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The Impact of ESG Performance on Green Innovation among Traditional Energy Enterprises—Evidence from Listed Companies in China

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Abstract: To address escalating environmental challenges and the energy crisis, traditional energy companies must initiate green transformations and enhance green innovation. ESG (Environmental, Social, and Governance) performance is vital for gauging enterprises' sustainable development. Therefore, this study explores the relationship between the ESG performance of traditional energy companies and their extent of green innovation. It aims to investigate whether improving ESG performance can lead to enhanced green innovation within these companies. Therefore, this paper employs a fixed effect model to analyze the impact of ESG performance on green innovation among traditional energy companies, specifically focusing on those listed in the Chinese A-share market from 2013 to 2022. The results indicate that ESG performance significantly promotes green innovation within traditional energy companies. The mechanism test's findings reveal that ESG performance impacts green innovation via three key pathways: innovation investment, external monitoring, and government subsidies. Furthermore, further analysis reveals that the intense market competition environment positively moderates the effect of ESG performance enhancement on the extent of green innovation. This implies that, by improving their ESG performance, traditional energy companies can enhance their green innovation and green transformation efforts. Moreover, this impact is particularly pronounced among state-owned enterprises.

Keywords: ESG performance; green innovation; traditional energy industry; green transformation

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1. Introduction

Global attention has been paid to the resolution of ever-intensifying climate issues, efforts toward sustainable development, and reductions in greenhouse gas emissions. China, which ranks among the world's major carbon emitters, has outlined sustainable development goals with the aim of reaching peak carbon emissions and achieving carbon neutrality. Although the conventional energy sector serves as a fundamental industry for the nation, it is also a significantly environmentally detrimental industry [1]. For instance, traditional coal, oil, and gas mining can result in persistent pollution to the ecological environment in mining areas, harm local ecosystems, and generate substantial greenhouse gas emissions during energy production and processing [2–4]. Simultaneously, global investors and financial institutions have started to focus on pursuing economic development while also prioritizing environmental protection. Pollution issues related to traditional energy companies have attracted increased interest [5,6]. For enterprises engaged in the production, processing, and sale of traditional fossil energy, the future prospects of the traditional energy industry have been significantly impacted [7–9]. Consequently, constrained by the "dual carbon" objective and in response to the impacts on the energy supply, traditional energy companies are in urgent need of transformation [10].

The fundamental aspect of enterprises' green transformation lies in enhancing the extent of green innovation [11,12]. Encouraging green innovation can not only lower the cost of clean energy and effectively address carbon emissions but can also generate a fresh impetus for economic growth. Existing research suggests that appropriate environmental regulations can foster companies' green innovation [13]. Guo et al. demonstrated that implementing sewage fees and augmenting financial investments in environmental protection compel companies to enhance their development and research endeavors in green innovation [14]. Lee and Xiao noted that sewage charges promote the output of corporate green invention patents [15]. Wang discovered that, following the enforcement of green credit policies, industries subject to green credit restrictions exhibit more robust green innovation performance than do those not subject to such restrictions [16]. Although green innovation is beneficial for both sustainable economic development and environmental protection, the development of green innovation is still hindered by many obstacles. Because of the prolonged investment cycle and the heightened risk of failure related to green innovation, both consumers and managers are reluctant to pay for green innovation due to concerns about corporate performance [17]. Managers prefer to be favored by investors to obtain more financing and use it for a company's development. Investors also hope to understand the company's internal situation by paying attention to both the company's economic benefits and whether the company assumes social responsibility.

The emergence of the concept of sustainable development represented by environmental, social, and corporate governance (ESG) provides new ideas for overcoming this dilemma. To help companies focus more on environmental concerns, in 2004, the United Nations Global Compact proposed incorporating ESG principles into investment decisions [18]. As an evaluation tool for corporate environmental protection and socially responsible investments, ESG metrics not only reflect a company's commitment to environmental stewardship but also its dedication to social welfare and shareholder value. On the one hand, corporate ESG performance may attract the attention of investors and alleviate the financing pressure that enterprises face, thereby increasing the amount of funds available for green innovation. On the other hand, corporate ESG performance can enable business governance to be supervised by investors so that investors can understand the internal conditions of the company. Consequently, these metrics are more favorably regarded in the capital markets [10,19].

In the past, the impact factors on ESG performance were mainly analyzed based on the content related to ESG performance and company fundamentals. Research shows that enhancing a business's ESG performance can contribute to its financial performance [20–22]. To improve financial performance, ESG-impressive companies lean toward focusing innovation efforts on the development of environmentally friendly products and procedures, a practice known as green innovation [23].

The primary objective of this study is to investigate whether traditional energy firms can enhance their extent of green innovation by improving their ESG (Environmental, Social, and Governance) performance. Additionally, as a complementary research goal, this paper explores the mediating role of internal factors and external stakeholders in the influence of ESG performance on green innovation within these companies. This approach aims to elucidate the pathways through which ESG performance can bolster green innovation efforts, providing valuable insights for traditional energy firms seeking to enhance their sustainability practices.

After analyzing data from Chinese-listed companies over the period from 2013 to 2022, this study successfully achieved its objectives. We find that traditional energy firms indeed can foster green innovation by enhancing ESG performance. Furthermore, both internal factors and external stakeholders are positively influenced by improved ESG performance, which, in turn, catalyzes green innovation. Moreover, our exploration into the effects of ESG performance on green innovation reveals that corporate property rights and the competitive environment faced by firms exert a heterogeneous effect on this dynamic. The theoretical model is shown in Figure 1.

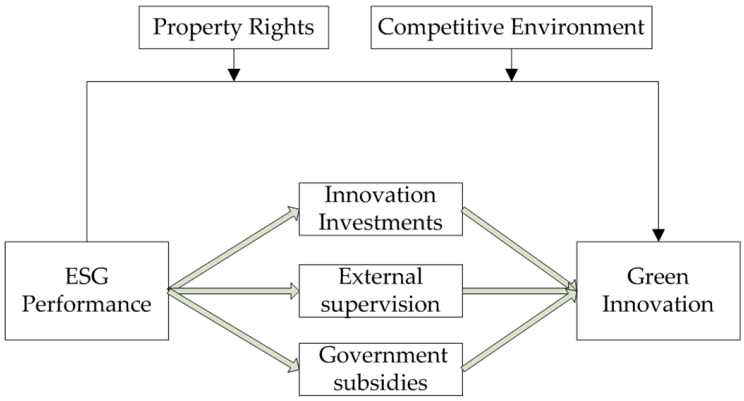

Figure 1. The theoretical model of this study.

This article addresses innovations regarding the following facets. First, we expand the investigation of the traditional energy industry and discuss the difficulties faced by traditional energy companies and the inevitability of green transformation. Second, given that green innovation is critical for organizational green transformation and that ESG performance is an important indicator of green sustainability, we widen the influence that drives green innovation by integrating ESG performance. Finally, since the research object of this article is China's listed traditional energy companies, we enhance the understanding of the degree of enterprise green innovation and the actual ESG performance of traditional energy companies listed in China. This study can also help traditional energy companies with exceptional ESG performance convey signals regarding green innovation and attract the attention of governments and investment institutions, enabling them to obtain more resources, which will help them adapt to the market and carry out green transformation.

The paper is structured as follows. The second section introduces hypotheses and theoretical mechanisms, and the third section discusses the research methods, variable selection, and sources. The fourth and fifth sections present the test and empirical results, followed by a deeper analysis provided in the sixth section. Finally, in the last chapter, the conclusion is presented.

2. Proposition of Theoretical Mechanisms and Hypotheses

2.1. ESG Performance and the Extent of Green Innovation in Traditional Energy Companies

On the one hand, existing research shows that traditional energy companies can convey to the market that they assume social responsibility and attach importance to environmental protection through good ESG performance. Such signals can bolster investors' trust in the company's long-term prospects and positive growth while also mitigating the financial challenges and funding concerns experienced by conventional energy firms [24]. By alleviating the financial dilemmas faced by traditional energy companies, ESG performance can form a sufficient supply of green resources for traditional energy companies, which can boost enterprises' incentive to initiate green innovation activities and strengthen the overall extent of green innovation [25].

On the other hand, neoclassical theory highlights the principal–agent problem in the green innovation process, where conflicting interests between owners and managers may lead to short-term thinking. This conflict, coupled with the long investment cycle and high risk of green innovation, can make stakeholders reluctant to invest, potentially hindering such efforts.

However, this paper argues that the special characteristics of traditional energy firms, which attract significant attention from a variety of stakeholders, actually facilitate a reduction in the principal–agent problem. This broad scrutiny ensures a stronger emphasis on long-term sustainability over short-term gains. Consequently, we assert that robust ESG performance within traditional energy companies significantly propels the advancement of

green innovation. Therefore, by recognizing the overarching influence of such stakeholder attention, we propose the following hypothesis:

H1: *Positive ESG performance of traditional energy companies can foster their green innovation.*

2.2. ESG Performance, Innovation Investments, and Green Innovation

If companies want to exhibit good ESG performance, they need to work hard to alleviate the environmental consequences of production activities. To perform this effectively, they are often required to increase their investments in innovation, particularly in green technologies. Through such investments, these companies can develop and implement innovative solutions that reduce their environmental footprint and contribute to sustainable development. This process inherently promotes green innovation, as it requires the introduction of new, environmentally friendly technologies and practices [26]. In addition, these innovation investments can attract more talented people who can contribute to the sustainable development of the company, improve its performance, and accelerate the development of green innovation [27,28]. In conclusion, traditional energy businesses increase their R&D investments to foster green innovation when considering the environment. Therefore, we propose the following hypothesis:

H2: *Positive ESG performance in traditional energy companies can foster increased investments in innovation, which in turn enhances their capacity for green innovation.*

2.3. ESG Performance, External Supervision, and Green Innovation

From the standpoint of information asymmetry, corporate stakeholders do not fully understand the company's internal information, and corporate managers have more information than corporate stakeholders [29]. To supervise the enterprise, business stakeholders need to collect relevant information, which requires them to pay higher costs than business operators. ESG performance conveys to the external capital market favorable signals and can reduce information collection costs for traditional energy company stakeholders, thereby effectively reducing the information asymmetry caused by blocked information acquisition channels [30]. This is conducive to the supervision of enterprises by corporate stakeholders, reducing the occurrence of principal–agent problems and thus urging enterprises to focus on green innovation, enhancing their efforts to research and develop green innovative products and fostering green innovation [31,32]. In conclusion, ESG performance reveals the internal information of a company to its stakeholders, lowering the costs of information gathering. This enhanced transparency aids stakeholders in effectively overseeing the company, prompting management to focus more on green innovation. Therefore, the following hypothesis is proposed:

H3: *ESG performance makes traditional energy companies more susceptible to external supervision, increasing their focus on green innovation.*

2.4. ESG Performance, Government Subsidies, and Green Innovation

Government subsidies are certain amounts of financial assistance provided by the government to specific enterprises or specific enterprise projects of enterprises within a certain period based on relevant national policies. By alleviating the financial pressure on traditional energy companies, government subsidies also reduce the risk in enterprises' green innovation process to a certain extent, thereby injecting vitality into this green innovation [33]. From the perspective of sustainable social development, the government, while implementing incentive policies, also mandates that firms comply with environmental conservation and social accountability regulations. Outstanding ESG performance is a clear indication of firms proactively embracing social responsibility and safeguarding the environment. Hence, higher ESG performance is associated with government departments viewing companies more favorably [34–37]. This not only helps alleviate financial pressure

but also enables the allocation of funds toward advancing green innovation. Overall, good ESG performance is likely to attract government subsidies, providing additional funds to support and enhance green innovation. Therefore, the following hypothesis is proposed:

H4: *Traditional energy companies with good ESG performance receive government subsidies that can be used to foster green innovation.*

3. Research Design

3.1. Selection of Samples and Data Sources

The content herein draws on previous scholarly studies [38]. In accordance with the categorization by the China Securities Regulatory Commission, we categorize the traditional energy industry into four sectors. These sectors include the oil and natural gas extraction industry; electricity, heat production, and supply industry; petroleum processing, coking, and nuclear fuel processing industry; and coal mining and washing industry. This study's research sample comprised companies in the traditional energy industry listed on the Shanghai and Shenzhen Stock Exchanges from 2013 to 2022. We excluded ST- and PT-type enterprises and those with severe anomalies or significant missing financial data. Ultimately, a total of 1227 sample observations from 147 traditional energy companies were obtained. The data sources include CSMAR, the Wind database, and the China Research Data Platform. We applied a 1% trimming process on both ends of the data distribution to alleviate the influence of outliers on the results.

3.2. Model Design and Variable Definition

We constructed a multivariate fixed effects model to assess how traditional energy companies' ESG performance affects green innovation. The model settings are as follows:

$$GP_{j,t} = \partial_0 + \partial_1 ESG_{j,t} + \partial_2 Controls_{j,t} + \sum year_t + \sum industry_i + \varepsilon_{j,t} \quad (1)$$

In Model (1), $GP_{j,t}$ represents the green innovation level of company j in period t, $ESG_{j,t}$ represents the ESG performance of company j in year t, $Controls_{j,t}$ represents the control variable, $year_t$ represents the year fixed effect, $industry_i$ represents the industry fixed effect, and $\varepsilon_{j,t}$ represents the random error. The specific variables are shown in the following Table 1.

Table 1. Description of variables.

Variable Category	Symbolic Representation of a Variable	Variable Name	Variable Explanations
Dependent variable	GPt	Green innovation level	Total quantity of green patent filings
	GPi	Green innovation and invention level	Quantity of green invention patent filings
	GPp	Green innovation practical level	Quantity of green utility patent filings
Independent variable	ESG	ESG performance	Sino-Securities Index ESG rating scores
Control variables	tobinq	Market value	Company market value divided by replacement cost
	cashflow	Cash flow ratio	Operating cash flow/sales revenue
	bs	Board size	Board of directors' membership count in listed companies
	Idr	Ratio of independent directors	Proportion of nonexecutive directors to the total board composition

Table 1. *Cont.*

Variable Category	Symbolic Representation of a Variable	Variable Name	Variable Explanations
Control variables	Ec	Equity concentration	Shareholding ratio of the largest shareholder of listed companies
	size	Enterprise size	Logarithmically assessed year-end total assets
	Duality	Concurrent appointments of directors and managers	If there is a concurrent role, it is 1; otherwise, it is 0
	Mo	Management shareholding ratio	Management's shareholding expressed as a fraction of total share capital

3.2.1. Dependent Variable

The green innovation level serves as the dependent variable in this paper. To assess this level, we adopted the approach in Li and Xiao and employed the quantity of green patent filings as a metric [15,39]. To delve more profoundly into the influence of ESG performance on various forms of green innovation, green patents are categorized as green invention patents or green practical patents in accordance with Chinese patent legislation. Based on Lee, we employed the quantity of green invention and green practical patent filings to gauge the levels of green invention patents and green practical patents [40]. The difference between the two is that green practical patents place greater emphasis on practicality and are more beneficial than green invention patents to traditional energy companies utilizing these patents in their production processes [41].

3.2.2. Independent Variable

The independent variable is ESG performance. To assess corporate ESG performance, most of the literature employs comprehensive ESG scores. Common international ESG scores include MSCI, Thomson Reuters, FSTE, and Bloomberg's ESG rating scores. In China, ESG scores include Sino-Securities Index ESG rating scores, the Syn Tao Green Finance ESG score, and the CSI ESG score. Because of the extensive time span of the sample selection and the absence of major international rating agency evaluations for Chinese companies, the Sino-Securities Index ESG rating score is more commonly employed. This score encompasses the ESG data of publicly traded corporations during the last decade. Therefore, we utilized the findings of Chen and the Sino-Securities Index ESG rating scores as the independent variable [42]. The Sino-Securities Index integrates China's national context and capital market characteristics to create a top-down ESG rating system. This system encompasses 16 categories, including resource utilization and climate change, incorporating 44 key indicators. The Sino-Securities Index uses this established ESG rating system to evaluate the ESG performance of listed companies. The Sino-Securities Index ESG score ranges from 0 to 100, with higher scores indicating superior performance.

3.2.3. Control Variables

We referenced the research of Quan and Tan to select the following control variables: market value (tobinq), cash flow ratio (cashflow), board size (bs), and independent director ratio (Idr) [43,44]. Additionally, variables such as duality of directors and managers (Duality), management shareholding ratio (Mo), ownership concentration (Ec), and company size (size) were employed as control variables.

4. Experimental Outcomes and Discussion

4.1. Descriptive Statistics

The descriptive statistics of the regression sample used in this investigation are presented in Table 2. The reported information includes maximum value, median, minimum value, standard deviation, mean, and sample size. The average ESG information disclosure

level of the sample is 72.98, with the maximum value reaching 83.95. This result indicates considerable potential for enhancing the ESG performance of traditional energy enterprises in China. The data pertaining to the green innovation invention level (GPi) and the green innovation practical level (GPp) exhibit a degree of similarity. The mean value of them is 0.39, representing a substantial difference from the maximum value. The median is relatively low, and the variance is considerable, suggesting overall low green innovation among China's traditional energy enterprises. There is a discernible disparity in green innovation performance among these enterprises, accompanied by a certain degree of volatility, warranting regression analysis.

Table 2. Descriptive statistics.

Variable	N	Mean	SD	Min	Median	Max
GP	1227	0.55	1.10	0.00	0.00	5.70
GPp	1227	0.39	0.90	0.00	0.00	4.65
GPi	1227	0.39	0.95	0.00	0.00	5.44
ESG	1227	72.98	5.63	55.06	73.27	83.95
tobinq	1227	1.43	0.73	0.81	1.17	5.05
cashflow	1227	0.07	0.06	−0.11	0.07	0.23
bs	1227	2.23	0.21	1.61	2.20	2.71
Idr	1227	36.44	4.27	31.25	33.33	50.00
Duality	1227	0.14	0.35	0.00	0.00	1.00
Mo	1227	4.24	11.39	0.00	0.00	52.43
Ec	1227	41.18	17.48	7.14	42.93	80.34
size	1227	3.15	0.07	3.01	3.15	3.34

4.2. Regression Results

To mitigate the influence of macroeconomic fluctuations and disparities among different energy industry types, a fixed effects model was utilized in this research. Table 3 presents the results of the baseline regression analysis that shows the relationship between ESG performance and green innovation in traditional energy corporations. Columns (1) to (3) present the regression outcomes that incorporate fixed effects without controlling for financial indicators. The regression coefficients of ESG performance on the three green innovation output indicators are positively significant at the 1% level. These findings indicate that the environmental, social, and governance (ESG) performance of conventional energy corporations plays a substantial role in promoting corporate green innovation. Columns (4) to (6) display the regression results after incorporating fixed effects; the regression coefficient of ESG performance on the level of green innovation remained significantly positive. This result underscores the concept that promoting improved ESG performance in traditional energy companies fosters advancements in green innovation.

Table 3. Baseline regression results.

Variable	(1) GPt	(2) GPi	(3) GPp	(4) GPt	(5) GPi	(6) GPp
ESG	0.051 ***	0.042 ***	0.037 ***	0.022 ***	0.018 ***	0.016 ***
	(9.612)	(9.428)	(8.507)	(4.111)	(3.890)	(3.588)
tobinq				0.230 ***	0.248 ***	0.225 ***
				(4.618)	(5.968)	(5.439)
cashflow				0.944 *	0.907	0.261
				(1.945)	(2.234)	(0.647)
bs				0.627	0.649	0.355
				(4.088)	(5.054)	(2.777)
Ec				0.006 ***	0.005 ***	0.004 **
				(3.020)	(2.956)	(2.311)

Table 3. *Cont.*

Variable	(1) GPt	(2) GPi	(3) GPp	(4) GPt	(5) GPi	(6) GPp
Idr				0.024	0.028	0.023
				(3.346)	(4.706)	(3.804)
size				6.508 ***	5.689 ***	5.072 ***
				(10.171)	(10.628)	(9.524)
Duality				0.141 *	0.092	0.058
				(1.771)	(1.378)	(0.875)
Mo				0.005*	0.005 **	0.004
				(1.930)	(2.178)	(1.621)
_cons	−3.127 ***	−2.767 ***	−2.238 ***	24.652 ***	22.156 ***	18.938 ***
	(−7.753)	(−8.108)	(−6.788)	(−13.073)	(−14.045)	(−12.065)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
N	1227	1227	1227	1227	1227	1227
R-sq	0.237	0.263	0.226	0.355	0.391	0.321

In the table, * denote significance at the 10% levels; ** denote significance at the 5% levels; and *** denote significance at the 1% levels.

5. Robustness Testing

5.1. Robustness Check

5.1.1. Replacement of Dependent Variable

This research employed two methods to substitute the dependent variable to test the regression results. One approach, based on the research of Song, entails replacing the numerical quantity of green patent filings with the proportion of green patent filings in the overall quantity of patent filings [45]. The analysis outcomes, shown in parts (1) to (3) of Table 4, demonstrate the significance of the effect of ESG performance on the proportion we used as a proxy dependent variable. This result further strengthens the reliability of the main regression findings. Although the number of green patent applications solely indicates a company's emphasis on green innovation, the quantity of green patents acquired signifies the actual level of green innovation achieved by a company. Hence, following previous studies, the second approach we used involves substituting the quantity of green patents acquired for the quantity of green patent filings [46]. The analysis outcomes are presented in parts (4) to (6) of Table 4. The regression coefficient is consistently positive and statistically significant, indicating the strength and reliability of the basic regression findings.

Table 4. Robustness check—replacement of the dependent variable.

Variable	(1) GPT	(2) GPiT	(3) GPpT	(4) GotP	(5) GotPi	(6) GotPp
ESG	0.003 ***	0.003 **	0.002 *	0.025 ***	0.015 ***	0.019 ***
	(2.656)	(2.479)	(1.695)	(5.169)	(4.173)	(4.260)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
_cons	−0.027 ***	−0.578 ***	−0.994 ***	−1.909 ***	−4.621 ***	−8.236 ***
	(−2.760)	(−3.798)	(−2.874)	(−12.798)	(−12.035)	(−11.864)
N	1216	1216	1216	1208	1208	1208
R-sq	0.092	0.092	0.087	0.381	0.430	0.341

In the table, * denote significance at the 10% levels; ** denote significance at the 5% levels; and *** denote significance at the 1% levels.

5.1.2. Changing Independent Variables

Considering the potential bias in comprehensive ESG scores arising from different evaluation systems used by various rating agencies, we employed the comprehensive ESG score published by Bloomberg for the regression analysis. This choice aims to circumvent

subjective biases caused by divergent evaluation systems. Table 5 presents the regression results, which are consistent with the primary regression results.

Table 5. Robustness check—replacement of the independent variable.

Variable	(1) GPt	(2) GPi	(3) GPp
ESG_pengbo	0.024 ***	0.025 ***	0.017 ***
	(3.783)	(4.776)	(3.248)
Controls	Yes	Yes	Yes
year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
_cons	27.765 ***	22.296 ***	22.495 ***
	(−8.446)	(−8.165)	(−8.338)
N	683	683	683
R-sq	0.455	0.497	0.435

In the table, * denote significance at the 10% levels; ** denote significance at the 5% levels; and *** denote significance at the 1% levels.

5.1.3. Changing Estimation Method

To account for potential deviations between the collected number of green patent applications and the actual number, we employed the Tobit estimation method used in Zhang and replaced the multidimensional panel fixed effects model [47]. By employing the new estimation method, as depicted in Table 6 (1) to (3), all regression coefficients of ESG performance demonstrated significant positivity.

Table 6. Robustness check—replacement of the method and supplementary variable.

Variable	(1) GPp	(2) GPi	(3) GPt	(4) GPt	(5) GPi	(6) GPp
ESG	0.012 ***	0.014 ***	0.018 ***	0.089 ***	0.096 ***	0.080 ***
	(2.735)	(3.045)	(3.357)	(5.428)	(5.605)	(4.890)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Province	No	No	No	Yes	Yes	Yes
_cons	14.780 ***	18.007 ***	19.796 ***	16.546 ***	19.874 ***	14.164 ***
	(−8.311)	(−9.967)	(−9.291)	(−8.701)	(−10.002)	(−7.509)
N	1227	1227	1227	1227	1227	1227
R-sq	0.409	0.459	0.442			

In the table, * denote significance at the 10% levels; ** denote significance at the 5% levels; and *** denote significance at the 1% levels.

5.1.4. Supplementary Variable Method

We acknowledge the likelihood of omitting the province in which the company is situated, which remains unchanged over time, potentially leading to biased and inconsistent estimation results and incorporated province fixed effects while retaining year and industry fixed effects. As shown in Table 6, columns (4) to (6), the regression results aligned consistently with the primary regression outcomes.

5.2. Endogeneity Test

5.2.1. Two-Stage Least Squares Test

As previously mentioned, the ESG performance of traditional energy companies can enhance corporate green innovation levels. However, it is also possible that companies with higher green innovation levels might exhibit better ESG performance, indicating potential endogeneity issues of mutual causality. To address this concern, we adopted the approach in Xi and utilized the first-period lag term (ESG1) and second-period lag term (ESG2) of corporate ESG performance as instrumental variables [48]. We conducted this analysis using two-stage least squares (2SLS), as presented in Table 7. Table 7 (1) illustrates the

correlation between ESG performance and its lagged term in the first-stage regression, and columns (2) to (4) display the second-stage regression results. The results indicate that the F statistics exceed 10, and the p values of the Sargan statistics are 0.388, 0.372, and 0.319, all greater than 0.050. These findings suggest that the instrumental variables meet the exogeneity requirements. Even after controlling for endogeneity issues, the regression results revealed that the ESG performance of traditional energy companies continues to significantly increase green innovation.

Table 7. Endogeneity test—2SLS.

Variable	(1) ESG	(2) GPt	(3) GPi	(4) GPp
ESG1	0.611 ***			
	(17.661)			
ESG2	0.076 **			
	(2.182)			
ESG		0.036 ***	0.030 ***	0.030 ***
		(2.929)	(2.911)	(2.970)
Controls	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
_cons	−22.959 **	−25.956 ***	−23.225 ***	−20.079 ***
	(−2.433)	(−10.492)	(−11.331)	(−9.858)
F		14.47	17.89	12.85
Sargan statistic		0.388	0.372	0.319
N	887	887	887	887
R	0.623	0.362	0.404	0.328

In the table, * denote significance at the 10% levels; ** denote significance at the 5% levels; and *** denote significance at the 1% levels.

5.2.2. Heckman Test

ESG performance can be influenced by ESG-related information released by some traditional energy companies that are collected by rating agencies, thus not covering all companies in this sector. To mitigate potential estimation biases resulting from information gaps, we employed the Heckman two-step method for estimation, which are shown in Table 8. Initially, the probit model was utilized to identify factors influencing the disclosure of ESG reports by listed companies, such as analyst attention, internal control quality, and the average ESG performance of different companies in the same year, as explanatory variables. This step estimated the probability of sample companies releasing ESG performance and calculated the inverse Mills ratio (IMR), which was then included in the regression model. The regression results demonstrated that ESG performance significantly and positively incentivizes the number of green patent applications, which aligns with the regression results obtained from the fixed effects model.

Table 8. Endogeneity test—Heckman test.

Variable	(1) GPt	(2) GPi	(3) GPp
ESG	0.0202 ***	0.0195 ***	0.0136 **
	(2.6809)	(3.1906)	(2.1829)
imr	0.6560 ***	0.5952 ***	0.4419 ***
	(4.4487)	(4.9947)	(3.6391)
Controls	Yes	Yes	Yes
year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
_cons	−23.6910 ***	−20.0375 ***	−19.4048 ***
	(−7.3220)	(−7.6625)	(−7.2832)
N	773	773	773
R-sq	0.418	0.485	0.395

In the table, * denote significance at the 10% levels; ** denote significance at the 5% levels; and *** denote significance at the 1% levels.

5.3. Mechanism Inspection

The previous theoretical analysis suggests that improved ESG performance may augment innovation investments, attract external oversight, and secure government subsidies, consequently enhancing the level of green innovation. Hence, we selected three indicators—total innovation investment (R&D), research report attention, and total government subsidies—and employed methodologies from Fang et al. and Jiang to establish a mediation model. This model aims to examine the mechanism of action [49,50].

$$GP_{j,t} = \partial_0 + \partial_1 ESG_{j,t} + \partial_2 Controls_{j,t} + \sum year_t + \sum industry_i + \varepsilon_{j,t} \quad (2)$$

$$Influence_{j,t} = \partial_0 + \partial_1 ESG_{j,t} + \partial_2 Controls_{j,t} + \sum year_t + \sum industry_i + \varepsilon_{j,t} \quad (3)$$

$$GP_{j,t} = \partial_0 + \partial_1 ESG_{j,t} + \partial_2 Influence_{j,t} + \partial_3 Controls_{j,t} + \sum year_t + \sum industry_i + \varepsilon_{j,t} \quad (4)$$

We employed stepwise regression across the three models mentioned above. $Influence_{j,t}$ represents the impact mechanism of the fulfillment of ESG responsibility on green innovation and encompasses three indicators: total innovation investment, research report attention, and government subsidies. Recognizing that green innovation demands substantial investments, we selected the total amount of innovation investment as the measure and utilized the logarithm of the total innovation investment as a reference [28]. External supervision necessitates the attention of various stakeholders to listed companies. Therefore, we employed research report attention to gauge external oversight [32]. For government subsidies, we drew from Shao and used the logarithm of the direct government subsidies amount as an intermediary variable in the regression [51]. The results of the mechanism test are shown in Table 9.

Table 9. Mechanism regression results.

Variable	(1) GPt	(2) R&D	(3) GPt	(4) Research Report Attention	(5) GPt	(6) Government Subsidies	(7) GPt
ESG	0.0391 ***	0.0585 ***	0.0231 ***	0.0615 ***	0.0287 ***	0.0425 ***	0.0275 ***
	(7.3213)	(5.2597)	(3.3894)	(9.3281)	(5.2657)	(3.0551)	(4.3142)
R&D			0.1857 ***		0.1741 ***		0.1090 ***
			(8.2020)		(7.5099)		(6.6772)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes
_cons	−6.482 ***	9.927 ***	−8.076 ***	−4.216 ***	−5.749 ***	10.842 ***	−7.674 ***
	−10.2978	7.1884	−9.4070	−5.4413	−9.1969	6.5456	−9.8945
N	1227	735	735	1218	1218	814	814
R-sq	0.299	0.425	0.353	0.361	0.330	0.411	0.431

In the table, * denote significance at the 10% levels; ** denote significance at the 5% levels; and *** denote significance at the 1% levels.

6. Further Analysis

6.1. Analysis of Property Rights Heterogeneity

The operations of traditional energy enterprises are impacted by the inconsistency in organizational structures and risk-taking capabilities between government-owned and privately owned enterprises. This heterogeneity in property rights causes differences in their operations. In light of this, we separated the sample into two groups—nonstate-owned and state-owned enterprises—and present the findings in Table 10, columns (1) and (2). According to column (1), the ESG performance of nonstate-owned enterprises within traditional energy companies does not have a significant impact on green innovation. However, in column (2), the correlation index of ESG performance among state-owned enterprises is 0.015, indicating a statistically meaningful positive impact at the 5% significance level.

These results indicate that ESG performance in Chinese state-owned enterprises notably promotes the extent of green innovation within traditional energy enterprises.

Table 10. Heterogeneity analysis based on property and market competition.

Variable	(1) Privately Owned Enterprises	(2) Government-Owned Enterprises	(3) Low Market Competition	(4) High Market Competition
	GPt	GPt	GPt	GPt
ESG	0.003	0.015 **	0.005	0.027 ***
	(0.404)	(2.343)	(0.552)	(3.925)
Controls	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
_cons	−3.307	−28.153 ***	−17.769 ***	−32.048 ***
	(−1.067)	(−12.411)	(−7.468)	(−10.492)
N	371	856	605	622
R-sq	0.227	0.510	0.215	0.527

In the table, * denote significance at the 10% levels; ** denote significance at the 5% levels; and *** denote significance at the 1% levels.

On the one hand, in China, state-owned enterprises are government-owned entities that possess a standardized system, enabling them to readily access financial resources. Government-owned companies typically facilitate convenient access to simplistic and low-cost financial resources, which is more advantageous for enhancing the level of green innovation among these entities [52]. Conversely, private and foreign-funded enterprises face relatively greater financial constraints. This characteristic is attributed to the fact that the primary sources of funds for nonstate-owned enterprises are institutional investors and financial institutions. Influenced by investment philosophies, short-term investors are hesitant to tolerate a decline in company performance. Nevertheless, the revenue return cycle from green innovation tends to be lengthy. Consequently, these investors show less interest in enterprises' levels of green innovation, leading to limited enhancement in the green innovation level.

On the other hand, government-owned companies are primarily under state control. Moreover, with increasing national emphasis on environmental protection, managers of these enterprises tend to prioritize long-term income generated by green innovation. This inclination arises from a commitment to support national policies, leading them to further endorse the development of green innovation.

Indeed, the inherent nature of state-owned enterprises dictates that they must shoulder specific environmental responsibilities. Consequently, government-owned enterprises are more predisposed to exhibiting commendable ESG performance, thereby exerting an influence on the green innovation level.

6.2. Analysis of Competitive Environment Heterogeneity

According to Yin, intense industry competition deepens stakeholders' awareness and comprehension of enterprise-related information [53]. In the face of heightened industry competition, companies encounter increased business risks and require more support from stakeholders. Consequently, companies endeavor to showcase improved ESG performance to secure support from stakeholders. Conversely, in a less competitive environment, companies may display a diminished eagerness to seek investor or government support by showcasing weaker ESG performance. If the industry environment is not competitive, the degree of information asymmetry among corporate stakeholders increases, external supervision decreases, and the impact of ESG performance in traditional energy enterprises on the extent of green innovation diminishes. We employed the Herfindahl–Hirschman Index (HHI) to quantify the industry competition faced by enterprises, as depicted in Formula (5). A higher HHI signifies a more rigorous competitive environment that the com-

pany faces within its industry. We drew on the research of Liu and categorized the sample into two groups based on industry competition—high and low competition—determined by whether the HHI was above or below its median, respectively [54]:

$$\mathrm{HHI}_{i,\mathrm{t}} = \sum \left(\frac{\mathrm{income}_{i,t}}{income_t} \right)^2 \quad (5)$$

where $income_{i,t}$ represents the operating income of company i in year t, and $income_t$ represents the sector's total operating income in year t. The research results are illustrated in columns (3) and (4) of Table 10. In industries in which the company is situated and competition is not fierce, ESG performance does not significantly enhance the green innovation of traditional energy enterprises. Conversely, in highly competitive industry environments, at the 1% significance level, the extent of green innovation in traditional energy companies is significantly influenced by ESG performance, consistent with expectations.

7. Conclusions and Discussion

This study empirically investigated how ESG performance in the traditional energy industry affects green innovation using a sample of traditional energy companies that are publicly listed on China's Shenzhen and Shanghai A shares markets from 2013 to 2022. The study findings indicate that the ESG performance of traditional enterprises can significantly promote their green innovation extent. This conclusion remains robust after conducting robustness and endogeneity tests, which involve substituting explanatory and explained variables, changing estimation methods, and utilizing lagged two-period ESG performance as the instrumental variable. Furthermore, we conducted an in-depth exploration of the influencing mechanisms, including enterprise innovation investment, external supervision, and government subsidies. The mechanism test revealed that ESG performance could foster green innovation by these mechanisms. Last but not least, we found that state-owned enterprises' ESG performance significantly promotes green innovation. This influence is more pronounced in a highly competitive market environment than in a less competitive market.

Our study offers several contributions. First, it delved into the impact of corporate ESG performance on the extent of green innovation, thereby enriching the body of research concerning the relationship between corporate ESG performance and green innovation. Distinguishing itself from previous studies, this paper zeroed in on traditional energy enterprises. Enhancing their capacity for green innovation is urgently needed for these companies, serving as a strategic move towards environmental sustainability and adaptation to the evolving international scenario. Therefore, through the research in this paper, we can make up for the lack of research on traditional energy companies. This not only fills a crucial gap in ESG research concerning traditional energy companies, but it also equips these companies with actionable insights derived from this study. Furthermore, it offers theoretical guidance for their green transformation through enhanced ESG performance.

Secondly, this paper identified innovation inputs, external monitoring, and government subsidies as mechanism variables. Most previous studies have focused solely on the mediating effect of ESG performance on the extent of green innovation from an innovation investment perspective, neglecting the influence of corporate stakeholders on corporate green innovation. We examined the influence of ESG on green innovation by integrating the mediating roles of both internal and external corporate factors. Specifically, we selected innovation investment to represent internal corporate influences and external monitoring along with government subsidies to epitomize external corporate influences. Upon analyzing the data, we concluded that firms' innovation investment, external monitoring, and government subsidies serve as significant mediating variables. These factors, influenced by ESG performance, in turn, impact green innovation. This not only enhances our understanding of the relationship between ESG and green innovation but also serves as a valuable addition to stakeholder theory.

Third, this paper examined the competitive environment's moderating role in the relationship between ESG performance and green innovation. While most studies con-

centrate on the moderating role of firms' property rights, they often overlook how the competitive environment further affects the relationship between ESG performance and green innovation. Our analysis indicated that a firm's ESG performance has a significant effect on green innovation, especially in a competitive market environment. This finding is crucial for companies in highly competitive sectors, underscoring the importance of contextual factors in boosting the positive impact of ESG on green innovation. Moreover, this study provides actionable guidance for traditional energy companies aiming to achieve sustainable transformation in these competitive settings.

The limitations of this paper are threefold. Firstly, the ESG concept has been popularized in China only in recent years, leading to non-uniform evaluation standards. Our data, sourced from the Sino-Securities Index agency, potentially introduced sample selection bias. Future research could benefit from the continuous development of ESG, utilizing more accurate analytical methods to expand coverage and enhance the accuracy of results. Secondly, our analysis focused solely on the overall ESG performance's impact on green innovation without dissecting the individual contributions of environmental (E), social (S), and governance (G) factors. Future research could delve into these specific dimensions, assessing how each one uniquely influences green innovation. Thirdly, this study is contextualized within China, limiting its generalizability. Future research should broaden the scope to include other countries, allowing for comparative analyses that can enhance this study's applicability and relevance globally.

Our study underscores the critical role of ESG performance in driving green innovation, providing valuable insights for traditional energy companies to enhance their sustainable practices in the future, responding to evolving global conditions. For enterprises, especially traditional energy companies undergoing green trans-formation, enhancing ESG performance is instrumental to elevating the extent of green innovation and facilitating the overall green transformation process. The findings of this study suggest that, amid intense competition, strong ESG performance proves to be particularly effective in cultivating advancements in green innovation. In future development processes, to enhance green innovation, managers must integrate a focus on the environment into the company's strategic planning and promoting ESG performance. This approach facilitates genuine improvements in green innovation levels and fosters green transformation for enterprises.

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