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ESG PERFORMANCE, R&D AND COPORATE VALUE OF CHINA'S LISTED COMPANIES

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1. Introduction

ESG is an acronym for Environment, Society and Governance. On the basis of traditional financial returns, ESG further considers the three levels of environment, social responsibility and corporate governance to evaluate the sustainability of business operations and social influence, and pay more attention to the sustainable growth and social contribution of enterprises. Under the background of countries responding to climate change, how to achieve sustainable development has received extensive attention [1]. As one of the main body of market economy, the production and operation activities of listed companies have a great impact on the ecological environment. For enterprises, ESG is also a more advanced, overall-view and comprehensive corporate governance concept. Therefore, in 1992, the Financial Action Agency of the United Nations Environment Program issued a statement, hoping that all kinds of investors will take environmental, social and corporate governance factors into account when conducting economic transactions with enterprises. With the further improvement of ESG evaluation standards by international financial institutions, relatively mature ESG rating frameworks have been formed abroad.

Although the development of ESG in China started relatively late, its high-quality sustainable development concept has attracted great attention from the government, regulatory agencies and the market itself. Driven by the "Double Carbon" goal, China has promulgated intensive regulations on the disclosure of corporate environmental, social and corporate governance information. According to the Guidelines on the Format of Disclosure According to the Law, enterprises are required to accelerate the construction of ESG and promote the construction and development of China's ESG system. In addition, the outbreak of the new crown pneumonia epidemic has also become a catalyst for the development of ESG in China, and the public has paid more and more attention to the performance of corporate social responsibilities. Therefore, under China's new economic development model,

It is of great practical significance to explore the realization path of enterprise ESG performance to its value enhancement, which is conducive to promoting the healthy development of enterprises, guiding the investment direction of capital market, improving the corporate governance structure and realizing high-quality economic development in an all-round way.

2. Theoretical analysis and research hypothesis

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ESG performance is one of the important indicators to measure corporate social responsibility behavior. Research on the impact of corporate social responsibility behaviors on corporate value has always been concerned by the academic community. At present, there are generally two different views: the value enhancing theory and the shareholder expense theory. The value enhancement theory holds that introducing social responsibility activities into corporate strategy and practice will generate competitive advantage and promote the creation of long-term shareholder value. These advantages include brand reputation, employee productivity, improvement of business operating efficiency, etc., as well as improved relationship with regulators, society and other stakeholders to obtain better investment projects and more funding sources. Based on this theory, it can be expected that the social responsibility measures of listed companies will be positively and significantly evaluated by the stock market. The shareholder cost theory argues that investments in CSR practices increase costs, put firms at an economic disadvantage, and lead to a decline in the market value of the firm. Specifically, some scholars believe that the commitment to sustainable development may lead to excessive investment and other activities that are not in the best interests of shareholders, and even destroy corporate value. Although the literature on CSR and shareholder value creation is mixed, a growing body of research supports the value enhancement theory.

2.1 ESG performance and corporate value of listed companies

The research conclusions of the impact of ESG on corporate value at home and abroad are as follows. Chen Yuqing (2005) et al. analyzed the status quo of ESG information disclosure of Chinese listed companies through sampling and found that the correlation between ESG and corporate value was not significant. Li Zheng (2006) research found that enterprises that undertake more social responsibilities will have lower enterprise value in the short term, but in the long run, undertaking social responsibilities will not reduce enterprise value. Wang Jianqiong and He Jingyi (2009) conducted an empirical study on the samples of manufacturing listed companies in Shanghai and Shenzhen stock markets in 2005 and found that there was no significant relationship between corporate social responsibility and ROE and other corporate financial performance. MinChung Kim and YongHee Kim (2014) found that corporate social responsibility strengthening behaviors increase shareholder value by increasing Tobin's Q, while corporate social responsibility weakening behaviors reduce shareholder value by increasing the company's systemic risk. Sadok El Ghoul and Omrane Guedhami, Yongtae Kim (2017) found that in countries with weak market systems, the positive correlation between corporate social responsibility and corporate value is more significant; in countries with weak equity and credit markets, corporate social responsibility Liability is linked to improved access to finance; countries with more limited commercial freedoms invest more and have lower risk of default, and countries with weaker legal systems have longer trade credit periods and higher future sales growth. Katsiaryna Salavei Bardos and Mine Ertugrul, Lucia Silva Gao (2020) [6] research shows that corporate social responsibility has a positive impact on product market perception, especially for standardized products and competitive industries, and this effect is more important for product quality attributes Significantly, it is

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concluded that product market perception is a corporate social responsibility and a channel for creating corporate value.

To sum up, at present, most scholars at home and abroad have come to the research conclusion that corporate social responsibility has a positive effect on corporate value, and only a small number of scholars have come to the opposite conclusion. As for the research on how corporate social responsibility affects corporate value, different scholars start from different perspectives, adopt different quantitative methods, and draw different research conclusions.

2.2 ESG performance, corporate innovation and corporate value of listed companies

McWilliams (2000) conducted research on corporate ESG performance and corporate innovation and found that the two are complementary effects that jointly promote corporate value. Anindita Chakravarty (2011) believes that in high-tech enterprises, moderate R&D investment can help enterprises gain an advantage in market competition and further enhance enterprise value. Carrasco (2013) believes that when ESG governance is transformed into corporate culture, it can prompt companies to innovate and achieve value enhancement. Li Shujuan (2016) conducted an empirical analysis on the correlation between innovation investment and corporate value of biomedical companies, and the results showed that technological innovation has a significant role in promoting corporate value. Zhou Jun (2017) found through sorting out the research results on technological innovation capability and corporate value at home and abroad that innovation capability and company value are not consistent. Most scholars believe that there is a positive relationship between the two, but there are also Some scholars believe that there is no significant correlation between the two. Yang Zhe (2018) obtained a "U-shaped" relationship between corporate innovation and corporate value through an empirical analysis of the relationship between environmental input, corporate innovation, and corporate value. Zou Shuyi (2019) believes that corporate innovation has a great role in promoting the value of the company. Zhang Lin and Zhao Haitao (2019) found that there is a significant positive correlation between ESG performance and corporate value. Liu Xiaoguang and Ding Yinkun (2020) conducted an empirical analysis of the data of my country's high-tech enterprises from 2013 to 2017, and the results showed that the technological innovation

There is a significant positive correlation between investment and enterprise value. Zhang Jinsong and Wang Mengmeng (2020) conducted an empirical study on the panel data of the manufacturing industry from 2014 to 2018, and believed that innovation input and output have a positive effect on the value of enterprises. Ji Chengjun and Bo Yang (2021) conducted empirical research on environmental performance, green technology innovation, and corporate value, and believed that green technology innovation can improve environmental performance. Chen Xu (2021) studied the relationship between corporate social responsibility contribution, corporate innovation and corporate value, and concluded that corporate social responsibility has a positive impact on technological innovation investment and corporate value, and that innovation investment has a positive impact on corporate social responsibility contribution and corporate value. Enterprise value has a mediating effect. Xu Mingyu et al. (2021) used a two-way fixed-

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effect model to study the performance of Chinese listed companies from 2018 to 2020, and found that companies with good ESG performance and

Companies with lower ESG performance have higher enterprise value than companies with lower ESG performance. Wang Bo and Yang Maojia (2022) conducted an empirical analysis of China's A-share companies from 2015 to 2019, and found that ESG performance has significantly improved the company's book value and market value. Yang Chengxinge (2022) found that ESG performance has a significant positive impact on the company's green innovation through an empirical study on ESG performance and the company's green innovation performance.

2.2.1 ESG performance and corporate value

Enterprise value is the sum of tangible and intangible asset values. Hu Quying and Lu Jun found that the environmental performance in ESG is positively correlated with enterprise value through research, that is, the better the enterprise's environmental performance, the higher the enterprise value. high. However, foreign scholars Filbeck and Gorman believe that environmental management will consume resources that should be used to improve the owner's economic interests, thereby reducing the financial value of the company, that is, there is a negative correlation between corporate ESG performance and corporate value. In terms of social responsibility, some scholars believe that the active fulfillment of social responsibilities by enterprises will help them establish a good image, thereby promoting the promotion of corporate value. In terms of corporate governance, a large number of studies have shown that the level of corporate governance can positively affect the promotion of corporate value. Overall, ESG performance is positively correlated with firm value. Based on this, this paper proposes research hypothesis 1:

H1: ESG performance is positively correlated with company value.

2.2.2 ESG performance, corporate innovation investment and company value

With the deepening of research, some scholars began to explore the role of ESG performance in promoting the promotion of corporate value. Zhang Fen used the data of listed companies in China from 2012 to 2018 and used the fractional regression method to study and found that green innovation can promote the growth of corporate value, which is more obvious in mid-to-high-level companies. Salim Chouaibi and Jamel Chouaibi collected data from 532 listed companies in Western Europe and North America, and proved that the advantages of ESG disclosure increased corporate value under the moderating effect of green innovation through the empirical analysis of generalized moment estimation, and over time Enterprise value will continue to rise. To sum up, ESG performance essentially affects corporate innovation. Better ESG performance can promote corporate R&D investment and the number of patent applications, while continuous innovation can enhance corporate value. The three present a progressive pattern. , Mutual transfer relationship. Accordingly, this paper puts forward research hypothesis 2:

H2: ESG performance enhances company value by promoting corporate innovation investment

2.2.3 Moderating role of enterprise digitalization level

The development of global digital technology is heating up, leading more and more companies to participate in the process of digital transformation, and use digital technology to upgrade and

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transform the enterprise structure, business management model and other aspects. On the one hand, the improvement of digitalization can help enterprises reduce internal management and control costs, innovative transaction costs and contract costs; It is more flexible and faster to respond to market and customer needs, and reduce the cognitive differences of stakeholders, thereby improving the knowledge flow ability of enterprises. In this process, not only the knowledge participants can obtain more cutting-edge cognitive value, but also promote the sharing and creation of knowledge, and then iteratively innovate the R&D content and R&D process, so that they can keep up with the forefront of the market. Provide support for knowledge update and industrial upgrading of the market where the enterprise is located. At the same time, a high level of digitalization represents a sound network foundation, digital participants can access more levels of technological innovation resources, and can provide greater flexibility for more complex coordination and integration. On this basis, the joint development of various production factors can greatly promote the open innovation of enterprises, and integrate green technology resources with high quality, which will reduce pollution, reduce consumption and improve ecology. Based on this, it is hypothesized that:

H3: The level of company digitalization has a positive regulatory effect on the relationship between corporate R&D investment and corporate ESG performance

3. Research Design

3.1 Data sources

The sample selected in this paper is the listed companies in the Shanghai and Shenzhen A-share markets from 2009 to 2019. The financial industry, ST, *ST stocks and companies with negative net assets are excluded. All continuous variables are contracted at the level of 1% tail processing. Since the COVID-19 epidemic started at the end of 2019, the R&D of listed companies was affected, so this article limits the sample to 2019, and collected data from 109 listed companies, including 30 companies with continuous ESG rating data samples. The relevant data of listed companies comes from the CSMAR database, and the ESG rating data comes from the SynTao ESG rating database. The original R&D data compiled by hand in this paper come from the notes to the annual reports of listed companies and the financial statement database of the Guotai Security Database (CSMAR). Eliminate firms and time samples with missing data. The baseline regression method used in this paper is a panel fixed effects model, and controls both individual and time fixed effects.

3.2 Variable setting

3.2.1 Company value

The explanatory variable in this paper is "company value", which is measured by TobinQ, which was proposed by James Tobin in 1969 and defined as the ratio of the market value of an asset to the replacement cost, which is the most representative measure of the market value of an companyOne of the indicators.

3.2.2 ESG performance

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Compared with the development of ESG ratings in foreign countries, the development of China's ESG rating system started relatively late. The current ESG rating system is a multi-faceted pattern, and there is no unified disclosure standard and indicator system. Although ESG ratings at home and abroad are quite different, they play their respective roles in different application scenarios. Domestic ESG ratings are more in line with China's ESG development reality and the ESG development status of Chinese companies. As a leading data company in China, SynTao has launched scientific and independent ESG ratings through in-depth research based on 20 years of data processing and analysis experience and risk monitoring capabilities. After comprehensive inspection, SynTao ESG rating database can provide the required ESG ratings for this research data.

3.2.3 Company R&D

The sample selected in this article is the listed companies in the Shanghai and Shenzhen A-share markets from 2009 to 2019, and the financial industry, ST, *ST stocks and companies with negative net assets are excluded. Since the COVID-19 epidemic started at the end of 2019, the research and development of listed companies were affected, so this article limits the sample to 2019. The original R&D data compiled by hand in this paper come from the notes to the annual reports of listed companies and the financial statement database of the Guotai Security Database (CSMAR).

The method of manual excavation of R&D expenses: After my country's accounting reform in June 2018, the income statement of each company's annual report added the item "R&D expenses". Therefore, the estimation of R&D expenses is divided into two stages: Fields such as "Research", "Development", "Test", "Experiment", "Technology", and "Innovation" are extracted from the "Financial Statement Notes-Management Expenses" entry in the annual report; Fields such as "research", "development", "test", "experiment", "technology", and "innovation" were extracted from the item "Notes to Financial Statements-R&D Expenses". In addition, this article also manually deletes non-required items of R&D activities, such as "R&D water and electricity fees", "Land use rights fees", and "R&D personnel wages".

3.2.4 Modulated variables

Enterprise Digital Level (EDL). Referring to the research of Wu Fei et al., and analyzing the annual reports of listed companies can make a more objective measurement of corporate technology and a more reasonable judgment of corporate strategic orientation. This paper crawls the keywords about digital transformation in the annual reports of listed companies through the method of text mining, and uses the frequency of keywords in the annual reports as a proxy indicator of the digital level of enterprises.

3.2.5 Control variables

Corporate value is affected by many factors. If we only study the relationship between ESG performance, corporate innovation and corporate value, the results will not be convincing. Therefore, it is necessary to add corresponding control variables for research. Considering that important financial indicators will affect the market value of enterprises, ROA, CF, enterprise size,

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asset turnover rate and enterprise age are used as control variables after combing a large number of literatures. The main variables in this paper are set in the following table.

Table 1. Data Descriptive

Variable	Explanation
Growth	Operating Income Growth Rate
Tobinq	(Market Value of Equity + Book Value of Debt)/Book Value of Total Assets
R&D	R&D Investment
roa	Ratio of net profit to total assets
Size	Ln (total assets)
Lev	Ratio of Total Liabilities to Total Assets）
Cash	Ratio of cash flow to total assets
Treat	Experimental group dummy variable
Time	Dummy variables before and after policy implementation
did	Interaction term for Treat and time
Huazheng_ESG	Huazheng ESG Rating Score
Bloomberg_ESG	Bloomberg ESG Rating Score
E	Bloomberg E sub-item
S	Bloomberg S Subsection
G	Bloomberg G Sub-item

4. Analysis of empirical results

4.1 Descriptive statistics

The descriptive statistics of the main variables in this paper are shown in Table 2. The average value of R&D data mined by hand in this paper is 0.858, that is, the average annual R&D expenditure of each company is 85.8 million yuan, the variance is 1.936, the minimum value is only 0.002, and the maximum value is 14.655, which shows that different companies have different R&D expenditures. The sample is representative. For different rating companies, Bloomberg's ratings have more gaps than Huazheng's ratings. The variance of Bloomberg's ratings is 6.582, while that of Huazheng's ratings is 1.031. Therefore, it is necessary to combine data from different rating companies to explore the results.

The mean value of the enterprise value (TobinQ) is 1.835, the standard deviation is 1.299, and the difference between the minimum value and the maximum value is close to 9, indicating that the market value of the sample enterprises is quite different. The average ESG performance score is 4.317, and the median is 4. Most of the sample companies have low ESG ratings. Most companies still aim to maximize their own financial value, and their awareness of protecting the environment and fulfilling social responsibilities is relatively weak. The average value of enterprise innovation capability (RDe) is 0.043, the standard deviation is 0.048, and the difference between the minimum value 0.001 and the maximum value 0.269 is large, indicating that the intensity of R&D investment varies among enterprises of different industries and different natures.

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There are big differences. The average value of the asset-liability ratio (Leverage) is 0.474, and the median is 0.490. The financial risk of the sample enterprises is generally high. The mean value of the proportion of state-owned shares (State) is 0.029, and the median is 0, indicating that the proportion of state-owned shares in sample companies is very low. The average value of ownership structure (TOP10) is 0.628, the median is 0.635, the standard deviation is 0.152, the minimum value is 0.269 and the maximum value is 0.935, and the shares of some companies are relatively scattered. There is no absolute control of the company by a major shareholder, and some companies' equity is concentrated in the hands of several major shareholders, and the shares held by small and medium shareholders are too small. It shows that the ownership structure of the sample companies is quite different. The mean value of Growth is 0.116, and the median is 0.095, both of which are greater than 0, indicating that the development trend of the sample enterprises is generally positive. The mean value of enterprise size (Size) is 24.038, the median is 23.807, and the sample enterprise sizes are all at a relatively high level. The average value of the asset turnover rate (Proper_turn) is 0.629, and the standard deviation is 0.375, which shows that the asset turnover rate of the sample enterprises varies greatly, and the overall value is not high, and the operating capacity needs to be improved urgently. The mean value of the enterprise age (Age) is 2.613, the median is 2.773, and the standard deviation is 0.575. Since the enterprise age index in this paper is obtained by adding 1 to the company's listing age and taking the natural logarithm, the listing age The sequence becomes stationary, so the age difference of firms is large(Table 2).

Table 2. Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
stkcd	1752	272987.000	263821.380	4.000	603999.000
year	1752	2015.514	2.780	2009.000	2019.000
growth	17529	0.182	0.376	-0.489	2.327
tobinq	17529	2.062	1.236	0.882	7.927
rd	17529	0.858	1.936	0.002	14.655
roa	17529	0.038	0.064	-0.293	0.193
size	17529	22.075	1.212	19.952	25.884
lev	17529	0.407	0.201	0.051	0.884
cash	17529	-0.155	0.207	-0.885	0.182
treat	17529	0.096	0.294	0	1
time	15936	0.604	0.489	0	1
did	15936	0.050	0.218	0	1
Huazheng_ESG	17719	6.434	1.031	4	9
Bloomberg_ESG	6064	20.527	6.582	9.091	44.215
E	5152	10.986	7.579	2.326	42.636
S	5923	23.356	9.184	7.017	56.140
G	6064	44.529	4.989	33.929	57.143

4.2.1 Impact of ESG performance on corporate value

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According to formulas (1)-(4), benchmark regression analysis was carried out, and Stata16 was used for model calculation, and the results are shown in Table 3.

Table 3. PSM

Variable	Unmatched Matched	Mean Treated	Control	%bias	%reduct |bias|	t-test t	p>|t|	V(T)/ V©
roa	U	0.0585	0.0356	36.80		13.99	0.000	0.89*
	M	0.0564	0.0641	-12.50	66.10	-3.790	0.000	1.050
size	U	23.92	21.88	178.6		75.50	0.000	1.46*
	M	23.88	23.80	6.800	96.20	1.770	0.0770	0.950
lev	U	0.475	0.400	37.80		14.67	0.000	0.980
	M	0.480	0.466	7.200	80.90	2.00	0.0450	0.89*
cash	U	|-.13122	-0.157	13.10		4.940	0.000	0.83*
	M	|-.13503	-0.144	4.500	65.70	1.310	0.190	0.910
growth	U	0.178	0.182	-1.100		-0.420	0.676	0.74*
	M	0.179	0.216	-10.50	-823.3	-3.050	0.00200	0.83*
tobinq	U	2.085	2.060	1.900		0.790	0.431	1.49*
M	M	2.036	2.197	-11.90	-543.4	-2.750	0.00600	0.53*

In the following section, the treatment group is associated with the PSM control group. The matching procedure selects 1:1 close-to-matching. The post-match bias can be seen to be essentially about 10%, which meets the matching standard. And the significance of the post-match variables diminished significantly, which was consistent with expectations. Samples that are not in the common range are then removed and a subsequent regression of the DID model is performed.

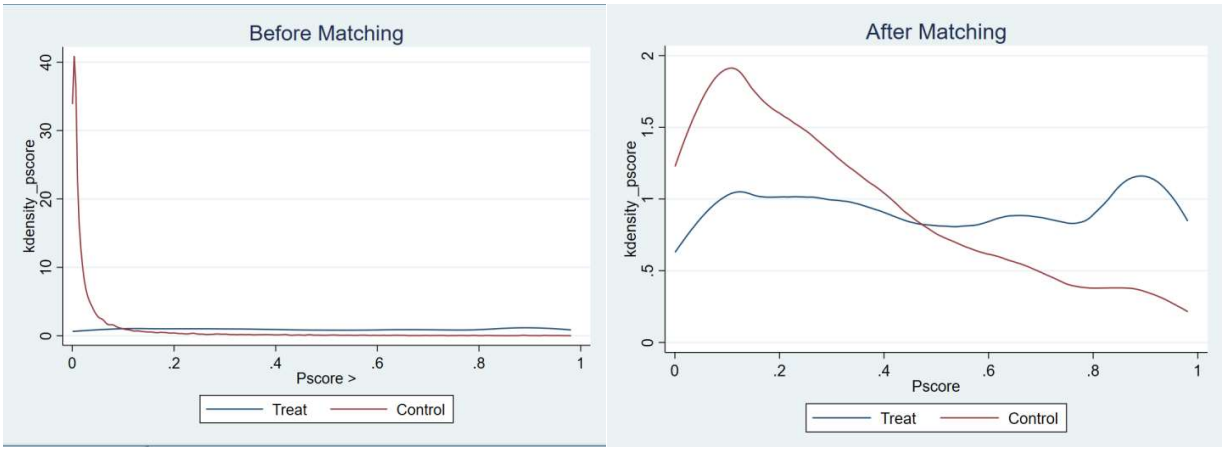

Figure 1. Plot of the kernel density function before and after pairing

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The figure shows the plot of the kernel density function before and after pairing, and it is obvious that the common range of values increases after pairing.

Table 4. DID baseline

	(1)	(2)
VARIABLES	rd	rd
did	0.868***	0.888***
	(8.24)	(8.57)
roa		0.314**
		(2.14)
size		0.572***
		(17.17)
lev		-0.364***
		(-4.65)
cash		0.039
		(0.75)
growth		0.014
		(0.51)
tobinq		0.043***
		(4.31)
Year FE	Y	Y
Stkcd FE	Y	Y
Constant	0.810***	-11.784***
	(103.04)	(-15.92)
Observations	15,332	15,332
R-squared	0.862	0.870

Robust t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The line 1 listed as the result of two-way fixed effect model 1 without control variables, the DID coefficient of the core variable is 0.868, which is significant at the 1% significance level. In order to isolate the endogenous influence as much as possible, we also introduced a series of control variables, and the result of the core variable coefficient did not change significantly, which was 0.868, which was significant at the 1% significance level. It shows that the ESG rating of SynTao Green Finance has affected the R&D expenditure of the enterprise, and this rating has increased the R&D of the enterprise by 86.8 million yuan.

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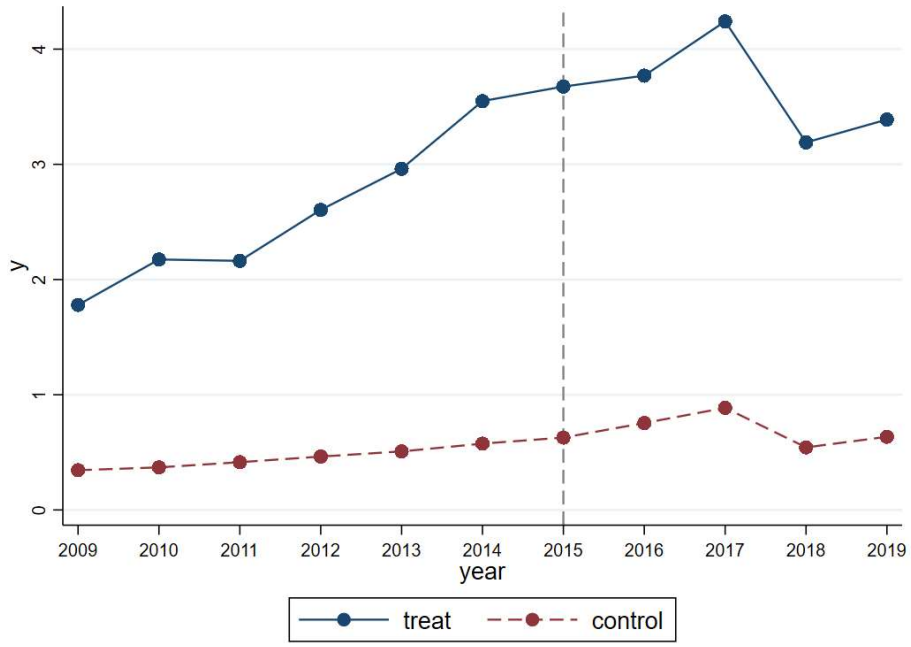

Figure 2. Parallel trend assumption

4.2.2 Test of the mediating effect of innovation input on the impact of ESG performance on corporate value

In this paper, the influence of fixed effects is considered for all models (1) to (3), and the three models are tested one by one according to the steps of the mediation effect test. The results are shown in Table below.

表 6　创新投入的中介效应检验

变量	(1)	(2)	(3)
	TobinQ	RDe	TobinQ
ESGscore	0.384***(8.48)	0.004***(5.12)	0.352***(8.22)
RDe			7.646***(3.50)
Leverage	−1.103(−1.59)	0.012(0.88)	−1.193*(−1.78)
State	−0.446(−1.17)	0.002(0.75)	−0.462(−1.22)
TOP10	−0.021***(−3.18)	0.001*(1.83)	−0.022***(−3.51)
Growth	0.342***(2.72)	0.007(0.64)	0.320***(2.66)
Size	0.731***(2.74)	−0.010**(−2.31)	0.808***(3.04)
Property_turn	0.377**(1.93)	−0.012***(−2.84)	0.465**(2.30)
Age	1.286***(3.79)	0.020***(3.75)	1.131***(3.38)
_cons	−19.204***(−3.42)	0.201**(2.20)	−20.741***(−3.70)
R^2	0.329	0.184	0.343
N	1485	1485	1485

注:***、**、* 分别表示在 1%、5%及 10%的水平上显著,括号内为 t 值.

First, we test the direct impact of corporate ESG performance on its value, and the results are shown in column (1) in Table 6. The regression coefficient of the enterprise ESG score to its value (TobinQ) is 0.384, which is significant at the 1% level, indicating that better ESG performance can help enhance enterprise value. With the goal of "carbon peak" and "carbon neutrality", investors are paying more and more attention to the performance of corporate social

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responsibilities. The pressure of external supervision on enterprises has increased, and they have actively fulfilled social responsibilities such as environmental protection. Release a positive signal to the market, so as to gain the favor of investors and gradually improve its own value, which is in line with the expectations of hypothesis 1 in this paper. In addition, among the control variables, the shareholding ratio of the top ten shareholders (TOP10) has a negative impact on the enterprise value at the significance level of 1%, indicating that an excessively high shareholding ratio of large shareholders will weaken the enthusiasm of small and medium shareholders to participate in the company's management, it is easy to appear the phenomenon of "speaking in one word", which is not conducive to the development of the company, which is in line with the research results of Zhang Wanli [18]. The relationship between enterprise size, company growth, asset turnover rate, enterprise age and enterprise value is also in line with the aforementioned theory in this paper.

Secondly, the relationship between ESG performance and corporate innovation capability is verified, and the results are shown in column (2) of Table 6. The regression coefficient of ESG score on enterprise innovation ability is positive, and it is significant at the 1% level, indicating that enterprises with better ESG performance have stronger innovation ability. Companies with better ESG performance usually have a higher awareness of environmental protection responsibilities, pay more attention to the impact of daily production and operation activities on the environment, actively undertake social responsibilities, and improve corporate governance. These goals force companies to continue to innovate. Research hypothesis 2 was verified.

Finally, it is tested whether innovation investment plays a mediating effect on the driving effect of ESG performance on corporate value. From column (3) in Table 6, it can be seen that the regression coefficient of ESG performance on enterprise value is 0.352, which is significant at the 1% level, when both innovation input (RDe) and ESG performance (ESG score) are included in the model for regression. The regression coefficient of innovation input on enterprise value is 7.646, which is significant at the 1% level. According to the mediation effect test method proposed by Wen Zhonglin et al. [19], innovation input (RDe) plays a part of the mediation role in the relationship between ESG performance and corporate value, that is, better ESG performance can promote innovation and then enhance corporate value. , the research hypothesis 3 of this paper has been verified, that is, better ESG performance can promote enterprises to increase R&D investment, improve innovation capabilities, and continuously improve their own development potential, thereby sublimating enterprise value.

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表 2 基准回归分析

Table 2 Benchmark regression analysis

	Model-1	Model-2	Model-3	Model-4
	EMV	ESG	EMV	ESG
ERI	0.356***	0.058**	0.348***	0.063***
	(5.870)	(2.510)	(5.850)	(2.660)
ESG			0.149***	
			(3.940)	
ERI*EDL				0.001**
				(2.180)
EDL				-0.003***
				(-2.710)
ZY	-3.763**	-0.121	-3.745**	-0.159
	(-2.380)	(-0.150)	(-2.390)	(-0.200)
PSR	0.004	0.009	0.003	0.009
	(0.400)	(1.530)	(0.270)	(1.54)
PBR	0.053***	-0.039***	0.059***	-0.037***
	(3.110)	(-3.700)	(3.350)	(-3.630)
SRT	0.017***	0.004**	0.017***	0.004**
	(3.170)	(2.390)	(3.040)	(2.180)
TWS	0.016*	0.010*	0.014	0.009*
	(1.780)	(1.940)	(1.630)	(1.780)
_cons	-6.176***	5.154***	-6.943***	5.131***
	(-5.360)	(12.500)	(-5.780)	(12.310)
N	5380	5380	5380	5380
adj. R-sq	0.257	0.045	0.265	0.050

注：括号中的数字表示标准误，下同。

As shown in Table 2, Model 1 examines the relationship between ESG and Value. The data shows that the regression coefficient of ESG is significantly positive, indicating that the improvement of a company's ESG performance has an effect on its market value, and H1 has been verified. Model 2 verifies the relationship between ESG and R&D. It can be seen that the regression coefficient of ESG is significantly positive, indicating that corporate R&D investment is the driving variable for optimizing corporate ESG performance, and H2 is verified. Model 3 adds the R&D variable on the basis of Model 1, and shows the regression results of the joint impact of ESG and R&D on Value. The results show that the regression coefficient of R&D is significantly positive, and the regression result of ESG is significantly positive (β=0.348). And compared with the ESG regression coefficient (β=0.356) in model 1, it has weakened by 0.008. Therefore, after controlling the R&D variable, the influence of ESG on Value decreases, indicating that corporate R&D investment plays a part in the relationship between corporate ESG performance and corporate market value. Mediating effect, H3 was verified. On the basis of Model 2, Model 4 adds EDL and the interaction term between EDL and ESG. The results show that the regression coefficient of ESG*EDL is significantly positive, indicating that the level of corporate

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digitalization plays a positive role in regulating the relationship between corporate ESG performance and corporate value. function, H4 was verified.

4.3 Heterogeneity test

Different industries may be affected by ESG differently. This article divides the samples into manufacturing and non-manufacturing. In the Huazheng rating data, the non-manufacturing coefficient is 0.051, which is significant at the 5% level; the manufacturing coefficient is 0.054, which is significant at the 1% level. It can be seen that for non-manufacturing companies, both the significance level and the coefficient are weaker than those of manufacturing companies. Similarly, in the Bloomberg rating, for every one point of ESG in manufacturing companies, R&D increased by 0.054 billion yuan, which was significant at the 1% level. However, no statistically significant results were seen in non-manufacturing companies.

Table 5. Heterogeneous test

	(1)	(2)	(3)	(4)
VARIABLES	manufacture rd	Non-manufacture rd	manufacture rd	Non-manufacture rd
Huazheng_ESG	0.054***	0.051**		
	(4.43)	(2.54)		
Bloomberg esg			0.054***	0.025
			(4.79)	(1.18)
roa	0.138	0.502**	1.094*	3.084***
	(0.83)	(2.55)	(1.85)	(3.53)
size	0.715***	0.220***	1.375***	0.131
	(17.79)	(7.04)	(11.75)	(0.75)
lev	-0.358***	-0.100	-0.202	-0.997**
	(-4.47)	(-0.90)	(-0.75)	(-2.48)
cash	0.034	0.019	0.101	-0.118
	(0.60)	(0.29)	(0.59)	(-0.58)
growth	0.020	-0.015	0.069	0.103
	(0.62)	(-0.72)	(0.88)	(1.60)
tobinq	0.038***	0.011	0.130***	0.000
	(4.23)	(0.81)	(3.15)	(0.01)
Year FE	N	Y	N	Y
Stkcd FE	N	Y	N	Y
Constant	-15.097***	-4.556***	-30.613***	-1.421
	(-16.83)	(-6.68)	(-11.27)	(-0.35)
Observations	12,647	4,459	4,291	1,707
R-squared	0.877	0.879	0.912	0.896

Robust t-statistics in parentheses

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*** p<0.01, ** p<0.05, * p<0.1

4.4 Robustness check

4.4.1 Sobel test

In order to prove the intermediary role of the company's ESG performance in the relationship between corporate R&D investment and corporate market value, this paper supplements the Sobel test, and the test results are shown in Table 3.

Table 6. Sobel robustness test results

Table 3 Sobel robustness test results

	Coef	Std Err	Z	P>|Z|
Sobel	0.063	0.006	9.786	0.000
Goodman-1	0.063	0.006	9.773	0.000
Goodman-2	0.063	0.006	9.798	0.000
	Pecent of total effect that is mediated:		6.138 %	
	Ratio of indirect to direct effect:		0.065	

As shown in the table, Sobel's Z value is 9.786, and the P value is less than 0.05. The null hypothesis is rejected, that is, the mediation effect has been tested, and the company's ESG performance will affect the company's market value through the company's R&D path.

4.4.2 Substitution variable method

In the above research, the explanatory variables are mainly measured by the ESG value in the SynTao database, and the data of two rating companies are used for verification in the robustness test. (1) and (2) are listed as Huazheng ESG rating data. (3)-(10) are listed as Bloomberg ESG rating data. Unfortunately, Huazheng data does not have sub-item ratings, only ESG total scores. When using Huazheng data, the coefficients are all positive regardless of whether fixed effects are added, and they are significant at the 1% level. The same conclusion can be drawn using Bloomberg rating data, that is, the higher the ESG score, the greater the R&D expenditure. Controlling other conditions, for every 1 point increase in the rating of Bloomberg, the R&D of the listed company will increase by 0.049 billion yuan. No matter which set of data is used, after adding the fixed effect, the coefficients all decrease in a small range, indicating that the original model may be affected by endogeneity, and adding the fixed effect can effectively alleviate this effect.

Table 7. How the esg grade influence R&D

VARIABLES	(1) rd	(2) rd	(3) rd	(4) rd	(5) rd	(6) rd	(7) rd	(8) rd	(9) rd	(10) rd
HuazhengESG	0.063***	0.055***								
	(5.41)	(5.26)								
Bloomberg esg			0.081***				0.049***			

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			(7.37)				(4.82)			
e				0.075***				0.042***		
				(6.72)				(4.65)		
s					0.046***				0.020***	
					(5.86)				(3.00)	
g						0.020*				0.013
						(1.68)				(1.31)
roa	0.489***	0.300**	-0.532	-0.909	-0.758	-0.440	1.604***	1.675***	1.524***	1.689***
	(2.88)	(2.34)	(-0.70)	(-1.00)	(-0.98)	(-0.59)	(3.44)	(3.07)	(3.23)	(3.59)
size	0.876***	0.519***	1.977***	2.129***	2.093***	2.146***	1.007***	1.152***	0.997***	1.074***
	(35.62)	(17.76)	(18.63)	(18.10)	(18.92)	(19.10)	(10.07)	(8.90)	(9.81)	(10.46)
lev	-0.261***	-0.217***	-0.286	-0.065	-0.317	-0.544	-0.348	-0.359	-0.266	-0.360
	(-3.97)	(-3.29)	(-0.88)	(-0.17)	(-0.93)	(-1.61)	(-1.56)	(-1.32)	(-1.16)	(-1.60)
cash	0.475***	0.032	1.585***	1.951***	1.590***	1.521***	0.019	0.195	0.092	0.027
	(7.07)	(0.71)	(6.26)	(6.71)	(6.15)	(6.02)	(0.14)	(1.25)	(0.67)	(0.20)
growth	-0.038	0.005	-0.007	-0.048	-0.074	-0.098	0.088	0.074	0.112**	0.075
	(-1.27)	(0.23)	(-0.06)	(-0.33)	(-0.65)	(-0.89)	(1.53)	(1.02)	(2.02)	(1.30)
tobinq	0.134***	0.032***	0.391***	0.449***	0.412***	0.382***	0.102***	0.116***	0.107***	0.113***
	(14.24)	(4.13)	(9.21)	(8.63)	(9.33)	(8.96)	(3.08)	(3.10)	(3.15)	(3.36)
Year FE	N	Y	N	N	N	N	Y	Y	Y	Y
Stkcd FE	N	Y	N	N	N	N	Y	Y	Y	Y
Constant	-19.007***	-10.944***	-45.393***	-48.148***	-47.482***	-48.381***	-22.221***	-24.915***	-21.478***	-23.352***
	(-35.16)	(-16.69)	(-18.80)	(-18.15)	(-18.88)	(-18.91)	(-9.55)	(-8.29)	(-9.10)	(-9.76)
Observations	17,286	17,106	6,040	5,144	5,904	6,040	5,998	5,093	5,860	5,998

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R-squared	0.293	0.875	0.280	0.288	0.278	0.271	0.905	0.911	0.907	0.904

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.4.3 ESG factors analysis

Table 4. How the esg grade influence R&D

VARIABLES	(1) rd	(2) rd	(3) rd	(4) rd	(5) rd	(6) rd	(7) rd	(8) rd	(9) rd	(10) rd
HuazhengESG	0.063***	0.055***								
	(5.41)	(5.26)								
Bloomberg esg			0.081***				0.049***			
			(7.37)				(4.82)			
e				0.075***				0.042***		
				(6.72)				(4.65)		
s					0.046***				0.020***	
					(5.86)				(3.00)	
g						0.020*				0.013
						(1.68)				(1.31)
roa	0.489***	0.300**	-0.532	-0.909	-0.758	-0.440	1.604***	1.675***	1.524***	1.689***
	(2.88)	(2.34)	(-0.70)	(-1.00)	(-0.98)	(-0.59)	(3.44)	(3.07)	(3.23)	(3.59)
size	0.876***	0.519***	1.977***	2.129***	2.093***	2.146***	1.007***	1.152***	0.997***	1.074***
	(35.62)	(17.76)	(18.63)	(18.10)	(18.92)	(19.10)	(10.07)	(8.90)	(9.81)	(10.46)
lev	-0.261***	-0.217***	-0.286	-0.065	-0.317	-0.544	-0.348	-0.359	-0.266	-0.360
	(-3.97)	(-3.29)	(-0.88)	(-0.17)	(-0.93)	(-1.61)	(-1.56)	(-1.32)	(-1.16)	(-1.60)
cash	0.475***	0.032	1.585***	1.951***	1.590***	1.521***	0.019	0.195	0.092	0.027
	(7.07)	(0.71)	(6.26)	(6.71)	(6.15)	(6.02)	(0.14)	(1.25)	(0.67)	(0.20)
growth	-0.038	0.005	-0.007	-0.048	-0.074	-0.098	0.088	0.074	0.112**	0.075

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	(-1.27)	(0.23)	(-0.06)	(-0.33)	(-0.65)	(-0.89)	(1.53)	(1.02)	(2.02)	(1.30)
tobinq	0.134***	0.032***	0.391***	0.449***	0.412***	0.382***	0.102***	0.116***	0.107***	0.113***
	(14.24)	(4.13)	(9.21)	(8.63)	(9.33)	(8.96)	(3.08)	(3.10)	(3.15)	(3.36)
Year FE	N	Y	N	N	N	N	Y	Y	Y	Y
Stkcd FE	N	Y	N	N	N	N	Y	Y	Y	Y
Constant	-19.007***	-10.944***	-45.393***	-48.148***	-47.482***	-48.381***	-22.221***	-24.915***	-21.478***	-23.352***
	(-35.16)	(-16.69)	(-18.80)	(-18.15)	(-18.88)	(-18.91)	(-9.55)	(-8.29)	(-9.10)	(-9.76)
Observations	17,286	17,106	6,040	5,144	5,904	6,040	5,998	5,093	5,860	5,998
R-squared	0.293	0.875	0.280	0.288	0.278	0.271	0.905	0.911	0.907	0.904

Robust t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

In this paper, the data of two rating companies are used to verify the model (2). (1) and (2) are listed as Huazheng ESG rating data. (3)-(10) are listed as Bloomberg ESG rating data. Unfortunately, Huazheng data does not have sub-item ratings, only ESG total scores. When using Huazheng data, the coefficients are all positive regardless of whether fixed effects are added, and they are significant at the 1% level. The same conclusion can be drawn using Bloomberg rating data, that is, the higher the ESG score, the greater the R&D expenditure. Controlling other conditions, for every 1 point increase in the rating of Bloomberg, the R&D of the listed company will increase by 0.049 billion yuan. No matter which set of data is used, after adding the fixed effect, the coefficients all decrease in a small range, indicating that the original model may be affected by endogeneity, and adding the fixed effect can effectively alleviate this effect.

However, the three sub-items of ESG have their own emphasis. It can be seen that in the regression results of the fixed effect model, for every point of e rating, the R&D expenditure of the enterprise increases by 0.042, but for every point of the s rating, the R&D expenditure of the enterprise only increases by 0.02. Consistent with our guess, different sub-item scores have different R&D expenditures. In addition, no matter whether fixed effects are added or not, the coefficients in front of g are not significant, indicating that the g score has no statistically significant impact on corporate R&D expenditures. This may be because g itself represents corporate governance, which is an endogenous factor of the company, and has little connection with the same endogenous R&D amount. The results of this paper are similar to those of Pedersen et al.: ESG can be used as a pricing factor in the capital asset pricing model, especially the E and S factors can obtain higher market valuations.

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5. Conclusions and recommendations

5.1 Research Conclusions

With the emergence of the new crown epidemic, the rapid development of China's economy has been affected to a certain extent. Issues in the field of R&D and innovation of enterprises represent the sustainable development capabilities of enterprises. Numerical regression and OLS regression study the impact of ESG performance on firm value mediated by firm innovation. The research conclusions are as follows:

5.1.1 ESG performance has a positive effect on corporate value

As the level of corporate value increases, ESG performance has a stronger effect on corporate value, indicating that companies actively practicing ESG concepts can promote corporate value, and the effect is more obvious as corporate value increases.

(2) On the whole, the relationship between corporate innovation and corporate value is positive and significant at the 1% significance level. Judging from the quantile regression results, when the enterprise value is at a medium level, the significant positive effect of enterprise innovation on enterprise value reaches the maximum.

(3) The interactive impact of ESG performance and corporate innovation on corporate value is significantly positively correlated at the 1% confidence level. The quantile regression results show that although the correlation coefficient is gradually decreasing with the increase of the enterprise value level, overall, the two still have strong significance at the 1% confidence level.

5.2 Suggestions

5.2.1 Actively integrate ESG concepts into corporate development strategies

ESG is a development concept that pursues the maximization of economic, environmental and social comprehensive value. It can effectively guide important participants in the market to focus on technological innovation while creating economic value, thereby promoting sustainable economic development. The ESG concept represents the comprehensive development capability of the enterprise, so the better the ESG performance of the enterprise, the more likely it is to gain an advantage in the market competition. Enterprises should combine the ESG concept with the company's development strategy, build a corresponding governance management framework and supporting mechanisms on this basis, and use the ESG concept as an important reference when making business decisions.

5.2.2 Continuously improve key technologies, innovative development level and international influence

With the rapid development of China's economy, the demand for innovation and development of enterprises is getting higher and higher. Innovation and research and development are the core competitiveness of enterprises and the fundamental driving force for sustainable development. Enterprises should take advantage of their own innovation and research and development advantages to further reduce environmental pollution and ecological damage through technological innovation, and at the same time continuously improve the pollution control level of environmental protection facilities in general. Enterprises should continuously improve their research and development capabilities, and through independent innovation, gradually build a

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research and development system with developed countries as the guide and local research and development as the core, and at the same time introduce international talents with a global perspective to ensure the high level and high quality of enterprise research and development and sustainability, to achieve synchronization with the international level.

5.2.3 Financial leverage and liquidity

While the enterprise is committed to R&D and innovation in the course of operation, it must maintain an appropriate ratio of financial leverage and liquidity, and the concentration of equity should be at a reasonable level. For enterprises whose value is at different stages of development, moderately adjust the operation and management strategy to achieve a better improvement of enterprise value.

5.2.4 Digital strategies

Based on the regulating effect of the digitalization level of enterprises, it is recommended that all enterprises accelerate digital transformation, choose digital strategies according to their own conditions, use their own business model as a breakthrough point, and pay attention to the overall coordination of digital technology and existing resources. In the process of digital transformation , We must pay attention to the systematic nature of internal digitalization, and unify digital product standards and protocols. Furthermore, digital transformation will have a "painful period" for some enterprises. Therefore, the government or relevant departments can reform and improve some market management systems and administrative approval processes that may hinder the digital transformation of enterprises, and help enterprises accurately apply digital technology. The potential risks of transformation, so as to help enterprises smoothly transition through the "painful period" of digital transformation.

5.2.5 Limitations

Although this paper analyzes and verifies the relationship and mechanism between corporate R&D investment and corporate market value, there are still some limitations: on the one hand, this paper uses panel data of listed companies in China and does not distinguish between industries in the research. Industry-specific research can be carried out by subdividing industries; on the other hand, the ESG performance and digitalization level of enterprises discussed in this article have gradually achieved multi-dimensional comprehensive evaluation. In the future, different ESG evaluation systems and multi-dimensional digital measurement can be considered means to measure variables.

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