ESG disclosure on green innovation performance, we construct the following model:

$$\mathrm{VRS}_{i,t} = \alpha_0 + \alpha_1 \mathrm{ESG}_{i,t} + \alpha_2 \mathrm{control}_{i,t} + \sum \mathrm{Firm} + \sum \mathrm{Year} + \sum \mathrm{Ind} + \varepsilon_{i,t} \quad (2)$$

$$\mathrm{M}_{i,t} = \beta_0 + \beta_1 \mathrm{ESG}_{i,t} + \beta_2 \mathrm{control}_{i,t} + \sum \mathrm{Firm} + \sum \mathrm{Year} + \sum \mathrm{Ind} + \varepsilon_{i,t} \quad (3)$$

$$\mathrm{VRS}_{i,t} = \theta_0 + \theta_1 \mathrm{ESG}_{i,t} + \theta_2 \mathrm{M}_{i,t} + \theta_3 \mathrm{control}_{i,t} + \sum \mathrm{Firm} + \sum \mathrm{Year} + \sum \mathrm{Ind} + \varepsilon_{i,t} \quad (4)$$

In Models (2), (3), and (4), the mechanism variables M are financing constraints (WW) and internal control quality (IC), while the meanings of the remaining variables are consistent with those in Equation (1).

Financing Constraints

We use the WW index to measure corporate financing constraints, where a higher WW index indicates greater financing constraints. Columns (1) and (2) in Table 5 present the results of the mechanism test for financing constraints. Column (1) shows that the regression coefficient between ESG disclosure and financing constraints is -0.526, significant at

Table 3. Benchmark regression.

Variables	(1)	(2)	(3)
	VRS	VRS	VRS
ESG	0.761***	0.807***	0.552***
	(3.85)	(4.10)	(2.88)
Size			0.041***
			(7.90)
FirmAge			-0.030
			(-0.69)
Cashflow			0.020
			(0.63)
FL			0.002
			(1.15)
Board			0.022
			(0.98)
Indep			0.000
			(0.41)
Top1			0.001***
			(2.72)
Dual			-0.019***
			(-3.07)
Constant	0.971***	1.153***	0.224
	(30.54)	(19.57)	(1.35)
Observations	784	784	784
R-squared	0.580	0.605	0.654
Firm	YES	YES	YES
Year	YES	YES	YES
Ind	NO	YES	YES

Note: Robust standard errors clustered to the city level are in parentheses; ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, the same as below.

Table 4. Robustness Tests.

Variables	(1)	(2)	(3)
	VRS	VRS	VRS
ESG	0.547***	0.390*	
	(2.84)	(1.86)	
ESG2			0.006***
			(2.90)
Size	0.041***	0.048***	0.041***
	(7.90)	(7.85)	(7.88)
FirmAge	-0.032	-0.009	-0.030
	(-0.73)	(-0.19)	(-0.68)
Cashflow	0.020	0.002	0.020
	(0.64)	(0.05)	(0.63)
FL	0.002	0.002	0.002
	(1.18)	(0.98)	(1.15)
Board	0.024	0.022	0.023
	(1.03)	(0.92)	(0.98)
Indep	0.000	0.000	0.000
	(0.48)	(0.48)	(0.42)
Top1	0.001***	0.001**	0.001***
	(2.73)	(2.38)	(2.72)
Dual	-0.019***	-0.016**	-0.019***
	(-3.06)	(-2.47)	(-3.06)
Constant	0.220	-0.411**	0.224
	(1.32)	(-2.19)	(1.35)
Observations	784	758	784
R-squared	0.654	0.898	0.654
Firm	YES	YES	YES
Year	YES	YES	YES
Ind	YES	YES	YES
Pro	YES		
Ind×Year		YES	

the 1% level, indicating that ESG disclosure reduces the financing constraints of new energy enterprises. Comparing the baseline regression with column (2), we find that the regression coefficients of the independent variables decrease after including financing constraints and remain significant at the 5% level. This indicates that financing constraints mediate the relationship between ESG disclosure and green innovation performance in new energy enterprises.

Quality of Internal Controls

We use the "Dibo-China Listed Company Internal Control Index" (IC) published by Shenzhen Dibo Enterprise Risk Management Technology Co., Ltd. as a mechanism variable to measure the quality of internal control. This index, designed based on the realization of five internal control objectives – compliance, reporting, asset safety, operation, and strategy – comprehensively reflects the level of internal control and risk management ability of listed companies. A higher IC index indicates better internal control quality. Columns (3) and (4) in Table 5 show the results of the mechanism test for internal control quality. Column (3) indicates

Table 5. Mechanism tests.

Variables	(1)	(2)	(3)	(4)
	WW	VRS	IC	VRS
ESG	-0.526***	0.489**	2.405***	0.450**
	(-3.81)	(2.46)	(4.38)	(2.00)
WW		-0.150**		
		(-2.50)		
IC				0.052***
				(2.87)
Size	-0.058***	0.032***	0.030*	0.034***
	(-15.52)	(4.96)	(1.86)	(5.14)
FirmAge	0.001	-0.019	-0.310**	-0.071
	(0.02)	(-0.42)	(-2.37)	(-1.35)
Cashflow	-0.185***	0.017	0.182**	0.056
	(-7.83)	(0.47)	(2.01)	(1.54)
FL	-0.000	0.002	0.003	0.002
	(-0.34)	(1.26)	(0.68)	(1.22)
Board	-0.018	0.012	-0.009	0.019
	(-1.08)	(0.50)	(-0.14)	(0.73)
Indep	-0.001	0.000	-0.000	-0.000
	(-1.33)	(0.14)	(-0.19)	(-0.24)
Top1	-0.001*	0.001**	0.001	0.001**
	(-1.90)	(2.15)	(1.19)	(2.33)
Dual	-0.004	-0.019***	-0.017	-0.017**
	(-0.82)	(-2.91)	(-0.98)	(-2.37)
Constant	0.277**	0.272	0.927*	0.167
	(2.29)	(1.57)	(1.89)	(0.85)
Observations	721	721	645	645
R-squared	0.472	0.662	0.138	0.681
Firm	YES	YES	YES	YES
Year	YES	YES	YES	YES
Ind	YES	YES	YES	YES

that the regression coefficient between ESG disclosure and internal control quality is 2.405, significant at the 1% level, suggesting that ESG disclosure enhances internal control quality in new energy enterprises. Column (4) shows that the results remain significantly positive even after adding internal control quality, indicating that internal control quality partially mediates the effect of ESG disclosure on the green innovation performance of new energy enterprises.

Heterogeneity Analysis

Whether It Is a High-Tech Enterprise

When analyzing the effect of ESG disclosure on green technology innovation in new energy enterprises, it is crucial to consider whether the enterprises belong to the high-tech industry, as this characteristic influences the impact of ESG disclosure. Columns (1) and (2) in Table 6 present group regressions based on high-tech and non-high-tech industry status, along with a Chow test. The results indicate that the p-value of the Chow test is

Table 6. Results of heterogeneity analysis.

Variables	Whether it is a high-tech enterprise		Institutional Investor Concerns		Location of the Enterprise		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	NO	YES	LOW	HIGH	EAST	WEST	Central
	VRS	VRS	VRS	VRS	VRS	VRS	VRS
ESG	1.395**	0.476**	0.218	0.864**	0.480**	0.362	0.594
	(2.39)	(2.36)	(0.87)	(2.43)	(2.30)	(0.67)	(0.85)
Size	-0.005	0.048***	0.041***	0.040***	0.046***	0.078***	-0.004
	(-0.30)	(8.57)	(6.43)	(3.86)	(7.75)	(6.02)	(-0.18)
FirmAge	0.123	-0.078	-0.012	-0.025	0.014	-0.245*	-0.137
	(1.08)	(-1.57)	(-0.21)	(-0.30)	(0.26)	(-1.97)	(-1.10)
Cashflow	-0.001	0.024	0.021	0.003	0.027	-0.076	0.141
	(-0.01)	(0.71)	(0.50)	(0.05)	(0.73)	(-1.09)	(0.81)
FL	0.000	0.002	0.004	-0.002	0.001	-0.002	0.069**
	(0.08)	(1.06)	(1.58)	(-0.69)	(0.69)	(-0.50)	(2.68)
Board	0.075	0.017	0.024	-0.007	0.008	0.015	0.290***
	(0.88)	(0.69)	(0.77)	(-0.17)	(0.32)	(0.25)	(2.73)
Indep	0.002	0.000	0.000	-0.001	-0.000	0.001	0.009***
	(0.66)	(0.07)	(0.20)	(-0.42)	(-0.09)	(0.74)	(3.14)
Top1	-0.001	0.001***	0.001*	0.003***	0.001***	0.000	-0.000
	(-0.93)	(3.10)	(1.88)	(3.52)	(3.16)	(0.22)	(-0.08)
Dual	-0.059**	-0.017**	-0.015*	-0.031***	-0.015**	-0.055**	-0.007
	(-2.13)	(-2.58)	(-1.83)	(-2.61)	(-2.39)	(-2.58)	(-0.19)
Constant	0.326	0.107	-0.002	-0.140	0.045	-0.350	0.332
	(0.63)	(0.62)	(-0.01)	(-0.52)	(0.22)	(-1.05)	(0.46)
Observations	111	673	510	273	597	124	63
R-squared	0.789	0.640	0.636	0.674	0.686	0.670	0.842
Firm	YES	YES	YES	YES	YES	YES	YES
Year	YES	YES	YES	YES	YES	YES	YES
Ind	YES	YES	YES	YES	YES	YES	YES
P value	0.013		0.087				

0.013, passing the between-group coefficient difference test. ESG disclosure significantly promotes the green innovation performance of new energy enterprises in both high-tech and non-high-tech industries. The regression coefficient for non-high-tech industry enterprises is 1.395, while for high-tech industry enterprises, it is 0.476. Therefore, ESG disclosure has a more pronounced effect in non-high-tech industry enterprises. According to resource-based theory and legitimacy theory, non-high-tech firms may rely more on ESG to acquire external resources and legitimacy due to a lack of internal high-tech resources. Conversely, high-tech firms, with sufficient internal endowments for green innovation, experience a less significant impact from ESG disclosure on green innovation performance.

Institutional Investor Concerns

Institutional investor concern, as an external governance mechanism, can constrain and supervise listed companies in their green technology innovation activities [18]. Columns (3) and (4) in Table 6 present group regressions based on different levels of institutional investor concern, accompanied by a Chow test. The results show that the P-value of the Chow test

is 0.087, and the regression coefficient for firms with high institutional investor attention is 0.864, significant at the 5% level. This indicates that ESG disclosure does not significantly impact firms with low institutional investor attention. The likely reason is that institutional investors' supervision and attention prompt companies to focus more on ESG practices. Institutional investors enhance the signaling effect of corporate ESG disclosure, strengthen trust and connections with stakeholders, and help reduce financing costs.

Location of the Enterprise

Disparities in resource endowments, economic development levels, and policy and institutional environments across China's eastern, central, and western regions may lead to uneven development of ESG performance among firms in these regions. Columns (5), (6), and (7) in Table 6 display the impacts of ESG disclosure on the green innovation performance of new energy companies in the three major regions of China. The results reveal significant regression coefficients in the eastern region, while they are insignificant in both the central and western regions. This suggests that ESG disclosure has a more pronounced effect on promoting the green innovation performance of new energy firms in the eastern region. Compared to the central and western regions, the eastern region benefits from a more mature financial market and more comprehensive green innovation support policies, enabling better implementation of the ESG concept and enhancement of green innovation performance among new energy enterprises.

Conclusions

We analyzed data from A-share new energy companies from 2010 to 2022 to examine the relationship between ESG disclosure and green innovation performance, yielding the following conclusions. First, ESG disclosure positively impacts the green innovation performance of new energy companies, a conclusion that remains robust across various tests. Second, ESG disclosure promotes corporate green innovation primarily by alleviating financing constraints and enhancing the quality of internal control. Third, heterogeneity tests reveal that the green innovation effect of ESG disclosure is more pronounced among high-tech firms, that arises institionainvestor's high attetion, and firms in eastern China.

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Conflict of Interest

The authors declare no competing interests.

Ethics Approval and Consent to Participate

This article does not contain any studies with human participants or animals performed by any of the authors.

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