



Green Innovation as a Dual Mechanism in the ESG-Export Performance Nexus

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Abstract. Global green trade regulations are undergoing rapid restructuring, increasing the signaling importance of firms' sustainable business capabilities. This study uses A-share listed companies in Shanghai, Shenzhen, and Beijing from 2014 to 2024 to investigate the effect of environmental, social, and governance (ESG) performance on corporate export outcomes and the mediating and moderating role of green innovation. Empirical results indicate that ESG performance significantly promotes export expansion, with stronger effects observed in non-state-owned enterprises and in firms within non-heavily polluting industries. Green innovation functions both as a mediator and as a moderator. It transmits the impact of ESG performance to export performance and delineates the boundary conditions under which ESG performance yields diminishing marginal returns. This research extends the analysis of the economic consequences of ESG to the arena of international market competition, elucidating the dynamic process through which non-financial signals are converted into export competitiveness, and offering policy-relevant guidance for differentiated ESG policies and incentives for green technology.

Keywords: ESG Performance, Export Performance, Green Innovation, Resource Orchestration Theory.

1 Introduction

Firms are the primary actors in foreign trade and constitute a critical microfoundation for the transformation, upgrading, and high-quality development of international commerce. Currently, global trade patterns and green low-carbon regulations are undergoing profound change, placing pressure on traditional export models that rely on cost advantages and scale expansion [1]. Reliance on low-price competition alone is no longer sufficient to sustain firms' long-term participation in international markets. Concurrently, green trade measures such as the European Union Carbon Border Adjustment Mechanism are being progressively implemented, and overseas customers, investors, and regulators are attaching increasing importance to firms' environmental responsibilities, social performance, and governance practices [2]. Environmental, social, and governance (ESG) performance has thus evolved from a mere soft constraint on corporate

social responsibility to an important signal of a firm's sustainable capabilities, a mechanism for reducing international transaction risks, and an instrument for overcoming green trade barriers. Consequently, investigating whether ESG performance enhances corporate export outcomes has substantial theoretical and practical significance.

Recent scholarship on the economic consequences of ESG has expanded, addressing corporate financial performance, financing constraints, innovation capability, and total factor productivity. The majority of studies indicate that strong ESG performance improves the quality of corporate information disclosure, mitigates external financing constraints, enhances reputation and risk management, and thereby positively affects firm performance. For example, Sheng et al. (2022) demonstrated that ESG performance enabled family firms to raise total factor productivity by promoting technological innovation, easing financing constraints, and improving information transparency [3]. In the green innovation literature, Wu & Chen (2023) reported a significant positive relationship between green innovation and corporate financial performance based on meta-analysis [4]. However, extant research has predominantly focused on the internal outcomes of ESG within firms, with limited attention to how ESG influences firms' outcomes in international markets. There is a paucity of systematic research directly linking ESG as a nonfinancial signal to firms' competitive performance in global markets. Moreover, studies examining the mediating mechanisms between ESG and firm performance primarily emphasize internal management channels such as financing constraints, innovation efficiency, or risk-taking, and seldom adopt a resource orchestration perspective [5]. Green innovation represents a critical orchestration node in converting ESG resources into export competitiveness, yet the process by which ESG soft power is transformed into export-oriented growth through green innovation remains underexplored.

To address these gaps, this study uses A-share listed firms in Shanghai, Shenzhen, and Beijing from 2014 to 2024 to examine systematically the impact of ESG performance on export outcomes, conducting heterogeneity analyses by ownership type and industry pollution intensity. The study also investigates the mechanism and role of green innovation. The contributions are twofold. First, from a theoretical perspective, the study moves beyond the static treatment of ESG as a signaling resource or purely an internal governance instrument by introducing resource orchestration theory. It highlights that the value-creation potential of ESG lies in firms' active management, coordinated allocation, and transformative utilization of resources. Accordingly, the analysis of ESG and firm performance is extended from signal transmission and internal governance to the domain of international market competition, offering a more processual and contextual account of how ESG enhances export competitiveness. Second, with respect to mechanism identification, the study examines simultaneously the mediating and moderating roles of green innovation within a unified framework. Empirical evidence indicates that green innovation not only mediates the effect of ESG on export performance but also conditions the marginal efficacy of ESG. The identification of this dual role overcomes the limitations of prior research that treated mediation and moderation separately, and reveals the deeper logic that the conversion of ESG soft

power into tangible export growth depends on substantive green innovation capabilities. This provides a novel perspective for understanding the nonlinear interaction between ESG and export performance.

2 Theoretical Basis and Research Hypotheses

2.1 The Relationship between Corporate ESG and Export Performance

Signaling theory, introduced by Spence, addresses how an information-advantaged party can reduce identification costs and adverse selection for an information-disadvantaged party by transmitting credible signals in an environment of asymmetric information [6]. The central tenet is that, when information is unevenly distributed between trading parties, high-quality actors have an incentive to incur costs to convey signals of their intrinsic quality in order to distinguish themselves from lower-quality actors, thereby reducing market frictions and facilitating transactions. Information asymmetry is particularly acute in international trade. Geographic distance, institutional differences, and cultural barriers impede overseas importers' ability to fully assess exporters' operational status, product quality, and regulatory compliance, rendering adverse selection and market frictions significant constraints on export expansion.

ESG performance, as a high-quality, hard-to-imitate, and continuously invested non-financial signal, can mitigate information asymmetry in international trade [7]. ESG ratings, produced by third-party professional agencies, are relatively objective and authoritative and can signal to foreign markets that a firm possesses durable operational capabilities and robust risk management. Moreover, strong ESG performance indicates that a firm has established institutional arrangements in environmental management, social responsibility, and corporate governance, suggesting that its products are more likely to meet international standards and importing-country regulations. This reduces screening costs and transaction risks for importers and enhances trust and recognition among overseas stakeholders. When importers, consumers, and trading partners form favorable perceptions of a firm's quality and compliance based on ESG signals, they are more likely to engage in trade, expand procurement, and increase order volumes, thereby contributing to export scale growth and improved export performance. Wei et al. (2025) found that superior ESG ratings helped firms overcome international green trade barriers, expand market boundaries, strengthen international brand reputation and overseas consumer recognition, and generate differentiated competitive advantages [8]. Based on this reasoning, the following Hypothesis 1 is proposed.

H1: Corporate ESG performance has a significant positive effect on export performance; that is, higher ESG performance is associated with greater annual export volume.

2.2 The Mediating Role of Green Innovation in the Relationship between ESG and Export Performance

Resource orchestration theory departs from the static assumptions of the traditional resource-based view and offers a dynamic framework for managing heterogeneous resources and constructing competitive advantage [5]. The theory argues that sustained competitive advantage arises not from mere resource possession but from firms' active management, coordinated deployment, and value transformation of resources. By engaging in structured integration, capability bundling, and commercial exploitation, dispersed resources can be converted into enduring market advantages.

Viewed through this resource orchestration lens, ESG performance constitutes a heterogeneous bundle of resources spanning environmental, social, and governance dimensions. The value of ESG lies principally in a firm's capacity to orchestrate these resources, and green innovation constitutes a central transmission node in that orchestration process. ESG compliance and practices compel firms to integrate internal and external green resources, strengthen the foundation for innovation, and align research and development (R&D) efforts with compliance and reputational advantages. Firms can thereby convert external regulatory and market pressures into innovation orientation, and through the commercial application of green innovations produce export products that satisfy international standards, overcome green trade barriers, and generate differentiated competitive advantages. Empirical studies provide support for this pathway. Huang & Qi (2024) documented that ESG enhanced green innovation across multiple dimensions [9]. Shu et al. (2024) demonstrated a positive effect of green innovation on export scale [10]. On the basis of this theoretical and empirical evidence, the following Hypothesis 2 is proposed.

H2: Green innovation significantly mediates the relationship between ESG performance and export performance, such that higher ESG performance leads to increased green innovation, which in turn raises annual export volume.

3 Data and Methodology

3.1 Sample Selection and Data Sources

This study uses annual data for A-share listed firms in Shanghai, Shenzhen, and Beijing for the period 2014 to 2024 as the initial sample. Primary data comes from *Choice* financial database and *Sino-Securities Index Information Service (Shanghai) Co., Ltd.* Industry classification follows the 2012 industry classification standard of the China Securities Regulatory Commission. To ensure sample reliability, the initial dataset is subjected to the following screenings: (1) exclude observations with missing variable data; (2) exclude firms in the financial sector; (3) exclude firms designated as *ST* or **ST* during the sample period; (4) apply winsorization at the 1st and 99th percentiles to mitigate the influence of outliers on model estimation. After these procedures, the final sample comprises 15,129 firm-year observations.

3.2 Variable Definition and Measurement

3.2.1 Explained Variable – Enterprise Export Performance (*EXPORT*). Firm export performance captures the annual outcome and market performance of sample firms' export activities. Export performance is measured by the total operating revenue generated from export trade in the accounting year. Higher values indicate more active export operations, broader penetration of overseas markets, stronger international competitiveness, and greater potential for scale and efficiency gains in export activity. Given the right-skewed distribution of export value and the presence of zero observations, the measure is constructed as the natural logarithm of export value plus one. This transformation helps to reduce heteroscedasticity in the empirical analysis.

3.2.2 Explanatory Variable – ESG Performance (*ESG*). ESG performance is measured using the *Huazheng* ESG rating published by *Sino-Securities Index Information Service (Shanghai) Co., Ltd.* This index is an independent third-party index institution authorized to compile indices for the Shanghai, Shenzhen, and Hong Kong exchanges. Its ESG rating system integrates international ESG frameworks with the regulatory orientation, institutional environment, and business characteristics of the Chinese A-share market. The system excludes indicators that are inapplicable domestically and incorporates localized dimensions such as poverty alleviation, regulatory sanctions, and social responsibility fulfillment. Coverage extends to all A-share listed firms, making it a widely used local ESG measure in Chinese academic research. The *Huazheng* ESG rating adopts a nine-level classification from AAA to C. Following common practice in the Chinese ESG literature, the nine categorical levels are mapped to an ordinal scale 1-9 in descending order (C=1, CC=2, CCC=3, B=4, BB=5, BBB=6, A=7, AA=8, AAA=9), where higher values indicate superior ESG performance [11].

3.2.3 Mediating Variable – Green Innovation Level (*GREEN*). Green innovation is operationalized as the annual number of green patent applications filed by each firm in the fiscal year. This indicator captures the output of firms' green technology R&D activities; higher counts reflect more active green innovation and greater technological capacity for low-carbon transformation. Green patent applications constitute a direct outcome of R&D investment in environmentally relevant technologies and serve as a key channel through which firms accumulate technological reserves and achieve breakthroughs in green and low-carbon domains.

3.2.4 Control Variables. Following empirical studies on firms' export behavior and performance, the analysis includes the following control variables hypothesized to affect export performance, including firm size (*A*, natural logarithm of year-end total assets), leverage ratio (*LEV*), operating cash flow (*CF*), return on assets (*ROA*), book-to-market ratio (*BM*), year-on-year growth rate of operating revenue (*GROWTH*), firm age (*AGE*), and shareholding ratio of the largest shareholder (*TSH1*).

3.3 Empirical Models

Based on the hypotheses developed above, the study estimates multiple regression models to assess the effect of ESG performance on firm export performance and to examine the mediating role of green innovation. The baseline specification used to test H1 is shown in the following equation (1).

$EXPORT_{i,t} = \alpha_0 + \alpha_1 ESG_{i,t-1} + \alpha_2 Controls'_{i,t-1} + \sum YEAR + \sum IND + \varepsilon_{i,t}$ (1)

Here, **Controls** includes the mediating variable (*GREEN*) defined in Section 3.2.3 and the control variables defined in Section 3.2.4. $\sum YEAR$ and $\sum IND$ represent year and industry fixed effects, respectively. $\varepsilon_{i,t}$ denotes the idiosyncratic error term. To mitigate endogeneity concerns, all explanatory and control variables are measured with a one-period lag. A significantly positive α_1 would support H1.

To assess the effect of ESG on green innovation, which constitutes the first step of the proposed mediation mechanism in H2, the following first-stage model (equation (2)) is estimated.

$GREEN_{i,t} = \beta_0 + \beta_1 ESG_{i,t-1} + \beta_2 Controls'_{i,t-1} + \sum YEAR + \sum IND + \varepsilon_{i,t}$ (2)

In the second step of the mediation test, equation (3) is specified to examine the effect of *ESG* on *EXPORT* when *GREEN* is excluded.

$EXPORT_{i,t} = \theta_0 + \theta_1 ESG_{i,t-1} + \theta_2 Controls'_{i,t-1} + \sum YEAR + \sum IND + \varepsilon_{i,t}$ (3)

In these two equations, **Controls** only comprises the variables defined in Section 3.2.4. Mediation is inferred when β_1 in model (2) is statistically significant and θ_1 in model (3) is statistically significant; furthermore, if the absolute value of θ_1 in model (3) is larger than the absolute value of α_1 in model (1), the evidence supports partial mediation of green innovation in the relationship between ESG and export performance, thereby supporting H2.

4 Research Results and Analysis

4.1 Descriptive Analysis

Table 1. Descriptive statistical results.

Variable	Count	Mean	Standard deviation	Minimum	Median	Maximum
<i>ESG</i>	15129	4.1635	1.0117	1	4	6
<i>EXPORT</i>	15129	19.3841	2.3058	12.5937	19.6064	24.4435
<i>GREEN</i>	15129	9.0630	25.1080	0.0000	1.0000	186.0000
<i>A</i>	15129	22.3386	1.2539	20.1818	22.1532	26.2723
<i>LEV</i>	15129	0.4105	0.1879	0.0680	0.4052	0.8640
<i>CF</i>	15129	0.1197	0.1908	-0.3542	0.0842	1.0526
<i>ROA</i>	15129	0.0555	0.0707	-0.2218	0.0532	0.2653

Variable	Count	Mean	Standard deviation	Minimum	Median	Maximum
<i>BM</i>	15129	0.4069	0.2561	0.0587	0.3495	1.3355
<i>GROWTH</i>	15129	0.1615	0.3196	-0.4612	0.1136	1.6620
<i>TSH1</i>	15129	0.3224	0.1394	0.0857	0.3008	0.7029
<i>AGE</i>	15129	19.9785	5.5767	9	20	37

Descriptive statistics for the variables are presented in Table 1. The mean value of *ESG* is 4.1635 with a standard deviation of 1.0117 and a median of 4.0000, suggesting limited dispersion in ESG scores across the sample and an overall level below the midpoint (grade B); the highest observed categorical rating does not exceed BBB. The mean of export performance is 19.3841 with a standard deviation of 2.3058, indicating heterogeneity in export revenue among firms; the minimum and maximum values are 12.5937 and 24.4435 respectively, such that the maximum observed export value is approximately 140,100 times the minimum after back-transformation to the original scale. The mean of the green innovation variable (*GREEN*) is 9.0630 while the median is 1 and the maximum is 186, reflecting that green patenting activity is concentrated in a small subset of highly innovative firms and that within-sample dispersion is substantial.

4.2 Multicollinearity Test

A variance inflation factor test is conducted to assess multicollinearity among regressors. The minimum VIF (that of *TSH1*) is 1.0568, the maximum VIF (that of *A*) is 2.2359, and the average VIF is 1.3973. All VIF values are well below commonly used thresholds, indicating that multicollinearity is not a serious concern and that the included variables may be retained for estimation.

4.3 Panel Regression Analysis

4.3.1 Results of Hypothesis 1. Based on the preceding H1, a panel regression model is estimated to assess the effect of ESG performance on firm export performance and to examine heterogeneity across ownership and industry types. Table 2 reports the baseline regression results. Column (1) for the full sample shows a positive and statistically significant coefficient on *ESG* at the 5% level. Interpreting this coefficient implies that a one standard-deviation increase (1.0117) in ESG is associated with an approximately 5.63% increase in export performance ($e^{0.0542 \times 1.0117} - 1 \approx 5.63\%$). This finding supports the core hypothesis that superior ESG performance materially enhances firms' export outcomes. A plausible mechanism is that higher ESG ratings reflect more complete corporate governance and greater transparency, which signal compliance and management quality to foreign markets, thereby strengthening trust among overseas customers and partners and reducing transaction costs. Concurrently, stronger environmental and social performance can improve brand image and align with the growing green preferences of consumers in developed markets, expanding export market share.

Columns (2) and (3) present results by ownership type and reveal significant heterogeneity. For state-owned enterprises (SOEs) the *ESG* coefficient is 0.0360 and not

statistically significant. One explanation is that SOEs often undertake policy-driven export tasks and their export strategies may be influenced by government directives or national strategic objectives, resulting in lower market orientation [12]. State-owned firms also typically possess greater scale and resource endowments, so their export competitiveness may depend more on policy support and scale advantages than on ESG signaling. By contrast, for non-SOEs, the *ESG* coefficient is 0.0553 and significant at the 10% level, indicating a stronger ESG effect. Non-SOEs face more intense market competition and financing constraints; ESG ratings therefore function as a reputational signal that alleviates information asymmetry and helps establish credibility in international markets. These firms are generally more market-oriented and more responsive to international demand for green products, enabling superior ESG performance to facilitate entry into higher-end segments. Moreover, lacking the implicit policy backing of SOEs, non-SOEs have greater incentives to build differentiated competitiveness through ESG.

Industry heterogeneity is also evident. Following Li et al. (2021), eighteen industries are classified as heavily polluting based on the 2012 China Securities Regulatory Commission industry classification and the Ministry of Environmental Protection’s catalogue for environmental verification of listed companies [13]. In the heavily polluting subsample, the *ESG* coefficient is 0.0143 and not significant, suggesting a limited effect of ESG on export performance for these firms. This may reflect that exports from heavily polluting sectors are often bulk raw materials or intermediate goods where price remains the primary competitive dimension, and that ESG improvements in such sectors tend to emphasize end-of-pipe treatment and compliance investments rather than fundamental changes in production technology. Foreign buyers may also be skeptical of potential greenwashing. In the non-heavily polluting subsample, the *ESG* coefficient is 0.0648 and significant at the 5% level, indicating a stronger positive effect. Firms in these sectors, such as consumer goods and services, tend to exhibit higher value added, and brand reputation and consumer perception exert greater influence on export competitiveness. ESG performance can therefore be translated more directly into brand premiums. Additionally, these firms’ export destinations are often developed markets with stringent environmental and social requirements, where ESG ratings function as a market entry credential. Non-heavily polluting industries also typically face lower costs to improve ESG and greater scope for green innovation and supply chain optimization.

Table 2. Regression results for Hypothesis 1.

	Full sample	SOEs	Non-SOEs	Heavy polluting firms	Non-heavy polluting firms
<i>ESG</i>	0.0542**	0.0360	0.0553*	0.0143	0.0648**
<i>GREEN</i>	0.0014*	0.0041*	0.0001	0.0099***	-0.0012
<i>A</i>	0.9455***	0.8661***	0.9791***	0.7389***	1.0672***
<i>LEV</i>	0.9540***	1.0000*	0.9360***	1.6333***	0.5770**
<i>CF</i>	0.7856***	0.5014	0.7367***	0.1496	0.9561***
<i>ROA</i>	1.2259***	0.7671	1.3064***	1.9390**	1.2066***
<i>BM</i>	-0.0330	0.5461*	-0.1615	0.4033	-0.2438
<i>GROWTH</i>	0.2889***	0.3962***	0.2632***	0.3666***	0.2701***

	Full sample	SOEs	Non-SOEs	Heavy pollut- ing firms	Non-heavy pol- luting firms
<i>TSH1</i>	-0.1106	-0.8610	0.0452	-0.7930*	0.1751
<i>AGE</i>	-0.0029	0.0035	-0.0011	-0.0220	0.0040
<i>Year FE</i>	Yes	Yes	Yes	Yes	Yes
<i>Industry FE</i>	Yes	Yes	Yes	Yes	Yes
<i>F</i>	248.79	55.489	204.82	67.959	199.88
<i>R-squared</i>	0.3591	0.3931	0.3575	0.3128	0.3877
<i>N</i>	15129	2948	12181	4359	10770

Note: The data in the table are regression coefficients of each variable, and ***, **, and * are significant at the significance level of 1%, 5% and 10% respectively.

4.3.2 Results of Hypothesis 2. This section tests whether green innovation mediates the relationship between ESG performance and firm export performance. The potential moderating role of green innovation is also assessed. Results are reported in Table 3.

Column (1) presents a regression with *GREEN* as the dependent variable. The coefficient on *ESG* is 1.9605 and is significant at the 1% level, indicating that superior ESG performance is associated with higher levels of green innovation. This finding suggests that ESG practices may encourage increased investment in green R&D and greater green patenting through environmental management requirements, stakeholder pressures, and more efficient resource allocation. Column (2) reports the effect of *ESG* on *EXPORT* without controlling for *GREEN*. The *ESG* coefficient is 0.0569 and significant at the 5% level. This coefficient is larger in absolute value than the *ESG* coefficient obtained in the full-sample baseline that includes *GREEN* (0.0542 in Table 2), implying that inclusion of *GREEN* attenuates the direct effect of ESG on export performance. This pattern provides evidence of partial mediation, supporting H2. The mediating pathway can be interpreted as follows. Firms with higher ESG performance face stronger stakeholder and regulatory expectations that motivate green R&D; green innovation outputs, such as patents and cleaner production processes, enhance firms' green competitiveness, facilitate compliance with stringent import standards, reduce green trade barriers, and enable entry into higher value export markets.

Table 3. Regression results for Hypothesis 2.

	(1) <i>GREEN</i>	(2) <i>EXPORT</i>	(3) <i>EXPORT</i>
<i>ESG</i>	1.9605***	0.0569**	0.0353
<i>ESG × GREEN</i>	/	/	0.0021***
<i>GREEN</i>	/	/	-0.0088*
<i>A</i>	9.8316***	0.9591***	0.9447***
<i>LEV</i>	0.9661	0.9553***	0.9659***
<i>CF</i>	-1.4731	0.7835***	0.7880***
<i>ROA</i>	-19.5250***	1.1990***	1.2576***
<i>BM</i>	-7.8168***	-0.0438	-0.0240
<i>GROWTH</i>	-0.2070	0.2887***	0.2881***
<i>TSH1</i>	-4.6274	-0.1170	-0.1038

	(1) GREEN	(2) EXPORT	(3) EXPORT
<i>AGE</i>	-0.2036**	-0.0032	-0.0028
<i>Year FE</i>	Yes	Yes	Yes
<i>Industry FE</i>	Yes	Yes	Yes
<i>F</i>	155.39	256.16	242.20
<i>R-squared</i>	0.2536	0.3590	0.3596
<i>N</i>	15129	15129	15129

Note: The data in the table are regression coefficient of each variable, and ***, **, and * are significant at the significance level of 1%, 5% and 10% respectively.

Column (3) examines moderation by including the interaction term $ESG \times GREEN$. The coefficient on this interaction term is positive and significant at the 5% level, indicating that the positive effect of ESG on export performance is amplified as firms' green innovation capacity increases. This result implies that green innovation not only transmits ESG effects but also conditions their magnitude, i.e., when green innovation is limited, ESG may operate mainly as compliance disclosure or reputational signaling with limited impact on product differentiation or technological barriers; when green innovation is strong, ESG is more likely to be converted into concrete innovations, certifications, and product attributes that command premiums in international markets, thereby strengthening export performance.

These mediation and moderation findings are complementary rather than contradictory. The mediation result shows that green innovation is a transmission mechanism through which ESG affects exports; the moderation result shows that green innovation amplifies the marginal effect of ESG. Collectively, the evidence indicates that green innovation plays a dual role in the ESG-export relationship, functioning both as a mediating pathway and as a boundary condition for ESG's effectiveness.

5 Conclusion and Policy Implications

This study employs panel data for A-share listed firms in Shanghai, Shenzhen, and Beijing over 2014–2024 to investigate the effect, mechanism, and boundary conditions of ESG performance on firm export performance using panel regression models. The principal findings are as follows. First, ESG performance exerts a significant positive effect on export performance, with stronger effects observed among non-SOEs and firms in non-heavily polluting industries. Second, green innovation functions both as a partial mediator and as a positive moderator in the ESG-export relationship. Green innovation therefore serves as an important transmission channel through which ESG enhances export outcomes and as a key boundary condition that amplifies the effectiveness of ESG, indicating that the conversion of ESG-related soft power into tangible export gains depends on substantive green innovation capacity.

Policy implications follow from these findings. Regulatory authorities should accelerate the standardization and incentives for ESG disclosure, moving disclosure practices for listed firms from voluntary provision toward mandatory regulation and promoting mechanisms that enhance the credibility and comparability of ESG information. Financial and trade policy instruments, such as green credit support and export credit

insurance tailored to ESG performance, can be used to encourage firms to integrate ESG considerations into export strategies. Policymakers should adopt differentiated promotion strategies by ownership and industry. For SOEs, strengthen the alignment of ESG assessment with market-oriented performance to encourage market-driven export decision making; for heavily polluting industries, raise environmental access requirements and provide targeted green transformation subsidies to discourage superficial end-of-pipe compliance and incentivize structural upgrading. Finally, public support for green innovation should be expanded through tax incentives, dedicated R&D funds, and expedited intellectual property protection for green technologies, thereby positioning green innovation as the core mechanism that translates ESG performance into sustainable export competitiveness.

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