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The Impact of Digital Investment on Corporate ESG Performance —— The Regulatory Effect Based on the Market Environment

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Abstract. With the ESG concept deeply rooted in the hearts of the people, how companies can improve their ESG performance has attracted the attention of management circles. The study used Chinese listed companies as a sample to empirically test the relationship between digital investment and corporate ESG performance, as well as the changes in the impact of digital investment on corporate ESG performance from the perspective of market environment. The study found that digital investment can significantly improve the ESG performance of enterprises, and the market environment of the enterprise will have a negative regulatory effect on the relationship between digital investment and enterprise ESG performance. This research enriches the research on factors affecting corporate ESG performance and provides a theoretical basis for companies to improve ESG performance through digital investment.

Keywords. ESG, digital investment, market environment

1. Introduction

In June 2004, the United Nations Global Compact systematically proposed the concept of ESG (Environment, Social and Governance) for the first time. The ESG philosophy advocates that companies not only pursue economic interests, but also balance them with the environment (E), society (S) and corporate governance (G) [1]. As the concept of ESG becomes more and more popular, academic research on ESG has also been carried out, mainly focusing on theoretical analysis, evaluation system construction and economic consequences research. Most scholars agree that ESG can help companies solve important issues related to achieving sustainable development, they believe that improving ESG performance plays an important role in enhancing corporate credibility [2], attracting external investment [3], mitigating financial risks [4], and enhancing corporate value [5]. Therefore, in recent years, corporate ESG performance has gradually become an important criterion for regulatory authorities and investment institutions to measure corporate sustainable development potential. However, according to the ESG Research Report of China's Listed Companies (2021), only 8.07% of China's listed companies have an ESG rating of A, and the overall score is still low. Against this

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background, it is very important to explore a scientific path to promote corporate ESG performance improvement.

Relatively speaking, there are relatively few empirical studies on ESG influencing factors. Existing studies mainly focus on the impact of corporate board characteristics, employee freedom, investors, and other factors on ESG performance [1, 6, 7]. Although these literatures consider the motivation of enterprises to fulfill social responsibility, they are mostly from the perspective of stakeholders. In the era of digital economy, the practice form of corporate social responsibility often changes with the input of digital resources. As an indicator to measure corporate digitalization strategies based on emerging digital technologies [8, 9], digital investment not only helps enhance the efficiency of information circulation inside and outside the enterprise [10] and promotes enterprises to carry out green innovation [11], but also inhibits the phenomenon of real earnings management [12]. However, no scholars have yet conducted empirical research on the relationship between digital investment and corporate ESG performance. In addition to the special digital resources inside the enterprise, the external environment of the enterprise, such as the legal environment, market environment, social media environment, etc., may also affect the development strategy and responsible behavior of the enterprise [13, 14]. The research shows that a good market environment helps to improve the efficiency of resource allocation and promote technological innovation of enterprises [15], therefore, may also become a contingency factor affecting the relationship between digital investment and corporate ESG performance, but no research has yet conducted an empirical test on this.

Based on the above research gaps, this article takes China's A-share manufacturing listed companies as a sample to discuss the following issues: First, can companies' digital investments improve their ESG performance? Second, how will the impact of digital investment on corporate ESG performance change under the perspective of market environment? The goal of this study is to cover the gap regarding the influence of digital investment on corporate ESG performance, taking into consideration the moderation effect of market environment and explore feasible ways to improve corporate ESG performance. The research results show that digital investment is an important factor affecting corporate ESG performance, and the market environment will negatively regulate this impact. This conclusion not only provides a theoretical basis for enterprises to improve ESG performance through digital investment, but also helps enterprises to seize new opportunities for digital development and achieve sustainable development goals.

2. Theoretical analysis and research hypotheses

2.1. Digital investment and corporate ESG performance

It has become a general trend to integrate big data, cloud computing, 5G, Internet of Things and other digital technologies to assist enterprises in ESG governance to promote the performance improvement of corporate ESG. The ESG performance of an enterprise is determined by three factors, including environmental responsibility performance (E), social responsibility performance (S) and corporate governance performance (G). Firstly, with the help of digital technologies such as big data, digital investment can not only help companies quickly identify their own environmental responsibility defects [16], but also reduce the cost of green innovation by effectively integrating and using various

green innovation resources [11], then enable the green ecological manufacturing process and renewable cycle [17] and improve the environmental performance of the enterprise. Secondly, by building a basic digital platform or digital carrier, enterprises can quickly capture and analyze the value demands of various stakeholders, and a strong innovation orientation will enable enterprises to generate new processes and technologies in response to the multiple value propositions of stakeholders [10], thus realizing the value co-creation between enterprises and stakeholders [16]. In addition, enterprises will gain better reputation and reputation [18], which will further promote the improvement of corporate ESG performance. Finally, based on the data obtained from digital investment, decision support systems, etc. can help managers clarify the correlation between things, thereby reducing irrational decisions. The flattening of the organization has greatly increased the speed and sharing of information within the enterprise, and employees have more voices, which can play a good role in internal supervision and feedback [19]. In addition, the interconnection of internal and external information of enterprises greatly reduces the information acquisition cost of external participants [20], and enterprises will face stronger external supervision, which can effectively reduce the occurrence of opportunistic behaviors and promote the improvement of corporate governance performance. Based on this, the study proposes the following hypothesis:

H1. *Digital investment can promote the improvement of corporate ESG performance.*

2.2. The regulating role of market environment

At present, there is no clear conclusion on whether the market environment can have a positive impact on the relationship between digital investment and corporate ESG performance. On the one hand, with the continuous improvement of the market environment, the transparency of market operation, the circulation and allocation efficiency of elements have also been greatly improved in [21, 22], which enables enterprises to obtain and allocate resources at less cost and have more resources to improve production and take responsibility. Therefore, the market environment may have a positive effect on the relationship between digital investment and ESG performance. On the other hand, the regional factor market with perfect market environment is relatively developed, lacking the motivation for enterprises to obtain external resources, and when the market environment is good, the government's intervention and supervision will often become weak, which may lead to maintaining market fair order and protecting digital property rights [23], thus affecting the healthy development of enterprises and causing the decline of the role of digital investment on ESG performance. Therefore, the market environment may also have a negative regulatory effect on the relationship between digital investment and ESG performance. Based on this, the study proposed the following research hypotheses:

H2a. *Market environment has a positive regulatory effect on the relationship between digital investment and ESG performance.*

H2b. *Market environment has a negative regulatory effect on the relationship between digital investment and ESG performance.*

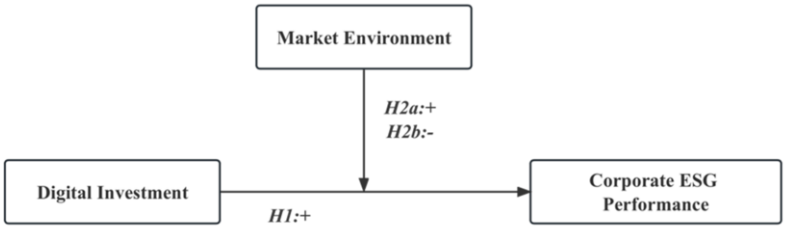

Figure 1. Research model.

3. Research design

3.1. Sample selection and data source

The 2017-2021 China's A-share manufacturing listed companies were selected as the initial research sample to construct the non-equilibrium panel model. In the process of data pre-processing, the data were matched according to the stock code and year information, and the company samples with many missing data, the ST companies with abnormal financial status and the companies delisted during the period were excluded, and finally 10,931 observed values were obtained. In addition, to reduce the outlier interference, the observed values of continuous variables were reduced according to the upper and lower 1% quantile, and the data processing and model estimation were completed using Python 2.7, Excel 2013 and Stata16.0. In the paper, the data of the ESG performance of the explained variable enterprises comes from the ESG rating of China Securities, the digital investment data of the core explanatory variable is from the annual report of Juchao Net, the market environment data is from the China Province Market Index 2021, and the other data are from the CSMAR database. The specific definitions and measures of the main variables are shown in Table 1.

Table 1. Primary variable definitions

Type of Variable	Variable Name	Variable Symbol	Variable Measure
Explanatory Variable	Digital investment	*DI*	The natural logarithm of the text analysis
Explained Variable	Corporate ESG performance	*ESG*	China certificate ESG ratings each quarterly average
Regulated Variable	Market circumstances	*Market*	Market index in China by Province Market Index 2021
Controlled Variable	Enterprise age	*Age*	Establishment year + 1 take the natural log
	Scale	*Size*	Natural logarithm of the annual total assets
	All capital earnings rate	*Roa*	Average balance of net profit / total assets
	The proportion of fixed assets	*Fixed*	Net fixed assets / total assets
	TobinQ value	*TobinQ*	(Market value of tradable shares + number of non-tradable shares * net assets per share + book value of liabilities) / total assets

Equity concentration	*Top1*	The largest shareholder shareholding ratio
Two jobs in one	*Dual*	When the chairman and the general manager are assigned the same value of 1, otherwise it is 0
Nature of stock rights	*Soe*	Whether it is a state-owned enterprise, the state-owned holding enterprise assigns a value of 1, otherwise it is 0
Industry effect	*Industry*	Industry virtual variable, assigned a value of 1 when belonging to the industry, or 0 otherwise
Time effect	*Year*	Annual dummy variable, assigned to 1 when belonging to that year, or 0 otherwise

3.2. Model setting

The mixed OLS model for multiple regression analysis, while the regression to reduce the effect of heteroscedasticity. Among them, model (1) is used to test hypothesis 1, and model (2) is used to test hypothesis 2a and hypothesis 2b. The specific regression model is:

$$ESG = \alpha_0 + \alpha_1 DI + \sum \alpha_j Controls + \sum Industry + \sum Year + \varepsilon \quad (1)$$

$$ESG = \beta_0 + \beta_1 DI + \beta_2 Market + \beta_3 DI * Market + \sum \beta_j Controls + \sum Industry + \sum Year + \varepsilon \quad (2)$$

Among them, corporate ESG performance (*ESG*) is the explained variable, digital investment (*DI*) is the explanatory variable, market environment (*Market*) is the regulatory variable, $\sum Controls$ representing the control variable, $\sum Industry$ representing the industry fixed effect, and $\sum Year$ representing the time fixed effect.

4. Hypothesis testing and results discussion

4.1. Benchmark model test

Table 2. Main effect test

	1	2	3	4
Variable	**ESG**	**ESG_{t+1}**	**ESG_{fe}**	**ESG_{psm}**
DI	0.0431***	0.0392***	0.0475***	0.0938***
	(4.81)	(3.72)	(3.25)	(4.40)
Controls	Yes	Yes	Yes	Yes
Industry Effect	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes
Individual Effect	No	No	Yes	No
_cons	2.8733***	1.6958***	7.3712***	2.9234***
	(13.24)	(6.68)	(5.55)	(13.45)
N	10882	8031	10882	10875
Adj.R^2	0.1275	0.1586	0.0168	0.1279

Note1: ***, **, and * represent the statistical test significance levels at 1%, 5%, and 10% respectively;
Note2: Yes/No represents controlled/uncontrolled, the same below.

Column 1 of Table 2 shows the regression results of the benchmark model. The test results show that the regression coefficient of digital investment (*DI*) is 0.0431, and is significantly positive at the 1% confidence level, indicating that digital investment can significantly promote the improvement of corporate ESG performance. Hypothesis H1 is verified.

In addition, the study also discusses the possible endogenous issues between digital investment and corporate ESG performance. First, to control the endogeneity problem caused by bidirectional causality, the study lagged the explanatory variables by one period and retested them. The regression results are shown in column 2 of Table 2. Secondly, to control the endogeneity problem caused by omitted variables, individual fixed effects were further added to the model and retested. The regression results are shown in column 3 of Table 2. Finally, to control the endogeneity problem caused by sample self-selection, the caliper matching (caliper = 0.05) method in the propensity score matching method (PSM) is further used to estimate the net effect of digital investment on corporate ESG performance. The regression results are shown in column 4 in Table 2. The regression results of the above tests are all significantly positive at the 1% confidence level, indicating that the conclusion that "digital investment can significantly promote the improvement of corporate ESG performance" is robust.

4.2. Moderating effect test

Table 3. Market environment regulation function test

Sample Group	**Better Market Environment**	**Worse Market Environment**	**Full Sample**
	1	**2**	**3**
Variable	**ESG**	**ESG**	**ESG**
DI	0.0584***	0.0214*	0.0413***
	(4.62)	(1.72)	(4.55)
Market			0.0213***
			(3.43)
*DI *Market*			-0.0126***
			(-2.65)
Controls	Yes	Yes	Yes
Industry Effect	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes
_cons	4.2108***	5.8603***	2.9908***
	(5.49)	(5.68)	(13.60)
N	5483	5399	10719
Adj.R^2	0.1327	0.1330	0.1303

The test results of the moderating effect of the market environment are shown in Table 3. Columns 1 and 2 are the group regression results of the market environment, and the median of the market environment is used as the dividing node to divide the samples into a sample group with a poor market environment (column 1) and a sample group with a good market environment (column 2). The results show that the regression coefficient of

digital investment (*DI*) in the sample group with better market environment is 0.0214, which is only significant at the 10% level, while the regression coefficient of digital investment (*DI*) in the sample group with poor market environment is 0.0584, and Significantly at the 1% level, significantly better than the sample group with a better market environment, indicating that the incentive effect of digital investment on corporate ESG performance in areas with better market environment is weak, and the market environment has a negative relationship between digital investment and ESG performance regulating effect. Further, column 3 shows the product regression results of the market environment, and the interaction term (*DI*Market*) between digital investment and market environment is significantly negative at the 1% level (-0.0126), which once again shows that the market environment has an impact on digital investment and ESG The expressed relationship has a negative moderating effect, hypothesis H2a is not established, and hypothesis H2b is verified.

5. Conclusions

As the ESG concept becomes more and more popular, the ESG performance of companies has become an important criterion for regulatory authorities and investment institutions to measure the sustainable development potential of companies. However, the lack of corporate social responsibility still often occurs. In this context, companies urgently need to explore ESG performance. To maintain a competitive advantage and achieve sustainable development. Based on this, the study uses China's manufacturing listed companies as research samples to empirically test the relationship between digital investment and corporate ESG performance, as well as the impact of digital investment on corporate ESG performance from the perspective of market environment. The study found that digital investment can significantly improve the ESG performance of enterprises, and the market environment of the enterprise will have a negative regulatory effect on the relationship between digital investment and enterprise ESG performance. Therefore, companies should seize new opportunities for development in the digital economy era and pay attention to the stimulating role of digital investment in corporate ESG practices. Especially companies in areas with poor market development, they need to try to use digital power to obtain resources at low cost and maintain their competitive position, thereby improving the company's ESG performance and achieving sustainable development goals.

There are still some shortcomings in the research and areas for further research. On the one hand, the research objects are limited to listed manufacturing companies. The applicability of the research conclusions to other industries needs to be verified. In the future, the analysis can be expanded to samples from different industries. On the other hand, although this article provides a theoretical basis for enterprises to invest in digitalization to improve ESG performance, it lacks more detailed guidance. Further relevant cases can be added in the future.

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