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Research on the Impact of ESG Performance on Corporate Investment Efficiency

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Abstract: *Under the background of "dual carbon", achieving sustainable development is a long-term goal for enterprises. At the same time, ESG is based on the development concepts of green environment, social, and corporate governance, and its disclosure information is crucial for the long-term operation of enterprises as a focus of stakeholders' attention. Investment efficiency plays a key role in the stable development of enterprises, so this paper takes the data of Chinese A-share listed companies from 2011-2021 as the research sample, adopts two-way fixed effects through panel data, and conducts regression analysis on ESG performance and enterprise investment efficiency. The results show that good ESG performance can effectively alleviate enterprises' over investment and under investment, and effectively improve enterprise investment efficiency. Further analysis reveals that for enterprises with different lifecycles and industries, mature and heavily polluting industries have a greater investment efficiency improvement effect on ESG performance. This study has enlightening significance for enterprises to systematically manage ESG, improve the quality of ESG information data, and promote sustainable development of enterprises.*

Keywords: *ESG; Investment efficiency; Bidirectional fixed effects model*

1. Introduction

At the 75th session of the United Nations General Assembly, General Secretary pledged to the world that "China will strive to control the peak of carbon dioxide emissions before 2030 and achieve carbon neutrality by 2060". The goal will deeply promote the long-term high-quality development of the real economy that is healthy, efficient, green, and environmentally friendly. 2023 is the third year of proposing the goals of "carbon peak" and "carbon neutrality". With the introduction and implementation of a series of policies related to the "dual carbon" goals, the sustainable development capability of enterprises has become an important component of enterprise value, and the capital market is increasingly paying attention to the comprehensive disclosure of non-financial information of enterprises. The ESG evaluation system focuses on three aspects: green environment, social responsibility, and corporate governance. It quantifies the comprehensive level of enterprises, reflects their sustainable development capabilities, and provides impetus for enterprises to practice the concept of sustainable development. It has become an important lever for implementing the "dual carbon" strategy, a business norm in the new era, and one of the forefront issues in academic research [1-3].

The establishment of a comprehensive evaluation system for ESG performance of listed companies in China was first formally proposed in the "ESG Research Report on Chinese Listed Companies" by the China Securities Investment Fund Industry Association in 2018. In December 2021, the "2021 China ESG Development White Paper" was released, which aims to further promote the development and practice of ESG in China from four aspects: policy recommendations, academic research, industry practice, and international exchanges, based on the successful experience of foreign countries, and contribute to the high-quality development of China's national economy.

Investment activities are the core of enterprise financial management activities and a crucial part of enterprise operation and management. Investment efficiency is the resource allocation state formed by the investment and financing activities of enterprises, which determines whether the value of the enterprise increases or not. Under the efficient conditions of the capital market, how to better improve the operational performance of enterprises and achieve long-term sustainable development, the investment efficiency brought by the investment decisions made by the management of enterprises is the focus of their attention. It should not only be conducive to stable growth in the current period, but also benefit the long-term, and prevent ineffective and inefficient investments. With the increasing attention of various sectors of society to ESG, the investment scale based on ESG as the basis for investment

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decisions is becoming larger and larger. More and more regulatory agencies, investors, and physical enterprises are referring to ESG concepts to practice long-term national and social goals in policy formulation, investment, operation, and other important decisions [4-8].

In theory, based on the concepts of ESG, financing constraints, and information asymmetry, this article selects the ESG rating data of China's A-share market indicator Huazheng to measure. Multiple financial indicators are selected to cover and regress the degree of inefficient investment of enterprises, with the growth rate of operating efficiency as the main measure. The impact of ESG performance on enterprise investment efficiency is explored, and ESG information disclosure is taken as a perspective to deepen and enrich the company's investment efficiency. At the same time, attention is also paid to the impact of non-financial information, which broadens the research perspective and results of ESG information disclosure. Expanded research areas related to ESG performance and corporate investment efficiency, helping companies achieve green and sustainable development.

In practical terms, high-quality and sustainable economic development has always been a focus of attention in China's economic development process. Listed companies in China face economic obstacles caused by inefficient investment due to insufficient and excessive investment. Enterprises should not limit their business goals to profits, but should also assume social responsibility. Transparency in information disclosure is the first concern for investors' investment. Listed companies disclose ESG information, improve the transparency of non-financial company information in the market, reduce information uncertainty between companies and stakeholders, improve inefficient investment, and promote good resource allocation for stakeholders. This has important practical significance for enterprises and society to achieve green economy and provide new ideas for realizing green economy[9-12].

2. Journals reviewed

2.1 ESG Performance Research

ESG in this article refers to an indicator system that comprehensively evaluates a company's sustainable development based on its performance in three aspects: environmental, social responsibility, and corporate governance. The concept of ESG emerged in Western countries. In 2006, the United Nations Responsible Investment Guidelines first clearly reflected the concepts of environmental protection and conservation in the report, and since then, various international organizations and investment institutions have gradually improved them. At the same time, according to the relevant regulations formulated by global exchanges, although the disclosure of ESG information is semi mandatory, it is beneficial for maintaining the competitive advantage of enterprises.

With the popularization of ESG theory, its evaluation system has also been established. Although mainstream institutions such as MCSI, FISE Russell, and Sustainalytics have their own focus on the scope of investigation and underlying indicators, they all organically connect the entire process of investment, evaluation, and disclosure of enterprises, which has a certain guiding effect on investment. Azmi W (2021) points out from the perspectives of enterprise value and risk performance management that ESG management systems can effectively improve corporate financial performance, gain long-term sustainable competitive advantages, and promote high-quality economic development of enterprises.

In recent years, with the further deepening of the domestic green development concept, China has also built an ESG evaluation system based on its national conditions, including data from all A-share listed companies such as Huazheng, CSI, and Shangdao Ronglv. A pyramid scoring system has been constructed to refine and stratify the data. Chinese scholars Zhang Qiaoliang and Sun Ruijuan (2015) conducted a 2 × 2 two factor experiment and believed that in the case of poor financial performance and excellent ESG performance, users of independent financial statements will have a strong "anchoring" effect on the value judgment of the enterprise; Sun Dong and Yang Shuo (2019) believe that good debt paying ability, profitability, and reasonable capital structure can improve a company's ESG performance by constructing an ESG and Return on Capital (ROCE) panel regression model; Wang Haijun, Chen Bo, and He Yu (2022) used the double difference propensity score matching model (PSM-DID) and believed that whether it is rating events or rating scores, being selected for ESG ratings can effectively improve a company's valuation, which has a positive impact.

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2.2 Research on Enterprise Investment Efficiency

The investment efficiency of a company refers to the difference in investment efficiency obtained by comparing its actual investment level with the optimal investment state. In the capital market, investment decisions of enterprises are influenced by various factors such as accounting conservatism and equity nature, which leads to inefficient investments and to some extent weakens the investment efficiency of enterprises. Vogt (1944) used free cash flow to measure investment efficiency, established a model, and analyzed the two most common forms of inefficient investment in China's capital market: overinvestment and underinvestment.

At the same time, based on the free cash flow and sales growth rate of enterprises, BHV and Richardson models were established to better measure the investment efficiency of companies. Subsequently, representative models such as Biddle (2009) and Chen (2011) were developed for measurement. In recent years, scholars at home and abroad have conducted a series of studies through model construction. Bitar (2018) studied a sample of over 20000 American companies and empirically showed that high-quality social information disclosure can boost the investment efficiency of enterprises; Chinese scholar Li Shengnan (2008) found that enterprises are mainly affected by financing restrictions and agency problems, which affect inefficient investment and lead to a decrease in investment efficiency. He emphasized the connection between the asymmetry of information between enterprises and society, bringing new ideas for improving investment efficiency of enterprises. Li Jigang's (2022) research found that digital inclusive finance has overall improved the investment efficiency of enterprises, and the breadth and depth of coverage and use of digital inclusive finance will have a positive impact on the investment efficiency of enterprises. Zhang Guangsheng's (2022) research shows that there is a negative correlation between local economic growth pressure and inefficient investment of enterprises within the jurisdiction, which can have a suppressive effect on it and improve the level of corporate governance through pathways. Ning Ze et al. (2023) found through research that the improvement of managers' quality and ability has a significant impact on the investment efficiency of companies, and commercial credit financing can play a partial intermediary role in the relationship between managers' quality and ability and the investment efficiency of enterprises.

2.3 The relationship between ESG performance and investment efficiency of enterprises

Anwar and Malik (2020) believe that good ESG performance can improve investment efficiency by alleviating financing constraints and reducing information asymmetry to reduce agency problems. According to the review, most existing literature can be divided into these two aspects for a certain degree of exploration.

Firstly, in terms of financing constraints, the current prevailing view is that good ESG performance has a positive impact on investment efficiency by alleviating financing constraints. In the context of corporate ecological environment, Qiu Muyuan and Yin Hong (2019) believe that ESG has a differentiated impact on the financing costs of enterprises based on panel data models; In terms of information disclosure, Xue Yuting, Tian Gaoliang, and Li Xing (2022) used the Richardson model to study the forward-looking information of listed companies and found that companies with higher financing constraints and poorer information environments have a more significant effect on improving investment efficiency through forward-looking information disclosure; Based on the perspective of corporate governance, Long Haiming and Ouyang Jiajun (2022) measured a company's financing constraints through the SA index, and believed that the improvement of a company's ESG performance can indirectly exert the effect of dynamically adjusting its capital structure for the next period by alleviating financing constraints.

Secondly, in terms of agency issues, good ESG performance improves investment efficiency by reducing agency problems. Marwa Samett and Anis Jarboui (2017) found that corporate social responsibility can help companies solve problems of delegation and information asymmetry, thereby improving their investment efficiency; In terms of disclosing information on corporate financial and other conditions, Lin Zhonggao and Liu Wenqing (2022) found that based on the comparability of accounting information, reducing agency problems can curb inefficient investment. At different stages of enterprise development, Gao Jieying, Chu Dongxiao, Lian Yonghui, and Zheng Jun (2022) analyzed based on the BHV model and believed that companies with higher maturity, information dissemination efficiency, commercialization, and legal system can better curb overinvestment by monetizing through ESG channels[13-18].

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2.4 The relationship between ESG performance and investment efficiency of enterprises

For ESG related theories, with the background of the 18th National Congress and the adherence to the "Five in One" integrated approach of socialism with Chinese characteristics, the concept of green development has become a new guiding principle for China's economic development. Therefore, ESG has also become a key research direction for Chinese scholars. It can be found that the rise of ESG concept was relatively late, but through literature investigation, it has been discovered. Abroad is much earlier than domestically, and research on ESG related theories has only begun to develop and improve in China in recent years. Therefore, foreign countries are relatively more mature than domestic ones, while domestic research on ESG related data, theories, and experiences is still in the accumulation stage.

In terms of the theory of investment efficiency, existing literature has discussed the factors and measurement methods that affect investment efficiency. From the perspective of influencing factors, internal controls, financial evaluation indicators, and multiple factors such as information asymmetry and financing constraints make a company's investment efficiency high or low. However, regarding the measurement of investment efficiency, there is currently no consensus based on different interpretations and definitions of the concept of investment efficiency by scholars at home and abroad.

As for the study of the impact of ESG performance on corporate investment efficiency, due to the late rise of ESG concepts, although most scholars in China have realized that good ESG performance of enterprises is conducive to improving investment efficiency, previous literature research has mostly focused on the role of corporate social responsibility and corporate governance in the environment. Currently, research on the relationship between ESG performance and corporate investment efficiency has begun to emerge. Therefore, starting from the reality of the Chinese stock market, selecting ESG indices that are more in line with China's national conditions and can reflect the characteristics of listed companies can also provide a broader perspective on the overall ESG evaluation performance of listed companies. The conclusion on the relationship between ESG evaluation performance and investment efficiency also has certain research value[19-24].

3. Theoretical analysis and research hypotheses

3.1 ESG Performance and Corporate Investment Efficiency

Asymmetric information and agency problems are two important factors that affect the investment efficiency of companies. According to signal theory, signal transmission and information discrimination are two related aspects of signal theory, highlighting the positions of both parties in the transmission process from the perspective of information asymmetry. Compared with information discrimination, the theoretical research and application of signal transmission in academic research are more extensive. According to research on theoretical information asymmetry, external investors, as weak players in company information, have insufficient understanding of the company and carry significant risks. Therefore, when investing in the company, they often pursue higher returns and the amount and quality of information disclosed by the company. Companies with high ESG scores will disclose more non-financial information, and the quality and transparency of their information will also be higher, which can reduce information asymmetry between the company and investors on a larger scale. Therefore, when investors invest, they not only reduce the cost of collecting information to a certain extent, but also lower external investors' expectations of risk levels, thereby reducing the required investment return rate for investors and lowering the company's financing costs, thereby improving the company's financing efficiency.; In addition to the financial information such as profits and liabilities that we are familiar with, many non-financial interests have also increasingly attracted the attention of a large number of investors. Dhaliwal et al. (2011) found that ESG performance, as a form of non-financial reporting disclosure by companies, conveys more information about the characteristics of the company to lenders such as banks, reduces the degree of information asymmetry, and helps companies obtain external financing. From this, it can be seen that good ESG of enterprises can effectively reduce the constraints caused by financing, reduce the problem of insufficient investment in high-quality projects due to financial constraints, and prevent overinvestment caused by poor quality projects, thereby improving the investment efficiency of enterprises.

According to the agency theory, different goals and concepts can lead to conflicts of interest between shareholders and management. Jensen's (1976) study found that when management has significant investment decision-making power, if their behavior is not controlled and stimulated, they may be tempted to continuously invest in order to generate costs and improve personal reputation in their work,

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resulting in overinvestment and company fund privatization to generate unreasonable costs, leading to insufficient investment in the enterprise. And the good ESG performance of enterprises is conducive to constraining the problems caused by such agency relationships, thereby improving the investment efficiency of enterprises. Firstly, Gao Yingjie (2021) found that ESG evaluation performance can serve as a constraint mechanism to alleviate agency problems and reduce speculative activities among managers; Secondly, a good ESG performance evaluation of a company can demonstrate the efforts made by the company and its employees towards social development, establish a good image of the company, and thus attract the attention of various stakeholders and media, facing stronger external supervision and constraints. According to the credibility mechanism, for companies that perform well in ESG evaluation, the media will give more attention. When this attention reaches a critical point, the company's senior management will become more cautious in investing and deciding to improve the investment efficiency of Tanli's human resources industry under external pressure; Yao Youfu and Huang Yan (2023) found that ESG performance achieves effective supervision and management of corporate management's embellishment behavior by mitigating agency problems and market supervision pressure. Therefore, company managers will choose their investment projects more carefully and make investment decisions, which can effectively control their company's underinvestment and overinvestment, thereby further improving the company's investment efficiency.

At the same time, in previous studies, stakeholder theory has been considered a major theoretical basis for exploring the impact of social responsibility disclosure on companies. Therefore, this theory can also be applied to explore the relationship between the implementation of ESG concepts in enterprises and their investment efficiency. Based on stakeholder theory, external investors will use various methods and channels to collect information about the company when making investments, thereby deepening their understanding of the company. In the process of formulating accounting standards, the formulation of accounting standards should not only consider the financial condition of the company, but also the non-financial condition of the company. Excellent ESG ratings mean that companies will place greater emphasis on long-term goals and sustainable development in their operations. So, in addition to studying the company's financial information, external stakeholders will also focus their attention on the company's internal governance, environmental and social responsibility disclosure information. In this case, the company is more likely to gain recognition from shareholders or creditors as stakeholders. Investors will make corresponding adjustments to the required interest rates and returns when investing, which can better reduce the overall financing costs of the company and further improve its investment efficiency[25-36].

Based on the above analysis, this article proposes the following hypotheses:

H1: Good ESG performance can improve a company's investment efficiency.

3.2 ESG performance and investment efficiency of enterprises with different life cycles

According to the theory of enterprise lifecycle, the development and growth of a company can be divided into four stages: start-up, growth, maturity, and decline. Companies at different stages of development have varying economic capabilities, and the process of improving their environmental, social, and governance performance will incur certain costs that cannot be borne indefinitely. This further determines that there are differences among companies in improving their ESG performance levels. During the development process of companies at different stages of their lifecycle, various indicators of the company will constantly change, including human resources, investment goals, production efficiency, development scale, etc., which may also be affected by financial constraints and agency problems. These different reasons may lead to inefficient investment in the enterprise. Therefore, the role of ESG indicators in improving investment efficiency also varies for companies at different stages of development.

From the perspective of cash flow, if a company has low profits and insufficient cash flow, and invests too much in ESG in order to improve its ESG evaluation performance, it will not only fail to alleviate the company's financial pressure, but also increase the company's cost of funds and increase the possibility of financial difficulties. In sharp contrast, mature enterprises have stable development, higher cash flow, less operating pressure, stable income, and stable inflow of funds and earnings. Wang Qinggang and Xu Xinyu (2016) believe that in the mature stage, a company has a stable capital flow and capital surplus, which has a significant positive impact on fulfilling the social responsibilities of various stakeholders and helping to realize the value of the enterprise. Therefore, mature enterprises are fully capable of improving their ESG performance in the context of less capital constraints and sufficient cash flow. At the same time, the operation of the company is gradually developing towards specialization and

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scale, and the transparency of the company's information is also gradually improving. When creditors provide loans, they may relax restrictions on the company, which in a sense also alleviates the company's underinvestment. Therefore, a good ESG evaluation performance for mature enterprises can effectively alleviate their underinvestment.

Based on the above analysis, this article proposes the following hypotheses:

H2: For mature enterprises, good ESG performance is more conducive to improving investment efficiency.

3.3 ESG performance and investment efficiency of enterprises in different industries

Compared to general industrial enterprises, heavy industrial enterprises generate more pollution, bear more environmental responsibilities, and also bear greater social regulatory pressure. Since 2006, the government has increased regulatory efforts on environmental protection issues in companies. In 2015, the new 'Environmental Protection Law' officially incorporated ecological red lines into the law, with the aim of better promoting the implementation of national environmental protection policies by listed companies in severely polluting industries in China. At the same time, in areas such as environmental issues, the ESG evaluation performance of heavily polluting industry enterprises will play a key role in their investment and financing behavior. This is because these enterprises need to undergo environmental evaluation and verification whether they engage in equity financing or bank loan financing. Good ESG performance can show the public the efforts that a company has made towards environmental protection and sustainable development. So, compared to other industries, stakeholders such as the public and investors are more concerned about whether companies in heavily polluting industries disclose social responsibility information. Han Jing et al. (2021) pointed out that for enterprises in non heavy polluting industries, information disclosure by enterprises in heavy polluting industry environments can better improve their investment efficiency. Therefore, for companies in heavily polluting industries, good ESG performance not only demonstrates the company's environmental protection measures and socially responsible behavior to investors, providing a benchmark for financial and risk assessment, but more importantly, can assist the company in obtaining financing through the approval of project environmental impact reports, alleviate financing difficulties caused by insufficient funds, and thus improve the company's investment efficiency[37-40].

Based on the above analysis, this article proposes the following hypotheses:

H3: Compared with other industries, the good ESG performance of enterprises in heavily polluting industries has a more significant impact on improving their investment efficiency.

4. Sample selection and research design

4.1 Sample selection and data sources

During this period, the sample data was screened and processed according to the following steps: (1) ST and * ST type companies were excluded; (2) Exclude financial and real estate companies (3) Exclude companies that have been listed for less than one year (4) Exclude samples of companies with asset liability ratios exceeding 1; (5) Excluding samples with missing variables with abnormal uncertainty, a total of 1015 companies and 5449 sample observations were obtained. In the calculation process, to prevent anomalies in the calculation results caused by data outliers, a 1% truncation method was used for all continuous variables.

4.2 Variable Definition

1) Dependent variable: investment efficiency

Currently, when studying investment efficiency in China, Richardson (2006) model and representative models such as Biddle (2009) and Chen (2011) are mostly used for measurement. However, in recent years, Ellili(2021), When Gao Yingjie et al. (2021) explored investment efficiency, they all chose Biddle (2009). Therefore, this article also chose the Biddle (2009) model for the main regression analysis. Later, in the robustness test, the Chen (2011) model was selected to measure the company's investment efficiency. The following is the Biddle (2009) model:

$$Inv_{i,t} = \beta_0 + B_1 SalesGrowth_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

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Inv refers to the total amount of funds paid by the enterprise for purchasing and constructing various assets, acquiring subsidiaries, and investing cash, minus the net amount of funds recovered from disposing of various assets, the net amount of funds received from disposing of subsidiaries, and the amount of funds obtained from recovering investments, compared with the total assets at the beginning of the current period; SalesGrowth is the growth rate of sales revenue, and the residual obtained from regression of model (2) is used to measure the level of inefficient investment (Misinv) of each enterprise. If the residual is greater than 0, it indicates overinvestment by the enterprise; If the remaining residual is less than 0, it indicates that the enterprise has insufficient investment (Underinv). If the absolute value of the residual is larger, it indicates that the company's inefficient investment level is higher and the investment efficiency is lower; On the contrary, the smaller the absolute value of the residual, the higher the investment efficiency of the company.

2) Core explanatory variable: ESG performance

In recent years, China has also established ESG evaluation systems including Huazhong Securities, Zhongzheng Securities, and Shangdao Ronglv. Due to the fact that the Shangrong Greenway rating only covers some components and is updated annually and semi annually, while the Huazhong ESG index is based on the international mainstream ESG index and is consistent with the actual situation of the Chinese stock market and the characteristics of various companies, and is updated quarterly, covering all listed companies, this article draws on the research of previous scholars such as He Qing (2023) and Hu Jie (2023) to assign values from 1-9 to Huazhong ESG's 9 ratings of C, CC, CCC, B, BB, BBB, A, AA, AAA each quarter, and takes the average of each quarter's rating to measure the company's annual ESG performance.

3) Control variable

Given that the financial condition and internal governance control level of a company are important factors affecting its investment efficiency, according to previous studies by Gao Yingjie (2021), Wang Rong (2022), and others, this study selected the company's size (LnSize), leverage level (Lev), profit margin level (Roa), growth (Growth), cash level (Cash), asset tangibility (Tang), and company age (LnAge) as financial control variables, with independent director ratio (Indep), equity concentration (Fhold), management compensation (LnSala), and property rights nature (Soe) as internal governance control variables, and added time fixed effects and industry fixed effects (μ_t). Effect (φ_{ind}).

4.3 Model building

To investigate the relationship between ESG performance of listed companies and investment efficiency, and to verify the above hypotheses, the following basic regression model was established with reference to Benlemlih and Bitar (2018):

$$Misinv_{i,t} = \delta_0 + \delta_1 ESG_{i.t} + \sum \delta_j \, Controls_{i,t} + \mu_t + \varphi_{ind} + \varepsilon_{i,t} \quad (2)$$

Table 1 Variable definition table

type of variable	Variable name	variable symbol	Variable description
explained variable	inefficient investment	Misinv	Model (1) regression residual absolute value
	Overinvestment	Overinv	Model (1) has a regression greater than 0 residual absolute value
	undercapitalize	Underinv	Model (1) returns the absolute value of the residual less than 0
explanatory variable	ESG grade	ESG	In each quarter, the value of Hua Zheng ESG rating is assigned from low to high as 1~9, and the annual average is taken
controlled variable	scale	LnSize	Take the logarithm of total assets
	Leverage level	Lev	Total liabilities to total assets
	Profitability	Roa	Net profit to total assets
	Growth	Growth	increase rate of business revenue
	Cash levels	Cash	Corporate monetary funds/total assets
	Tangible assets	Tang	(Total assets-net intangible assets)/total assets
	Company age	LnAge	Take logarithms of the number of years a company has been listed
	Management compensation	LnSala	Management compensation takes logarithms
	Proportion of independent directors	Indep	Number of independent directors/number of directors
	Shareholding concentration	Fhold	Shareholding ratio of the largest shareholder
	Shareholding ratio	Top10	Shareholding ratio of the top ten shareholders
	Nature of the business	Soe	The virtual variable is 1 for state-owned enterprises and 0 for the rest

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5. Empirical Results and Analysis

5.1 Descriptive statistics

Table 1 presents a descriptive statistical analysis of the empirical data obtained in this study. From the perspective of explained inefficient investment, the average inefficiency investment of the company is 0.047, with a median of 0.039, indicating a high level of inefficiency investment. The standard deviation is 0.041, with a minimum of 0.001 and a maximum of 0.264, and the maximum and minimum values are 0.041, 0.001, and 0.264, respectively. The significant difference between the maximum and minimum values suggests that the company has significant differences in inefficient investment. There are a total of 5449 samples, of which 1902 samples exhibit overinvestment and 3547 samples exhibit underinvestment. However, it is noteworthy that although the proportion of samples with insufficient investment is high, the degree of ineffective investment caused by overinvestment is also low. This indicates that most companies still face financing constraints and need more financial support to achieve optimal investment levels. Corporate investors also need to strengthen internal supervision and governance to safeguard their own rights and interests.

From the perspective of explanatory variables, the average ESG score is 4.057, with a median of 4, representing that the overall ESG performance of the company remains at around B level, with an average deviation of 0.945. Overall, the average level of listed companies is not significantly different

In terms of controlled factors, the average size of the company is 21.56, with a maximum of 25.31 and a minimum of 19.77. This shows that there are certain differences in operating scale among different enterprises. The average financial leverage is 0.348, with a minimum of 0.025 and a maximum of 0.887. This indicates that there are significant differences in debt levels among listed companies in the sample. The average return on total assets is 0.042, with a minimum of -0.381 and a maximum of 0.221. On the surface, the overall profit of listed companies is at a moderate level, and there are significant differences between different levels. In terms of company growth, the average of the sample companies is 0.243, the maximum value is 3.303, and the minimum is -0.701, indicating that the growth of most sample companies is at a low level, with only a few companies at a high level, but the overall difference is also significant.

Table 2 Descriptive Statistics of Main Variables

Variable	N	Mean	p50	SD	Min	Max
Misinv	5449	0.0470	0.0390	0.0410	0.00100	0.264
Overinv	1902	0.0630	0.0420	0.0610	0	0.309
Underinv	3547	0.0380	0.0380	0.0210	0.00100	0.117
ESG	5449	4.057	4	0.945	1	6.250
LnSize	5449	21.56	21.47	0.888	19.77	25.31
Lev	5449	0.348	0.332	0.177	0.0250	0.887
Roa	5449	0.0420	0.0450	0.0700	-0.381	0.221
Growth	5449	0.243	0.131	0.499	-0.701	3.303
Cash	5449	0.185	0.153	0.124	0.0150	0.780
Tang	5449	0.957	0.964	0.0350	0.721	1
LnAge	5449	2.804	2.833	0.312	1.609	3.526
LnSala	5449	15.23	15.21	0.615	13.57	17.18
Indep	5449	0.382	0.375	0.0540	0.333	0.571
Fhold	5449	0.329	0.309	0.130	0.0890	0.706
Top10	5449	0.625	0.639	0.118	0.298	0.912
Soe	5449	0.0720	0	0.258	0	1

5.2 Correlation and multicollinearity test

Table 2 shows the relationship matrix between the main variables, indicating a negative correlation between ESG performance and inefficient investment, including underinvestment and overinvestment. At the same time, the regression model includes multiple variables. In order to avoid multicollinearity among the variables, a multivariate collinearity analysis method was used to test the multicollinearity of the above factors. Usually, when the VIF value exceeds 10, it indicates that there is a group of collinear variables. As shown in Table 3, the VIF values are all small, with a maximum of 1.71, a minimum of 1.01, and a mean of 1.3, indicating that there is no severe multicollinearity among the variables and regression analysis can be performed.

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Table 4 Results of multicollinearity test

Variable	VIF	/VIF
LnSize	1.710	0.584
Lev	1.660	0.602
Top	1.610	0.620
Fhold	1.520	0.660
LnSala	1.440	0.693
Roa	1.330	0.751
Cash	1.240	0.807
ESG	1.100	0.906
LnAge	1.090	0.919
Soe	1.050	0.950
Tang	1.040	0.958
Indep	1.020	0.978
Growth	1.010	0.988
Mean	VIF	1.300

5.3 Regression Analysis

Table 5 ESG Performance and Inefficient Investment Regression Results

Variable	(1) Misinv	(2) Overinv	(3) Underinv
ESG	-0.001***	-0.003***	-0.002***
	(-3.218)	(-3.413)	(-4.916)
LnSize	0.000	-0.001	0.002**
	(0.120)	(-0.357)	(2.714)
Lev	0.022***	0.061***	-0.007***
	(4.610)	(4.518)	(-3.172)
Roa	0.033***	0.126***	-0.023**
	(7.238)	(5.749)	(-2.835)
Growth	0.001	0.002	0.000
	(0.447)	(0.612)	(0.742)
Cash	-0.014**	-0.023	-0.002
	(-2.722)	(-1.410)	(-1.227)
Tang	-0.011	-0.049	0.070***
	(-0.339)	(-0.610)	(3.846)
LnAge	-0.004*	-0.011**	0.005
	(-2.044)	(-2.448)	(1.687)
LnSala	-0.000	0.001	-0.003***
	(-0.055)	(0.482)	(-4.902)
Indep	0.037***	0.061**	0.012
	(3.452)	(2.662)	(1.543)
Fhold	0.003	-0.001	0.005*
	(0.407)	(-0.083)	(1.872)
Top10	0.006	0.009	-0.011*
	(1.592)	(0.691)	(-2.119)
Soe	-0.003***	-0.012**	0.004***
	(-3.823)	(-2.576)	(3.571)
_cons	0.058	0.130	-0.021
	(1.533)	(1.388)	(-0.998)
year	Yes	Yes	Yes
Ind	Yes	Yes	Yes
N	5449	1902	3547
r2	0.051	0.063	0.134
r2_a	0.045	0.046	0.126

The fundamental article conducted regression analysis on model (2), and the results show in Table 4 and Table 5 that the ESG evaluation performance of enterprises has an impact on their investment efficiency, underinvestment, and overinvestment. From Table 4 and Table 5, it can be seen that the company's ESG performance factor is -0.001, which is significant at the 1% level and shows a clear negative correlation with the company's inefficient investment. This means that the better the company's ESG performance, the less inefficient the company's investment will be, thus significantly improving the company's investment efficiency. in other words, Each level of ESG performance will result in a 2.13% reduction in non efficient investment (coefficient 0.001 as a percentage of the average non efficient investment of 0.047), therefore assuming H1 holds true, while also considering overinvestment and underinvestment. The ESG performance coefficients are -0.003 and -0.002, respectively, which are significant at the 1% level. This indicates that good ESG performance has a positive impact on improving the company's overinvestment and underinvestment, further supporting the null hypothesis H1. This indirectly reflects that companies with high-quality ESG information disclosure and good performance

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have better internal governance, stronger social responsibility, higher corporate culture and social ethical standards, less likelihood of management conducting revenue management and hiding negative news, higher accuracy of financial reporting, less information asymmetry, and improved communication and trust between management and investors, thereby attracting more investors and reducing agency costs for the company.

5.4 Heterogeneity analysis

1) ESG performance and investment efficiency of enterprises with different life cycles

Based on the company life cycle division method proposed by Wang Qinggang and Xu Xinyu (2016), this article divides the company's cash flow into four stages according to its life cycle: start-up, growth, maturity, and decline.

Table 6 Division of enterprise life cycle stages

	Net cash flow from operating activities	Investment activities net cash flow	Fundraising activities net cash flow
Early stage	-	-	+
growth period	+	-	+
maturation period	+	-	-
winter	-	+	+ perhaps-

According to the regression analysis results in Table 6 and Table 7, it can be found that ESG and investment efficiency are not statistically significant when the enterprise is in the start-up, growth, and decline stages. However, when the enterprise is in the mature stage, the ESG coefficient is -0.002 and is significantly negatively correlated at the 1% level. This data indicates that for mature enterprises with strong profitability and stable cash flow, good ESG performance is more conducive to improving investment efficiency. Verified hypothesis H2.

Table 7 Regression Results of ESG Performance and Inefficient Investment in Enterprises with Different Lifecycles

Variable	(1) Misinv (Start up period)	(2) Misinv (Growth period)	(3) Misinv (Maturity period)	(4) Misinv (Decline period 1)	(5) Misinv (Decline period 2)
ESG	-0.001	-0.000	-0.002***	-0.006	-0.003
	(-0.665)	(-0.565)	(-3.538)	(-1.703)	(-0.650)
LnSize	-0.001	-0.001	0.001	0.002	-0.005
	(-0.554)	(-0.432)	(1.330)	(0.851)	(-0.935)
Lev	0.021***	0.034***	-0.011**	-0.003	0.037
	(3.518)	(3.765)	(-2.279)	(-0.345)	(1.112)
Roa	0.044*	0.126***	0.013	-0.024	-0.061**
	(2.191)	(4.991)	(1.614)	(-1.838)	(-2.652)
Growth	0.003	-0.002	0.004**	-0.003***	0.003
	(0.865)	(-0.670)	(3.101)	(-3.738)	(0.907)
Cash	0.043	-0.041***	-0.012***	0.078**	0.000
	(1.754)	(-3.590)	(-5.347)	(2.481)	(0.026)
Tang	-0.057	0.014	0.005	-0.104	-0.042
	(-0.975)	(0.227)	(0.186)	(-0.784)	(-0.405)
LnAge	0.002	-0.013**	0.003	0.018***	0.006*
	(0.330)	(-2.964)	(0.831)	(3.805)	(2.084)
LnSala	0.004	-0.001	0.001*	0.003	-0.005
	(1.356)	(-0.291)	(2.163)	(0.549)	(-1.050)
Indep	0.038	0.071***	0.014	-0.061	-0.014
	(0.965)	(4.742)	(1.323)	(-1.575)	(-0.304)
Fhold	-0.017*	-0.006	0.014***	-0.040**	0.035
	(-1.958)	(-0.462)	(4.459)	(-2.895)	(0.902)
Top10	-0.003	0.041***	-0.014*	0.007	0.034
	(-0.211)	(3.107)	(-2.159)	(0.562)	(0.714)
Soe	-0.009*	-0.006	0.001	-0.002	-0.009
	(-2.151)	(-1.662)	(0.409)	(-0.312)	(-1.184)
_cons	0.063	0.084	0.018	0.089	0.205
	(1.236)	(1.545)	(0.640)	(0.840)	(0.919)
year	Yes	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes	Yes
N	684	1854	1927	101	119
r2	0.097	0.076	0.049	0.516	0.468
r2_a	0.051	0.059	0.033	0.327	0.278

2) ESG performance and investment efficiency of enterprises in different industries

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This article groups the sample data according to industry attributes, drawing on the approach of Pan Ailing et al. (2019). The coal mining and washing industry, oil and gas mining industry, black metal ore mining and selection industry, non-ferrous metal ore mining and selection industry, textile industry, leather, fur, feathers and their products and footwear industry, paper and paper products industry, petroleum processing, coking and nuclear fuel processing industry, chemical raw materials and chemical products, manufacturing industry, chemical fiber manufacturing industry, rubber and plastic products industry, non-metallic mineral products industry, black metal smelting and rolling processing industry, non-ferrous metal smelting and rolling processing industry, electricity and heat production and supply industry are classified as heavily polluting industries. The remaining sample data is divided into other industry sample groups for group regression analysis.

Table 8 Regression Results of Enterprises in Different Industries

Variable	(1) Misinv Other industries	(2) Misinv Heavy polluting industries
ESG	-0.001	-0.002**
	(-1.659)	(-5.528)
LnSize	0.001	-0.001
	(0.521)	(-1.065)
Lev	0.017**	0.040*
	(2.511)	(2.885)
Roa	0.032***	0.026
	(5.486)	(1.772)
Growth	0.001	-0.004
	(0.668)	(-1.101)
Cash	-0.018***	0.007
	(-3.510)	(0.881)
Tang	-0.003	-0.048
	(-0.082)	(-1.261)
LnAge	-0.002	-0.011
	(-0.845)	(-1.295)
LnSala	-0.001	0.003
	(-0.611)	(1.001)
Indep	0.031***	0.069**
	(3.529)	(4.281)
Fhold	0.003	-0.003
	(0.303)	(-0.403)
Top10	0.005	0.008
	(0.865)	(0.424)
Soe	-0.003***	-0.000
	(-3.157)	(-0.117)
_cons	0.046	0.094*
	(0.957)	(3.035)
year	Yes	Yes
Ind	Yes	Yes
N	4429	1020
r2	0.053	0.055
r2_a	0.046	0.031

As shown in Table 8, among other industry groups, The ESG factor coefficient is -0.001, which is not statistically significant. However, in the heavy pollution industry group, the ESG coefficient is -0.002, which is significantly negative at the 5% level. Therefore, it can be concluded that compared with other industries, good ESG performance of enterprises in heavy pollution industries can better improve their investment efficiency. Verified hypothesis H3. This indirectly illustrates the heavy pollution industry dominated by industrial and chemical industries. Due to strict environmental protection regulations by the government, and given that the China Securities Regulatory Commission has explicitly stated that key polluting units announced by the ecological environment must disclose relevant environmental information in accordance with the law, companies operating in high pollution industries have greater benefits in ESG management. Good ESG performance of enterprises has a greater impact on reducing inefficient investments.

5.5 Robust Test

In order to make the regression analysis results more reliable and test the robustness of the research conclusions, the following robustness tests were conducted: Given that there are multiple ways to measure the investment efficiency of the dependent variable, the method of replacing the dependent variable was chosen, and the Chen model was introduced to measure the inefficiency investment of

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enterprises. The following model (3) was constructed.

$$Inv_{i,t} = \beta_0 + \beta_1 NEG_{i,t-1} + \beta_2 SalesGrowth_{i,t-1} + \beta_3 NEG_{i,t-1} \times SalesGrowth_{i,t-1} + \varepsilon_{i,t} \quad (3)$$

Among them, $SalesGrowth_{i,t-1}$ is the revenue growth rate of enterprise i in the previous period, $NEG_{i,t-1}$ is a dummy variable. When $SalesGrowth_{i,t-1}$ is greater than 0, take 1, otherwise take 0, $NEG_{i,t-1} \times SalesGrowth_{i,t-1}$ is the interaction term between the two variables, Misinv_C is used to measure the level of inefficient investment in a company. Overinv_C represents overinvestment by the enterprise, while Underinv_C represents underinvestment by the enterprise. Therefore, the hypotheses in this article are reviewed, and the results are shown in Tables 9, 10, and 11.

The results in columns (1) to (3) of Table 9 show that after controlling for factors such as enterprise size, industry, and company characteristics, ESG is significantly negatively correlated with inefficient investment, overinvestment, and underinvestment, indicating that good ESG performance can reduce a company's level of inefficient investment (overinvestment and underinvestment), demonstrating the robustness of the main regression results. Assuming H1 is validated.

Table 9 The robustness test results of ESG on inefficient investments

Variable	(1) Misinv_C	(2) Overinv_C	(3) Underinv_C
ESG	-0.001**	-0.002***	-0.001***
	(-2.674)	(-4.210)	(-3.317)
LnSize	0.000	-0.002	0.002***
	(0.093)	(-0.567)	(3.206)
Lev	0.022***	0.062***	-0.009***
	(4.547)	(4.870)	(-4.609)
Roa	0.039***	0.134***	-0.017*
	(9.104)	(7.033)	(-1.841)
Growth	0.001	0.002	0.001
	(0.582)	(0.534)	(1.670)
Cash	-0.015**	-0.023	-0.004
	(-3.017)	(-1.660)	(-1.763)
Tang	-0.015	-0.070	0.072***
	(-0.452)	(-1.004)	(5.338)
LnAge	-0.004*	-0.011**	0.005*
	(-2.095)	(-2.288)	(2.168)
LnSala	0.000	0.001	-0.002***
	(0.096)	(0.440)	(-4.923)
Indep	0.033***	0.049**	0.010**
	(3.596)	(2.362)	(2.982)
Fhold	0.003	-0.002	0.006**
	(0.460)	(-0.226)	(2.598)
Top10	0.006	0.007	-0.010*
	(1.186)	(0.491)	(-1.947)
Soe	-0.004***	-0.011**	0.004**
	(-3.724)	(-2.917)	(2.869)
_cons	0.058	0.156**	-0.033**
	(1.702)	(2.356)	(-2.494)
year	Yes	Yes	Yes
Ind	Yes	Yes	Yes
N	5449	1944	3505
r2	0.051	0.068	0.111
r2_a	0.045	0.052	0.103

From Table 10, it can be seen that when a company is in the start-up, growth, and decline stages, the ESG performance evaluation and investment efficiency show no significant statistical significance. However, when the company is in the mature stage, the ESG coefficient is -0.002 and significantly negatively correlated at the 1% level. This data indicates that for mature companies, good ESG performance is more conducive to improving investment efficiency. Hypothesis H2 has been validated, and its regression results are robust.

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Table 10 Results of Stability Testing for Enterprises with Different Lifecycles

Variable	(1) Misinv_C (Start up period)	(2) Misinv_C (Growth period)	(3) Misinv_C (Maturity period)	(4) Misinv_C (Decline period 1)	(5) Misinv_C (Decline period 2)
ESG	-0.000	-0.001	-0.002***	-0.006	-0.001
	(-0.228)	(-0.735)	(-3.704)	(-1.535)	(-0.133)
LnSize	0.000	-0.001	0.000	-0.001	-0.007
	(0.074)	(-0.390)	(0.972)	(-0.262)	(-1.273)
Lev	0.017**	0.033***	-0.009*	-0.012	0.029
	(2.664)	(3.552)	(-2.003)	(-1.160)	(0.720)
Roa	0.038*	0.135***	0.018*	-0.008	-0.056***
	(1.962)	(5.721)	(2.134)	(-0.604)	(-3.899)
Growth	0.003	-0.002	0.004***	-0.006**	0.003
	(1.038)	(-0.474)	(4.574)	(-3.151)	(0.577)
Cash	0.042*	-0.045***	-0.012***	0.077**	-0.009
	(1.944)	(-4.014)	(-5.028)	(2.595)	(-0.697)
Tang	-0.071	0.015	-0.003	-0.116	-0.005
	(-1.088)	(0.263)	(-0.100)	(-1.772)	(-0.038)
LnAge	0.001	-0.013**	0.002	0.020***	0.004
	(0.162)	(-2.940)	(0.643)	(6.073)	(1.601)
LnSala	0.003	-0.001	0.001**	0.001	-0.000
	(1.122)	(-0.271)	(3.090)	(0.252)	(-0.050)
Indep	0.028	0.068***	0.012	-0.091**	-0.007
	(0.866)	(5.159)	(1.168)	(-3.012)	(-0.136)
Fhold	-0.018**	-0.006	0.014***	-0.011	0.045
	(-2.839)	(-0.467)	(4.646)	(-1.199)	(1.081)
Top10	-0.001	0.039***	-0.014**	-0.027**	0.027
	(-0.044)	(3.108)	(-2.207)	(-2.640)	(0.578)
Soe	-0.008	-0.006*	-0.000	-0.004	-0.008
	(-1.784)	(-1.810)	(-0.035)	(-1.043)	(-0.754)
_cons	0.056	0.083	0.029	0.145*	0.172
	(1.192)	(1.714)	(1.059)	(2.059)	(0.667)
year	Yes	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes	Yes
N	684	1854	1927	95	114
r2	0.089	0.077	0.050	0.518	0.374
r2_a	0.043	0.060	0.034	0.344	0.168

Table 11 Results of Stability Testing for Enterprises of Different Industry natures

Variable	(1) Misinv_C Other industries	(2) Misinv_C Heavy polluting industries
ESG	-0.000	-0.002***
	(-0.583)	(-8.704)
LnSize	0.001	-0.002
	(0.571)	(-2.063)
Lev	0.016**	0.042*
	(2.458)	(2.944)
Roa	0.039***	0.027
	(6.479)	(1.643)
Growth	0.001	-0.003
	(0.702)	(-0.976)
Cash	-0.019***	0.003
	(-3.506)	(0.375)
Tang	-0.009	-0.031
	(-0.284)	(-0.750)
LnAge	-0.002	-0.013
	(-0.765)	(-1.793)
LnSala	-0.001	0.004
	(-0.577)	(1.366)
Indep	0.029***	0.061**
	(3.921)	(3.449)
Fhold	0.003	-0.001
	(0.315)	(-0.181)
Top10	0.006	0.007
	(0.708)	(0.350)
Soe	-0.004**	-0.001
	(-2.841)	(-0.513)
_cons	0.049	0.075*
	(1.090)	(2.402)
year	Yes	Yes
Ind	Yes	Yes
N	4429	1020
r2	0.053	0.056
r2_a	0.046	0.032

According to the regression analysis, it can be seen that the sample data is divided into heavily

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polluting industries and other industries. The ESG coefficient of other industries is 0, with no significant statistical significance, while the ESG coefficient of heavily polluting industries is -0.002, which is significantly negative at the 1% level. Therefore, it can be concluded that compared to other industries, the good ESG evaluation performance of heavily polluting industry enterprises is more significant in improving their investment efficiency. Hypothesis H3 has been validated, demonstrating the robustness of its regression results.

5.6 Empirical conclusion

This paper analyzes the relevant data of China's A-share listed companies from 2011 to 2021, uses the Biddle model to measure the investment efficiency of the explained variable enterprises, constructs a two-way fixed effect regression model by fixing the industry and year, selects a total of 12 control variables based on the company's financial status and internal governance control level. Through descriptive, correlation and collinearity analysis, it can be seen that companies have a large difference in inefficient investment, the proportion of underinvested samples is high, and the degree of ineffective investment due to excessive investment is low, and the overall performance of enterprise ESG is in a medium state. There is a negative correlation between ESG evaluation performance and inefficient investment of enterprises, and there is no significant multicollinearity variable. Based on the above analysis, a conclusion can be drawn that good ESG evaluation performance can suppress the overinvestment and underinvestment of companies, and thus suppress the inefficient investment of companies. The better the ESG performance of a company, the less inefficient its investments will be, thus significantly improving its investment efficiency. Furthermore, through further heterogeneity analysis, it can be concluded that for enterprises with different lifecycles and industries, having higher profits and more stable capital flows in the mature stage, excellent ESG performance of enterprises will be more conducive to improving their investment efficiency. Compared with other industries, enterprises in heavily polluting industries with good ESG performance can better enhance their investment efficiency. Finally, in order to verify the correctness of this paper, we chose to replace the dependent variable to validate the correctness of this paper. We introduced the Chen model to measure the inefficiency investment of enterprises and proved that the regression results were robust.

6. Countermeasures and suggestions

6.1 Conclusion

Taking the relevant data of China's A-share listed enterprises from 2011 to 2021 as the research sample, this paper conducts statistical analysis, establishes feasible models, regression and other methods. First, it measures the investment efficiency of enterprises by selecting classic models. Secondly, on this basis, it verifies the relationship between ESG performance evaluation performance and the company's investment efficiency through experience. On this basis, it deeply studies the relationship between ESG performance evaluation performance and the company's investment efficiency from different life cycles and industry levels, and deeply analyzes the relevant influencing factors. Thus, the following conclusion can be drawn:

(1)The investment efficiency of listed companies in China still needs to be further improved, with more than half of the companies in a state of underinvestment. However, from the perspective of inefficient investment, the phenomenon of excessive investment by companies is more serious.

(2)The ESG evaluation performance of a company has a significant positive impact on its investment efficiency, which means that companies with good ESG evaluation performance can effectively reduce their inefficient investments and improve their investment efficiency. On the one hand, good ESG performance of enterprises can effectively reduce the degree of information asymmetry between internal and external factors, lower intermediary costs, and improve investment efficiency. On the other hand, a company's good ESG performance has stronger supervision and control over management, which can to some extent weaken agency conflicts, reduce management's selfish behavior, and always maintain caution in choosing high-quality projects that are beneficial to the company's development, thereby improving the company's investment efficiency.

(3)The impact of a company's ESG evaluation performance on its investment efficiency varies across different life cycles. Given that companies at different stages of development have different economic capabilities, mature enterprises have stable development, higher cash flow, less operating pressure, stable income, and stable inflow of funds and earnings. Therefore, a good ESG evaluation of a company can

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better suppress inefficient investment in mature enterprises, which is more conducive to improving the investment efficiency of the company. However, it has no significant impact on companies in the start-up, growth, and decline stages.

(4)The nature of the industry can affect the relationship between a company's ESG performance and investment efficiency. Although a company's ESG performance is negatively correlated with investment efficiency in other industries and heavily polluting industries, for other industries, a good ESG evaluation performance of companies in heavily polluting industries can better enhance their investment efficiency. Therefore, for companies in heavily polluting industries, it is even more important for them to improve their ESG performance, showcase their environmental protection measures and socially responsible behavior to investors, provide financial and risk assessment benchmarks for investors, enable projects to pass the approval of environmental impact reports, assist companies in obtaining financing, alleviate financing difficulties caused by insufficient funds, and thus improve the company's investment efficiency.

6.2 Suggestion

In terms of enterprises, companies should strengthen their environmental and social practices related to ESG, and improve their own ESG evaluation performance. Firstly, companies are the main targets for implementing ESG. Only when companies have sufficient understanding of the importance and necessity of ESG practices can they promote the in-depth development of ESG practices. Implementing ESG related concepts can not only benefit the long-term development of a company, but also enhance its economic benefits and promote the healthy development of the entire society, creating a favorable market environment for the company and providing feedback to it. From the above analysis, it can be seen that higher ESG evaluation performance can improve a company's investment efficiency. Therefore, whether in production, personnel training, or engineering investment, enterprises should strengthen the ESG concept, implement ESG construction in practice, and actively try in environmental governance, social and corporate management. At the same time, strengthening the disclosure of corporate reporting information allows stakeholders to have a more timely and accurate understanding of the company's ESG performance, thereby providing more support for the company's development. Ultimately, the company can establish connections with the government or other knowledgeable institutions, strengthen the promotion of ESG related concepts within the company, and provide suggestions on corporate governance, ESG issues, and development trends.

In terms of government management, by strengthening the guidance and supervision of government regulatory departments on ESG disclosure of listed companies, we can assist enterprises in practicing ESG. Given that China's current ESG disclosure system is still in its infancy and the relevant systems and regulations are not yet perfect, many problems have arisen in ESG practice, such as, The quality of ESG information disclosure is poor, with low disclosure rates for social and environmental indicators, and even no disclosure; The ESG information disclosure system is not perfect, and the standards for disclosure are also inconsistent, and so on. Therefore, the government should strengthen guidance for companies, increase punishment for companies, formulate reasonable legal documents for the problems of non disclosure of relevant information and low disclosure quality in current ESG practices, and encourage enterprises to actively disclose information related to ESG topics, so as to make the ESG information disclosure system more standardized. Furthermore, it indirectly helps the company make correct management decisions and improve its investment efficiency. In addition, the general public and media can also carry out public opinion supervision, work together with regulatory authorities, and provide correct guidance on the company's behavior in governance, environmental protection, and social responsibility.

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Table 3 Results of variable correlation test

Variable	Misinv	Oveinv	Underinv	ESG	Size	Lev	Roa	Growth	Cash	Tang	Age	Lnsala	Indep	Fhold	Top10	Soe
Misinv	1															
Overinv	0.999***	1														
Underinv	0.990***	.	1													
ESG	-0.00800	-0.0190	-0.085***	1												
LnSize	0.0200	0.038*	-0.0180	0.022*	1											
Lev	0.041***	0.099***	-0.053***	-0.134***	0.480***	1										
Roa	0.038***	0.064***	-0.071***	0.261***	-0.043***	-0.367***	1									
Growth	-0.0150	-0.00600	-0.0120	-0.025*	-0.038***	0.0140	-0.0210	1								
Cash	-0.052***	-0.060***	-0.0240	0.127***	-0.186***	-0.360***	0.228***	0.00800	1							
Tang	-0.048***	-0.045**	0.0230	0.034**	-0.053***	-0.056***	0.060***	0.0120	0.177***	1						
LnAge	-0.044***	-0.060***	0.0230	0.0190	0.126***	0.059***	-0.042***	-0.0210	-0.125***	-0.051***	1					
LnSala	-0.00600	0.0120	-0.093***	0.088***	0.491***	0.177***	0.135***	-0.027**	0.0120	0.028**	0.193***	1				
Indep	0.048***	0.055**	0.028*	0.049***	-0.056***	-0.00700	-0.00900	0.00900	0.00100	-0.0140	-0.00500	-0.089***	1			
Fhold	0.0220	0.0110	-0.00600	0.097***	-0.0130	-0.097***	0.152***	-0.026*	0.087***	-0.052***	-0.037***	-0.073***	0.066***	1		
Top10	0.0180	0.0150	-0.067***	0.172***	-0.078***	-0.184***	0.254***	-0.024*	0.187***	-0.00800	-0.141***	-0.027**	0.049***	0.566***	1	
Soe	-0.037***	-0.065***	0.0210	-0.00100	0.126***	0.100***	-0.062***	0.081***	-0.026*	-0.048***	0.096***	0.087***	-0.076***	0.070***	-0.00900	1