



## Research article

# Environmental, social, and governance performance, financing constraints, and corporate investment efficiency: Empirical evidence from China

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## ABSTRACT

This study explores the connection between environmental, social, and governance (ESG) performance, financing constraints, and corporate investment efficiency. The hypotheses in this study are formulated based on the principles of stakeholder and agency theories. We used secondary data from Chinese A-share listed companies from 2010 to 2021 to conduct an empirical analysis using the Ordinary Least Squares (OLS) and Fixed Effect (FE) estimators. The results indicate that good ESG performance can enhance corporate investment efficiency. Compared to over-investment, ESG performance has a more pronounced effect on mitigating under-investment. Using a mediating analysis model, we also find that ESG performance exerts an inhibitory influence on both under- and over-investments by mitigating corporate financing constraints. Heterogeneity analysis indicates that the enhancing effect of ESG performance on corporate investment efficiency is more significant in non-state-owned corporations, low-pollution corporations, and corporations with a higher proportion of institutional investors. This study provides insights for listed companies to improve ESG performance to enhance capital allocation efficiency and promote sustainable development.

## 1. Introduction

In recent years, a series of social movements, such as the MeToo movement in the United States in 2017 and the Fridays for Future movement initiated by Swedish environmental activist Greta Thunberg in 2018, alongside global climate change issues and frequent corporate governance problems like the Wirecard financial fraud and Facebook data privacy breaches, has driven investors to place greater emphasis on responsible investment, particularly in relation to Environmental, Social, and Governance (ESG) factors [1–3]. Corporate ESG performance plays a vital role in providing investors with insights into a company's environmental governance, social responsibility, and corporate governance [4], effectively reducing the information asymmetry related to the company's non-financial data [5,6].

According to the literature [7,8], ESG performance has become a key indicator for assessing a company's non-financial performance, managerial excellence, and risk mitigation capabilities. Therefore, companies should comprehensively improve their ESG performance to optimize resource allocation, enhance transparency, and strengthen their attractiveness to investors, while also boosting their sustainable development capability in a highly competitive market [9]. To further advocate for responsible investment

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principles and promote companies to firmly practice ESG, this paper aims to investigate whether ESG performance enhances corporate investment efficiency, and through which channels ESG performance influences investment efficiency.

It is well known that investment, as one of the basic financial activities of a company, can significantly impact the company's future production, management, and development, making its efficiency a long-term concern for both scholars and investors. In a highly competitive market environment, low investment efficiency makes it difficult for companies to convert numerous high-return investment opportunities into actual investments, potentially putting them at a disadvantage. In this context, good ESG performance disclosure provides an effective means to improve corporate investment efficiency [10]. On the one hand, good ESG performance alleviates information asymmetry and internal agency problems, thereby enhancing corporate transparency and reducing financing constraints, which optimizes capital utilization and resource allocation. On the other hand, good ESG performance fosters a positive corporate social image, bolsters trust and interaction between the company and its stakeholders, and enhances corporate reputation. Together, these factors contribute to enhanced investment efficiency and long-term competitiveness [11–16].

However, according to neoclassical economic theory, ESG performance could also decrease investment efficiency due to its consumption of corporate resources and utilization as a tool for managerial self-interest [17–19]. For example, based on a sample of US companies from 1992 to 2014, Bhandari and Javakhadze found that corporate social responsibility reduced the sensitivity of investment to investment opportunities, leading to increased inefficient investment behavior, particularly in companies with weaker management compensation incentives and resource shortages [19].

These pieces of evidence indicate that scholars have drawn different conclusions regarding the impact of ESG performance on corporate investment efficiency based on different theoretical frameworks. Notably, most studies on the impact of ESG performance on corporate investment efficiency have focused on samples from developed countries in Europe [13] and the United States [19–21]. While research on ESG topics in emerging markets [22,23], particularly in China [24–30], has been increasing, these studies primarily focus on the relationship between ESG performance and corporate operating performance and capital market outcomes. However, few studies have directly used samples from China and other emerging markets to assess the impact of ESG performance on corporate investment efficiency. Additionally, few studies have explored the role of financing constraints in the impact of ESG performance on corporate investment efficiency. Therefore, using samples of Chinese A-share companies listed in Shanghai and Shenzhen, this paper aims to further explore how ESG information disclosure effectively improves corporate investment efficiency, which is an important issue with strong research value and significance.

To thoroughly investigate the impact of ESG performance on corporate investment efficiency and uncover potential transmission mechanisms, it is essential to integrate more ESG factors into future corporate management and investment strategies. This will help improve corporate investment efficiency, optimize resource allocation, and enhance long-term competitiveness and sustainable development capabilities.

This paper empirically examines the impact of ESG performance on corporate investment efficiency for Chinese A-share companies listed in Shanghai and Shenzhen from 2010 to 2021, as well as the distinct impacts of ESG performance on under-investment and over-investment. The results are validated through robustness and endogeneity tests. Additionally, this study explores the internal mechanism by which ESG performance improves corporate investment efficiency by alleviating financing constraints. Finally, the study investigates the differences in the impact of ESG performance on corporate investment efficiency between state-owned and non-state-owned enterprises, as well as between light and heavy pollution enterprises.

The potential contributions of this paper are significant to the field of sustainability. First, this study verifies the facilitating effect of ESG performance on corporate investment efficiency using Chinese A-share company data, which provides new insights for Chinese firms to enhance their investment efficiency. Second, this paper reveals the mechanism by which ESG performance improves corporate investment efficiency through the alleviation of financing constraints, exploring the critical role of ESG information disclosure in this process, thus advancing the understanding of sustainable business practices. Finally, the study offers a robust theoretical framework that integrates stakeholder and information asymmetry theories, underscoring the strategic value of ESG management and providing actionable insights for firms aiming to enhance their investment strategies and align with sustainable development goals.

The remainder of this paper is structured as follows: Section 2 introduces the theoretical background, and Section 3 reviews the theoretical literature and presents the research hypotheses. Section 4 provides the data and research methodology. Section 5 presents the empirical results and analysis, and Section 6 offers the discussion. Section 7 concludes the study.

## 2. Theoretical background

### 2.1. Stakeholder theory

According to stakeholder theory, a company's success depends not only on satisfying the needs of shareholders but also on addressing and fulfilling the requirements of various stakeholders, including investors, customers, suppliers, and other parties [31]. Stakeholder theory emphasizes that by effectively managing stakeholders' needs and expectations, companies can reduce conflicts, enhance their reputation, and strengthen overall competitiveness. Good ESG performance enables companies to manage stakeholder relationships more efficiently, thereby improving long-term performance and sustainable development capabilities [29].

According to stakeholder theory, regular publication of ESG reports allows companies to showcase their efforts and achievements in environmental, social, and governance aspects [32]. Such transparency fosters trust and enhances the confidence of investors and other stakeholders, attracting additional investment and partnerships. This, in turn, can reduce the company's financing costs, improve resource allocation efficiency, and ultimately enhance investment efficiency.

From the perspective of external stakeholders, companies must focus on non-financial performance aspects while pursuing profit

maximization. By effectively promoting their good ESG performance via official websites and media channels, companies improve their reputation and transparency while fostering greater trust among investors, customers, and suppliers [33]. This impact attracts more capital and resources, lowers financing costs, optimizes resource allocation, and significantly enhances corporate investment efficiency [34].

## 2.2. The theory of information asymmetry

According to information asymmetry theory, in corporate management, managers typically possess more internal information than external investors, leading to potential inefficiencies in investment decisions [35]. The information advantage held by corporate managers can hinder external investors from accurately assessing the true value and future performance of the firm, thereby affecting their investment decisions and the firm's financing capabilities [36]. To mitigate this information asymmetry, firms need to establish robust information disclosure systems that ensure transparency and timely transmission of information, thereby enhancing investor confidence and decision-making effectiveness [37].

Within the framework of information asymmetry theory, good ESG performance can partially mitigate the issue of information asymmetry. By regularly publishing ESG reports and related information, companies can demonstrate their efforts and achievements in environmental protection, social responsibility, and corporate governance to external investors [38]. This transparency builds trust among external investors by providing clearer expectations regarding the company's future performance, reducing uncertainties caused by information asymmetry. By enhancing information transparency, firms can attract more investors, lower financing costs, optimize resource allocation, and ultimately improve investment efficiency.

According to the theory of information asymmetry, the disclosure and use of ESG performance reports also pose potential challenges [22]. If management exploits information asymmetry by selectively disclosing favorable ESG information while concealing negative aspects, it results in incomplete and distorted information disclosure, further exacerbating information asymmetry [39]. Additionally, management may overemphasize the company's ESG achievements to garner more external support and financing opportunities [40]. Although such actions might enhance the company's image in the short term, they could lead to a decline in investor trust over the long term, increasing information asymmetry and harming the firm's long-term investment efficiency. Therefore, firms must ensure the completeness and authenticity of ESG information disclosure, avoiding selective disclosure that could intensify information asymmetry, thereby maintaining long-term investment efficiency and external investor trust [41].

## 3. Literature review and hypotheses development

### 3.1. ESG performance and corporate investment efficiency

The ESG (Environmental, Social, and Governance) rating has emerged as a critical indicator for assessing a company's sustainability [42]. In recent years, scholars have extensively explored the economic consequences of ESG performance, focusing on several key areas: the impact of ESG on corporate green innovation capacity, firm value, financial performance, financing constraints, corporate risk, and human capital investment efficiency. Good ESG performance improves the transparency of a company's R&D processes and production supply chains, thereby strengthening its innovation capabilities [37,43] and ultimately increasing firm value [44]. Moreover, ESG performance has a positive and stable effect on a company's financial performance [45,46], as it helps alleviate financing constraints [10,47], reduce financing costs [48], and decrease operational risks [49] and corporate risk exposure [50]. ESG practices also improve the efficiency of human capital investments [33,51] and boost overall investment efficiency [20,52].

Furthermore, research has demonstrated that ESG performance offers a range of benefits to firms, including increased operational efficiency [53], enhanced customer interest [54], suppression of earnings management activities [55], and strengthened social trust [27,56]. These factors collectively make strong ESG performance a crucial driver for achieving sustainable development and long-term investment success.

In traditional enterprise management, the pursuit of profit maximization is the primary objective of business activities, and investment plays a significant role in expanding production and achieving profit growth [57,58]. Therefore, improving corporate investment efficiency has become a key focus of research in this area [59]. Previous studies have analyzed methods to enhance investment efficiency from various perspectives, including industrial policy transformation [60], corporate social responsibility strategies [61], corporate governance characteristics [62], and digital transformation [63]. Among these approaches, ESG performance reports are highly effective communication tools, providing external investors with critical information about a company's social responsibility practices. This warrants a closer examination of their role in enhancing corporate investment efficiency.

According to the theories of information asymmetry and stakeholder theory, on the one hand, good ESG performance reflects a company's ability to balance the interests of owners, managers, suppliers, investors, and the general public; this leads to an optimized investment environment, better integrated investment channels, and ultimately improves investment efficiency [64]. On the other hand, the good ESG performance of enterprises can alleviate information asymmetry between internal and external investors and investees [65]. The root of this outcome is as follows. From within the corporate structure, good ESG performance can improve the openness and transparency of corporate management and investment decisions, which is conducive to supervising the rational arrangement of funds by enterprises and limiting the aggressive over-investment and conservative under-investment behavior of corporate executives [66]. externally, good ESG performance sends positive signals of the company's sustainable and sound development, establishes a good social image, and obtains the financial support and other resources required for development to reduce the inefficiency of enterprises' investment behavior [67]. Given the prior discussion on the potential adverse effects of ESG performance

on corporate investment efficiency, this study proposes two alternative hypotheses, 1a and 1b: ESG performance has a significant positive impact or a significant negative impact on the improvement of corporate investment efficiency. Furthermore, to highlight the contributions of this study more clearly, we have summarized recent literature on ESG performance and corporate investment efficiency. as detailed in Table 1.

**Hypothesis 1a.** ESG performance is significantly positively correlated with corporate investment efficiency.

**Hypothesis 1b.** ESG performance is significantly negatively correlated with corporate investment efficiency.

**Table 1**

Summary of studies related to ESG performance and corporate investment efficiency.

No.	Title	Findings	Scene	Author (year)
1	The Effect of a Company's ESG Level on Labor Investment Efficiency	It was found that there was a significant negative (–) result between the ESG level of a company and labor investment inefficiency. Among them, only governance scores significantly reduced labor investment inefficiency	South Korea	J. Han, K. Jung (2024)
2	ESG Ratings in India: Assessing Their Reliability for Investment Decisions	The study determines that investors to some extent rely on these ratings to achieve profitable investment outcomes by analyzing the relationship between asset class concentration and ESG ratings.	India	M. Dhuri, R. Sinha, S. Shukla (2024)
3	The Impact of ESG Performance on the Value of Family Firms: The Moderating Role of Financial Constraints and Agency Problems	Among the three ESG components, we find that environmental and social performances have a positive and statistically significant impact on firm value. However, we find no evidence of any significant effect of governance score on firm value	254 firms that belong to the 500 largest family-owned firms worldwide	C. Méndez, C. Maquieira, J. Arias (2023)
4	ESG and Investment Efficiency: The Role of Marketing Capability	The study finds strong evidence that firms with better marketing capabilities (MC) are more likely to engage in ESG activities. Additionally, firms with strong marketing capabilities that engage in ESG activities can reduce investment inefficiencies.	United States	W. Hu, J. Sun, Y.-E. Lin, J. Hu (2023)
5	The Effect of Overconfidence and ESG level on Investment Efficiency	The study finds that managers' overconfidence tends to reduce investment efficiency, but firms with higher ESG ratings can mitigate this negative impact and improve investment efficiency. Even in cases of managerial overconfidence, higher ESG ratings can still reduce inefficiencies caused by over-investment.	South Korea	J. Sim (2023)
No.	Title	Findings	Scene	Author (year)
6	Environmental, social and governance performance (ESG) and firm investment efficiency in emerging markets: the interaction effect of board cultural diversity	The study finds that firms with stronger ESG performance have higher investment efficiency. Additionally, in environments prone to over-investment, board cultural diversity negatively moderates the relationship between ESG performance and investment efficiency.	India and 6 other emerging market countries	A. Al-Hiyari, I.I. A., M. Kolsi, O. Kehinde (2022)
7	Audit quality, media coverage, environmental, social, and governance disclosure and firm investment efficiency: Evidence from Canada.	The results indicate that audit quality and public media exposure are two main drivers of ESG transparency, and there is a negative correlation between ESG transparency and firm-level investment inefficiency.	Canada	A. Hammami, M. Zadeh (2019)
8	Impact of Corporate Environmental Responsibility on Investment Efficiency: The Moderating Roles of the Institutional Environment and Consumer Environmental Awareness	The study finds that corporate environmental responsibility significantly improves investment efficiency, particularly in regions with a strong institutional environment, though the effects are not immediate. Additionally, increased consumer environmental awareness helps companies address under-investment.	China	S. Zeng, Y. Qin, G. Zeng (2019)
9	Board gender diversity, competitive pressure and investment efficiency in Chinese private firms	The study finds that female directors significantly improve investment efficiency by monitoring management, reducing agency problems, and enhancing resource allocation, particularly in curbing over-investment.	China	M. Sultan Sikandar, M.A. Majeed, T. Ahsan (2019)
10	Corporate Social Responsibility and Investment Efficiency	The study shows that high levels of Corporate Social Responsibility (CSR) can significantly reduce investment inefficiency and thus improve investment efficiency, especially in CSR activities related to primary stakeholders.	United States	M. Benlemlih, M. Bitar (2018)

### 3.2. ESG performance and financing constraints

Based on both domestic and international theoretical and empirical studies, the economic impact of ESG performance is influenced by various factors, including national institutions, legal frameworks, and levels of economic development [68,69]. Therefore, to fully understand the effects of ESG performance on financing constraints, it is essential to consider China's distinct level of economic development and institutional environment. First, ESG performance disclosure requirements in China primarily hinge on voluntary advocacy, with no mandatory provisions to impose constraints. As a key indicator of a company's non-financial information, ESG performance plays a crucial role in evaluating a firm's capacity for sustainable and healthy development [70].

Listed corporations actively embracing ESG principles can effectively communicate positive signals of corporate commitment to green and sustainable development. This, in turn, creates a favorable environment for securing support from green credit policies, subsequently leading to a notable reduction in corporate financing constraints [40,71]. Second, enterprises boasting commendable ESG performance tend to attract significant attention from investors and external media, consequently mitigating the asymmetry in accessing corporate value information. Such firms create a favorable external financing environment and channels, resulting in a reduction in the cost of external capital procurement [72,73]. Furthermore, superior ESG performance serves as an indicator of well-established and comprehensive corporate governance systems within enterprises. This helps regulate the investment behavior of top management, reducing agency costs. In turn, this situation enhances the rationality and soundness of financing decisions and reduces the level of corporate financing constraints [74,75]. Thus, we propose the following hypothesis:

**Hypothesis 2.** ESG performance is significantly negatively correlated with financing constraints.

### 3.3. ESG performance, financing constraints, and corporate investment efficiency

Based on the above analysis, companies with good ESG performance are better positioned to secure financial resources and other forms of support from a diverse range of stakeholders [76,77], effectively alleviating financing constraints and enhancing their investment capacity and operational efficiency [11,78]. Therefore, this study introduces financing constraints as a key mechanism variable to investigate how ESG influences corporate investment efficiency through this pathway [79,80].

By incorporating financing constraints as a mediating variable, we aim to explore how ESG performance impacts corporate financing ability and, in turn, affects investment decisions and efficiency [81]. On the one hand, good ESG performance may reduce capital costs and broaden access to financing channels, thus mitigating funding shortages and promoting more efficient investment activities. On the other hand, companies with poor ESG performance are likely to face stronger financing constraints, resulting in under-investment or inefficient capital allocation, and ultimately reducing corporate investment efficiency [67]. Therefore, we posit the following hypothesis:

**Hypothesis 3.** ESG performance improves corporate investment efficiency by alleviating financing constraints.

### 3.4. Theoretical framework

Existing research suggests that the performance of ESG may influence corporate investment efficiency by affecting internal governance factors such as board culture [23,64,81]. However, through a systematic review and analysis of relevant literature, we can reasonably infer a relationship between ESG performance and corporate investment efficiency that includes external influences, indicating the need to consider factors such as the financing environment, alongside the impact of ESG on the intrinsic value of target companies [4,12,82]. Consequently, there is a need for a theoretical framework distinct from current research, which accounts for the mediating role of financing constraints in the influence of ESG performance on corporate investment efficiency, while also delineating the structural impacts of under-investment and over-investment within non-efficient investment. Fig. 1 illustrates the theoretical framework of this study. According to Fig. 1, ESG performance positively affects corporate investment efficiency and mitigates under-investment and over-investment within non-efficient investment. In addition to considering the direct impact of ESG performance on corporate investment efficiency, this theoretical framework integrates the perspective of financing constraints, exploring how ESG performance affects corporate investment efficiency by alleviating financing constraints. This theoretical framework offers multiple extendable research perspectives and theoretical development spaces, representing an emerging research direction worthy of further exploration by scholars in the field of ESG and corporate investment efficiency.

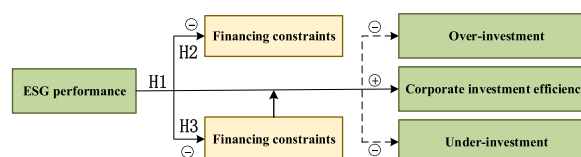


Fig. 1. Theoretical framework.

## 4. Methodology

### 4.1. Data sources

This study utilizes panel data from Chinese A-share listed corporations, covering the period from 2010 to 2021, as the primary data set. The sample period of 2010–2021 was chosen for several key reasons. First, in 2008 and 2009, the Shanghai Stock Exchange and Shenzhen Stock Exchange issued guidelines requiring listed companies to disclose information related to corporate social responsibility. Additionally, as 2021 marked the second year following the onset of the pandemic, the data can reflect its impact on corporate investment efficiency and facilitate a comparative analysis of performance before and after the pandemic, allowing for robust statistical analysis and reliable findings.

To ensure the reliability of the sample, we carefully screened and processed the data based on the following criteria: (1) exclusion of listed corporations within the financial industry; (2) exclusion of listed corporations categorized as T, such as ST or \*ST, which are characterized by unstable development and significant data index volatility, particularly concerning investment efficiency; (3) removal of listed corporate with incomplete financial data; and (4) use of a winsorizing 1 % and 99 % treatment to mitigate the influence of extreme values on all research variables. ESG disclosure data were sourced from Huazheng Company's ESG rating data set, while other financial data were extracted from the CSMAR database. Excel and Stata 18.0 were used for statistical analysis and data management. A final data set of 24,524 valid observations was derived.

### 4.2. Variables

#### 4.2.1. Dependent variables

The dependent variable in this study is corporate investment efficiency. Among the models for measuring investment efficiency, the models developed by Richardson [83] and Biddle [84] are widely accepted. Compared to Biddle's investment efficiency model, Richardson's model is more comprehensive and sophisticated in analyzing corporate investment behavior. This model not only focuses on capital expenditures and investment returns but also incorporates cash flow, financial leverage, and industry effects, allowing it to more accurately reflect corporate investment efficiency under different market conditions. Additionally, the Richardson investment efficiency model can be adjusted according to specific research needs, offering greater flexibility and extensibility. Therefore, we used the Richardson investment efficiency model to gauge corporate investment efficiency. The specific model is outlined as follows.

$$INV_{i,t+1} = \alpha_0 + \alpha_1 \text{TobinQ}_{i,t} + \alpha_2 \text{LEV}_{i,t} + \alpha_3 \text{CASH}_{i,t} + \alpha_4 \text{SIZE}_{i,t} + \alpha_5 \text{AGE}_{i,t} + \alpha_6 \text{RET}_{i,t} + \alpha_7 \text{INV}_{i,t} + \sum \text{YEAR} + \sum \text{INDU} + \varepsilon \quad (1)$$

The Model (1) utilizes an industry-by-industry, year-by-year regression to obtain the residuals to measure the level of corporate inefficient investment. In model (1), INV represents inefficient investment, which is calculated as INV = (cash paid for acquisition of fixed assets, intangible assets and other long-term assets – cash recovered from disposal of fixed assets, intangible assets and other long-term assets)/total assets; TobinQ represents corporate growth, which is calculated as TobinQ = (market value of outstanding shares + number of non-outstanding shares x net assets per share + book value of liabilities)/total assets; LEV indicates debt to asset ratio; CASH indicates free cash flow; SIZE indicates enterprise size; AGE Indicates number of years in business; RET indicates basic earnings per share ratio;  $\alpha_0$  is a constant term,  $\alpha_1$ – $\alpha_7$  is the coefficient of each explanatory variable, variable  $\varepsilon$  is the residual, a positive result means that the firm has over-investment behavior, the larger the value, the greater the degree of over-investment (Over\_Inv), and conversely a negative result means under-investment (Under\_Inv), the smaller the value, the greater the degree of under-investment.

#### 4.2.2. Independent variable

Currently, ESG performance data comes from a variety of sources, including international institutions such as MSCI, Bloomberg, and FTSE Russell, as well as domestic agencies like HuaZheng, SynTao Green Finance, and Run Ling Global. In this study, we utilize the HuaZheng ESG rating data to measure ESG performance. There are two main reasons for selecting the HuaZheng rating. Firstly, the rating system integrates international standards with the unique characteristics of the Chinese market, providing a comprehensive assessment of the sustainable development capabilities of Chinese listed companies across the three dimensions of environmental, social, and governance. Secondly, the HuaZheng ESG rating employs an industry-weighted average approach to quantify a company's ESG performance into nine grades (ranging from C to AAA) and assigns corresponding numerical values (from 1 to 9), facilitating precise quantitative analysis.

#### 4.2.3. Intermediate variable

This research uses the KZ index to gauge the financing constraints of the mediating variables. The KZ index reflects the level of financing constraints faced by a firm, based on indicators such as operating cash flow, cash dividends, cash holdings, leverage ratio, and Tobin's Q. Its advantage lies in its ability to incorporate multiple financial indicators, providing a comprehensive assessment of a firm's financing constraints. A higher KZ index value indicates greater financing constraints, reflecting a firm's increased dependency on internal capital due to difficulties in accessing external funding. The specific model (2) is presented as follows.

$$\text{KZ} = -1.001909 * \text{OCF}/\text{Asset} + 3.139193 * \text{Lev} - 39.3678 * \text{Dividends}/\text{Asset} - 1.314759 * \text{Cash}/\text{Asset} + 0.2826389 * \text{TobinQ} \quad (2)$$

in model (2), OCF, Dividends, and Cash are operating net cash flow, dividends, and cash holding levels, respectively, and are



normalized to total assets at the beginning of the period.

#### 4.2.4. Control variables

To account for potential influences on corporate investment efficiency from other factors, this study follows the precedent set by many scholars and introduces the following control variables primarily considering corporate financial characteristics and internal governance into the regression model: corporate size, financial leverage, nature of the ultimate controller, equity concentration, percentage of independent directors, free cash flow, and management expense ratio. In addition, year and industry variables are incorporated as dummy variables.

The definitions of variables in this study are presented in Table 2.

#### 4.3. Model setting

This study refers to the stepwise test of mediation effects apply by He and Shi [85] and constructs models (3), (4), and (5) to validate H1, H1a, and H1b, respectively; model (6) to validate Hypothesis 2; and model (7) to validate H3.

$$Ineff_{i,t} = \beta_0 + \beta_1 ESG_{i,t} + \beta_2 Controls_{i,t} + \sum Year + \sum Industry + \varepsilon \quad (3)$$

$$Under\_Inv_{i,t} = \beta_0 + \beta_1 ESG_{i,t} + \beta_2 Controls_{i,t} + \sum Year + \sum Industry + \varepsilon \quad (4)$$

$$Over\_Inv_{i,t} = \beta_0 + \beta_1 ESG_{i,t} + \beta_2 Controls_{i,t} + \sum Year + \sum Industry + \varepsilon \quad (5)$$

$$KZ_{i,j} = \beta_0 + \beta_1 ESG_{i,t} + \beta_2 Controls_{i,t} + \sum Year + \sum Industry + \varepsilon \beta \quad (6)$$

$$Ineff_{i,t} = \beta_0 + \beta_1 ESG_{i,t} + \beta_2 KZ + \beta_3 Controls_{i,t} + \sum Year + \sum Industry + \varepsilon \quad (7)$$

in model (3)–(7), Ineff represents the corporate inefficient investment; Under\_Inv and Over\_Inv represents the under-investment and the over-investment respectively; The variable KZ refers to the financing constraints; Controls stands for a series of control variables; Year, Industry, and  $\varepsilon$  reflect the year fixed effects, the industry fixed effects, and the random disturbance term, respectively.

#### 4.4. Descriptive statistical analysis

Table 3 provides the descriptive statistical results for the main variables. In the sample period, The corporate investment efficiency has a minimum value of 0.0005, a maximum value of 0.330, and a standard deviation of 0.0528. These results indicate that corporate investment inefficiency is common among listed corporations, with significant differences in the degree of inefficient investments across firms. The ESG performance has a minimum value of 1, a maximum value of 9, and a standard deviation of 1.147. These results indicate that the overall ESG performance of listed corporations in China is in the middle to high levels, but there is a large gap between corporations. The mean value of financing constraints is 1.2098, indicating that the level of financing constraints of listed corporations in China is generally high. Lastly, the results of the variance-inflated factor analysis of the model show that the VIF of each variable is below 10, excluding the problem of multicollinearity among the variables.

**Table 2**  
Variable definitions.

Variable Type	Variable Name	Variable Definition
Dependent Variables	Ineff	Taking the absolute value of the residuals of Richardson investment efficiency model
	Under_Inv	Degree of under-investment, taking the absolute value of the negative residual of Richardson's investment efficiency mode
	Over_Inv	Degree of over-investment, taking the positive residual of Richardson investment efficiency mode
Independent Variable	ESG	Assigned from lowest to highest according to CSI ESG ratings
Intermediate variable	KZ	KZ index
Control Variables	SIZE	Natural logarithm of the company's total assets
	LEV	Ratio of total liabilities to total assets of the Company
	NSONE	1 if it is a state-owned enterprise, Otherwise 0
	TobinQ	Ratio of market value to book value of the company
	Mfee	Administrative expenses/operating income
	Age	Natural logarithm of the number of years the company has been listed
	Indep	Ratio of independent directors to total number of board members
	Fhold	Shareholding ratio of the largest shareholder
	Ocf	Net cash flows from operating activities/total assets at end of year
	Year	Annual dummy variables
	Industry	Industry dummy variable

**Table 3**  
Descriptive statistical results of the main variables.

Variable Type	variables	N	mean	sd	min	p50	max
Dependent Variables	Ineff	24524	0.0426	0.0528	0.0005	0.0262	0.330
	over ineff	9458	0.0505	0.0649	0.0005	0.0269	0.330
	under ineff	15066	−0.0376	0.0427	−0.330	−0.0258	−0.000500
Independent Variable	ESG	24524	6.517	1.148	1	6	9
Intermediate variable	KZ	24524	1.2098	2.4098	−11.3311	1.4202	13.6624
Control Variables	SIZE	24524	22.29	1.330	15.58	22.11	28.64
	RET	24524	0.125	0.541	−0.822	0.00680	14.28
	Mfee	24524	0.0918	0.0793	0.00760	0.0720	0.766
	TobinQ	24524	2.084	1.475	0.802	1.619	17.73
	NSOE	24524	0.391	0.488	0	0	1
	Indep	24524	0.375	0.0540	0.273	0.357	0.600
	ocf	24524	0.0462	0.0697	−0.224	0.0455	0.257
	Lev	24524	0.445	0.205	0.0274	0.441	0.925
	Fhold	24524	0.343	0.148	0.0832	0.321	0.758

## 5. Results

### 5.1. Impact of ESG performance on corporate investment efficiency

This paper first performs regression estimation on the benchmark regression models (3), (4), and (5). The results are presented in Table 4. Column (1) shows the regression results after including control variables, industry-fixed effects, and year-fixed effects. The results indicate that the regression coefficient of ESG is  $-0.003$ , which is significant at the 1 % level. This result indicates that good ESG performance helps reduce corporate investment inefficiency. In terms of economic significance, a one-level improvement in firms' ESG performance reduces inefficiency by 0.003, which represents an increment of 7.04 % of the mean value of efficiency. The results in columns (2) and (3) indicate that the regression coefficients between ESG performance and over-investment and under-investment are  $-0.005$  and  $-0.003$  ( $p < 0.01$ ), respectively. This outcome suggests that good ESG performance reduces firms' over-investment and addresses the under-investment problem. The effects of the remaining control variables on corporate investment efficiency are consistent with those of previous studies. The empirical results support H1a. These findings align with Ellili et al. (2022) [86] and Zeng et al. (2019) [87], both of whom establish a positive linear relationship between ESG performance and investment efficiency, particularly in mitigating under-investment.

### 5.2. Impact of ESG performance on financing constraints

Column (2) of Table 5 presents the regression results for ESG performance's impact on corporate financing constraints. The results reveal a significant negative relationship between ESG performance and financing constraints, as indicated by a regression coefficient of  $-0.134$ , with statistical significance at the 1 % level. This result implies that firms with better ESG performance experience lower levels of financing constraints. The possible reason is that strong ESG performance reduces the risk premium demanded by investors, as it lowers uncertainty related to the firm's risk profile. By sending a positive signal to the market about the firm's commitment to sustainability and responsible governance, good ESG performance attracts more investors and financial support. This increased investor confidence leads to improved access to capital, thereby reducing the firm's financing constraints. Consequently, the empirical results support hypothesis H2.

### 5.3. Mediating role of financing constraints

In this study, we employ the three-step method proposed by Baron and Kenny (1986) [88] to systematically analyze the mediation effect, examining the role of the mediator variable between the independent and dependent variables. The specific steps and results of the analysis are as follows: First, we examine the direct impact of ESG performance on corporate investment efficiency. Column 1 of Table 5 shows that the regression coefficient of ESG performance on investment efficiency is  $-0.003$  ( $p < 0.01$ ). Second, we test the effect of ESG performance on corporate financing constraints. The results in Column 2 of Table 5 indicate that the regression coefficient of ESG performance on financing constraints is  $-0.134$  ( $p < 0.01$ ). Third, we assess the impact of financing constraints on corporate investment efficiency. Column 3 of Table 5 shows that the regression coefficient of financing constraints on investment efficiency is 0.005 ( $p < 0.01$ ). Moreover, Column 4 of Table 5 shows that the direct effect of ESG performance on investment efficiency is reduced after incorporating financing constraints, with the coefficient decreasing from  $-0.003$  to  $-0.005$  ( $p < 0.01$ ). This result indicates that financing constraints play a partial mediating role between ESG performance and corporate investment efficiency. These empirical results support H3.



**Table 4**  
The benchmark regression results.

	(1)	(2)	(3)
	Ineff	Over_Inv	Under_Inv
ESG	−0.003*** (0.001)	−0.005*** (0.001)	−0.003*** (0.001)
SIZE	−0.001 (0.000)	−0.002** (0.001)	−0.001*** (0.000)
RET	0.000 (0.001)	0.015*** (0.001)	−0.013*** (0.001)
Mfee	0.034*** (0.005)	0.051*** (0.011)	0.021*** (0.004)
TobinQ	0.006*** (0.000)	−0.002** (0.001)	0.010*** (0.000)
NSOE	−0.012*** (0.001)	−0.020*** (0.002)	−0.007*** (0.001)
Indep	0.015** (0.006)	0.019 (0.012)	0.008 (0.006)
ocf	−0.014*** (0.005)	0.016 (0.010)	−0.031*** (0.005)
Lev	0.012*** (0.002)	0.017*** (0.004)	0.006*** (0.002)
Fhold	0.001 (0.002)	0.002 (0.005)	0.003 (0.002)
_cons	0.038*** (0.008)	0.094*** (0.017)	0.030*** (0.008)
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
N	24524	9458	15066
Adj. R <sup>2</sup>	0.103	0.074	0.224

Standard errors in parentheses.

\*p < 0.1, \*\*p < 0.05, \*\*\*p < 0.01.

**Table 5**  
The mediation effect regression results.

	(1)	(2)	(3)	(4)
	Ineff	KZ	Ineff	Ineff
ESG	−0.003*** (0.001)	−0.134*** (0.018)		−0.005*** (0.000)
KZ			0.005*** (0.000)	0.001*** (0.000)
SIZE	−0.001 (0.000)	−0.181*** (0.009)	−0.002*** (0.000)	−0.001 (0.001)
RET	0.000 (0.001)	−0.292*** (0.019)	−0.001 (0.001)	0.038*** (0.005)
Mfee	0.034*** (0.005)	0.835*** (0.118)	0.038*** (0.005)	0.008*** (0.000)
TobinQ	0.006*** (0.000)	0.417*** (0.007)	0.008*** (0.000)	−0.011*** (0.001)
NSOE	−0.012*** (0.001)	0.282*** (0.019)	−0.012*** (0.001)	0.017*** (0.006)
Indep	0.015** (0.006)	0.429*** (0.147)	0.017*** (0.006)	−0.098*** (0.007)
ocf	−0.014*** (0.005)	−16.584*** (0.122)	−0.098*** (0.007)	0.049*** (0.003)
Lev	0.012*** (0.002)	7.391*** (0.048)	0.050*** (0.003)	−0.003 (0.002)
Fhold	0.001 (0.002)	−0.926*** (0.057)	−0.004 (0.002)	−0.004*** (0.001)
_cons	0.038*** (0.008)	1.556*** (0.201)	0.057*** (0.008)	0.046*** (0.008)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	24524	24524	24524	24524
Adj. R <sup>2</sup>	0.103	0.739	0.116	0.117

Standard errors in parentheses.

\*p < 0.1, \*\*p < 0.05, \*\*\*p < 0.01.

## 5.4. Robustness analysis

### 5.4.1. Common support test

To mitigate potential non-random selection bias, this research utilizes the propensity score matching (PSM) method to enhance the study's robustness. The process is detailed as follows: (1) Sample Stratification: Samples are categorized into experimental and control groups based on corporate ESG performance levels; (2) Probit Model Development: A Probit model, incorporating influencing factors for ESG performance, is constructed. The selected matching variables include control variables, year, and industry dummy variables, with all control variables being those used in the empirical regression of this study; (3) Matching Process: Using the control variables previously specified, matching is conducted using the kernel matching method; (4) Matched Sample Outcomes: The results of the balanced test are presented in Table 6. After matching, the absolute standardized differences of all variables are below 5 % and not statistically significant.

(5) Validation of Common Support: A density function plot (Fig. 2) is generated using PSM to further assess the fitting effect of the experimental versus control groups. The results illustrate that following PSM, sample enterprises in the experimental group, with propensity values ranging from 0.2 to 1, overlap with corporate counterparts in the control group. This result suggests an improved common support overlap, which aligns with the assumption of common support. (6) Regressive Analysis: The matched treatment and non-received treatment groups undergo another regression analysis, generating 19049 matched observations. These results are consistent with the fundamental regression findings outlined previously, thereby reasserting the method's scientific rigor and rationality.

### 5.4.2. Metrics for substituting explanatory variables

For the primary regression analysis, this study uses core explanatory variables based on Huazheng's ESG ratings data from the Wind database. However, considering that ESG rating may not be derived from purely objective information (e.g., corporate financial statements), the fairness of indices compiled by specific organizations may be a subject of debate. To address concerns with data availability and robustness, this study conducts a supplementary test using the Bloomberg ESG database as an alternative source for measuring ESG performance. After substituting the alternative explanatory variables, the coefficients of ESG2 in the regressions related to overall non-investment efficiency, financing constraints, over-investment, and under-investment remain significantly negative at the 1 % level. The results are presented in Table 7. As shown in column (1) of Table 7, the coefficient of ESG2 on overall non-investment efficiency is  $-0.0002$ , signifying a significant negative relationship at the 1 % level. This outcome suggests that even when changing the measurement of explanatory variables, the core conclusions of this research remain unaffected. Moreover, the other regression findings align with the previously established results. These consistent results confirm the robustness of the primary regression outcomes.

### 5.4.3. Metrics for replacing explanatory variables

The operating growth rate is utilized as a replacement for Tobin's Q in Richardson's residual model to redefine firm growth in this study. The outcomes are detailed in column (2)–(4) of Table 7. The regression results show that the coefficients between ESG performance and corporate investment inefficiency, under-investment, and over-investment are  $-0.006$  ( $p < 0.01$ ),  $-0.010$  ( $p < 0.01$ ), and  $-0.003$  ( $p < 0.01$ ). It is consistent with the benchmark regression results, indicating that the inhibitory effect of corporate ESG performance on corporate inefficiency investment exists robustly.

### 5.4.4. Lag test

To address the potential issue of bidirectional causality between ESG performance and corporate investment efficiency, this study introduces a one-period lagged explanatory variable. The findings presented in column (5) of Table 7 indicate that the coefficient of the lagged explanatory variable (ESG3) is  $-0.002$ , signifying statistical significance at the 1 % level. These results affirm the robustness of the core regression analysis. Note that even after extending the lag to two, three, four, and five periods, the results continue to exhibit statistical significance, underscoring the consistency and strength of the findings.

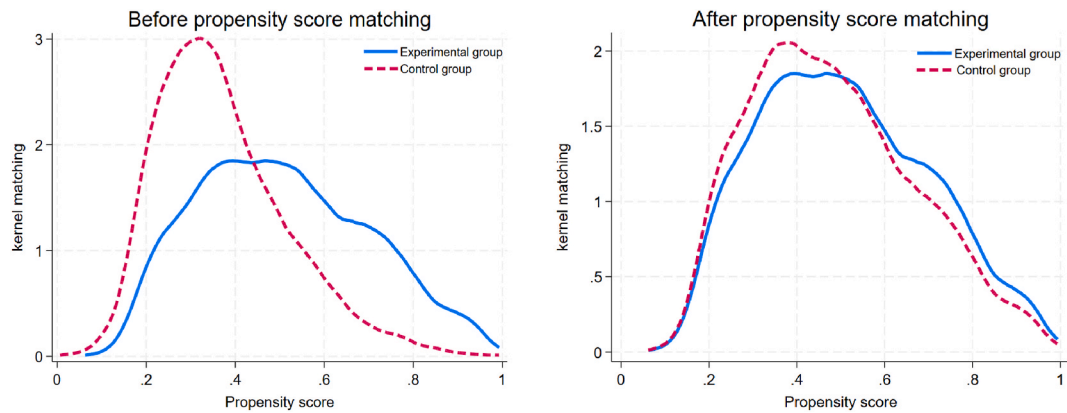
### 5.4.5. Instrumental variable estimations

In this study, we employ the instrumental variable (IV) approach to mitigate potential endogeneity issues. Specifically, following [89], we use the Air Quality (AQ) published by the China Meteorological Administration as an instrumental variable. The rationale for selecting air quality as the instrument is threefold: first, as a regional environmental indicator, air quality is closely related to the environmental policies and corporate social responsibility awareness in the location where a company operates, which may influence ESG performance, particularly in its environmental efforts. Second, while air quality may have some impact on ESG performance, its direct impact on corporate investment efficiency is weaker and more indirect, allowing for the effective control of other confounding factors related to investment efficiency. Third, air quality exhibits strong externalities and is not easily influenced by individual firms, making it relatively independent as an instrumental variable and unlikely to be directly related to corporate investment decisions. After appropriately controlling for fixed effects, it can be reasonably assumed that this instrumental variable influences corporate investment efficiency mainly through its impact on ESG performance, rather than through other channels, thereby satisfying the requirement of exogeneity.

Table 8 presents the results of the instrumental variable regressions. The first-stage results show that the coefficient of the instrumental variable on ESG is statistically significant, indicating a strong correlation between the chosen instrument and ESG performance. Furthermore, the F-statistic for the weak instrument test is 347.74, well above the critical threshold of 10. This high F-

**Table 6**  
Balance test results.

Variable Name	Unmatched	Standard Deviation (%)	Error Erosion (%)	T-examine	
	Matched			T-value	P-value
Lev	U	18.900	93.4	14.400	0.000
	M	1.2		0.870	0.383
Size	U	68.7	94.8	53.600	0.000
	M	3.6		0.44	0.661
ocf	U	11.800	69.1	9.000	0.000
	M	−3.600		0.29	0.773
Indep	U	−0.700	14.8	−0.510	0.611
	M	−0.600		−0.390	0.694
Fhold	U	23.500	95.6	18.020	0.000
	M	1		0.690	0.488
TobinQ	U	−17.700	97.5	−13.340	0.000
	M	−0.400		−0.330	0.744
NSOE	U	45.100	93.1	34.620	0.000
	M	−3.100		−0.03	0.978
Mshare	U	−27.400	98.2	−20.660	0.000
	M	−0.500		−0.380	0.705
Mfee	U	−14.400	88.7	−10.950	0.000
	M	1.6		1.210	0.228



**Fig. 2.** Density function of probability distribution of propensity score values.

**Table 7**  
Replacement variables and lagged test results.

	(1)	(2)	(3)	(4)	(5)
	Ineff	Ineff2	Over_Inv2	Under_Inv2	Ineff
ESG		−0.006*** (0.001)	−0.010*** (0.002)	−0.003*** (0.001)	
ESG2	−0.0002*** (0.0000)				
ESG3					−0.002*** (0.001)
Controls	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
N	21165	24268	8953	15315	20441
Adj. R <sup>2</sup>	0.089	0.056	0.090	0.091	0.165

Standard errors in parentheses.

\*p < 0.1, \*\*p < 0.05, \*\*\*p < 0.01.

**Table 8**  
Instrumental variable approach.

Variable	First stage	Second stage
	ESG	Ineff
ESG		−0.064** (0.027)
AQ	0.018*** (0.000)	
Controls	Yes	Yes
Year	Yes	Yes
Industry	Yes	Yes
Constant	−2.631*** (0.000)	−0.149** (0.050)
N	17832	17832

Standard errors in parentheses.  
\*p < 0.1, \*\*p < 0.05, \*\*\*p < 0.01.

statistic suggests that the instrumental variable is appropriately selected and has strong explanatory power. The second-stage regression results reveal that the coefficient of ESG is negative and statistically significant at the 5 % level, further supporting the core conclusion of this study: ESG performance significantly reduces inefficient investment.<sup>1</sup>

5.4.6. Heckman two-stage test

Furthermore, we utilize the Heckman two-stage regression to address potential sample selection bias. Specifically, in the first step, we use the control variables from the baseline model and the instrumental variables constructed earlier as independent variables, and the core explanatory variable (ESG performance) as the dependent variable to construct a selection equation based on a Probit model.<sup>2</sup> This allows us to calculate the inverse Mills ratio. The estimation results from the first step show that the coefficient of the instrumental variable is significantly positive, indicating that the selected instrumental variable significantly enhances corporate ESG performance, which is consistent with the results reported in Table 8, this is not repeated here.

In the second step, we include the inverse Mills ratio as an additional control variable in the baseline model for regression analysis. The results of Heckman’s second-stage test are shown in columns (1) to (3) of Table 9. These results demonstrate that IMR is significant at the 1 % level and passes the significance test. This outcome suggests that the original model may have a sample selection bias problem. After controlling for the variables as control variables, the regression coefficients of ESG on inefficiency, over-investment, and under-investment are negative and significant at the 1 % level. This result aligns with the benchmark regression results. Therefore, the positive impact of ESG performance on corporate investment efficiency remains robust.

5.5. Heterogeneity analysis

5.5.1. Property rights heterogeneity

Within the current Chinese market landscape, listed corporations with different ownership structures exhibit varying motivations and willingness to engage in ESG disclosure. Thus, differences in shareholding structure affect the role of ESG performance in enhancing corporate investment efficiency. To account for these differences, we categorize listed corporations based on the nature of the actual controllers. Those controlled by state-owned enterprises, administrative agencies, institutions, central agencies, and local agencies fall into the state-owned enterprises category, while the rest are classified as non-state-owned enterprises.

The results presented in columns (1)–(2) of Table 10 reveal that ESG performance plays a markedly pronounced role in enhancing the investment efficiency of non-state-owned listed corporations. This discrepancy can be attributed to the fact that state-owned enterprises, which enjoy strong government backing and ample access to financing sources, face relatively relaxed financing constraints. By contrast, non-state-owned enterprises operate within more constrained financing conditions, with limited financial resources and anticipated funding availability significantly impacting corporate investment decision-making processes. Consequently, non-state-owned listed enterprises grappling with more substantial financing constraints stand to gain greater benefits from publishing positive ESG disclosure information [86]. Therefore, ESG performance can exert a significantly substantial marginal effect on the investment efficiency of non-state-owned listed corporations.

<sup>1</sup> In addition to the instrumental variable previously discussed, this study also employs the average ESG ratings of other listed companies in the same city as each sample firm as an additional instrumental variable. The results remain robust. Due to space constraints, the justification for this instrumental variable and the corresponding results are available upon request.

<sup>2</sup> In the first-step estimation of the Heckman treatment effect model, it is necessary to include an exclusion restriction variable, which can only affect the dependent variable in the first-step estimation and not the dependent variable in the second-step estimation. Therefore, we select the previously constructed instrumental variable as the exclusion restriction variable.

**Table 9**  
Results of the Heckman two-stage test.

Variables	(1)	(2)	(3)
	Ineff	Over_Inv	Under_Inv
ESG	−0.030*** (0.006)	−0.076*** (0.002)	−0.005** (0.040)
IMR	0.016*** (0.003)	0.044*** (0.007)	0.069*** (0.008)
_cons	−0.136*** (0.020)	−0.220*** (0.039)	−0.045** (0.019)
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
Adj. R <sup>2</sup>	0.106	0.081	0.225
N	17830	6831	10999

Standard errors in parentheses.

\*p < 0.1, \*\*p < 0.05, \*\*\*p < 0.01.

**Table 10**  
Heterogeneity analysis test results.

variables	(1)	(2)	(3)	(4)	(5)	(6)
	Ineff	Ineff	Ineff	Ineff	Ineff	Ineff
	State-owned enterprises	Non-state-owned enterprises	Heavily polluting enterprises	Lightly polluting enterprises	Multi-institutional investors as a percentage of corporate	Fewer institutional investors than corporations
ESG	−0.002** (0.001)	−0.004*** (0.001)	−0.003** (0.001)	−0.004*** (0.001)	−0.005*** (0.001)	−0.001 (0.001)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R <sup>2</sup>	0.098	0.147	0.165	0.243	0.294	0.126
N	9590	14934	6911	17613	12262	12262
The p-value for the coefficient difference <sup>a</sup>	0.050**		0.065*		0.033**	

Standard errors in parentheses.

\*p < 0.1, \*\*p < 0.05, \*\*\*p < 0.01.

<sup>a</sup> The inter-group coefficient difference tests in the heterogeneity analysis are calculated based on a seemingly unrelated regression model.

### 5.5.2. Industry heterogeneity

Within China's distinctive market economy system, enterprises across different industries encounter distinct market conditions and varying levels of government intervention. These variations stem from differences in development characteristics, environmental preservation mandates, and the extent of government involvement among industries. Consequently, the influence of ESG performance on the investment efficiency of listed corporations varies significantly according to industry. This study divides the entire sample into two categories, namely, heavy polluters and light polluters, based on the classification and management directory specified in the "List of listed corporate' environmental verification industry" (Environmental Affairs Office Letter [2008] No. 373). This classification enables us to conduct an in-depth exploration of the connection between ESG performance, financing constraints, and corporate investment efficiency.

The results in columns (3)–(4) of Table 10 indicate that favorable ESG performance notably bolsters the investment efficiency of listed corporations operating in industries associated with light pollution. By contrast, the impact of ESG performance on corporate investment efficiency in heavily polluting sectors is comparatively weaker. One possible explanation for this disparity is that relative to heavily polluting industries, those in the light pollution sector generally face less stringent ESG disclosure requirements. Consequently, investors have substantial confidence in the ESG disclosure reports of corporations operating in the light pollution industry. Hence, positive ESG disclosure likely encourages investment resources to be directed toward listed corporations, ultimately leading to increased corporate investment efficiency. Conversely, for corporations entrenched in heavily polluting industries, prevailing stereotypes impact how investors perceive heavily polluting enterprises' ESG disclosure practices. Investors may harbor a degree of skepticism on the ESG disclosure behavior of these corporations. Moreover, good ESG performance may be misinterpreted as "whitewash" behavior by heavily polluting corporations. This misunderstanding diminishes the effectiveness of ESG disclosure in enhancing corporate investment efficiency within this context.

### 5.5.3. Institutional investor heterogeneity

Institutional investors play a pivotal role in influencing the ESG disclosure and financing choices of listed corporations. Institutional

investors' capacity to facilitate information transmission and oversight contributes to an enhanced external information environment for these corporations, thereby impacting the quality of corporate investment decisions. Moreover, the influence of ESG performance on corporate investment efficiency differs based on the proportion of institutional investors among corporate investors. This study utilizes the proportion of institutional investors within firms as a proxy indicator for corporate investor engagement. Samples exhibiting a higher proportion of institutional investors compared with the median value for corporate respective industries and quarters are classified as the multi-institutional investor group. Conversely, samples with a lower proportion than the median are categorized as the fewer institutional investor group.

The outcomes presented in columns (5)–(6) of Table 10 reveal that samples featuring a greater proportion of institutional investors in listed corporations exhibit a more pronounced contribution of ESG performance to corporate investment efficiency. This phenomenon can be attributed to the fact that in corporations with a higher concentration of institutional investors, the efficiency of transmitting the positive effects of good ESG disclosure is more substantial. Consequently, these positive effects are conveyed directly and effectively to investors.

## 6. Discussion

### 6.1. Theoretical implications

From a theoretical perspective, this study makes three significant contributions. First, good ESG performance has a positive effect on improving corporate investment efficiency, and its impact on under-investment is more significant compared to over-investment. Therefore, corporate decision-makers are encouraged to adopt a long-term sustainable strategic vision and recognize the enduring benefits of ESG practices, and make proactive investments in ESG initiatives. Compared to existing studies that primarily focus on the effects of Environmental [79], Social [21], or Governance [77,90] on corporate investment efficiency, this research adopts a more holistic approach by examining ESG performance as a unified rating. This comprehensive perspective provides a deeper understanding of how the combined effect of all three components influences investment efficiency. Furthermore, in the theoretical analysis, unlike existing studies [91] that primarily consider the impact of ESG performance on corporate performance from the perspective of agency problems, this paper integrates stakeholder theory and information asymmetry theory to focus on analyzing the impact of ESG performance on corporate investment efficiency from the viewpoint of external oversight.

Second, existing literature primarily explores the internal mechanisms and heterogeneity of ESG performance affecting corporate investment efficiency from perspectives such as board cultural diversity [23], audit quality and media exposure [81], managerial overconfidence [52], marketing capabilities [20], and asset class concentration [22]. Some studies have also examined the impact of ESG performance on financing constraints [40,91,92]. However, research examining the effect of ESG performance on corporate investment efficiency through the lens of financing constraints is limited. On the other hand, most existing research focuses on markets in countries such as the United States [20,21], South Korea [33,52], Canada [81], and India [22], with relatively few studies examining the Chinese market. Therefore, this study uses a sample of Chinese publicly listed companies to further explore the relationship between ESG performance, financing constraints, and corporate investment efficiency, contributing to the development and deepening of theory in this field, and assisting companies in devising more effective financing strategies and enhancing investment efficiency.

Third, in the heterogeneity analysis, the results show that ESG performance has a more significant impact on improving investment efficiency in low-pollution enterprises compared to heavy polluters. This may be because the environmental efforts of low-pollution companies are more likely to be perceived as genuine and credible by investors, while those of heavy polluters are more likely to be viewed as “greenwashing.” Therefore, heavy polluters should enhance the authenticity of their ESG practices by adopting more transparent measures to build investor trust. They should avoid superficial initiatives and prioritize meaningful environmental improvements to genuinely enhance investment efficiency and corporate reputation. This study is among the first to reveal a negative two-way relationship between industry characteristics and ESG performance, underscoring the need for heavy polluters not only to avoid “greenwashing” but also to moderate their ESG performance to prevent skepticism arising from overly positive portrayals.

### 6.2. Managerial and policy implications

This study offers practical implications for companies developing their ESG systems and for regulators guiding investor focus. Specifically, it includes the following aspects.

First, corporations should actively engage in ESG practices to enhance their ESG performance. The evidence suggests that strong ESG performance can alleviate financing constraints and improve corporate investment efficiency. Additionally, strengthening corporate social responsibility and improving information disclosure are essential for meeting sustainability requirements and integrating resources. Corporations should incorporate ESG principles into daily operations, product manufacturing, and investment choices, which can foster environmental awareness and corporate governance, contributing to long-term corporate sustainability.

Second, investors should leverage online platforms to better understand companies' ESG performance and ensure they are evaluating genuine ESG efforts. This can help identify and discourage “greenwashing” behaviors. The analysis also indicates that institutional investors can play a significant role in enhancing corporate investment efficiency based on ESG performance. To address financing constraints, financial institutions and institutional investors should support companies with strong ESG performance by promoting green bonds and green initiatives. This could contribute to the growth of a green capital market ecosystem in China, addressing corporate financing needs.

Third, from the perspective of regulatory bodies, it is important to accelerate the standardization and mandatory disclosure of ESG



reports and strengthen supervision to prevent deceptive practices like “greenwashing.” At present, ESG disclosure in China remains mostly voluntary, with no standardized framework governing report content and structure. This can result in inconsistencies and exaggerations. Strengthening monitoring systems will help improve the credibility of ESG reports, particularly from firms in heavily polluting industries, and increase investor confidence.

### 6.3. Limitations and future research agenda

This study has certain limitations, which suggest directions for future research. First, the sample size is constrained by the relatively recent introduction of ESG ratings in China and variations among rating agencies regarding ESG rating criteria, systems, and coverage. This study relies solely on the Huazheng ESG rating database, which may introduce potential biases in the results. Future research could incorporate alternative ESG rating databases to expand the sample size and improve the generalizability of the findings. Second, due to the accessibility and accuracy of Huazheng ESG data, the data in this study only covers the period from 2010 to 2021. Future studies could include ESG performance data from 2022 onwards to generate more robust conclusions. Third, although we explored the role of financing constraints in the relationship between ESG performance and corporate investment efficiency, this study did not explore the potential influence of other factors on this relationship. Future research could further explore other mechanisms through which ESG performance affects corporate investment efficiency, to gain a clearer understanding of their interaction.

## 7. Conclusion

This study explores the relationship between ESG performance and corporate investment efficiency using data of 3185 listed Chinese A-share corporate for 2010–2021. The findings can be summarized as follows. First, ESG performance improves corporate investment efficiency by suppressing under-investment and over-investment, and its impact on under-investment is more significant compared to over-investment. The possible reason is that ESG performance enhances the transparency of a firm’s non-financial performance and boosts investor confidence in the firm’s sustainability, thereby improving its financing capacity. Second, the influence of ESG performance on investment efficiency is partially mediated by financing constraints. That is, ESG performance improves investment efficiency by alleviating corporate financing constraints. Third, the effect of ESG performance on corporate investment efficiency differs across various types of firms. Private corporations, those categorized as light polluters, and businesses with a substantial institutional investor presence exhibit a more significant positive effect compared with state-owned enterprises, corporations in industries with heavier pollution footprints, and those with a limited proportion of institutional investors. These variations emphasize the diverse role of ESG performance across different corporate settings.

However, this research has certain limitations. Firstly, this study is based on publicly available ESG ratings, which may not fully reflect the breadth of ESG activities or reflect differences in reporting standards across firms. Secondly, the analysis is constrained to listed Chinese A-share companies, which may limit the generalizability of the findings to other markets or unlisted firms. Finally, while the study accounts for variations across different firm types, it does not fully explore the potential impact of external factors such as regulatory changes or economic conditions that may also affect the relationship between ESG performance and investment efficiency.

Future research could overcome these limitations by investigating the impact of ESG performance across different markets or economic contexts, potentially using cross-country data to enhance the understanding of global ESG dynamics. Longitudinal studies that track changes in ESG performance over time could provide insights into the causal relationship between ESG activities and investment outcomes.

### CRedit authorship contribution statement

**Wei Li:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Jian Zhu:** Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization. **Changqing Liu:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization.

### Informed consent

Not applicable.

### Data availability

Data associated with my study has not been deposited into a publicly available repository.  
Data will be made available on request.

### Ethical statement

This article does not contain any studies with human or animal subjects performed by any of the authors.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## References

- [1] S. Park, K.-S. Oh, Integration of ESG information into individual investors' corporate investment decisions: utilizing the UTAUT framework, *Front. Psychol.* 13 (2022) 899480, <https://doi.org/10.3389/fpsyg.2022.899480>.
- [2] F. Khalid, A. Razzaq, J. Ming, U. Razi, Firm characteristics, governance mechanisms, and ESG disclosure: how caring about sustainable concerns? *Environ. Sci. Pollut. Control Ser.* 29 (2022) 82064–82077, <https://doi.org/10.1007/s11356-022-21489-z>.
- [3] Z. Ni, Corporate ESG investment: factors affecting the economic sustainability, *Advances in Economics, Management and Political Sciences* 39 (2023) 210–214, <https://doi.org/10.54254/2754-1169/39/20231971>.
- [4] C. Zhu, X. Liu, D. Chen, Y. Yue, Executive compensation and corporate sustainability: evidence from ESG ratings, *Heliyon* 10 (2024) e32943, <https://doi.org/10.1016/j.heliyon.2024.e32943>.
- [5] C. Ye, X. Song, Y. Liang, Corporate sustainability performance, stock returns, and ESG indicators: fresh insights from EU member states, *Environ. Sci. Pollut. Control Ser.* 29 (2022) 20789, <https://doi.org/10.1007/s11356-022-20789-8>.
- [6] Y. Hao, ESG based on strategic map perspective: raising the dimension of corporate social responsibility from investment guidance, in: an overview on business, *Management and Economics Research* 1 (2023) 117–123, <https://doi.org/10.9734/bpi/aobmer/v1/7245A>.
- [7] S. Zainullin, O. Zainullina, Scientific review digitalization of corporate culture as a factor influencing ESG investment in the energy sector, *Int. Rev.* 1 (2021) 130–136, <https://doi.org/10.5937/intrev2102132Z>.
- [8] D. Zhang, Z. Zhao, C.K. Lau, Sovereign ESG and corporate investment: new insights from the United Kingdom, *Technol. Forecast. Soc. Change* 183 (2022) 121899, <https://doi.org/10.1016/j.techfore.2022.121899>.
- [9] R. Zhou, J. Hou, F. Ding, Understanding the nexus between environmental, social, and governance (ESG) and financial performance: evidence from Chinese-listed companies, *Environ. Sci. Pollut. Control Ser.* 30 (2023) 1–23, <https://doi.org/10.1007/s11356-023-27449-5>.
- [10] A.M. Habib, Do business strategies and environmental, social, and governance (ESG) performance mitigate the likelihood of financial distress? A multiple mediation model, *Heliyon* 9 (2023) e17847, <https://doi.org/10.1016/j.heliyon.2023.e17847>.
- [11] R. Anwar, J. Malik, When does corporate social responsibility disclosure affect investment efficiency? A new answer to an old question, *Sage Open* 10 (2020) 215824402093112, <https://doi.org/10.1177/2158244020931121>.
- [12] J.F. Houston, H. Shan, Corporate ESG profiles and banking relationships, *Rev. Financ. Stud.* 35 (2022) 3373–3417, <https://doi.org/10.1093/rfs/hhab125>.
- [13] M. Samet, A. Jarbouli, How does corporate social responsibility contribute to investment efficiency? *J. Multinat. Financ. Manag.* 40 (2017) 33–46, <https://doi.org/10.1016/j.mulfin.2017.05.007>.
- [14] R. Lambert, C. Leuz, R. Verrecchia, Accounting information, disclosure, and the cost of capital, *J. Account. Res.* 45 (2007) 385–420, <https://doi.org/10.1111/j.1475-679X.2007.00238.x>.
- [15] H. Liu, H.-A. Lee, A study on the relationship between ESG activities and earnings management of Chinese listed companies, *The Academic Society of Global Business Administration* 20 (2023) 65–90, <https://doi.org/10.38115/asgba.2023.20.2.65>.
- [16] M. Zhong, L. Gao, Does corporate social responsibility disclosure improve firm investment efficiency? Evidence from China, *Rev. Account. Finance* 16 (2017) 348–365, <https://doi.org/10.1108/RAF-06-2016-0095>.
- [17] R. Benabou, J. Tirole, Individual and corporate social responsibility, *Economica* 77 (2010) 1–19, <https://doi.org/10.1111/j.1468-0335.2009.00843.x>.
- [18] P. Krüger, Corporate goodness and shareholder wealth, *J. Financ. Econ.* 115 (2014) 62, <https://doi.org/10.2139/ssrn.2287089>.
- [19] A. Bhandari, D. Javakhadze, Corporate social responsibility and capital allocation efficiency, *J. Corp. Finance* 43 (2017) 354–377, <https://doi.org/10.1016/j.jcorpfin.2017.01.012>.
- [20] W. Hu, J. Sun, Y.-E. Lin, J. Hu, ESG and investment efficiency: the role of marketing capability, *Sustainability* 15 (2023) 16676, <https://doi.org/10.3390/su152416676>.
- [21] M. Benlemlih, M. Bitar, Corporate social responsibility and investment efficiency, *Journal of Business Ethics* Forthcoming (2018) 647–671, <https://doi.org/10.1007/s10551-016-3020-2>.
- [22] M. Dhuri, R. Sinha, S. Shukla, ESG ratings in India: assessing their reliability for investment decisions, *European Economics Letters* 14 (2024) 2731–2742, <https://doi.org/10.52783/eel.v14i2.1623>.
- [23] A. Al-Hiyari, M. Kolsi, O. Kehinde, Environmental, social and governance performance (ESG) and firm investment efficiency in emerging markets: the interaction effect of board cultural diversity, *Corporate Governance International Journal of Business in Society* 3 (2022) 650–673, <https://doi.org/10.1108/CG-03-2022-0133>.
- [24] L. Wang, J. Qi, H. Zhuang, Monitoring or collusion? Multiple large shareholders and corporate ESG performance: evidence from China, *Finance Res. Lett.* 53 (2023) 103673, <https://doi.org/10.1016/j.frl.2023.103673>.
- [25] X. Liu, Performance of corporate sustainability based on ESG perspective, *Advances in Economics, Management and Political Sciences* 13 (2023) 82–91, <https://doi.org/10.54254/2754-1169/13/20230675>.
- [26] K. Wang, S. Yu, M. Mei, X. Yang, G. Peng, B. Lv, ESG performance and corporate resilience: an empirical analysis based on the capital allocation efficiency perspective, *Sustainability* 15 (2023) 16145, <https://doi.org/10.3390/su152316145>.
- [27] T. Tang, L. Yang, Shaping corporate ESG performance: role of social trust in China's capital market, *China Finance Rev. Int.* 14 (2023) 34–75, <https://doi.org/10.1108/CFRI-07-2023-0187>.
- [28] Y. Qi, R. Wang, R. Wang, The impact of corporate ESG performance on environmental investment, *International Business & Economics Studies* 6 (2024) 99, <https://doi.org/10.22158/ibes.v6n1p99>.
- [29] B. Tian, J. Yu, Z. Tian, The impact of market-based environmental regulation on corporate ESG performance: a quasi-natural experiment based on China's carbon emission trading scheme, *Heliyon* 10 (2024) e26687, <https://doi.org/10.1016/j.heliyon.2024.e26687>.
- [30] F. Huang, M. Chen, R. Liu, The nature of corporate social responsibility disclosure and investment efficiency: evidence from China, *Front. Environ. Sci.* 11 (2023) 1028745, <https://doi.org/10.3389/fenvs.2023.1028745>.
- [31] S. Yao, Y. Li, J. Ni, Does the disclosure of internal control material deficiency remediation information matter for ESG performance? Evidence from China, *Heliyon* 10 (2024) e32933, <https://doi.org/10.1016/j.heliyon.2024.e32933>.
- [32] L. Xue, J. Dong, Y. Zha, How does digital finance affect firm environmental, social and governance (ESG) performance? — Evidence from Chinese listed firms, *Heliyon* 9 (2023) e20800, <https://doi.org/10.1016/j.heliyon.2023.e20800>.
- [33] J. Han, K. Jung, The effect of a company's ESG level on labor investment efficiency, *Korean Accounting Information Association* 42 (2024) 1–25, <https://doi.org/10.29189/KAIAAIR.42.1.1>.

- [34] Y. Liu, Y. Deng, Y. Liu, C. Li, M. Ankrah Twumasi, Y. Cheng, Do disclosure of ESG information policies inhibit the value of heavily polluting Enterprises?—evidence from China, *Heliyon* 9 (2023) e22750, <https://doi.org/10.1016/j.heliyon.2023.e22750>.
- [35] Khaled Hussainey, Tamanna Dalwai, Handbook of banking and finance in the MENA region | transformations in banking, *Financ. Regul.* 13 (2024) 452. <https://www.worldscientific.com/worldscibooks/10.1142/q0435>.
- [36] D. Niu, Z. Wang, Can ESG ratings promote green total factor productivity? Empirical evidence from Chinese listed companies, *Heliyon* 10 (2024) e29307, <https://doi.org/10.1016/j.heliyon.2024.e29307>.
- [37] Y. Wang, X. Wang, From ratings to action: the impact of ESG performance on corporate innovation, *Heliyon* 10 (2024) e26683, <https://doi.org/10.1016/j.heliyon.2024.e26683>.
- [38] A.M. Habib, N. Mourad, The influence of environmental, social, and governance (ESG) practices on US firms' performance: evidence from the coronavirus crisis, *J. Knowl. Econ.* 15 (2023) 2549–2570, <https://doi.org/10.1007/s13132-023-01278-w>.
- [39] Y. Liu, S. Wang, L. Chen, The impact of institutional investors' shareholding on the efficiency of corporate investment, *Advances in Economics and Management Research* 6 (2023) 177, <https://doi.org/10.56028/aemr.6.1.177.2023>.
- [40] Z. Yu, From ratings to action: the impact of ESG performance on corporate innovation, *Highlights in Business, Econ. Manag.* 16 (2023) 600–607, <https://doi.org/10.54097/hbem.v16i.10671>.
- [41] A.M. Habib, Does real earnings management affect a firm's environmental, social, and governance (ESG), financial performance, and total value? A moderated mediation analysis, *Environ. Dev. Sustain.* (2023), <https://doi.org/10.1007/s10668-023-03809-6>.
- [42] N. Zhu, E.N.T. Aryee, A.O. Agbemang, I. Wiredu, A. Zakari, S.Y. Agbadzidah, Addressing environment, social and governance (ESG) investment in China: does board composition and financing decision matter? *Heliyon* 10 (2024) e30783 <https://doi.org/10.1016/j.heliyon.2024.e30783>.
- [43] M. Wang, Y. Wang, S. Wen, ESG performance and green innovation in new energy enterprises: does institutional environment matter? *Res. Int. Bus. Finance* 71 (2024) 102495 <https://doi.org/10.1016/j.ribaf.2024.102495>.
- [44] B. Xiao, Z. Wenyao, T. Gera, ESG certification, green innovation, and firm value: a quasi-natural experiment based on SynTao Green Finance's ESG ratings: a pre-registered report, *Pac. Basin Finance J.* 86 (2024) 102453, <https://doi.org/10.1016/j.pacfin.2024.102453>.
- [45] G. Friede, T. Busch, A. Bassen, ESG and financial performance: aggregated evidence from more than 2000 empirical studies, *Journal of Sustainable Finance & Investment* 5 (2015) 210–233, <https://doi.org/10.1080/20430795.2015.1118917>.
- [46] X.-N. Yin, J.-P. Li, C.-W. Su, How does ESG performance affect stock returns? Empirical evidence from listed companies in China, *Heliyon* 9 (2023) e16320, <https://doi.org/10.1016/j.heliyon.2023.e16320>.
- [47] D. Christensen, G. Serafeim, A. Sikochi, Why is corporate virtue in the eye of the beholder? The case of ESG ratings, *Account. Rev.* 97 (2022) 147–175, <https://doi.org/10.2308/TAR-2019-0506>.
- [48] D. Zhang, B. Lucey, Sustainable behaviors and firm performance: the role of financial constraints' alleviation, *Econ. Anal. Pol.* 74 (2022) 220–233, <https://doi.org/10.1016/j.eap.2022.02.003>.
- [49] G. Giese, L.-E. Lee, D. Melas, Z. Nagy, L. Nishikawa, Foundations of ESG investing: how ESG affects equity valuation, Risk, and Performance 45 (2019) 69–83, <https://doi.org/10.3905/jpm.2019.45.5.069>.
- [50] F. He, C. Ding, W. Yue, G. Liu, ESG performance and corporate risk-taking: evidence from China, *Int. Rev. Financ. Anal.* 87 (2023) 102550, <https://doi.org/10.1016/j.irfa.2023.102550>.
- [51] J. Song, Corporate ESG performance and human capital investment efficiency, *Finance Res. Lett.* 62 (2024) 105239, <https://doi.org/10.1016/j.frl.2024.105239>.
- [52] J. Sim, The effect of overconfidence and ESG level on investment efficiency, *The Academic Society of Global Business Administration* 20 (2023) 20–39, <https://doi.org/10.38115/asgba.2023.20.6.20>.
- [53] R. Aroul, S. Sabherwal, S. Villupuram, ESG, operational efficiency and operational performance: evidence from Real Estate Investment Trusts, *Managerial Finance ahead-of-print* 48 (2022) 1206–1220, <https://doi.org/10.1108/MF-12-2021-0593>.
- [54] H. Servaes, A. Tamayo, The impact of corporate social responsibility on firm value: the role of customer awareness, *Manag. Sci.* 59 (2013) 1045–1061, <https://doi.org/10.1287/mnsc.1120.1630>.
- [55] Z. Mao, S. Wang, Y. Lin, ESG , ESG rating divergence and earnings management: evidence from China, *Corp. Soc. Responsib. Environ. Manag.* 31 (2024) 3328–3347, <https://doi.org/10.1002/csr.2748>.
- [56] ESG performance, investor attention, and company reputation: threshold model analysis based on panel data from listed companies in China, *Heliyon* 9 (2023) e20974, <https://doi.org/10.1016/j.heliyon.2023.e20974>.
- [57] Y. Lu, R. Liu, Y. Cao, Y. Li, Tax burden and corporate investment efficiency, *Sustainability* 15 (2023) 1747, <https://doi.org/10.3390/su15031747>.
- [58] M. Arif, A. Sajjad, S. Farooq, M. Abrar, A.S. Joyo, M. Porto Ferreira, The impact of audit committee attributes on the quality and quantity of environmental, social and governance (ESG) disclosures, *Corporate Governance International Journal of Business in Society ahead-of-print* 21 (2020) 497–514, <https://doi.org/10.1108/CG-06-2020-0243>.
- [59] J. Du, W. Li, B. Lin, Y. Wang, Government integrity and corporate investment efficiency, *China Journal of Accounting Research* 11 (2018) 213–232, <https://doi.org/10.1016/j.cjar.2017.03.002>.
- [60] B. Zhou, S. Zhao, Industrial policy and corporate investment efficiency, *J. Asian Econ.* 78 (2021) 101406, <https://doi.org/10.1016/j.asieco.2021.101406>.
- [61] J. Li, X. Qin, Y.-E. Lin, Strategy corporate social responsibility and investment efficiency: the role of substitute and complement, *Bus. Soc.* (2024), <https://doi.org/10.1177/00076503241254544>.
- [62] A. Kaab Omeir, A. Jorjorzadeh, M. Ghaeed, V. Khodadadi, Corporate governance and investment efficiency: with emphasis on managerial conservatism, *Manag. Sci.* 63 (2024) 279–585, <https://doi.org/10.1287/mnsc.2015.2341>.
- [63] Z. Chen, K. Jiang, Digitalization and corporate investment efficiency: evidence from China, *J. Int. Financ. Mark. Inst. Money* 91 (2024) 101915, <https://doi.org/10.1016/j.intfin.2023.101915>.
- [64] A. Kouaib, Corporate sustainability disclosure and investment efficiency: the Saudi arabian context, *Sustainability* 14 (2022) 13984, <https://doi.org/10.3390/su142113984>.
- [65] K. Cook, A. Romi, D. Sanchez, J. Sánchez, The influence of corporate social responsibility on investment efficiency and innovation, *J. Bus. Finance Account.* 46 (2018) 494–537, <https://doi.org/10.1111/jbfa.12360>.
- [66] N. Ellili, Impact of ESG disclosure and financial reporting quality on investment efficiency, *Corporate Governance, The International Journal of Business in Society* 22 (2022) 1094–1111, <https://doi.org/10.1108/CG-06-2021-0209>.
- [67] N. Adambekov, Z. Adambekova, A. Filipowska, Impact of ESG on the investment attractiveness of business, *Central Asian Economic Review* 2 (2023) 105–117, <https://doi.org/10.52821/2789-4401-2023-2-105-117>.
- [68] L. Liao, G. Chen, D. Zheng, Corporate social responsibility and financial fraud: evidence from China, *Account. Finance* 59 (2019) 3133–3169, <https://doi.org/10.1111/acfi.12572>.
- [69] A. Issa, H. Yousef, A. Bakry, J. Hanaysha, A. Sahyouni, Does the board diversity impact bank performance in the MENA countries? A multilevel study, *Corporate Governance: the International, Journal of Business in Society ahead-of-print* 21 (2021) 865–891, <https://doi.org/10.1108/CG-06-2020-0222>.
- [70] M. Linnenluecke, Environmental, social and governance (ESG) performance in the context of multinational business research, *Multinat. Bus. Rev.* 30 (2022) 1–16, <https://doi.org/10.1108/MBR-11-2021-0148>.
- [71] Y. Huang, F. Bai, M. Shang, M. Ahmad, On the fast track: the benefits of ESG performance on the commercial credit financing. <https://doi.org/10.21203/rs.3.rs-2665493/v1>, 2023.
- [72] X. Hu, ESG and financial constraints, *SHS Web of Conferences* 169 (2023) 5, <https://doi.org/10.1051/shsconf/202316901071>.
- [73] A. Hamrouni, R. Boussaada, N. Ben Farhat Toumi, Corporate social responsibility disclosure and debt financing, *J. Appl. Account. Res.* 20 (2019) 394–415, <https://doi.org/10.1108/JAAR-01-2018-0020>.
- [74] X. Bai, J. Han, Y. Ma, W. Zhang, ESG performance, institutional investors' preference and financing constraints: empirical evidence from China, *Borsa Istanbul Review* 22 (2022) S157–S168, <https://doi.org/10.1016/j.bir.2022.11.013>.

- [75] X. Lai, Z. Fan, Can ESG certification help company get out of over-indebtedness? Evidence from China, *Pac. Basin Finance J.* 76 (2022) 101878, <https://doi.org/10.1016/j.pacfin.2022.101878>.
- [76] M. Gibson, Is Corporate Governance Ineffective in Emerging Markets?, *Finance and Economics Discussion Series* 1999, 1999, pp. 1–39, <https://doi.org/10.17016/FEDS.1999.63>.
- [77] Y. He, C. Chen, H. Yue, Managerial overconfidence, internal financing, and investment efficiency: evidence from China, *Res. Int. Bus. Finance* 47 (2018) 501–510, <https://doi.org/10.1016/j.ribaf.2018.09.010>.
- [78] M. Bostian, R. Färe, S. Grosskopf, T. Lundgren, Environmental investment and firm performance: a network approach, *Energy Econ.* 57 (2016) 243–255, <https://doi.org/10.1016/j.eneco.2016.05.013>.
- [79] S. Zeng, Y. Qin, G. Zeng, Impact of corporate environmental responsibility on investment efficiency: the moderating roles of the institutional environment and consumer environmental awareness, *Sustainability* 11 (2019) 4512, <https://doi.org/10.3390/su11174512>.
- [80] M. Hai, Z. Fang, Z. Li, Does business group's conscious of social responsibility enhance its investment efficiency? Evidence from ESG disclosure of China's listed companies, *Sustainability* 14 (2022) 4817, <https://doi.org/10.3390/su14084817>.
- [81] A. Hammami, M. Zadeh, Audit quality, media coverage, environmental, social, and governance disclosure and firm investment efficiency: evidence from Canada, *International Journal of Accounting & Information Management ahead-of-print* 28 (2019) 45–72, <https://doi.org/10.1108/IJAIM-03-2019-0041>.
- [82] P. Li, R. Zhou, Y. Xiong, Can ESG performance affect bond default rate? Evidence from China, *Sustainability* 12 (2020) 2954, <https://doi.org/10.3390/su12072954>.
- [83] S. Richardson, Over-investment of free cash flow, *Rev. Account. Stud.* 11 (2006) 159–189, <https://doi.org/10.1007/s11142-006-9012-1>.
- [84] G. Biddle, G. Hilary, R. Verdi, How does financial reporting quality improve investment efficiency? *J. Account. Econ.* 48 (2009) 112–131, <https://doi.org/10.2139/ssrn.1146536>.
- [85] X. He, J. Shi, The effect of air pollution on Chinese green bond market: the mediation role of public concern, *J. Environ. Manag.* 325 (2023) 116522, <https://doi.org/10.1016/j.jenvman.2022.116522>.
- [86] N. Ellili, Impact of ESG disclosure and financial reporting quality on investment efficiency, *Corporate Governance, The International Journal of Business in Society* 22 (2022) 1094–1111, <https://doi.org/10.1108/CG-06-2021-0209>.
- [87] S. Zeng, Y. Qin, G. Zeng, Impact of corporate environmental responsibility on investment efficiency: the moderating roles of the institutional environment and consumer environmental awareness, *Sustainability* 11 (2019) 4512, <https://doi.org/10.3390/su11174512>.
- [88] R. Baron, D. Kenny, The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations, *J. Pers. Soc. Psychol.* 51 (1986) 1173–1182, <https://doi.org/10.1037//0022-3514.51.6.1173>.
- [89] K. Wu, D. Kong, W. Yang, Does environmental, social, and governance rating affect firms' real earnings management — evidence from China, *Finance Res. Lett.* 67 (2024) 105764, <https://doi.org/10.1016/j.frl.2024.105764>.
- [90] M. Sultan Sikandar, M.A. Majeed, T. Ahsan, Board gender diversity, competitive pressure and investment efficiency in Chinese private firms, *Eurasian Business Review* 10 (2019) 417–440, <https://doi.org/10.1007/s40821-019-00138-5>.
- [91] C. Méndez, C. Maquieira, J. Arias, The impact of ESG performance on the value of family firms: the moderating role of financial constraints and agency problems, *Sustainability* 15 (2023) 6176, <https://doi.org/10.3390/su15076176>.
- [92] T. Guimarães, R. Malaquias, Performance of equity mutual funds considering ESG investments, financial constraints, and the COVID-19 pandemic, *Brazilian Business Review* 20 (2023) 18–37, <https://doi.org/10.15728/bbr.2023.20.1.2.en>.