ESG Performance and High-Quality Development of Emerging Industries: Evidence from Micro-Level Enterprise Data

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Abstract: Based on a study utilizing panel data from China's A-share listed firms strategic emerging industries within spanning from 2018 to 2023, an empirical exploration of the interplay between ESG performance, R&D innovation, and enterprise high-quality development was conducted. The empirical findings indicate a positive link between corporate ESG performance and high-quality development, the with governance dimension showing the most substantial connection. ESG performance amplifies the role of R&D innovation in promoting high-quality development. Notably, a U-shaped relationship is observed between ESG performance and high-quality development, where exceeding a critical ESG score threshold accelerates advancement. Likewise, R&D innovation **U-shaped** exhibits impact on a development, high-quality with performance enhancements gaining momentum beyond a particular threshold. However, the interaction between overall ESG performance and R&D innovation does not exhibit statistical significance. Drawing from these insights. policymakers are recommended to implement a multifaceted strategy encompassing regulatory reforms, R&D tax incentives, and ESG scoring objectives, bolstered by technical support and intellectual property protection. This comprehensive approach can effectively foster upgrades in corporate ESG governance, innovation capabilities, and management models, thereby driving sustainable, high-quality development in emerging industries.

Keywords: ESG Performance; R&D

Innovation; High-Quality Development; Nonlinear Relationship; Threshold Effect

1. Introduction

In recent years, environmental, social, and governance (ESG) issues have risen to prominence in the business domain. Current research mostly concentrates on the linear association between ESG performance and corporate performance, yet its nonlinear influence on high-quality development has been underexplored. This study undertakes an in-depth analysis of the connections among ESG performance, R&D innovation, and high-quality development, leveraging data from A-share listed companies in China's strategic emerging industries over the 2018 - 2023 period. The research is poised to make two marginal contributions: firstly, it unveils a "U-shaped" link between corporate ESG performance and high-quality development; secondly, empirically it assesses the interaction between corporate ESG performance and R&D innovation. Consequently, this study not only enriches the comprehension of the intricate relationships among ESG performance, R&D innovation, and corporate high-quality development but also carries substantial theoretical and practical importance for steering government policy formulation as well as corporate ESG management and R&D innovation strategies.

2. Literature Review and Theoretical Framework

2.1 The Connotation and Value of ESG Performance

In recent years, environmental, social, and governance (ESG) performance has garnered increasing attention as a critical factor in 36

evaluating corporate holistic performance and long-term sustainable development. The significance of ESG performance can be understood from several perspectives. First, ESG performance enables companies to identify and address management risks arising from potential environmental and social issues that may impact their operations or reputation. Second, firms prioritizing ESG performance are more likely to be perceived as long-term investment opportunities, as demonstrate sustainable business thev models capable of weathering market volatility and economic downturns.

2.2 Corporate High-Quality Development

While academic consensus on the definition of high-quality development remains elusive, there is general agreement that its evaluation encompasses diverse methodologies and perspectives [1]. A People's Daily editorial that high-quality development posits constitutes "progress that fulfills people's aspirations for better living standards and embodies the new development philosophy." Recent literature has increasingly adopted total factor productivity (TFP) as a metric for high-quality development. For instance, China's economy has transitioned from rapid growth to a high-quality development stage, necessitating transformations in economic quality, efficiency, and drivers, where enhancing TFP serves as crucial а achieving mechanism for high-quality [2]. advancement Similarly, economic studies have employed firm-level TFP to operationalize high-quality development [3, 4].

2.3 ESG Performance, R&D Innovation, and Corporate High-Quality Development Numerous studies have endeavored to investigate the connections between ESG performance, R&D innovation. and high-quality corporate development. For instance, environmental performance is found to mediate the link between R&D investment and financial performance. This implies that R&D innovation is more likely to contribute to high-quality development when combined with strong environmental commitments [5]. Additionally, some research has delved into the specific mechanisms through which ESG

performance and R&D innovation interact to enhance high-quality development. It has been shown that ESG performance positively moderates the relationship between R&D investment and innovation outcomes. This suggests that firms with robust ESG practices demonstrate greater ability to transform R&D expenditures into concrete innovations [6].

Although many studies in this field have observed either positive or negative linear links between corporate ESG performance and operational outcomes. few have comprehensively analyzed its nonlinear effects in the context of high-quality development. Notably, some research has found a U-shaped relationship between environmental performance and innovation results, where both very low and extremely high levels of environmental performance are associated with weaker innovation capacity [7]. Overall, existing literature highlights the complex and context-dependent interactions among ESG performance, R&D innovation, and corporate high-quality development.

3. Empirical Investigation of ESG Performance, R&D Innovation, and Corporate High-Quality Development

3.1 Characteristics of ESG Performance, R&D Innovation, and High-Quality Development Indices

First, we applied winsorization to the overall ESG performance scores, R&D innovation intensity, and high-quality development indices at the 1st and 99th percentiles to reduce the impact of outliers. Using firms' concurrent market capitalization for weighting purposes, we computed their annual weighted averages for each fiscal year. The findings are displayed in the table titled "Weighted Averages of ESG Performance, R&D Innovation. and High-Quality Development Indices."

Table 1 indicates that over the sample period, corporate ESG performance, R&D innovation intensity, and the high-quality development index have all demonstrated an increasing trend. This suggests that Chinese enterprises have progressively strengthened their R&D innovation capabilities, shown greater focus on ESG practices, and achieved tangible improvements in their overall ESG scores. Moreover, the level of high-quality development has also displayed a steady upward movement during the sample period.

Table 1. Weighted Means of ESG Performance, R&D Innovation, and High-Quality Development Indices

Ingn-Quanty I		թուս	i mun	
Indicator	2018	2019	2020	2021
High-Quality Development Index	14.38	14.42	14.43	14.54
ESG Performance	5.49	6.04	6.03	6.27
R&D Intensity	4.84	5.04	5.18	5.41

3.2 The Relationship between ESG Performance and Corporate High-Quality Development

Using the aforementioned theoretical model, constructed the high we quality development index of enterprises and performed linear regression analysis between this index and the overall ESG performance scores. The results are presented in the "Linear Regression of ESG Performance and High - Ouality Corporate Development" figure. Figure 1 shows a positive link between ESG performance and high - quality development.



Figure 1. Linear Fit between ESG Performance and Corporate High-Quality Development

3.3 Empirical Investigation of R&D Innovation and Corporate High-Quality Development

Using data on corporate R&D intensity, we performed a linear regression analysis between R&D intensity and the high quality development index. The results are presented in the "Linear Regression of R&D Intensity and High - Quality Corporate Development" figure. The analysis shows an inverse relationship between R&D intensity and high - quality development, which differs from some previous research findings. Subsequent multivariate regression analysis will further investigate this relationship to confirm its robustness.

4. Research Design on ESG Performance, R&D Innovation, and Corporate High-Quality Development

4.1 Data Sources

Listed company data are primarily sourced from the China Stock Market & Accounting Research Database (CSMAR), while corporate ESG metrics are obtained from the Wind Database.The sample consists of A-share firms listed between 2018 and 2023, with financial sector entities and ST stocks excluded. Firms with missing critical variables were systematically removed to ensure data integrity.

4.2 Variable Selection

4.2.1 Corporate high-quality development

As per the above theoretical framework, this study quantifies enterprise high - quality development using total factor productivity (TFP, symbolized as Hq). The TFP growth accounting framework is a well - recognized and widely - used methodology in academic circles. For estimating firm - level TFP in strategic emerging industries, the Levinsohn - Petrin (LP) approach is mainly adopted. The natural logarithm of TFP is used in regression analyses. To meet research requirements and address methodological constraints from the sample data, the Olley -Pakes (OP) method and Generalized Method of Moments (GMM) are also utilized in robustness checks for TFP estimation.

4.2.2 ESG performance

In this research report, the ESG data we use comes from the Wind Database. It is highly acclaimed for its reliability in academic and investment fields. The ESG metrics include scores in three aspects: Environmental Dimension Score indicates a company's environmental responsibility and its investments in pollution control, resource efficiency, and climate action. Social Dimension Score measures how well a company fulfills its social responsibilities, covering labor practices, community participation, and human rights programs. Governance Dimension Score examines

corporate governance, such as board independence, the transparency of executive pay, and the protection of shareholder rights. The overall ESG score is referred to as ESG. 4.2.3 R&D innovation variables

This report employs R&D intensity as a metric to gauge R&D innovation. It is computed by dividing R&D expenditure by sales revenue, a figure symbolized by Rd. 4.2.4 Corporate characteristic variables

Given the significant influence of firm characteristics on the analysis, this report incorporates the following control variables: Firm Age (Age): Measured as the number of years since establishment to the year of analysis. The natural logarithm of age is included in regressions. Firm Size (Size): Represented by the market capitalization of listed companies. The log-transformed value is used in regressions, as firm size critically impacts the research Operational focus. Capability (CAR): Captured by the current asset turnover ratio, reflecting management efficiency. Ownership Structure (State): A dummy variable indicating state ownership (1 for state-owned enterprises, 0 otherwise), substantial research highlights as its relevance to the research topic. Industry Characteristics: Industry-specific effects are controlled for using sectoral classifications. Descriptive statistics for these variables are presented in Table 2.

	Table 2. Descriptive Statistics of Variables									
Variable	Obs	Mean	Std.Dev	Min	Max					
Hq	8,854	2.669583	0.064691	2.301601	2.937326					
ESG	8,854	5.964746	0.862923	1.97	9.63					
Rd	8,854	5.263772	6.504424	0.000	267.59					
Size	8,854	15.82103	1.078838	13.50107	21.67878					
Roe	8,854	-0.05242	2.489386	-186.557	64.0564					
Dar	8,854	0.439499	0.19333	0.014268	0.997603					
Age	8,854	2.998487	0.282588	1.574847	4.001315					
CAR	8,854	1.222887	0.945132	0.029046	16.167					
State	8,854	0.274226	0.446149	0	1					

Table 2. Descriptive Statistics of Variables

4.3 Model Specification

Given the panel data structure spanning 2018–2023 and building upon

$$Hq_{it} = \beta_0 + \beta_{1t} ESG_{it} + \beta_{2t} Rd_{it} + \sum_{n=3}^{N} \beta_{nt} Contrs_i$$

Hq denotes the corporate high-quality development index, operationalized through total factor productivity (TFP). te represents the financial efficiency of host cities for strategic emerging industry firms, measured via the stochastic frontier analysis (SFA) methodology delineated in preceding sections. Contrs denotes the set of control variables firm characteristics, for including firm size (Size), firm age (Age), operational capability (CAR), debt-to-asset ratio, ownership type (State), and others. u_i denotes firm-specific fixed effects, ε_{it} denotes the idiosyncratic error term.

5. Empirical Analysis of ESG Performance, R&D Innovation, and Corporate High-Quality Development

methodological frameworks established in prior research [8-11]. we formulate the baseline econometric model as follows:

 ϵ_{it} (1)

 $s_{it} + u_i + \varepsilon_{it}$ 5.1 Analysis of Baseline Regression Results The baseline regression outcomes are presented in Table 3. The F-statistic for individual effects testing is $22.47 \ (p = 0.000)$, decisively rejecting the null hypothesis of no individual effects. То determine the appropriate specification, a Hausman test was conducted, yielding a statistically significant value of 619.25 (p = 0.0241). This confirms the superiority of the fixed effects model over random effects estimation. The model demonstrates satisfactory explanatory power with an R² of 0.4173, indicating that 41.73% of the variance in high-quality development is accounted for by the selected covariates. The detailed interpretation of estimation results proceeds as follows.

The regression analysis reveals a statistically significant positive relationship between

corporate ESG performance and high-quality development. However, the analysis reveals a statistically significant negative correlation between R&D intensity and high-quality development. Regarding the control variables: Firm size, leverage ratio, firm age, and profitability demonstrate significant positive associations with high-quality development. Notably, state ownership exhibits a detrimental impact, suggesting institutional barriers to quality upgrading in state-controlled enterprises.

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	(1)	(2)	(3)
variables	Hq	Hq	Hq
ESG	0.0009**	0.0014***	0.0009*
	(2.256)	(2.610)	(1.877)
Rd	-0.0020***	-0.0027***	-0.0020***
	(-28.456)	(-12.171)	(-6.533)
Size	0.0228***	0.0173***	0.0228***
	(50.395)	(20.653)	(37.924)
Dar	0.0489***	0.0298***	0.0489***
	(20.941)	(4.847)	(10.381)
Age	-0.0020	0.0129**	-0.0020
	(-0.902)	(2.416)	(-0.749)
CAR	0.0179***	0.0166***	0.0179***
	(42.608)	(11.770)	(12.727)
State	0.0039***	-0.0059**	0.0039*
	(3.176)	(-2.035)	(1.933)
cons	2.2757***	2.3312***	2.2757***
	(285.791)	(173.213)	(220.072)
N	8854	8854	8854
R^2		0.4173	
F(Individual effects)		22.47***	
Hausman test		619.25**	

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able 3.	Baseline	Regression	Results

Notes: t-statistics are reported in parentheses; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

5.2 Analysis of ESG Dimension-Specific Regression Results

Next, we conducted regression analyses between the three constituent dimensions of ESG (environmental, social, and governance) and corporate high-quality development. The results are presented in Table 4. As shown in the table, the environmental score exhibits no statistically significant relationship with high-quality development, and the social responsibility dimension also lacks a significant causal association. However, the governance dimension score demonstrates a statistically significant positive correlation with high-quality development at the 1% level. suggests that corporate This governance is a critical driver of high-quality development.

5.3 Interaction Effects between ESG Performance and R&D Innovation

To investigate the relationships among ESG performance, R&D innovation. and corporate high-quality development, this study constructs interaction terms between ESG performance and R&D innovation to examine their combined effects. The interaction term for the total ESG score and R&D innovation is denoted as ESG Rd; the interaction term for the environmental dimension score and R&D innovation is inv Rd; the interaction term for the social responsibility dimension score and R&D innovation is soc Rd; and the interaction term for the corporate governance dimension score and R&D innovation is gov Rd. In this section of the analysis, the baseline regression model from earlier sections is retained. with each interaction term introduced sequentially into the model.

The symbol definitions in these models remain consistent with the benchmark regression framework. These specifications are derived by sequentially introducing the following interaction terms into the baseline model: $ESG_Rd \ Soc_Rd \ Soc_Rd \ Gov_Rd$. We estimate each augmented

specification using fixed-effects panel OLS regressions with robust standard errors clustered at the firm level, maintaining methodological continuity with prior analyses.

Table 4.	Regression	Results	of ESG	Dimensions	and Cori	orate High-	Ouality	Development

	(1)	(2)	(3)
variables	Hq	Hq	Hq
Environmental Dimension	0.0002		
Score	(1.122)		
Social Dimension Score		0.0001	
Social Dimension Score		(0.078)	
Governance Dimension Sector			0.0008***
Governance Dimension Score			(2.800)
Rd	-0.0027***	-0.0027***	0027***
	(-12.224)	(-12.211)	(-12.158)
Size	0.0175***	0.0175***	0.0174***
	(20.860)	(20.829)	(20.942)
Roe	-0.0000	-0.0000	-0.0000
	(-0.099)	(-0.080)	(-0.054)
Dar	0.0295***	0.0295***	0.0294***
	(4.652)	(4.641)	(4.628)
Age	0.0174***	0.0179***	0.0124**
	(3.735)	(3.608)	(2.393)
CAR	0.0166***	0.0166***	0.0166***
	(11.813)	(11.829)	(11.859)
State	-0.0060**	-0.0060**	-0.0060**
	(-2.058)	(-2.064)	(-2.071)
cons	2.3231***	2.3211***	2.3348***
	(186.437)	(169.382)	(178.393)
N	8854	8854	8854
R^2	0.4164	0.4163	0.4172
F	156.2208	161.2647	152.0773

 $Hq_{it} = \beta_0 + \beta_{1t}ESG_{it} + \beta_{2t}Rd_{it} + \beta_{3t}ESG_{R}d_{it} + \sum_{n=4}^{N}\beta_{nt}Contrs_{it} + u_i + \varepsilon_{it}$ (2) $Hq_{it} = \beta_0 + \beta_{1t}ESG_{it} + \beta_{2t}Rd_{it} + \beta_{3t}inv_{R}d_{it} + \sum_{n=4}^{N}\beta_{nt}Contrs_{it} + u_i + \varepsilon_{it}$ (3) $Hq_{it} = \beta_0 + \beta_{1t}ESG_{it} + \beta_{2t}Rd_{it} + \beta_{3t}soc_{R}d_{it} + \sum_{n=4}^{N}\beta_{nt}Contrs_{it} + u_i + \varepsilon_{it}$ (4)

$$Hq_{it} = \beta_0 + \beta_{1t} ESG_{it} + \beta_{2t} Rd_{it} + \beta_{3t} \text{gov}_R d_{it} + \sum_{n=4}^N \beta_{nt} \text{Contrs}_{it} + u_i + \varepsilon_{it}$$
(5)

Regression results are presented in Table 5: Interaction Effects between ESG Performance and R&D Innovation. Column (1)reports the interaction effect aggregate between ESG performance (ESG Rd) and R&D innovation; Column (2) examines the environmental dimension's interaction (Env Rd); Column social responsibility (3) analyzes the Column interaction term (Soc Rd); (4) evaluates the governance dimension's moderating effect (Gov Rd).

From the regression results in the first column of the table, it can be observed that the interaction term between the overall ESG

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score and R&D innovation is statistically insignificant. This indicates that the overall ESG score neither promotes nor inhibits R&D innovation, and thus does not exhibit a mediating effect on corporate high-quality development. However. for the environmental dimension of the ESG score, the regression coefficient of the interaction term between the environmental score and innovation is 0.0008, which is R&D significant at the 1% level. This suggests that the environmental dimension score promotes innovation R&D but exacerbates its effect high-quality suppressive on development. In other words, improvements

in environmental performance intensify the negative impact of R&D innovation on high-quality development.

For the social responsibility and corporate governance dimensions, the interaction terms with R&D innovation show coefficients of 0.0018, both significant at the 1% level. This

indicates that higher scores in the social responsibility and corporate governance dimensions further amplify the negative effect of R&D innovation on high-quality development.

	(1)	(2)	(3)	(4)
	Hq	Hq	Hq	Hq
ESG_Rd	0.0021 (0.345)			
inv_Rd		0.0008*** (5.306)		
soc_Rd			0.0018***(10.730)	
gov_Rd				0.0018*** (11.896)
Contrs	YES	YES	YES	YES
Industry	YES	YES	YES	YES
_cons	2.3323*** (169.998)	2.3379*** (190.621)	2.3918***(167.904)	2.4446*** (160.792)
N	8854	8853	8853	8853
R^2	0.4173	0.4229	0.4575	0.4790
F	158.0579	159.3635	167.4163	171.0666

Table 5. Interaction Effects between ESG reflormance and K&D innovatio	Т	able 5. Interaction	Effects I	between	ESG	Performance	and	R&D	Innovatio
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Notes: t-statistics are reported in parentheses; ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

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5.4 Nonlinear Relationship between ESG Performance and Corporate High-Quality Development

Building on the preliminary findings of a positive linear association between ESG performance and high-quality development, this section investigates potential nonlinear dynamics between these variables. We constructed a quadratic fit plot (Figure 2) to visualize the curvilinear relationship, employing the following approach:



In Stata, overlaying confidence intervals and scatter plots with fitted lines is a commonly used data visualization technique that helps us better understand the relationships within the data. The scatter plot displays the ESG performance of each enterprise and its corresponding high-quality development score, allowing us to examine their distribution patterns and identify potential trends or correlations. The quadratic fitted curve represents the nonlinear relationship between a company's ESG performance and

its high-quality development score. A confidence interval refers to the range within which we can be highly confident that the true value of a statistic (e.g., the fitted line) lies when calculated from a sample. Confidence intervals are typically used to assess the precision and reliability of the statistic. In Figure 3, the confidence interval is represented by the gray shaded area around the fitted line, illustrating the precision and reliability of the fitted curve. "U-shaped" Clearly. there exists а relationship between corporate ESG performance and high-quality development. This implies that during the early stages of advancing ESG initiatives and improving overall ESG scores, the enhancement of ESG scores may negatively impact high-quality development. However, once a company's ESG performance exceeds a certain critical

$$Hq_{it} = \beta_0 + \beta_{1t} ESG_{it} + \beta_{2t} Rd_{it} + \beta_{3t} ESG_{it}$$

The symbols in the equation above follow the same definitions as those in the baseline regression model. The regression results are presented in Table 6.

Table 6. Nonlinear Test RegressionResults of ESG Performance andCorporate High-Quality Development

A	<u> </u>		A
ESG	ESG2	Obs	<i>R</i> ²
0048*	0.0005**	8854	0.4171
Notes: **	and *	denote	statistical
significance	at the 5	% and 1	0% levels,
respectively.			

The regression results indicate that the quadratic term coefficient of ESG is statistically significant at the 5% level. Thus, during the initial phase of corporate ESG management (when ESG scores are relatively low), improvements in ESG performance-manifested as rising ESG scores-lead to a decline in high-quality development levels. This corresponds to the left half of the aforementioned nonlinear relationship curve. However, once а company's ESG management surpasses a critical threshold, further increases in ESG scores accelerate improvements in high-quality development, as reflected in the right half of the curve.

This phenomenon arises because early-stage ESG management imposes constraints on firms, such as environmental restrictions, governance requirements, and social threshold, higher ESG scores correlate with greater high-quality development levels. A plausible explanation is that in the initial phase of ESG development and management, improvements across ESG dimensions may constrain corporate growth quality. After overcoming this "growing pains" construction period—where ESG scores reach a critical threshold—companies with ESG management surpassing this level find that higher ESG performance increasingly supports their high-quality development.

The following empirical test is conducted to examine the "U-shaped" relationship between ESG performance and corporate high-quality development. First, we introduce the squared term of the corporate ESG score, denoted as "ESG²," into the baseline regression model from the previous section. This yields the following model:

 $G2_{it} + \sum_{n=4}^{N} \beta_{nt} \text{Contrs}_{it} + u_i + \varepsilon_{it}$ β_{3t} (6) responsibility obligations. These pressures force companies to reform their production methods, optimize energy consumption, and innovate in fulfilling social responsibilities. However, the restructuring of development models to align with ESG principles does not yield immediate benefits; it requires long-term management and transformational efforts under ESG guidance. Consequently, while ESG management constrains short-term high-quality development, it ultimately accelerates progress in high-quality development in the long run.

5.5 Nonlinear Relationship between R&D Innovation and Corporate High-Quality Development

A quadratic fitted curve between R&D innovation and high-quality development is plotted, as shown in Figure 4. From the figure, a visually discernible nonlinear "U-shaped" relationship can be observed between the two variables. It is important to note that the high-quality development index in the graph uses its original numerical values, denoted as hq1.

This suggests that when a company's R&D intensity falls below a certain threshold, increased R&D efforts inhibit high-quality development. However, once R&D intensity surpasses a critical value, further increases in R&D efforts accelerate improvements in Figure 4. Quadratic Fit of R&D Innovation (Rd) and High-Quality Development

high-quality development.

In this section, we introduce the quadratic term of R&D innovation (denoted as Rd²) into the aforementioned baseline regression model to investigate its nonlinear relationship with high-quality development, as specified in the following regression model:

The symbols in the equation above follow the same definitions as those in the baseline

 $Hq_{it} = \beta_0 + \beta_{1t} ESG_{it} + \beta_{2t} Rd_{it} + \beta_{3t} Rd_{it} + \sum_{n=4}^{N} \beta_{nt} Contrs_{it} + u_i + \varepsilon_{it}$

Table 7. Nonlinear Test RegressionResults of ESG Performance andCorporate High-Quality Development

Rd	Rd2	Obs	R ²
0.00174***	0.0001***	8854	0.4292
Notes: **	and *	denote	statistical
· · · · · · · · · · · · · · · · · · ·	· + +1· · 5 0/	and 100	/ 11.

significance at the 5% and 10% levels, respectively.

6. Discussion and Recommendations

6.1 Recommendations for ESG Management, R&D Innovation, and Corporate High-Quality Development

Based on the research findings and China's national context, the following policy recommendations are proposed:

Strengthen corporate ESG management, particularly in corporate governance, which helps elevate the level of high-quality Chinese development in enterprises. undergone enterprises have numerous regulatory reforms in recent years, especially in corporate governance. The government has enhanced corporate ESG management and improved governance standards through regulatory reforms to foster high-quality enterprise development.

Support enterprises in their investment and

regression model.

As shown in Table 7. The regression results indicate that the quadratic term coefficient is statistically significant at the 1% level. This implies that when a company's R&D intensity is in the lower range, R&D innovation inhibits high-quality development levels. However, once R&D intensity exceeds a critical threshold, further increases in R&D efforts accelerate improvements in high-quality development. This finding reflects, to some extent, that the high-quality development of most listed companies in China during the sample period was not driven by core technological innovation. In other words, R&D innovation among Chinese listed companies has not yet contributed significantly to their high-quality development; instead, it has suppressed it. To address this, there is a need to optimize the policy environment and market mechanisms for R&D innovation, thereby enhancing the effectiveness of corporate R&D efforts.

(7)improvement in environmental, social responsibility, and corporate governance (ESG), which will help strengthen the impact of corporate R&D innovation. Governments can promote the enhancement of corporate ESG performance by encouraging the implementation of corporate social responsibility practices and supporting enterprises in environmental protection efforts.

Establish critical thresholds for corporate ESG management and encourage enterprises to maintain an appropriate level in ESG practices to drive high-quality development. The government can incentivize companies to sustain moderate ESG management levels by setting targets for ESG ratings.

Strengthen support and incentives for corporate R&D innovation to promote high-quality development of enterprises. The government can bolster enterprises' development in R&D innovation hv providing professional technical support, intellectual property protection, and other measures.

Encourage enterprises to pursue model innovation and management innovation to drive high-quality development. The government can facilitate this by promoting exemplary enterprise management practices and encouraging collaboration between businesses, innovative enterprises, and higher education institutions to advance model innovation and technology transfer.

6.2 Other Recommendations and Future Research Directions

Future research could conduct more in-depth and nuanced discussions by incorporating heterogeneity industrv and regional heterogeneity to yield more detailed findings. The threshold points of the "U-shaped" relationships between ESG performance, R&D innovation, and high-quality development warrant further exploration. For instance, calculating the mean scores across ESG dimensions at these critical thresholds could provide actionable references for corporate practices. Additionally, deriving more precise thresholds based on enterprise nature and industry-specific heterogeneity would enhance practical applicability.

7. Conclusions

The research findings indicate the following: First, there is a statistically significant positive correlation between corporate ESG performance and high-quality development, with the governance dimension being particularly prominent, while the environmental and social dimensions show significant association. Second. no the interaction effect between overall ESG performance and R&D innovation is not statistically significant. However, the interaction term coefficients for all three ESG dimensions (environmental, social responsibility, and governance) with R&D innovation are significantly positive. indicating each ESG that dimension enhances the positive impact of R&D innovation on high-quality development. the relationship between ESG Third, performance and high-quality development "U-shaped" follows а pattern-initial in ESG hinder improvements may development, but once a critical threshold is surpassed. further enhancements ESG accelerate high-quality development. Fourth, impact of R&D the innovation on high-quality development also exhibits a "U-shaped" relationship, showing a negative correlation in the low-intensity phase but

significantly boosting development levels once the threshold is exceeded.

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