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The Effect of ESG Performance on Corporate R&D Investment in China

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Abstract

This study investigates the impact of ESG performance on firms' R&D investment using a dynamic panel approach of non-financial A-share listed firms in China from 2011 to 2021. The results show that ESG performance significantly promotes corporate R&D investment and further show that the effect of ESG is not consistent across all firms. Firms located in the eastern region, operating in manufacturing and service sectors, and those with more minor capital scales exhibit a more substantial effect of ESG on promoting R&D. Among the three ESG components, corporate governance plays the most decisive role in promoting R&D investment, followed by the social dimension. In contrast, the environmental dimension appears less significant. These findings indicate that ESG is not merely a means to enhance reputation; it can also serve as the foundation for continuous innovation.

Keywords: ESG Performance, R&D Investment, Promotional Effect, GMM, China

Introduction

Achieving sustainable development is a long-term task for the government and enterprises (Tu et al., 2022). The Environmental, social, and governance (ESG) framework is becoming a new standard for evaluating corporate behavior, adding non-financial dimensions beyond traditional financial indicators. ESG practices are becoming a strategic tool that enables companies to balance economic performance with environmental and social responsibilities, which can help enterprises integrate their long-term value creation with society's overall interests.

More and more companies are actively incorporating ESG factors into their strategic planning. Research and development investment clearly indicates a company's commitment to long-term innovation and sustainable growth. Therefore, the company's investment in research and development (R&D) has become a key area of focus.

To further explore this issue, Figure 1 illustrates the correlation between ESG performance and R&D investment in 2011 and 2021. It presents scatter plots of ESG scores and R&D intensity for non-financial A-share firms listed on the Chinese stock market. The fitted value

lines in both plots indicate a mild positive relationship, suggesting that firms with better ESG scores tend to invest more in R&D. However, this relationship does not seem strongly positive.

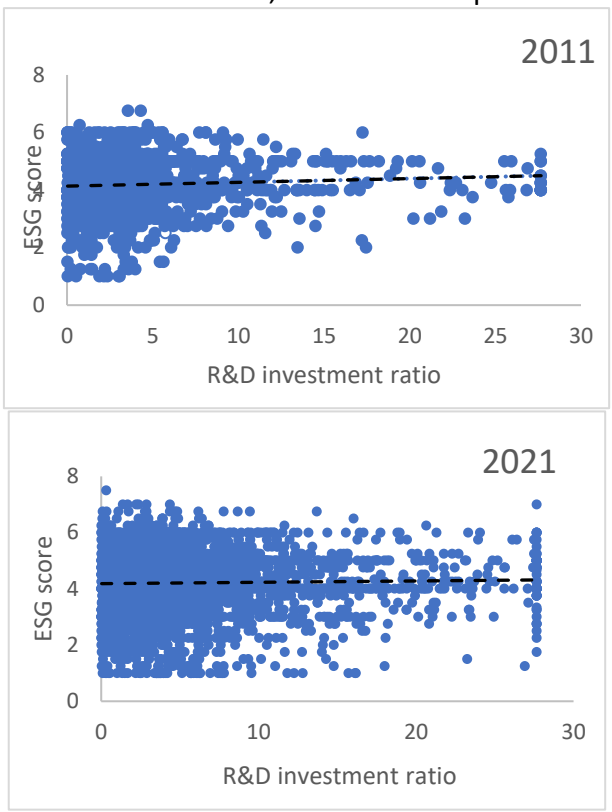

Figure 1. ESG Scores and R&D Investment Intensity in 2011 and 2021
Sources: the China Stock Market & Accounting Research (CSMAR) database.

This may be due to the nature of R&D itself. Innovation through R&D remains the cornerstone of a firm's technological progress and long-term competitiveness. Meanwhile, R&D activities are often costly, uncertain, and usually take time to generate results (Guo & Wang, 2020). This raises a critical question: As firms pursue ESG goals, how willing are they to commit to innovation under such risks and constraints?

In practice, enterprises often face two strategic paths for innovation investment. Some incorporate ESG into their long-term innovation plans, aiming to achieve substantial innovation and sustainable competitive advantages. Other companies adopt a method based solely on compliance, focusing on meeting regulatory or reputational expectations while making very limited investments in innovation. These differences may explain why ESG-R&D cannot show an obvious relationship.

Despite increasing emphasis on ESG, its role in driving meaningful innovation is still debated. The preliminary evidence from the scatter plots suggests that a simple correlation does not capture the full picture. This highlights the need for a more in-depth and dynamic analysis that considers firm characteristics, ESG components, and time-lag effects.

In reality, enterprises often face two strategic paths to innovation. On the one hand, some enterprises carry out substantive innovation, integrating ESG into their long-term innovation strategies to establish sustainable competitive advantages. On the other hand, some

enterprises adopt symbolic or compliance-type innovation, aiming to make superficial efforts to meet regulations or reputational pressures rather than truly committing to creating innovative outcomes. These diverging approaches raise doubts about the actual effectiveness of ESG initiatives in driving genuine technological progress.

This study identifies some research gaps. Firstly, although an increasing number of studies have shown that ESG factors are beneficial for aspects such as financial returns, valuation, and productivity (Barnett and Salomon, 2012; Yin et al., 2018; Sheng, 2022), there is limited research about the specific impact of environmental, social, and governance factors on R&D investment itself, while the investment in R&D projects is a key mechanism for achieving sustainable transformation.

To address these gaps, this paper goes beyond analyzing the overall environmental, social, and governance effects, subdividing them into environmental (E), social (S), and governance (G) components and studying their different roles in shaping innovation behavior. We also explore the differences in the relationship between environmental governance and R&D across different enterprise types, industries, and regional contexts.

Furthermore, this study makes the following contributions. Firstly, it provides strong empirical evidence for the long-term impact of ESG on R&D. Secondly, by identifying the influencing conditions of environmental, social, and governance factors on innovation and determining the most important ones among them through the analysis based on sub-samples and sub-indicators, this paper provides specific policy recommendations for different types of companies.

Literature Review

Many studies suggest that ESG performance promotes enterprise innovation by fostering long-term competitiveness, reducing financing constraints, and building stakeholder trust. For instance, green research and development are often incentivized by environmental regulations and sustainability goals (Cascillo et al., 2024; Farooq & Thavorn, 2025). In developing economies such as China, the pressure related to ESG encourages enterprises to pursue low-carbon transformation through green technologies (Hao et al., 2025). These investments usually lead to product differentiation and market premiums.

In terms of society, ESG practices can enhance R&D efficiency through better employee engagement, consumer loyalty, and supply chain collaboration. Park & Jang (2021) cited Google's "20% Innovation Time" policy as an example of socially embedded innovation management. Empirical evidence indicates that ESG-driven stakeholder relationships positively impact an innovative culture and reduce the talent turnover rate (Khalil et al., 2024;) Narula et al., 2023. In the consumer market, a higher ESG score is also associated with the willingness to pay premiums, providing an additional source of funds for innovation (Singhania & Gupta, 2024).

Regarding governance, enterprises with stronger internal control, long-term incentive plans, and transparent decision-making are more likely to support continuous R&D investment (Chen et al., 2025; Sharma et al., 2025). For instance, Microsoft's long-term equity compensation mechanism is a key driver for its continuously increased R&D investment

related to artificial intelligence (Arvidsson & Dumay, 2022). This is particularly important in China, where the ownership structure, especially between state-owned and private enterprises, regulates the effectiveness of ESG (Yang et al., 2025).

These findings have received extensive support from the stakeholder theory, which holds that ESG is a platform for balancing the interests of different stakeholders while creating long-term corporate value (Freeman, 1984; Cheng & Han, 2025).

However, some studies suggest that implementing ESG may crowd out research and development expenditures. Environmental compliance costs may limit innovation budgets, especially in resource-constrained or heavily polluting industries (Lee et al., 2022; Mohd Daud et al., 2024). For instance, Bagh et al. (2024) documented how environmental certification has delayed biodiesel innovation in Indonesia's palm oil industry.

In the governance dimension, there is a concern that "formalism is above substance." To meet rating agency standards, some companies prioritize superficial ESG disclosures while neglecting core innovations (Liu et al., 2025; Wang & Chu, 2024). Although there are formal ESG departments in many family businesses, the governance structure remains rigid, restricting the autonomy of research and development (Zhao et al., 2025).

In the social dimension, a resource siphon effect occurs when enterprises redirect their innovation budgets to charitable or public welfare projects to meet stakeholders' expectations (David et al., 2024; Rauf et al., 2024). These resource misallocations are particularly problematic in small and medium-sized enterprises with limited management capabilities.

This view is based on the resource allocation theory, which holds that financial and management resources are limited, and excessive ESG commitments may dilute strategic investment in innovation.
Some literature has also found no apparent connection between ESG and research and development due to institutional or industry characteristics. In some Chinese state-owned enterprises, ESG goals are more consistent with policy requirements rather than innovation goals (Lu et al., 2024; Sariyer et al., 2024). Furthermore, studies based on short time frames or narrow samples (for example, small and medium-sized enterprises) may not be able to capture the delayed effect of ESG on innovation (Hauff & Nilsson, 2023; Puzzonia, 2018).

Contingency theory explains this by emphasizing the fit between ESG strategies and the company's external environment. The theory of institutional complexity further indicates that the multidimensional logic of ESG may cause internal frictions, thereby leading to counterbalancing effects among environmental, social, and governance priorities (Aich et al., 2021).

Methodology

Building on stakeholder theory (Freeman, 1984) and the resource-based view (Barney, 1991), ESG performance may be a strategic asset that facilitates long-term innovation by reducing agency costs, attracting long-term investors, and enhancing firm reputation. To control for firm-specific characteristics, we include a set of variables informed by prior research (Lemmon

et al., 2008; Love, 2003; Duchin et al., 2010). Therefore, the model is set as equation (1):

$$RD_{it} = \beta_0 + \beta_1 ESG_{it} + \beta_2 Size_{it} + \beta_3 Growth_{it} + \beta_4 Cash_{it} + \beta_5 Roa_{it} + \beta_6 Age_{it} + \varepsilon_{it} \quad (1)$$

where RD_{it} denotes the R&D investment intensity of firm i in year t, ESG_{it} represents the ESG score, $Size_{it}$ represents firm size, $Growth_{it}$ represents the annual growth rate of operating revenue. $Cash_{it}$ represents cash holdings, defined as cash and cash equivalents divided by total assets. ROA_{it} represents firm profitability, measured as net income over total assets. Age_{it} represents firm age, calculated as the years since the firm's establishment or listing, ε_{it} is the error term.

This study employs a dynamic panel Generalized Method of Moments (GMM) estimator to examine the effect of ESG performance on firms' R&D investment. The GMM approach is particularly well-suited for this analysis because it addresses several econometric challenges in panel data, including unobserved firm-specific heterogeneity, potential endogeneity of the explanatory variables, and the dynamic nature of firms' R&D investment. Specifically, we use the two-step system GMM estimator developed by Blundell & Bond (1998), which improves efficiency by combining moment conditions in both levels and first differences. All variables are transformed into natural logarithmic form to reduce data dispersion in the regression analysis. The dynamic model is specified as follows:

$$RD_{it} = \beta_0 + \beta_1 RD_{it-1} + \beta_2 ESG_{it} + \beta_3 Size_{it} + \beta_4 Growth_{it} + \beta_5 Cash_{it} + \beta_6 Roa_{it} + \beta_7 Age_{it} + \varepsilon_{it} \quad (2)$$

Variables measurement

The ESG data in this study come from the CSI ESG Rating system, which is built on a globally accepted ESG framework adapted to fit China's regulatory and market environment. The system uses a four-layer indicator structure and assigns ratings on a nine-point scale, from AAA (9) to C (1). It covers all A-share listed companies and a broad range of Hong Kong-listed firms, including those in the Hang Seng Composite Index, the Growth Enterprise Market (GEM), and companies eligible for the Hong Kong Stock Connect. R&D investment intensity (RD) is defined as the ratio of annual R&D spending to operating revenue, following the method used by Wang et al. (2017).

To account for firm-level heterogeneity, we include several control variables based on existing literature (Lemmon et al., 2008; Love, 2003; Duchin et al., 2010): firm size (Size, measured by the natural log of total assets), market-to-book ratio (MB), financial leverage (Lev, total debt divided by total assets), return on assets (ROA), cash holdings (Cash, the ratio of cash and cash equivalents to total assets), ownership type (SOE, equal to 1 if the firm is state-owned), and capital intensity (Capital, the log of fixed assets per employee). Summary statistics are reported in Table 1.

Table 1
Variable Definitions and Data Sources

Variable	Definition	Measurement	Source
RD	R&D Investment Intensity	The ratio of R&D expenditure to total operating revenue	CSMAR
ESG	ESG Performance Score	ESG rating score	CSI ESG Ratings
Capital	Capital Intensity	Natural logarithm of fixed assets divided by the number of employees	CSMAR
Size	Firm Size	Natural logarithm of total assets	
ROA	Return on Assets	Net income divided by total assets	
Cash	Cash Holdings	Cash and cash equivalents divided by total assets	
Growth	the growth rate of operating revenue	The change in operating revenue is divided by the previous year's operating revenue.	
Age	firm age	the number of years since the firm's establishment or listing	

The sample includes all non-financial A-share listed firms in China from 2011 to 2021. We exclude firms marked as ST or ST*, financial firms, and any observations with missing or abnormal values. The final dataset consists of 17,611 firm-year observations. ESG data are obtained from the CSI ESG Rating system, while financial and control variables are sourced from the CSMAR database. Continuous variables are winsorized at the 1st and 99th percentiles to mitigate the impact of outliers.

Descriptive statistics correlation coefficient

We perform preliminary diagnostics before conducting panel regression analysis, including descriptive statistics and correlation tests. Table 2 highlights substantial variation in R&D investment intensity across firms, suggesting heterogeneous innovation behaviors. The correlation matrix is not reported for brevity but is available upon request.

Table2
Descriptive statistics

VarName	Mean	SD	Min	Median	Max
RD	4.850	4.800	0.300	3.710	27.670
ESG	4.150	1.040	1.000	4.000	8.000
Size	22.120	1.260	19.992	21.923	26.153
Growth	0.310	0.680	-0.610	0.138	4.241
Cash	0.170	0.130	0.013	0.130	0.628
Roa	0.040	0.060	-0.276	0.041	0.200
Age	1.950	0.920	0.000	2.079	3.332

Results and Discussion

Table 3 shows the regression results of the full sample. Both Difference-GMM (Diff-GMM) and System-GMM (Sys-GMM) estimators are employed in Table 3, with one-step and two-step variants. The two-step system GMM estimator is regarded as the primary specification, given its greater efficiency and robustness (Blundell & Bond, 1998).

The standard diagnostic tests confirm the validity of the dynamic panel model. As reported in Table 3, the Arellano–Bond test for first-order serial correlation (AR(1)) yields small p-values, indicating the expected presence of first-order autocorrelation in differenced residuals, and the test for second-order autocorrelation (AR(2)) shows non-significant p-values across all specifications, suggesting that the residuals do not suffer from second-order serial correlation. Additionally, the Hansen test for over-identifying restrictions presents p-values well above conventional significance thresholds, implying that the instruments used are valid and not correlated with the error term.

Table 3
Regression results of the full sample [DV: RD]

	Diff-GMM		Sys-GMM	
	1-Step	2-Step	1-Step	2-Step
L.RD	0.6447***	0.6344***	0.7429***	0.7443***
	(11.7172)	(11.3859)	(29.3776)	(28.9492)
ESG	0.1545***	0.1588***	0.1508***	0.1561***
	(5.1325)	(5.3273)	(8.3036)	(8.6014)
Size	-0.2409**	-0.2071**	-0.1855***	-0.1832***
	(-2.3528)	(-2.0895)	(-7.5380)	(-7.3648)
Growth	-0.0702	-0.0582	0.0380	0.0454
	(-1.4048)	(-1.1959)	(1.0149)	(1.2355)
Cash	-0.0282	0.1556	2.0466***	2.0026***
	(-0.0843)	(0.4859)	(8.0930)	(8.0968)
Roa	-6.6227***	-6.5928***	-5.4032***	-5.3326***
	(-10.4665)	(-10.6672)	(-10.9563)	(-11.0482)
Age	-0.5253***	-0.5193***	-0.3068***	-0.3027***
	(-4.0053)	(-4.0760)	(-7.7968)	(-7.7291)
_cons			5.0955***	4.9790***
			(8.1879)	(7.9482)
Year	Yes	Yes	Yes	Yes
AR(1)	0.0000	0.0000	0.0000	0.0000
AR(2)	0.8383	0.8200	0.8866	0.8849
Hansen	0.4264	0.4264	0.2014	0.2014

Note: *, *, and *** represent significance at the 10%, 5%, and 1% levels, respectively. t-statistics are reported in parentheses. Hansen and AR test values indicate corresponding p-values. The estimations are conducted using one- and two-step approaches under the difference-GMM and system-GMM frameworks.

Focusing on the system GMM two-step results, we find that ESG performance positively influences R&D investment intensity, with a coefficient of 0.1561 ($p < 0.01$). This result is not only statistically significant but also consistent across all estimation methods, which gives strong support to the hypothesis that firms with better ESG practices are better investing in innovation. The results of the ESG coefficient in different GMM approaches further strengthen the robustness of this relationship.

The lagged dependent variable, RD_{it-1}, is positive and significant across all methods, indicating strong path dependence in R&D activities. Firms tend to maintain their past innovation investments; therefore, a dynamic modeling approach is needed.

Some control variables show differences across methods. For instance, cash holdings have a strong and positive effect under the two-step system GMM specification but appear insignificant under difference GMM. This may reflect the superior efficiency of system GMM in capturing internal financing effects that support R&D. The consistently negative and significant coefficients for ROA and Age across all specifications suggest that more mature or highly profitable firms may tend to reduce R&D intensity, possibly due to risk aversion or prioritization of short-term returns.

Firm size (Size) is negatively associated with R&D, and this effect diminishes slightly under system GMM. This could indicate that despite economies of scale, larger firms may allocate proportionally fewer resources to innovation, perhaps due to bureaucratic inertia or focus on core mature businesses.

Subsample and Sub-indicator Analyses

In the previous section, we established that ESG performance significantly impacts firms' R&D investment. However, ESG is a composite environmental, social, and governance concept. Moreover, firms operate in different contexts—such as geographic regions, industries, and scales—which may influence how ESG relates to innovation. We now conduct analyses based on subsamples and sub-indicators to explore these differences more deeply. This allows us to understand better which dimension of ESG matters and under what conditions ESG contributes more effectively to R&D investment.

Table 4 reports results for firms in western, central, and eastern China. While ESG performance positively influences R&D investment in all regions, the eastern region exhibits the strongest overall performance. Its ESG coefficient is slightly higher than that of the central and western regions. This suggests that firms in the East are better positioned to translate ESG efforts into innovation, which may reflect institutional and policy differences across regions, as firms in the East benefit from stronger market institutions and clearer ESG regulatory expectations (García-Sánchez et al., 2021; Hao et al., 2025), but firms in less developed regions often treat ESG as compliance rather than a strategic tool (Lu et al., 2024).

Table 4
Regression Results of Subsample Analysis by Regional Classification [DV: RD]

	WEST		MIDDLE		EAST	
	Diff-GMM	Sys-GMM	Diff-GMM	Sys-GMM	Diff-GMM	Sys-GMM
L.RD	0.5575***	0.7713***	0.5036***	0.6054***	0.6683***	0.7597***
	(3.5265)	(7.4601)	(3.3402)	(8.445)	(10.5255)	(28.1748)
ESG	0.1527**	0.1524***	0.1794***	0.1521***	0.1416***	0.1604***
	(2.0545)	(3.1089)	(2.9409)	(3.512)	(3.9018)	(7.5099)
Size	-0.3013	-0.1765**	-0.2993	-0.2850***	-0.2027**	-0.1807***
	(-1.3956)	(-2.2222)	(-1.3012)	(-4.6472)	(-2.0471)	(-6.4505)
Growth	-0.0098	0.047	-0.0146	0.1141	-0.0957	0.0271
	(-0.0741)	(-0.4134)	(-0.1539)	(-1.5536)	(-1.6292)	(-0.6131)
Cash	0.6844	1.4980**	0.0719	1.9310***	-0.0853	1.9804***

	-0.7245	-2.2267	-0.1125	-3.7567	(-0.2273)	-6.793
Roa	-3.0993	-4.2742**	-6.9260***	-6.1540***	-6.7717***	-5.2594***
	(-1.4767)	(-2.4520)	(-5.0411)	(-5.6304)	(-9.7915)	(-9.9150)
Age	0.1416	-0.1719	-0.8586**	-0.4244***	-0.5410***	-0.2576***
	(0.3292)	(-1.5125)	(-2.0354)	(-4.0079)	(-3.7739)	(-6.1443)
cons		4.3882**		7.9353***		4.7550***
		(2.161)		(4.9648)		(7.0897)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1854	2224	3023	3569	12655	15254
AR(1)	0.0046	0.0006	0.0016	0	0	0
AR(2)	0.614	0.5927	0.9775	0.9664	0.4833	0.5208
Hansen	0.6001	0.4532	0.8503	0.892	0.6437	0.5504

Note: The symbols *, *, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. The reported values in parentheses are t-statistics. The p-values for the Hansen and AR tests are also indicated. The models are estimated using one- and two-step methods within the Difference-GMM and System-GMM frameworks.

Table 5 compares results across four industries. The service sector shows the most substantial effect of ESG on R&D, followed by manufacturing. In contrast, according to the main results from the 2-step system GMM, agriculture and mining show no significant impact. These results reflect differences in business models and stakeholder sensitivity. Service firms, being closer to consumers and more reliant on intangible assets, are more related to ESG expectations and more likely to integrate ESG into long-term innovation strategies. As supported by Eccles & Serafeim (2013), they suggest that service-oriented firms benefit more from social and governance improvements, which strengthen trust and loyalty among stakeholders, which are key drivers for sustained innovation. Manufacturing responds positively, possibly due to regulatory pressure and international supply chain expectations. In contrast, ESG appears less influential in resource sectors like agriculture and mining, where compliance costs dominate innovation strategy (Mohd Daud et al., 2024).

Table 5
Regression Results of Subsample Analysis Across Four Industries [DV: RD]

	AGRICULTURE		MINING		MANUFACTURING		SERVICES	
	Diff-GMM	Sys-GMM	Diff-GMM	Sys-GMM	Diff-GMM	Sys-GMM	Diff-GMM	Sys-GMM
L.RD	0.4070***	0.6449***	0.13	0.3148	0.5910***	0.7007***	0.6251***	0.8648***
	(5.3846)	(7.1179)	(0.567)	(1.0556)	(8.3242)	(20.2422)	(5.4684)	(24.2929)
ESG	0.0905	-0.0061	-0.0302	-0.0167	0.1504***	0.1271***	0.1325**	0.2084***
	(0.4238	(-0.0703)	(-0.7201)	(-0.2881)	(4.6333)	(6.0822)	(2.095)	(5.673)
Size	-0.0376	-0.2998	0.0086	-0.0773	-0.1649	-0.0915***	-0.3119*	-0.2277***

	(-0.0949)	(-1.4009)	(0.0435)	(-0.8588)	(-1.3840)	(-3.4226)	(-1.9205)	(-3.9974)
Growth	-0.116	0.2036	0.0369	-0.0621	-0.0285	0.0577	-0.1048	-0.0667
	(-1.5465)	(1.5931)	(0.5184)	(-0.5920)	(-0.4433)	(1.1704)	(-1.6304)	(-1.2186)
Cash	0.2466	0.3671	2.9616***	1.6039	-0.0794	1.6211***	0.8786	1.8198***
	(0.1559)	(0.2992)	(2.2501)	(1.2660)	(-0.2451)	(6.7182)	(1.0428)	(3.1271)
Roa	-0.1584	0.4859	0.6916	1.91	-6.9829***	-5.6974***	-5.8842***	-5.0163***
	(-0.0629)	-0.2467	(0.4821)	(1.0852)	(-9.2851)	(-9.5982)	(-5.2642)	(-5.4873)
Age	-0.7596	-0.2776	-0.1194	-0.3928	-0.4862***	-0.3719***	-0.6117**	-0.1682**
	(-1.0950)	(-1.0128)	(-0.1695)	(-0.9496)	(-3.3426)	(-7.9984)	(-2.1612)	(-2.4008)
cons		7.5895		5.543		3.3607***		5.6906***
		(1.4009)		(1.4518)		(5.1481)		(4.0952)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	194	227	284	340	133900	159950	39270	48030
AR(1)	0.4217	0.2352	0.3315	0.2467				
AR(2)	0.3193	0.2982	0.3503	0.4224	0.4199	0.333	0.3276	0.2882
Hansen	0.3123	0.2194	0.3864	0.0292	0.3569	0.3725	0.1978	0.0759

Note: The symbols *, *, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. The reported values in parentheses are t-statistics. The p-values for the Hansen and AR tests are also indicated. The models are estimated using two-step methods within the Difference-GMM and System-GMM frameworks.

In Table 6, firms are categorized into low-, middle-, and high-capital groups. The impact of ESG on R&D is strongest in low-capital firms, followed by middle and high-capital firms. This suggests that smaller firms gain more from ESG engagement because ESG helps build reputation, signal credibility, and attract external financing, which benefits that are more valuable for firms with limited resources. This result is consistent with Liang & Renneboog (2020) and Yang et al. (2025), who argue that ESG can act as an alternative form of capital for firms with limited access to traditional funding channels, thus encouraging innovation investment. Larger firms already possess internal resources and mature R&D systems, reducing their reliance on ESG as a driver of innovation (David et al., 2024).

Table 6.
Regression Results of Subsample Analysis by Firm Size [DV: RD]

	Low capital		Middle capital		High capital	
	Diff-GMM	Sys-GMM	Diff-GMM	Sys-GMM	Diff-GMM	Sys-GMM
L.RD	0.7730***	0.7029***	0.5847***	0.7440***	0.2191	0.8984***
	(6.214)	(19.8526)	(6.1292)	(14.5436)	(1.2433)	(20.2837)
ESG	0.2551***	0.1901***	0.1057**	0.1196***	0.0870**	0.1067***
	(3.3850)	(4.9299	(2.2503)	(4.3073)	(2.4837)	(4.4671)
Size	-0.3269	-0.1305	-0.202	-0.1434	-0.2351**	-0.1283***
	(-1.1454)	(-1.1519)	(-0.9470)	(-1.4079)	(-1.9966)	(-3.6106)
Growth	0.0789	0.2286***	-0.0909	0.0321	-0.0627	-0.1019**
	(0.5805)	(2.6086)	(-1.2633)	(0.5401)	(-1.3519)	(-2.5380)
Cash	0.3712	2.6007***	0.3795	1.9378***	-0.4128	0.6159*
	(0.6319)	(6.7804)	(0.7617)	(4.3342)	(-0.9935)	(1.8573)
Profit	-9.4884***	-8.3568***	-4.7010***	-3.6794***	-4.5251***	-2.9716***
	(-6.9717)	(-8.3355)	(-6.3197)	(-5.9858)	(-5.8817)	(-4.3519)
Year	-0.7517**	-0.5837***	-0.5188**	-0.2180***	0.0028	-0.0667
	(-1.9927)	(-7.3340)	(-1.9966)	(-3.5276)	(0.0129)	(-1.3911)
cons		4.7522**		3.9696*		3.0529***
		-1.9778		-1.7589		-3.3797
Year	Yes	Yes	Yes	Yes	Yes	Yes
N	4630	6297	6267	7364	6898	7704
ar1p	0	0	0	0	0.0654	0
ar2p	0.9606	0.877	0.0454	0.0516	0.8595	0.2421
Hansen	0.309	0.3695	0.7046	0.4706	0.4914	0.1575

Note: The symbols *, *, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. The reported values in parentheses are t-statistics. The p-values for the Hansen and AR tests are also indicated. The models are estimated using two-step methods within the Difference-GMM and System-GMM frameworks.

Table 7 disaggregates ESG into environmental (E), social (S), and governance (G) dimensions. The governance dimension has the most significant effect on R&D investment, followed by social, while the environmental component becomes insignificant under the system GMM. This trend may reflect the direct connection between governance quality and innovation systems. Good governance improves internal control, reduces agency costs, and aligns managerial incentives with long-term innovation goals, just as the mechanisms highlighted by Fatemi et al. (2021). Governance also strengthens transparency and accountability, enhancing investor confidence and supporting high-risk innovation projects.

The social dimension contributes positively, possibly through employee engagement, organizational culture, and stakeholder alignment, which are known to support innovation-friendly environments (García-Sánchez et al., 2021; Khalil et al., 2024).

However, the environmental dimension may involve more compliance-driven costs or long-term payoffs, which do not immediately translate into R&D outcomes, especially in industries where green investment is not central to the business model (Cascillo et al., 2024).

Table 7

Regression results of Subsample Analysis by ESG Dimensions [DV: RD]

	E		S		G	
	Diff-GMM	Sys-GMM	Diff-GMM	Sys-GMM	Diff-GMM	Sys-GMM
ESG_e	0.0519**	-0.001				
	(2.1271)	(-0.0615)				
ESG_s			0.0501***	0.0652***		
			(2.6390)	(5.5903)		
ESG_g					0.0656***	0.1165***
					(3.0976	(7.7761
L.RD	0.6397***	0.7445***	0.6374***	0.7435***	0.6391***	0.7447***
	(11.3869)	(28.8999)	(11.3980)	(28.9617)	(11.4124)	(28.8969)
Size	-0.1710*	0.1418***	-0.1791*	-0.1622***	-0.1768*	-0.1603***
	(-1.6831)	(-5.8951)	(-1.7668)	(-6.5853)	(-1.7490)	(-6.5326)
Growth	-0.0622	0.0447	-0.0591	0.0464	-0.0613	0.0479
	(-1.2670)	(1.2073)	(-1.2041)	(1.2575)	(-1.2500)	(1.2966)
Cash	0.1223	2.1026***	0.1281	2.1071***	0.1268	1.9203***
	(0.3796)	(8.4457)	(0.3976)	(8.4711)	(0.3943)	(7.7330)
Profit	-6.7337***	-5.1676***	-6.7346***	-5.2430***	-6.6801***	-5.3683***
	(-10.8494)	(-10.7787)	(-10.8585)	(-10.8947)	(-10.7502)	(-11.0718)
Year	-0.6028***	-0.3454***	-0.6090***	-0.3226***	-0.5529***	-0.3119***
	(-4.7013)	(-8.7991)	(-4.7526)	(-8.1812)	(-4.3131)	(-8.0579)
cons		4.7845***		4.9319***		4.5032***
		(7.6760)		(7.8725)		(7.2512)
Year	Yes	Yes	Yes	Yes	Yes	Yes
N	17760	21328	17760	21328	17760	21328
AR(1)	0	0	0	0	0	0
AR(2)	0.8411	0.8994	0.8473	0.9054	0.8507	0.9022
Hansen	0.399	0.206	0.4241	0.2292	0.4453	0.2005

Note: The symbols *, *, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. The reported values in parentheses are t-statistics. The p-values for the Hansen and AR tests are also indicated. The models are estimated using two-step methods within the Difference-GMM and System-GMM frameworks.

Conclusions and Policy Implications

This study investigates the impact of ESG performance on firms' R&D investment using a dynamic panel approach from 2011 to 2021. The results show that ESG performance significantly promotes corporate R&D investment, and the sub-analysis further shows that the effect of ESG is not consistent across all firms on R&D investment. Firms located in the eastern region, operating in manufacturing and service sectors, and those with smaller capital scales exhibit a stronger effect of ESG on promoting R&D. Among the three ESG components, corporate governance plays the most decisive role in promoting R&D investment, followed by the social dimension. In contrast, the environmental dimension appears less significant. These findings indicate that ESG is not merely a means to enhance reputation; it can also serve as the foundation for continuous innovation. However, different types of companies require different policy recommendations to achieve sustainable innovation.

Based on the findings, this paper proposes the following policy recommendations:
Firstly, the ESG-R&D link is more significant in the eastern region, where institutional environments are stronger. Regional governments in central and western China should improve ESG disclosure systems, offer targeted ESG training, and provide local innovation incentives for ESG engagement.

Secondly, Policymakers should adopt ESG guidelines specific to the industry. These guidelines can emphasize responsible innovation and stakeholder engagement in service sectors while encouraging cleaner technologies and compliance transformation in industries based on resources like agriculture and mining.

Thirdly, since ESG has the most significant impact on R&D in low-capital enterprises, policymakers should support SMEs in obtaining credit based on ESG and providing targeted innovation subsidies to help them overcome financial constraints and invest in innovation.
Moreover, as the governance dimension has the most significant impact on R&D, policymakers should enhance the board of directors' independence, raise the requirements for company information disclosure, and link executive compensation to long-term innovation performance. These measures strengthen internal discipline and reduce agency costs, aiming to create a more conducive environment for innovation.

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