Business and Management Theory and Practice 2025, 2(1), 3132.
https://doi.org/10.54517/bmtp3132

Article

Research on the impact of ESG performance on the investment efficiency of enterprises

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CITATION

Zhang X, Li P. Research on the impact of ESG performance on the investment efficiency of enterprises. Business and Management Theory and Practice. 2025; 2(1): 3132. https://doi.org/10.54517/bmtp3132

ARTICLE INFO

Received: 6 December 2024
Accepted: 10 March 2025
Available online: 20 March 2025

Abstract: Since the twenty-first century, the severity of the climate and environmental issues has continued to climb; how to achieve harmony between man and nature has become an unavoidable issue in the post-industrial era; in order to scientifically assess the sustainable development potential of enterprises, relevant departments and organizations have jointly constructed an ESG evaluation system, making it a hot spot of market concern. The research on ESG and corporate investment efficiency is still insufficient and mostly focuses on the impact of single ESG factors. Based on this, this paper innovatively starts from the global ESG perspective. It takes the data of China's A-share listed companies from 2018 to 2022 as the research object, aiming at deeply exploring the actual impact of ESG performance on investment efficiency. At the same time, this paper analyzes the difference of this effect under the variables of corporate nature, industry characteristics, and market attention. The study results show that ESG performance significantly optimizes firms' investment efficiency, and the inhibition effect on overinvestment is particularly significant. With the deepening of the research, it can be found that the positive impact of ESG performance on investment efficiency in the more heavily polluted industries is smaller than that of lightly polluted enterprises. This paper provides recommendations for government departments, third-party ESG rating agencies, and relevant enterprises based on the above research results. These recommendations are expected to promote the improvement of the ESG rating system, improve investment efficiency, and help the administration establish a more comprehensive ESG ecosystem.

Keywords: ESG performance; investment efficiency; over-invested; heavily polluting enterprises

1. Introduction

As global climate change, environmental pollution, social inequality, and corporate governance issues intensify, investors, businesses, governments, and non-governmental organizations (NGOs), among others, have begun to pay attention to corporate performance in these areas. In response, ESG (Environmental, Social, and Governance) rating systems have been developed to assess a company's sustainability capabilities comprehensively. Since the 1990s, investors have comprehensively considered ESG status in their investment decisions. The United Nations Environment Program incorporated ESG indicators as early as 1992, and the Principles for Responsible Investment formalized the framework for integrating ESG factors into investment decisions in 2006. China has also released a sustainable development strategy since 1994 and issued a series of policy documents to support the development of the ESG system after 2018. Taking the ESG rating system of CSI as an example, there is still room for improvement in the ESG performance of China's enterprises, which mainly stems from the relative lag in introducing ESG concepts and the

immaturity of the capital market. Currently, China's economy is pursuing high-quality development, and the traditional model is unsustainable, so it is crucial to improve investment efficiency. However, the existing research focuses on ESG as a single factor and less on its synergistic effect; ESG can not only guide enterprises to create more comprehensive value but also improve risk prevention ability, which is of far-reaching significance to promote the improvement of enterprise investment efficiency.

ESG performance can affect the investment efficiency of enterprises in many ways, and the environmental and social responsibility dimensions of ESG performance have a significant positive impact on green technology innovation. For example, enterprises' investment in environmental governance and social responsibility can enhance their ability to innovate in green technology, thus improving investment efficiency [1]. On the other hand, improved ESG performance can attract more investors' and analysts' attention, making it easier for enterprises to obtain financing, thus improving investment efficiency. The combination of digital transformation and ESG can also help to reduce the cost of enterprise operations and improve productivity, further enhancing the investment efficiency of enterprises [2]. Therefore, it is meaningful to study the impact of ESG on corporate investment efficiency. This paper adds a new perspective to the study of ESG performance and corporate investment efficiency, analyzing in depth the role mechanism of ESG and its segmented responsibilities in investment efficiency, distinguishing it from studies focusing only on the comprehensive performance of ESG, and providing a more detailed and comprehensive analysis. It also deepens the understanding of the correlation between ESG and investment performance at the corporate level, enhances corporate awareness of ESG responsibilities, and provides insights for corporations to improve their investment performance. At the same time, it analyzes the impact of property rights structure and industry characteristics on ESG performance and investment efficiency. It provides a valuable reference for constructing ESG systems and helps create a good business environment and a harmonious society. This paper explores the association between corporate ESG performance and investment efficiency, traces the evolution of ESG concepts, analyzes its mechanism in combination with economic theories, and explores how risk-taking and corporate heterogeneity affect the relationship between the two. Empirical tests are conducted with a sample of Chinese A-share listed companies from 2018–2022 to enhance the reliability of the conclusions and put forward policy recommendations.

The research methodology of this paper includes a literature review, combing the literature on end-of-service bonus performance, corporate investment efficiency, and business risk to establish the starting point of the study; empirical analysis, establishing regression models, and verifying the hypotheses by using Stata to conduct correlation and regression analyses; and a comparative study, classifying samples based on factors such as property rights and industry characteristics, and conducting cross-comparison regression analyses, which will provide references to project management and policy formulation. This paper explores the impact mechanism of ESG performance on investment efficiency from an ESG global perspective, further enriching existing research. It was found that ESG performance positively impacts corporate investment efficiency, and the paper decomposes the three areas of responsibility: environmental, social, and corporate governance. The paper also

combines both overinvestment and underinvestment to analyze the problem.

2. Theoretical analysis and research hypotheses

2.1. ESG performance and financial performance

Domestic and international academics have not yet formed a consistent view when exploring the association between ESG performance and corporate financial performance. Some scholars believe that corporate ESG performance has a positive effect on financial performance [3], and Giuseppeina pointed out that this effect is not a simple linear relationship [4]. They found that under the impact of the New Crown Pneumonia epidemic, despite the general decline in corporate earnings, firms with good ESG performance could reduce the magnitude of earnings decline, showing the positive return of ESG activities for firms during unfavorable market periods. However, some scholars hold a different view on this, arguing that there is no significant relationship or negative correlation between ESG performance and financial performance. Atan et al. argue that a single or a combination of ESG factors does not significantly correlate with corporate profitability [5]. For example, a study by Duque Risales and Aguilera Caracuel revealed a negative association between corporate ESG scores and financial performance [6]. In China, most scholars have found that corporate environmental performance, social responsibility, and corporate governance are positively associated with financial performance through single-factor analysis. However, in recent years, with in-depth research on the comprehensive study of ESG factors, some scholars have found that ESG-related behaviors can significantly promote corporate performance. For example, the research of Li et al. [7] and others shows that ESG performance and the three factors it includes have a significant positive impact on corporate performance.

2.2. ESG performance and corporate value

The impact of ESG performance on enterprise value has been widely discussed by academics at home and abroad. Numerous scholars generally agree that excellent ESG performance not only positively affects corporate performance but also effectively promotes corporate value enhancement. However, studies point out that the impact of ESG performance is mainly focused on the value enhancement of high-concerned companies. Capelle Blancard and Petit's study reveals a different picture, as they find that positive ESG information in the market does not significantly affect company value. However, negative ESG events lead to a decline in company market capitalization [8]. Notably, the correlation between ESG performance and firm value did not show a significant correlation during the New Crown Pneumonia epidemic. To address this, domestic scholars have explored the impact of environmental performance, social responsibility performance, and corporate governance performance on enterprise value from three dimensions. The research results show that all three dimensions of performance have a significant positive impact on enterprise value. Subsequently, the study by Zhang and Zhao synthesized the ESG performance of enterprises and confirmed its significant positive effect on enterprise value [9]. In addition, the analysis of related mechanisms also shows that corporate ESG

responsibility helps to reduce financing costs, improve operational efficiency, and reduce financial risks, thus realizing the growth of corporate value. In addition to the above studies on the impact of ESG performance on enterprise value, the ESG performance of enterprises in the capital market likewise significantly impacts their financing ability, stock return, and audit fee level. According to scholars' in-depth explorations, the superiority of an enterprise's ESG performance helps reduce its financing cost, especially since enterprises with outstanding performance in environmental and corporate governance can obtain lower financing costs. At the same time, the performance of the ESG index in the stock market also positively impacts firms; specifically, firms with higher ESG ratings have a relatively lower risk of share price collapse, while firms with higher ESG risk face lower stock returns. In addition, there is a correlation between ESG performance and firms' audit fees. A study by 10. Burke et al. found that negative ESG events or reports may increase auditors' work pressure, leading to auditor resignation and higher audit fees [10]. On the contrary, Xiao et al.'s study reveals the positive role of ESG ratings in reducing audit fees, with higher ESG ratings of listed companies contributing to lower audit fees [11]. At the micro level of firms, improving ESG performance also brings positive changes. Specifically, firms' credit and market investment risks decrease with enhanced ESG performance, although the effect on bankruptcy risk is insignificant. In addition, some scholars have found that a firm's good ESG performance can promote its progress in green technological innovation, which provides strong support for sustainable development.

2.3. ESG and corporate investment efficiency

In recent years, the concept of ESG (environmental, social, and governance) has attracted much attention, but there is insufficient research on its relationship with corporate investment efficiency. It has been found that ESG disclosure enhances corporate investment efficiency. Also, the conclusions of the studies are quite different. Some scholars point out that ESG performance can improve corporate investment efficiency from the perspective of the stakeholder theory and asymmetry of information theory [12,13]. The fulfillment of corporate ESG responsibility reflects the good attitude of the enterprise toward being responsible to all stakeholders. On the one hand, good ESG performance encourages the enterprise to establish a long-term and stable relationship with all parties, reduces the cost of stakeholders to supervise the enterprise, establishes a long-term supervision mechanism, restrains the self-interested behaviors of management's high-risk bearing, and improves the enterprise's investment efficiency.

On the other hand, good ESG performance helps enterprises gain the approval of stakeholders, obtain resources at lower costs, and promote improving enterprise investment efficiency. Domestically, Gao et al. also confirmed that ESG performance positively impacts investment efficiency with various mechanisms, including reducing agency costs and alleviating financing constraints [14]. Wang, on the other hand, suggested that ESG performance indirectly reduces inefficient investment by attracting talent and institutional attention [15]. From the viewpoint of information asymmetry theory, the improvement of corporate ESG performance and external

disclosure of non-financial information such as ESG can bridge the information gap between parties, reduce the cost of acquiring resources, supervise management's misbehavior, reduce corporate risk-taking, and thus improve the efficiency of corporate investment. Furthermore, it has also been shown that supporting ESG performance from principal-agent theories is not conducive to improving the efficiency of corporate investment) [16,17], corporate managers may deviate from shareholders' interests out of self-interest maximization, and in the ESG context, managers may over-invest in ESG projects to enhance their personal reputations, even if these projects do not offer economically optimal returns on investment, while agency costs are also an important issue to consider, and improved ESG performance may require firms to invest more resources in environmental, social and governance activities, which increases firms' operating costs and has a negative impact on firms' investment efficiency, and both Petrovits [18] and Krüger [19] point out that management may, at the expense of shareholders' interests by foregoing investment projects with positive NPV, thus increasing responsible investment and obtaining higher ESG ratings.

However, the current research focuses on individual ESG factors and has not formed a comprehensive system. In the future, it is necessary to further expand and deepen our understanding of the relationship between ESG and corporate investment efficiency more comprehensively and provide effective guidance for enterprises. Regarding the environment and investment efficiency, domestic and international studies point out that corporate environmental information disclosure is related to investment efficiency. From an environmental perspective, good ESG performance can significantly improve firms' access to resources, and firms' environmentally friendly behaviors reduce negative impacts on the environment and attract investors and consumers who value sustainable development. This positive brand image helps firms gain easier access to green financing and government subsidies [20,21]. Zhang et al. found that environmental information disclosure can alleviate underinvestment, but the effect on overinvestment is not obvious [22]. Other studies explored the dimensions of environmental insurance, new environmental protection laws, and air pollution, all of which showed that environmental factors positively impact corporate investment efficiency, especially more significantly in specific types of enterprises [23]. These findings provide references for policymaking and business practices. Scholars have different views on the relationship between CSR and investment efficiency. Barnea and Rubin believe that over-investment in social responsibility programs reduces efficiency [16].

Meanwhile, Tian and Twite [24] argued that corporate disclosure of information related to social responsibility facilitates access to exogenous finance at a lower cost while reducing the occurrence of underinvestment. McWilliams and Siegel [25] also argued that socially responsible firms are more likely to have access to quality human resources, which helps them to improve the quality of their investment decisions. In addition, after the mandatory disclosure policy in 2008, the disclosure of social responsibility information by listed companies significantly affects investment efficiency, eases financing constraints and reduces inefficient investment.

3. Research design

Enhancing corporate investment efficiency requires curbing inefficient investment, including overinvestment and underinvestment. Overinvestment stems from the difference in objectives between shareholders and management, management's pursuit of personal interests, and the dominant position of major shareholders. In contrast, enterprises with good ESG performance can inhibit aggressive or self-interested investment and improve investment efficiency due to the supervision of stakeholders and the media. Underinvestment results in high financing costs due to information asymmetry, and firms abandon positive NPV projects. ESG performance, as non-financial information, reduces investor uncertainty and risk perception, reduces financing costs, eases financing pressure, and reduces underinvestment. Therefore, we propose Hypothesis H: Enhancing ESG performance helps improve enterprises' investment efficiency.

3.1. Sample selection and data sources

China's capital market has a unique institutional background and market structure, and there are significant differences between the Chinese market and international markets due to differences in market characteristics. The relationship between ESG performance and investment efficiency in the Chinese market is more likely to be affected by the nature of the enterprise and other factors, such as the importance of state-owned enterprises in the economy and the government's role in guiding the economy. Meanwhile, China has recently made significant progress in ESG information disclosure and rating systems. The quality and availability of data have been improving, and policy orientation has made enterprises pay more attention to ESG performance in their investment decisions. In addition, China's energy, power, oil and gas, and other traditional high-pollution industries are actively undergoing green transformation, which has a wider research space than the foreign market, and the international ESG research is concentrated in the developed countries in Europe and the United States, whose assessment system and research conclusions may not be fully adapted to the Chinese market environment, so it is necessary to select Chinese data to study the impact of ESG performance on the investment efficiency of Chinese enterprises.

The research sample of this paper focuses on China's A-share listed companies between 2018 and 2022. In order to ensure the accuracy and reliability of the research data, this paper takes the following data processing steps:(1) Listed companies in the financial industry are excluded because their operating characteristics and risk-taking patterns are significantly different from those of other industries; (2) listed companies in the ST and *ST categories are excluded; (3) listed companies that are missing in key data are also excluded; and (4) in addition, in order to control the industry effect of the number of samples within an industry, we exclude those samples that have only one firm within a specific industry. After completing the above screening, this paper further winsorizes all continuous variables by 1% up and down to shrink the tails and reduce the impact of extreme values on the study results. Finally, a dataset containing 21,080 valid samples is obtained. For data collection, corporate ESG rating data were obtained from the WIND database, while other relevant financial data were obtained

from the CSMAR database. The organization and analysis of data were mainly done using Excel software, while STATA17.0 and SPSS27.0 software were used for the empirical research part.

3.2. Explained variable

Various models exist that aim to specify and quantify a firm's investment efficiency. These models include cash flow sensitivity models based on information asymmetry and financial constraints, which are used to assess the extent to which the level of investment responds to investment opportunities, as well as models based on Tobin's theory and principal-agent theory, which focus on the analysis of investment sensitivity. In addition, there is an innovative approach to measuring firms' investment efficiency by constructing a model that can estimate the difference between actual and expected investment levels, i.e., the residual investment model. This approach provides a unique perspective to understand and evaluate the efficiency of a firm's investment decisions. In this paper, we use Richardson's expected investment model, the core assumption of which is that a company's new investment expenditures can be divided into two main parts: one part is the investment expenditures that are expected to be required based on the company's strategy and external environment, and the other part is the inefficient investments due to various reasons. When the value of investment calculated by the model is greater than 0, it reflects possible overinvestment by the company; conversely, if it is less than 0, it means that the company may be underinvesting.

$$Inv_{i,t} = \alpha + \alpha_1 Growth_{i,t-1} + \alpha_2 Lev_{i,t-1} + \alpha_3 Cash_{i,t-1} + \alpha_4 Age_{i,t-1} + \alpha_5 Size_{t-1} + \alpha_6 Ret_{i,t-1} + \alpha_7 Inv_{i,t-1} + \Sigma Year + \Sigma Industry + \varepsilon_{i,t} \quad (1)$$

The ratio of the firm's new investment in that year to its total assets at the beginning of the period, based on the firm's balance sheet and cash flow statement; Growth_(i, $t-1$) denotes the growth opportunity of the firm in year $t-1$, expressed as Tobin's Q value; Cash_(i, $t-1$) denotes the firm's cash flow position in year $t-1$, expressed as the ratio of money funds to total assets at the beginning of the year; Lev_(i, $t-1$) denotes the financial leverage of the firm in year $t-1$, expressed as the gearing ratio; Age_(i, $t-1$) denotes the age of the firm at year $t-1$, expressed as the natural logarithm of the number of years the firm has been on the market plus one; *Size*_($t-1$) denotes the size of the firm's assets in year $t-1$, expressed as the natural logarithm of the total assets; Ret_(i, $t-1$) denotes the firm's stock return in year $t-1$; Year and Industry denote year and industry dummy variables, respectively; and denote residuals from model estimation. The model's residuals can be obtained after performing the OLS regression analysis of the model (1). By calculating the absolute value of these residuals, a measure of the extent of the company's inefficient investment (InefficientInv) is obtained. Specifically, the size of this absolute value directly reflects the degree of InefficientInv, i.e., the larger the absolute value, the less efficient the company's investment is.

Further analysis shows that when the model residuals are greater than 0, this scenario implies that the firm has overinvested (OverInv). This paper uses the value of the residuals to quantify the extent of this overinvestment. On the contrary, when the model residuals are less than 0, the firm may face the underlying dilemma. The

article uses the absolute value of the residuals to accurately assess the extent of this underinvestment.

3.3. Explanatory variable

ESG rating is the core tool to measure the ESG performance of enterprises, and there are well-known organizations at home and abroad, such as MSCI and FTSE Russell. Although China's ESG rating industry started late, it is developing rapidly, with representative organizations such as Caixin Green Gold Institute, Shangdao Ronglv, and the CSI ESG Index. CSI ESG Index comprehensively evaluates the ESG performance of listed companies and is divided into nine levels covering all A-shares. 20 In the first quarter of 2012, CSI optimized the ESG rating system to improve data comparability, increase data sources, and optimize the algorithm of core indicators. In this paper, the CSI ESG rating is selected as the key explanatory variable.

3.4. Control variable

Table 1. Variable definition table.

Type of variable	Variable name	Definition of variables
Explained variables	Investment efficiency (InefficInv)	Model (1) Absolute value of regression residuals
	Overinvestment (Overlnv)	Regression residuals for model (1) greater than zero
	Underinvestment (UnderInv)	Model (1) Absolute value of regression residuals less than zero
Explanatory variables	ESG performance (ESG)	CSI ESG Rating
	Environmental performance (Env)	Rating of E in CSI ESG ratings
	Social responsibility performance (Soc)	Rating of S in CSI ESG ratings
	Corporate governance performance (Gov)	Rating of G in CSI ESG ratings
Control variables	Growth opportunities (Growth)	Tobin's Q
	Leverage level (Lev)	Gearing ratio
	Cash level (Cash)	Ratio of money funds to total assets
	Business size (Size)	Natural logarithm of year-end total assets
	Age of the business (Age)	Natural logarithm of the number of years a company has been listed plus one
	Profitability level (Roa)	Net interest margin on total assets, equal to the ratio of net profit to total assets
	Proportion of sole directors (Idsize)	Ratio of the number of independent directors to the total number of board members
	Shareholding concentration (Top)	Proportion of shares held by the largest shareholder
	Time fixed effects (Year)	Time dummy variable for 2009–2019
	Industry fixed effects (Industry)	Industry dummy variables based on the SEC's 2012 guidelines for industry classification

In exploring the investment efficiency of firms, this paper incorporates several control variables that lead to changes in investment efficiency, including growth opportunity (Growth), which measures the growth potential of a firm, leverage level (Lev), which reflects the capital structure of a firm, cash level (Cash), which represents the liquidity of a firm, size (Size), which characterizes the scale of a firm, and the age

of a firm (Age), which measures the maturity of a firm, Profit level (Roa), which reflects the profitability of the firm, the proportion of independent directors (Idsize), which represents the corporate governance structure, and the equity concentration (Top), which reflects the equity structure. Meanwhile, to eliminate the influence of time and industry factors, this paper also controls time-fixed effects (Year) and industry-fixed effects (Industry). For specific definitions of these variables, see **Table 1** for details.

3.5. Model setting

Based on the variables selected above, in order to test hypothesis H, this paper develops models (2)–(5), where model (2) is used to test the relationship between corporate ESG performance and investment efficiency, and models (3)–(5) test the relationship between corporate environmental, social responsibility, and corporate governance performance and investment efficiency, respectively.

$$IefficInv_{i,t} = \beta_0 + \beta_1 ESG_{i,t} + \beta_2 Growth_{i,t} + \beta_3 Lev_{i,t} + \beta_4 Cash_{i,t} + \beta_5 Size_{i,t} + \beta_6 Age_{i,t} + \beta_7 Roa_{i,t} + \beta_8 Idsize_{i,t} + \beta_9 Top_{i,t} + Year + Industry + \epsilon_{i,t} \quad (2)$$

$$IefficInv_{i,t} = \beta_0 + \beta_1 Env_{i,t} + \beta_2 Growth_{i,t} + \beta_3 Lev_{i,t} + \beta_4 Cash_{i,t} + \beta_5 Size_{i,t} + \beta_6 Age_{i,t} + \beta_7 Roa_{i,t} + \beta_8 Idsize_{i,t} + \beta_9 Top_{i,t} + Year + Industry + \epsilon_{i,t} \quad (3)$$

$$IefficInv_{i,t} = \beta_0 + \beta_1 Soc_{i,t} + \beta_2 Growth_{i,t} + \beta_3 Lev_{i,t} + \beta_4 Cash_{i,t} + \beta_5 Size_{i,t} + \beta_6 Age_{i,t} + \beta_7 Roa_{i,t} + \beta_8 Idsize_{i,t} + \beta_9 Top_{i,t} + Year + Industry + \epsilon_{i,t} \quad (4)$$

$$IefficInv_{i,t} = \beta_0 + \beta_1 Gov_{i,t} + \beta_2 Growth_{i,t} + \beta_3 Lev_{i,t} + \beta_4 Cash_{i,t} + \beta_5 Size_{i,t} + \beta_6 Age_{i,t} + \beta_7 Roa_{i,t} + \beta_8 Idsize_{i,t} + \beta_9 Top_{i,t} + Year + Industry + \epsilon_{i,t} \quad (5)$$

where InefficInv_(*i*, *t*) denotes corporate investment efficiency, ESG_(*i*, *t*), Env_(*i*, *t)*, Soc_(*i*, *t*), and Gov_(*i*, *t*) denote corporate ESG, environmental, social responsibility, and corporate governance performances, respectively, and ϵ_(*i*, *t*) is the residual term. If β_1 in the model (2) is significantly negative, hypothesis H holds, i.e., corporate ESG performance can improve corporate investment efficiency.

4. Empirical results and analyses

4.1. Descriptive statistics of main variables

Table 2 demonstrates the descriptive statistics of the main variables. Among them, the mean value of inefficient investment is 0.0571, and the standard deviation is 0.0628, ranging from 0.00068 to 0.33163, indicating significant differences in investment efficiency among Chinese A-share listed companies. Notably, 6410 companies in the sample show overinvestment, accounting for 37.5%. In comparison, there are 10,692 underinvestment companies, accounting for a whopping 62.5% of the total, highlighting the prevalence of underinvestment problems. In terms of ESG ratings, the mean value of the sample companies is 73.607 with a standard deviation of 4.876, showing that the ESG ratings of most companies are located at level B or below, indicating a low overall ESG level. Further analysis shows that the lowest mean value of Environmental Rating (Env) is 61.803, which corresponds to the CCC level,

indicating that the overall performance of enterprises regarding environmental responsibility is poor. Comparatively, the Social Responsibility Rating (Soc) has a mean value of 76.8191, reaching the BBB level. In contrast, the Corporate Governance Rating (Gov) has the highest mean value of 78.326, in the range of B to BB, indicating that the sample firms perform better in corporate governance.

Table 2. Descriptive statistics of variables.

	N	Minimum	Maximum	Mean	Standard deviation	Variance
InefficInv	17,102	0.00068	0.332	0.057	0.063	0.004
Overlnv	17,102	0	0.537	0.001	0.012	0.000
UnderInv	17,102	0	0.176	0.000	0.005	0.000
ESG	17,102	59.17	84.787	73.607	4.876	23.776
Env	17,102	46.26	81.696	61.803	7.140	50.973
Soc	17,102	52.370	95.120	76.820	7.799	60.823
Gov	17,102	54.796	90.170	78.326	6.470	41.866
Size	17,102	20.044	27.545	22.484	1.461	2.136
ROA	17,102	−0.250	0.234	0.038	0.070	0.005
Lev	17,102	0.057	0.919	0.428	0.204	0.041
Growth	17,102	0.819	8.089	1.917	1.243	1.545
Cash	17,102	−0.144	0.251	0.052	0.066	0.004
Idsize	17,102	33.33	57.140	37.949	5.375	28.896
Age	17,102	0.693	3.367	2.188	0.820	0.672
Top	17,102	8.235	73.562	32.855	14.658	214.844

4.2. Correlation analysis of main variables

Table 3 demonstrates the Pearson correlation coefficients between the main variables. The data in the table shows that firms' ESG performance (ESG) and inefficient investment (Ineficlnv) show a significant negative correlation at the 1% significance level. This finding preliminarily verifies hypothesis H, which states that the better a firm's ESG performance, the lower its level of inefficient investment, which in turn indicates a more efficient investment, without considering other influencing factors. In addition, we observe a significant correlation between most of the control variables and Ineficlnv. Meanwhile, the correlation coefficients between most of the variables within the same model are less than 0.5, which suggests that there is no serious problem of multicollinearity between the variables, thus ensuring the robustness of the model.

Table 3. Correlation coefficient table.

	InefficInv	**OverInv**	**UnderInv**	**ESG**	**Env**	**Soc**	**Gov**	**Size**	**Lev**	**ROA**	**Growth**	**Cash**	**Age**	**Idsize**	**Top**
InefficInv	1	0.087**	0.017*	−0.027**	−0.066**	−0.001*	−0.094**	−0.175**	−0.223**	0.178**	0.151**	0.052**	−0.278**	0.020**	0.016*
OverInv	0.087**	1	−0.006	−0.020**	−0.015	−0.023**	−0.008	0.058**	0.048**	−0.017*	−0.028**	−0.005	0.131**	−0.006	0.016*
UnderInv	0.017*	−0.006	1	0.006	0.004	0.015	−0.004	0.047**	0.017*	0	−0.018*	−0.018*	0.069**	−0.015	−0.005
ESG	0.027**	−0.020**	0.006	1	0.563**	0.655**	0.702**	0.233**	−0.053**	0.209**	−0.041**	0.082**	−0.102**	0.067**	0.105**
Env	−0.066**	−0.015	0.004	0.563**	1	0.315**	0.118**	0.302**	0.160**	0.013	−0.112**	0.029**	0.088**	0.001	0.016*
Soc	−0.001*	−0.023**	0.015	0.655**	0.315**	1	0.113**	0.149**	0.080**	0.105**	−0.031**	0.019*	−0.083**	0.004	−0.020**
Gov	0.094**	−0.008	−0.004	0.702**	0.118**	0.113**	1	0.068**	−0.254**	0.285**	0.032**	0.116**	−0.163**	0.103**	0.179**
Size	−0.175**	0.058**	0.047**	0.233**	0.302**	0.149**	0.068**	1	0.545**	0.017*	−0.318**	0.048**	0.392**	−0.009	0.147**
Lev	−0.223**	0.048**	0.017*	−0.053**	0.160**	0.080**	−0.254**	0.545**	1	−0.339**	−0.273**	−0.174**	0.289**	−0.001	0.001
ROA	0.178**	−0.017*	0	0.209**	0.013	0.105**	0.285**	0.017*	−0.339**	1	0.234**	0.461**	−0.181**	−0.01	0.160**
Growth	0.151**	−0.028**	−0.018*	−0.041**	−0.112**	−0.031**	0.032**	−0.318**	−0.273**	0.234**	1	0.152**	−0.112**	0.034**	−0.097**
Cash	0.052**	−0.005	−0.018*	0.082**	0.029**	0.019*	0.116**	0.048**	−0.174**	0.461**	0.152**	1	−0.026**	0.002	0.112**
Age	−0.278**	0.131**	0.069**	−0.102**	0.088**	−0.083**	−0.163**	0.392**	0.289**	−0.181**	−0.112**	−0.026**	1	−0.022**	−0.057**
Idsize	0.020**	−0.006	−0.015	0.067**	0.001	0.004	0.103**	−0.009	−0.001	−0.01	0.034**	0.002	−0.022**	1	0.044**
Top	0.016*	0.016*	−0.005	0.105**	0.016*	−0.020**	0.179**	0.147**	0.001	0.160**	−0.097**	0.112**	−0.057**	0.044**	1

Note: Pearson correlation coefficients are reported in the upper triangle, $^{**}p < 0.01$, $^{*}p < 0.05$.

4.3. Regression analysis of ESG performance and investment efficiency

To confirm Hypothesis H, this paper conducted a regression analysis of corporate ESG performance and investment efficiency using firm-level clustered robust standard errors. **Table 4** details the regression results of ESG performance and inefficient investment (InefficInv) to test the correlation between corporate ESG performance and investment efficiency.

Table 4. Regression results of ESG performance and inefficient investment.

	(1) InefficInv	**(2) InefficInv**	**(3) InefficInv**	**(4) InefficInv**
ESG	−0.017***			
	(−2.951)			
Env		−0.004***		
		(−2.878)		
Soc			−0.025**	
			(−2.242)	
Gov				−0.015***
				(−2.580)
Growth	0.073***	0.072***	0.073***	0.073***
	(4.482)	(4.435)	(4.504)	(4.484)
Lev	−0.1***	−0.097***	−0.097***	−0.093***
	(−5.404)	(−5.282)	(−5.262)	(−4.958)
Cash	0.012	0.013	0.013	0.014
	(0.772)	(0.849)	(0.812)	(0.889)
Size	−0.036*	−0.036**	−0.04**	−0.046***
	(−1.985)	(−2.023)	(−2.299)	(−2.56)
Age	−0.171***	−0.169***	−0.17***	−0.169***
	(−12.519)	(−12.432)	(−12.491)	(−12.411)
Roa	0.106***	0.104***	0.105***	0.102***
	(5.841)	(5.771)	(5.792)	(5.573)
Idsize	0.015	0.014	0.014	0.011
	(1.158)	(1.057)	(1.052)	(0.858)
Top	−0.023	−0.024	−0.024	−0.025
	(−1.7)	(−1.751)	(−1.775)	(−1.857)
_cons	0.129***	0.126***	0.126***	0.116***
	(10.726)	(11.164)	(10.910)	(9.708)
Time effect	Yes	Yes	Yes	Yes
industry effect	Yes	Yes	Yes	Yes
N	17,102	17,102	17,102	17,102
*r*2	0.114	0.114	0.114	0.113
*r*2_*a*	0.113	0.113	0.113	0.113

Note: *$p < 0.01$, **$p < 0.05$, ***$p < 0.1$.

Table 5. Regression results of ESG performance and OverInv.

	(1) OverInv	(2) OverInv	(3) OverInv	(4) OverInv
ESG	−0.117***			
	(−2.732)			
Env		−0.141***		
		(−2.692)		
Soc			−0.075*	
			(−1.998)	
Gov				−0.013**
				−2.243
Growth	0.127**	0.132***	0.122**	0.118**
	−2.264	−2.352	−2.16	−2.088
Lev	−0.117**	−0.117**	−0.095***	−0.09
	(−2.010)	(−2.022)	(−2.648)	(−1.509)
Cash	0.075***	0.078***	0.08***	0.082***
	−3.494	−3.57	−3.591	−3.631
Size	0.184***	0.198***	0.14**	0.11
	−2.497	−2.72	−2.054	−1.592
Age	0.051	0.056	0.057	0.05
	−1.048	−1.155	−1.176	−1.026
Roa	0.073	0.057	0.074	0.063
	−1.334	−1.054	−1.348	−1.144
Idsize	0.003	0.004	0.001	0.003
	−0.057	−0.093	−0.012	−0.055
Top	0.006**	−0.004	0.002**	0.001
	−2.132	(−1.080)	−2.036	(−0.005)
cons	0.399	0.158	0.25	0.204
	(−0.845)	(−1.414)	(−1.153)	(−1.273)
Time effect	Yes	Yes	Yes	Yes
industry effect	Yes	Yes	Yes	Yes
N	6410	6410	6410	6410
*r*2	0.046	0.052	0.041	0.036
*r*2_*a*	0.026	0.032	0.021	0.016

Note: *$p < 0.01$, **$p < 0.05$. ***$p < 0.1$.

Table 4 demonstrates the regression results for the full sample, in which the regression coefficient between ESG and corporate investment efficiency is significantly negative at the 1% level, which supports Hypothesis H. That is, corporate ESG performance significantly reduces inefficient investment and thus enhances investment efficiency. In order to deeply explore the impact of each ESG sub-responsibility on investment efficiency, this paper further analyzes the effects of environment (Env) and corporate governance (Gov). The results show that the regression coefficients of these ESG sub-responsibilities are all significant at the 1%

level, and the regression coefficient of social responsibility (Soc) is significant at the 5% level. Social responsibility positively affects investment efficiency, while environmental and corporate governance responsibility shows a negative effect, contributing to investment efficiency. In this paper, the regression analysis of corporate ESG performance and overinvestment (OverInv) was conducted, and the regression results of ESG performance and overinvestment (OverInv) are detailed in **Table 5**.

The regression results in **Table 5** for the overinvestment and underinvestment samples show that the regression coefficients for both ESG performance and environmental responsibility (Env) are significant at the 1% level, and the regression coefficient for corporate governance (Gov) is significant at the 5% level. The regression results show that the coefficients of the independent variables are all negative, so ESG sub-responsibility can effectively inhibit corporate overinvestment. In this paper, we have conducted a regression analysis of firms' ESG performance with and without underinvestment (UnderInv), and **Table 5** details the results of the regression of ESG performance with overinvestment (UnderInv).

Table 6 shows that ESG performance hurts investment efficiency when underinvestment occurs, i.e., it inhibits underinvestment. Environmental and corporate governance performance inhibits overinvestment, and social responsibility and corporate governance performance inhibits underinvestment. ESG performance enhances regulation, reduces self-interested investment, reduces information risk, provides low-cost resources, alleviates resource bottleneck pressure, optimizes resource allocation, inhibits overinvestment, and enhances corporate investment efficiency.

Table 6. Regression results of ESG performance and underinvestment.

PanelC	**(1) UnderInv**	**(2) UnderInv**	**(3) UnderInv**	**(4) UnderInv**
ESG	−0.03**			
	(2.326)			
Env		−0.034		
		(−0.377)		
Soc			−0.19**	
			(2.4)	
Gov				−0.116**
				(−2.345)
Growth	0.166	0.166	0.163***	0.165
	(1.911)	(1.908)	(−3.321)	(1.903)
Lev	−0.378***	−0.399***	−0.343	−0.431***
	(−3.436)	(−3.745)	(−1.527)	(−4.013)
Cash	−0.14	−0.147	−0.129	−0.149
	(−1.615)	(−1.704)	(0.929)	(−1.743)
Size	0.143**	0.186***	0.105**	0.193***
	(2.139)	(2.422)	(−2.397)	(2.689)
Age	−0.115	−0.111	−0.115	−0.135
	(−1.371)	(−1.293)	(0.562)	(−1.591)

Table 6. (*Continued*).

PanelC	(1) UnderInv	(2) UnderInv	(3) UnderInv	(4) UnderInv
Roa	0.057	0.054	0.05	0.074
	(0.630)	(0.595)	(−0.490)	(0.820)
Idsize	−0.01	−0.012	−0.039	0.02
	(−0.129)	(−0.153)	(−1.935)	(0.240)
Top	−0.125	−0.117	−0.151***	−0.097
	(−1.548)	(−1.494)	(2.400)	(−1.217)
_cons	0.725	0.710	0.910	0.366
	(0.353)	(0.372)	(0.113)	(0.908)
Time effect	Yes	Yes	Yes	Yes
industry effect	Yes	Yes	Yes	Yes
N	10,692	10,692	10,692	10,692
*r*2	0.187	0.187	0.218	0.197
*r*2_*a*	0.135	0.136	0.169	0.146

Note: *$p < 0.01$, **$p < 0.05$. ***$p < 0.1$.

4.4. Further grouping test

The nature of the industry is that heavily polluting firms face the dual pressures of environmental costs and social expectations. Although ESG performance positively impacts economic performance, how ESG affects the investment efficiency of heavily polluting firms has not been deeply explored. Environmental policy pressure pushes firms to improve their ESG performance, but the additional costs and uncertainties associated with industrial transformation and upgrading make management's investment decisions more cautious. The public has high expectations for the ESG performance of heavily polluting firms but is also cautious. Based on the above analysis, this paper puts forward the hypothesis that among heavy polluters, the direct impact of ESG performance on investment efficiency may be relatively weak due to the special environmental pressures they face, the costs of transformation, and the complex expectations of the community on their ESG performance. To verify the above hypotheses, this paper subdivided the sample into two groups of heavy and non-heavy polluters based on industry characteristics and conducted regression analysis. Specifically, this paper defines 15 industries, such as coal, petrochemical, textile, and electric power, as heavy polluting industries according to the former Ministry of Environmental Protection's "List of Industry Classification and Management for Environmental Verification of Listed Companies." The relevant regression results are detailed in **Table 7**.

Table 7. Industry nature grouping regression results.

	Inefficlnv		**Overlnv**		**Underlnv**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Heavily polluting industries	**Non-heavily polluting industries**	**Heavily polluting industries**	**Non-heavily polluting industries**	**Heavily polluting industries**	**Non-heavily polluting industries**
ESG	−0.007***	−0.015***	−0.009**	−0.025**	−0.008**	−0.031***
	(−2.973)	(−2.679)	(−2.374)	(−2.023)	(−2.198)	(2.862)
Growth	0.109***	0.069***	−0.003	−0.018	−0.008	−0.005
	(6.023)	(7.703)	(−0.171)	(−1.023)	(−0.424)	(−0.526)
Lev	−0.065***	−0.118***	0.007	0.012*	0.007	−0.027
	(−3.065)	(−10.888)	(0.328)	(−1.932)	(0.298)	(−2.316)
Cash	−0.068***	−0.023***	−0.024	0.005	0.035	−0.036***
	(−3.542)	(−2.573)	(−1.181)	(1.067)	(1.726)	(−3.736)
Size	0.029	−0.005	0.052**	−0.018	0.04	0.032***
	(1.189)	(−0.405)	(2.024)	(0.483)	(1.565)	(2.65)
Age	−0.221***	−0.224***	0.071***	0.145	0.052***	0.065***
	(−24.629)	(−24.629)	(3.516)	(−1.500)	(2.586)	(6.707)
Roa	0.122	0.095***	0.009	0.018***	−0.004	0.021*
	(5.721)	(9.374)	(0.397)	(15.227)	(−0.164)	(1.929)
ldsize	0.025	0.014	0.002	−0.003	−0.021	−0.01
	(1.717)	(1.717)	(0.110)	(1.671)	(−1.239)	(−1.218)
Top	−0.005	−0.002	0.035*	0.022	−0.045***	0.002
	(−0.276)	(−0.189)	(1.948)	(−0.356)	(−2.474)	(0.218)
_cons	(−1.582)	(−0.427)	(−1.88)	(0.090)	(0.336)	(2.385)
	0.114	0.669	0.851	0.929	0.737	0.017**
Time effect	Yes	Yes	Yes	Yes	Yes	Yes
industry effect	Yes	Yes	Yes	Yes	Yes	Yes
N	4215	12,887	1693	4717	2522	8170
*r*2	0.331	0.342	0.146	0.124	0.111	0.111
*r*2_*a*	0.110	0.117	0.021	0.015	0.012	0.008

Note: *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Column (1) presents an overview of the total sample, while column (2) reports in detail the results of the regression analysis for the full sample. The regression results show that the sample of firms in heavy polluting industries is 4215 or 24.65% of the total sample, while the sample of firms in non-heavy polluting industries is 12,887 or 75.35%. Columns (1) and (2) show the effect of ESG performance on inefficient investment for firms in heavily polluting and non-heavily polluting industries, respectively. The regression coefficients for ESG are −0.007 for heavily polluting industries and −0.015 for non-heavily polluting industries. Both coefficients are negative, suggesting that an increase in ESG performance helps to reduce inefficient investment and that this effect is more pronounced in the non-heavily polluting industries columns, respectively. Regression analyses were conducted for the

overinvestment and underinvestment samples. The results show that ESG performance significantly negatively impacts overinvestment and underinvestment in both heavily polluting and non-heavily polluting firms. Columns (3) and (4) show the effect of ESG performance on overinvestment for firms in heavily polluting and non-heavily polluting industries, respectively. The regression coefficients for ESG are −0.009 for heavily polluting industries and −0.025 for non-heavily polluting industries. The two coefficients are negative, suggesting that improved ESG performance helps to discourage overinvestment and that this effect is more pronounced in non-heavily polluting industries. Columns (5) and (6) show the effect of ESG performance on underinvestment for firms in heavily polluting and non-heavily polluting industries, respectively. The regression coefficients for ESG are −0.008 for heavily polluting industries and −0.031 for non-heavily polluting industries, suggesting that improved ESG performance helps dampen underinvestment, which is more pronounced in non-heavily polluting industries. Overall, the improvement of ESG performance has a significant inhibitory effect on the inefficient investment and over-investment of enterprises in both heavily polluted and non-heavily polluted industries, and this effect is more significant in non-heavily polluted industries. In addition, other control variables also impact enterprises' investment behavior, and the specific influence mechanism and effect need further research and analysis.

4.5. Robustness test

Considering the possible endogeneity problem in the benchmark regression, this paper uses the instrumental variable method to conduct robustness tests. Since the ESG performance of enterprises will be affected by the ESG performance of other enterprises in the region where they are located, there is no direct relationship between the ESG performance of other enterprises and the investment efficiency of this enterprise. This paper refers to the method of Wang et al. [26] and adopts the average value of ESG performance of other listed companies in the city where each enterprise is located in the same year (ESG_IV) as the main instrumental variable, and conducts a regression by using the two-stage least squares (2SLS) method, i.e., the first-stage regression examines the effect of the average value of ESG performance of enterprises in the same region in the same year on the enterprise's ESG performance, while the second-stage examination examines the effect of the enterprise's ESG performance on the investment efficiency and the specific results are reported in **Table 8**.

Table 8. Instrumental variable regression results.

	(1) ESG	**(2) InefficInv**
ESG_IV	0.165*** (5.723)	
ESG		−0.023*** (−3.306)
Growth	−0.027*** (−3.003)	0.002*** (4.404)
Lev	−0.742*** (−9.779)	−0.001 (−0.098)

Table 8. (*Continued*).

	(1) ESG	(2) InefficInv
Cash	−0.024 (−0.368)	0.048*** (11.524)
Size	0.272*** (20.826)	0.006*** (3.206)
Age	−0.159*** (−7.601)	−0.014*** (−9.487)
Roa	2.146*** (11.106)	0.056*** (3.186)
Idsize	1.421*** (7.176)	0.056*** (3.186)
Top	−0.049 (−0.563)	−0.009*** (−2.578)
Constant	−2.644*** (−8.475)	
Time effect	YES	YES
Industry effect	YES	YES
N	5168	5168
*r*2	0.199	0.0468
*r*2_*a*	0.197	0.0489
Kleibergen-Paap rk LM		33.352 (0.000)
Cragg-Donald Wald F		113.03 (16.38)
Kleibergen-Paap rk Wald F		32.76 (16.38)

Note: *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Column (1) reports the first-stage regression results; the regression coefficient of ESG and the instrumental variable ESG_IV is 0.165 and significant at the 1% level, indicating that the ESG performance of other firms within the same region in the same year has a significant positive impact on the ESG performance of the firm. Column (2) reports the results of the second stage regression, and the regression coefficient of ESG is −0.016 when investment efficiency is the explanatory variable and is significant at the 5% level, proving the robustness of the previous findings. In order to examine the validity of instrumental variables, this paper also carried out the non-identifiable test, weak instrumental variables test, and endogeneity test. The *p*-value of the Kleibergen-Paap rk LM is 0.000, indicating that the original hypothesis of 'insufficient identification of instrumental variables' is significantly rejected at 1 percent and passes the non-identifiable test. In the weak instrumental variables test, the F value of the first stage regression is 32.76, and both Cragg-Donald Wald F and Kleibergen-Paap rk Wald F are greater than the critical value of 16.38 of the 10% bias in the Stock-Yogo weak ID test critical values, which passes the weak instrumental variables test. The *p*-value of the endogeneity test statistic is 0.0029, which means that ESG is endogenous at the 1% significance level.

In the previous regression analysis, we assigned values to the CSI ESG ratings and derived the main explanatory variables for ESG performance accordingly.

However, to deal with the possible controversy arising from the single-agency rating methodology, we consider the Bloomberg ESG ratings as a proxy for the core explanatory variables in the robustness testing session. Bloomberg ESG ratings use a percentage scoring mechanism and quantify firms' ESG performance (ESG_Bloomberg) and segmented responsibility performance, including environmental performance (Env_Bloomberg), through the natural logarithm of the score plus one. Such an approach aims to provide a more comprehensive and balanced assessment perspective.

Table 9. Reports the regression results.

	(1) InefficInv	**(2) InefficInv**	**(3) InefficInv**	**(4) InefficInv**
ESG_Bloomberg	−0.026***			
	(−2.693)			
Env_Bloomberg		−0.033***		
		(2.626)		
Soc_Bloomberg			−0.002**	
			(2.122)	
Gov_Bloomberg				−0.014***
				(−2.988)
Growth	0.07***	0.07***	0.073***	0.074***
	(4.482)	(4.305)	(4.453)	(4.532)
Lev	−0.095***	−0.094***	−0.098***	−0.098***
	(−5.404)	(−5.057)	(−5.293)	(−5.329)
Cash	0.012	0.011	0.013	0.013
	(0.772)	(0.695)	(0.821)	(0.819)
Size	−0.056*	−0.058***	−0.042**	−0.037**
	(−1.985)	(−3.045)	(−2.197)	(−2.015)
Age	−0.169***	−0.17***	−0.17***	−0.171***
	(−12.519)	(−12.489)	(−12.464)	(−12.507)
Roa	0.103***	0.103***	0.104***	0.104***
	(5.841)	(5.709)	(5.745)	(5.746)
Idsize	0.013	0.013	0.014	0.014
	(1.158)	(0.993)	(1.047)	(1.076)
Top	−0.024	−0.024	−0.024	−0.023
	(−1.700)	(−1.744)	(−1.743)	(−1.713)
_cons	0.129***	0.134***	0.122***	0.126***
	8.111	8.252	7.515	7.917
Time effect	Yes	Yes	Yes	Yes
industry effect	Yes	Yes	Yes	Yes
N	5198	5198	5198	5198
*r*2	0.108	0.108	0.107	0.108
*r*2_*a*	0.106	0.107	0.106	0.106

Note: *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

The results are reported in **Table 9**. Based on the data analyzed in column (1), the regression coefficient of corporate ESG performance (ESG_Bloomberg) is −0.026 and is significant at a 1% significance level. Among the ESG segmented responsibilities, the regression coefficients of Corporate Social Responsibility (Soc_Bloomberg) and Corporate Governance (Gov_Bloomberg) are −0.033 and −0.014, respectively, and are significant at a 1% significance level. In addition, the regression coefficients for environmental responsibility (Env_Bloomberg) were −0.002, respectively, significant at the 5% significance level. These findings validate hypothesis H of this paper, which is that all ESG dimensions are negatively correlated with inefficient corporate investment and indicate that ESG performance in corporate governance, environmental protection, and social responsibility significantly impacts corporate behavior.

5. Research conclusions and recommendations

5.1. Research conclusion

This paper innovatively examines the relationship between ESG and corporate investment efficiency from a global ESG perspective, complementing the lack of research on the subject. Conversely, this paper explores the relationship between ESG and investment efficiency based on 2018–2022 China A-share data and Huazheng ESG ratings. It was found that ESG performance enhances investment efficiency, especially significantly in suppressing overinvestment, thanks to strengthening regulation, limiting management's self-interested behavior, and alleviating information asymmetry. Among the subdivided ESG responsibilities, environmental and social responsibility performance is more conducive to suppressing overinvestment, and corporate governance performance dampens both underinvestment and overinvestment. On the other hand, improved ESG performance has a significant inhibitory effect on both underinvestment and overinvestment by firms in heavily polluted and non-heavily polluted industries, which is more pronounced in non-heavily polluted industries.

5.2. Theoretical and practical implications

ESG has gradually become one of the most important criteria for measuring enterprises' comprehensive value and influence. ESG is not only related to the long-term development of enterprises but also of great significance to stakeholders, enterprise managers, and the government. Specifically, companies with good ESG performance are more likely to be favored by investors. For example, during the New Crown epidemic, companies with higher ESG ratings presented higher stock returns and lower stock volatility. ESG-focused companies were also able to attract high-quality, innovative talent and enhance employee satisfaction and loyalty. From managers' perspective, ESG helps enhance corporate value and reduce business risks. For example, companies can better address the challenges posed by climate change by implementing ESG strategies. From the perspective of governments, ESG is important for enhancing social governance and promoting sustainable development.

5.3. Research recommendations

ESG has gradually become one of the most important criteria for measuring enterprises' comprehensive value and influence. ESG is not only related to the long-term development of enterprises but also of great significance to stakeholders, enterprise managers, and the government. Specifically, the ESG concept provides a new strategic thinking and management framework for enterprise managers, which helps them to better cope with various challenges and practice the sustainable development goals of the enterprise. From the government's point of view, the ESG concept plays a role in promoting economic development, maintaining social stability, protecting the environment, etc. ESG has rich practical significance, but there is still more room for improvement.

In order to improve China's ESG system, enterprises should deepen ESG practice, improve investment efficiency, clarify motivation, build incentive mechanisms, increase investment, disclose information promptly, and build risk warning mechanisms. Third-party rating agencies should strengthen the integration of resources, optimize the rating system, refer to international experience, formulate unified standards, strengthen information disclosure, and enrich the application of ESG results. Regulators should increase policy guidance, build an ESG ecosystem, formulate targeted policies, improve the information disclosure mechanism, clarify incentives and constraints, and strengthen international cooperation. Enterprises, rating agencies, and regulators must work together to promote the maturity and perfection of the ESG system and safeguard sustainable economic and social development.

5.4. Research shortcomings and prospects

The construction of China's ESG system is in its infancy, and the disclosure norms and mechanisms are not uniform, leading to uneven quality of corporate ESG information and affecting the comprehensiveness and accuracy of ESG ratings. In addition, existing studies mainly focus on the impact of ESG performance on current investment efficiency, and the long-term effect is not sufficiently explored. Future research needs to deeply explore the medium- and long-term effects of ESG performance on corporate investment efficiency to comprehensively assess the economic benefits of ESG practices and provide a scientific basis for enterprises to formulate long-term ESG strategies. With the construction of an ESG system and in-depth research, the relationship between ESG performance and investment efficiency will be more deeply understood.

Author contributions: Conceptualization, XZ and PL; methodology, PL; software, XZ; validation, XZ; formal analysis, XZ; investigation, PL; resources, PL; data curation, PL; writing—original draft preparation, PL; writing—review and editing, XZ and PL; visualization, XZ; supervision, XZ; project administration, PL; funding acquisition, XZ. All authors have read and agreed to the published version of the manuscript.

Conflict of interest: The authors declare no conflict of interest.

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