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Do ESG Practices Improve Firm Investment Efficiency in China? Evidence from Overinvestment and Underinvestment

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Abstract

Against the backdrop of the global sustainability transition, ESG performance has become a critical factor shaping firms' resource allocation efficiency and long-term value creation. Although a growing body of literature has examined the economic consequences of ESG, existing evidence on its effect on investment efficiency remains limited, particularly in emerging markets. Using panel data on 4,047 Chinese A-share listed firms from the Shanghai and Shenzhen stock exchanges over the period 2014–2024, this study employs a two-way fixed effects model to systematically examine the impact of the performance of ESG and its pillars on firm investment efficiency. To provide a more detailed understanding, this study further distinguishes between two forms of investment inefficiency, namely overinvestment and underinvestment. The empirical results show that ESG performance significantly improves firm investment efficiency, and that the environmental, social, and governance pillars all exert significant positive effects. Further analysis indicates that the effect of ESG performance on overinvestment is not significant, and only the environmental pillar shows a significant negative effect. This suggests that ESG performance may be less effective in constraining overinvestment driven by managerial opportunism or the misuse of free cash flow. In contrast, ESG performance plays a more significant and robust role in alleviating underinvestment, with all three pillars significantly reducing the level of underinvestment. These findings enrich the literature on the economic consequences of ESG from the perspective of investment efficiency and provide new empirical evidence on how ESG performance improves firms' resource allocation efficiency in emerging markets. The study also provides practical implications for firms, policymakers, and financial institutions seeking to promote more efficient investment decisions through ESG practices.

Keywords: ESG Performance, ESG Pillars, Investment Efficiency, Overinvestment, Underinvestment

Introduction

Investment efficiency is widely regarded as a core indicator of firms' capital allocation quality and is central to their long-term value creation (Richardson, 2006). When firms invest efficiently, firms can identify and undertake projects with positive net present value, thereby improving future cash flows and profitability. If a firm's investment deviates from its optimal level, resource misallocation may occur, reducing investment returns and increasing the likelihood of financial distress (Biddle et al., 2009). In practice, inefficient investment is pervasive, mainly due to information asymmetry and agency problems, and it mainly takes two forms: overinvestment and underinvestment. Overinvestment often arises when firms possess abundant financial resources and face severe agency conflicts. In such cases, managers may invest in projects with low marginal returns in pursuit of expansion or private interests (Barnea & Rubin, 2010; Jensen & Meckling, 1976). Underinvestment is more likely to occur when firms face severe information asymmetry or rising financial risk. Even when positive-NPV projects are available, firms may be unable to undertake them because of high external financing costs or limited internal funds, resulting in underinvestment and the loss of growth opportunities (Cariola et al., 2005).

Although ESG is widely regarded as an increasingly influential driver of firm sustainability, its effect on investment efficiency remains inconclusive. On the one hand, in the pursuit of higher ESG performance, firms may allocate excessive resources to environmental governance and social welfare projects, which may generate lower returns than core business activities and thereby reduce overall investment efficiency. Agency theory further suggests that managers may overinvest in corporate social responsibility initiatives for reputational purposes, thereby exacerbating investment inefficiency (Barnea & Rubin, 2010). On the other hand, although strong ESG performance may improve firms' access to external financing, the substantial upfront investment and compliance costs associated with ESG activities may still increase short-term financial pressure (Brogi et al., 2022). Even when ESG facilitates external capital access, limited internal cash flow may continue to constrain firms' ability to undertake optimal investment, thereby resulting in underinvestment (Campello et al., 2010). In addition, sustainable finance instruments such as green bonds are often accompanied by specific restrictions on the use of proceeds. While such instruments help channel capital toward environmentally sustainable projects, they may also reduce firms' flexibility in capital allocation (Flammer, 2021). This may create a mismatch between financing conditions and firms' actual investment needs, thereby undermining overall investment efficiency. Taken together, these competing arguments suggest that the effect of ESG performance on investment efficiency is theoretically ambiguous. Whether ESG performance alleviates or exacerbates investment inefficiency therefore remains an important empirical question.

Despite the growing importance of ESG performance in firm decision-making, existing research has primarily examined its effects on financial performance, market value, and innovation activities, while evidence on its impact on investment efficiency remains limited (Long et al., 2023; Malik & Kashiramka, 2024; Saygili et al., 2022). The current literature has three main limitations. First, most studies rely on aggregate ESG scores or a single ESG dimension, making it difficult to identify the heterogeneous roles of the environmental, social, and governance pillars in shaping firm behavior and resource allocation (Ho et al., 2022). Second, systematic empirical evidence on how ESG performance affects overinvestment and underinvestment separately remains scarce (Lian & Weng, 2024). Third, although research on

ESG performance and firm investment decisions in developed markets is relatively well established, empirical evidence from emerging economies remains insufficient (Poursoleyman et al., 2024).

To address these gaps, this study uses a panel dataset of Chinese A-share listed firms on the Shanghai and Shenzhen stock exchanges from 2014 to 2024 and employs a two-way fixed effects model to examine the relationship between ESG performance and investment efficiency. Specifically, it examines not only the overall effect of ESG performance, but also the heterogeneous effects of the environmental, social, and governance pillars on investment efficiency. In addition, by distinguishing between overinvestment and underinvestment, this study provides a more refined analysis of how ESG performance affects different forms of investment inefficiency. To ensure the reliability of the findings, a series of robustness checks are further conducted, including the use of alternative measures of investment efficiency, lagged ESG variables, exclusion of the COVID-19 pandemic years, and the inclusion of additional control variables. Furthermore, to alleviate potential endogeneity concerns arising from reverse causality, omitted variables, and sample selection bias, this study further employs lagged ESG variables, the Heckman two-stage selection model, and the system GMM estimator.

This study contributes to the literature in three main ways. First, rather than treating ESG as a single composite construct, this study decomposes ESG into its environmental, social, and governance pillars and examines their distinct effects on investment efficiency. This pillar-level analysis is crucial because the three dimensions reflect different corporate activities and may influence firms' investment behavior through different mechanisms. By moving beyond the aggregate ESG score, this study provides a more detailed understanding of how specific ESG pillars shape firms' capital allocation decisions and responds to the limited pillar-level evidence in the existing literature. Second, this study distinguishes between overinvestment and underinvestment and investigates the effect of ESG performance on each type of investment inefficiency separately. This distinction matters because overinvestment and underinvestment arise from different underlying frictions, such as agency problems and financing constraints, and may therefore be affected by ESG performance in different ways. By separating these two forms of inefficiency, this study offers a more refined assessment of the role of ESG performance in mitigating investment distortions and helps clarify the specific channels through which ESG performance affects firm investment behavior. Third, by focusing on Chinese A-share listed firms, this study extends the literature to an important emerging market setting. China provides a particularly relevant context because firms often face relatively high levels of information asymmetry and financing frictions, while ESG disclosure practices and related regulatory frameworks are still evolving. Examining this context not only enriches the evidence beyond developed markets, but also provides insight into whether and how ESG can serve as a governance and information mechanism to improve investment decisions in emerging economies.

Literature Review and Hypotheses

Stakeholder theory provides an important theoretical foundation for understanding how ESG performance affects corporate investment efficiency. This theory argues that firms should not serve only shareholders, but should also respond to the interests of multiple stakeholders, including employees, customers, suppliers, and local communities (Freeman, 1984). From this

perspective, ESG practices can improve the information environment surrounding firm investment decisions by enhancing disclosure quality, reducing agency conflicts, and strengthening external monitoring, thereby improving capital allocation efficiency (Lin et al., 2023). Existing empirical studies generally support a positive relationship between ESG performance and investment efficiency. In both developed and emerging markets, firms with stronger ESG performance tend to exhibit more efficient investment decisions and better capital allocation (Bilyay-Erdogan et al., 2024). Samet and Jarboui (2017), based on a sample of European firms, find that strong CSR performance improves investment efficiency for both underinvesting and overinvesting firms. Specifically, for underinvesting firms, better CSR performance promotes investment by reducing information asymmetry and improving external financing conditions. For overinvesting firms, CSR performance helps curb overinvestment by constraining the discretionary use of free cash flow and restraining managers' inefficient expansion behavior. Similarly, Al-Hiyari et al. (2022), using data from listed firms in seven emerging economies, find that firms with stronger ESG performance generally have higher investment efficiency. However, when board cultural diversity is high, the effectiveness of ESG performance in constraining managerial overinvestment becomes weaker. Likewise, Lian and Weng (2024) confirm that improvements in ESG performance can alleviate inefficient investment by reducing performance volatility and increasing market attention. Lin et al. (2025) also find that strong ESG performance promotes more efficient resource allocation, and that financial constraints, cash flow, and information transparency serve as important channels linking ESG ratings to investment efficiency.

The three ESG pillars affect firm investment efficiency through distinct channels. In the environmental pillar, firms with strong environmental performance face lower risks of regulatory penalties and environmental incidents, which helps stabilize future cash flows and supports long-term investment in high-return projects (Plumlee et al., 2015). Firms with better environmental performance also tend to use resources more efficiently, thereby improving investment efficiency (Rehman et al., 2024). In the social pillar, strong social performance enhances stakeholder trust and support, reduces transaction costs and conflict risks, and facilitates the implementation of investment projects (Ho et al., 2022). Firms that actively fulfill their social responsibilities typically face lower operating risk and are therefore more likely to achieve higher investment efficiency (Poursoleyman et al., 2024). In the governance pillar, an effective governance structure can constrain managerial opportunism and short-term speculative behavior, thereby reducing overinvestment and resource misallocation (Tran Phuong et al., 2022). Effective governance also promotes more systematic evaluation of capital budgeting and strategic decisions, which improves overall investment efficiency (Arora & Sharma, 2016). Therefore, this study proposes the following hypothesis:
H1: The performance of ESG and its pillars are positively associated with firm investment efficiency.

Overinvestment typically arises when firms have abundant internal funds, weak external monitoring, and limited constraints on managerial decision-making. When firms hold substantial cash flow, those with overconfident managers or more severe managerial opportunism are more likely to engage in overinvestment (Chiu et al., 2022; Wang et al., 2023). From the perspective of agency theory, firms with stronger ESG performance tend to have more effective governance mechanisms, which can restrain managerial incentives to pursue empire building or private benefits, thereby reducing overinvestment associated with

excess free cash flow (Lin et al., 2023). Empirical studies generally support this view. Ho et al. (2022) find that firms with strong CSR performance exhibit higher investment efficiency, and this effect is particularly pronounced in cases of overinvestment. One possible explanation is that CSR performance helps reduce information asymmetry and agency costs, thereby improving the quality of investment allocation. Liu and Tian (2021) further show that, among Chinese firms facing more severe agency problems, mandatory CSR disclosure reduces overinvestment. Similarly, Zhong and Gao (2017) find that CSR disclosure helps reduce information asymmetry and improve investment efficiency, with the effect being more pronounced for overinvesting firms. Guo et al. (2024) also report that higher-quality CSR disclosure can significantly alleviate both underinvestment and overinvestment by reducing agency costs and easing financing constraints, thereby improving investment efficiency. Consistent with this evidence, Bilyay-Erdogan et al. (2024) confirm a significant positive relationship between ESG performance and investment efficiency and further show that ESG engagement can mitigate overinvestment among firms with higher information asymmetry. In addition, Petcharat and Mula (2025) find that improvements in ESG reporting quality not only enhance investment efficiency but also significantly reduce corporate overinvestment. Therefore, this study proposes the following hypothesis:

H2: The performance of ESG and its pillars are negatively associated with firm overinvestment.

Underinvestment is closely associated with agency conflicts and information asymmetry, both of which hinder firms from obtaining the financial resources needed to undertake all value-creating investment opportunities (Cariola et al., 2005). When outside investors or creditors cannot accurately assess a firm's operating condition and project quality, the firm is likely to face higher financing costs. As a result, it may be unable to secure sufficient funding for positive-NPV projects, which ultimately leads to underinvestment. Li et al. (2021) point out that environmental uncertainty intensifies financing constraints, causing underinvesting firms to further reduce capital expenditure and indirectly lowering investment efficiency. In this context, ESG performance may help alleviate underinvestment through several channels. Firms with strong ESG performance tend to exhibit greater information transparency, which strengthens stakeholder trust and support and reduces underinvestment arising from financing constraints (Benlemlih & Bitar, 2018). Cook et al. (2019) further find that firms with stronger corporate social responsibility performance generally exhibit higher investment efficiency. High-CSR firms are less likely to invest excessively in negative-NPV projects and are better able to avoid underinvestment. Zamir et al. (2020) show that, among large firms in emerging Asian markets, corporate social responsibility disclosure primarily helps alleviate underinvestment, whereas its effect on restraining overinvestment is insignificant. One explanation is that CSR disclosure improves external financing conditions by increasing information transparency and reducing information asymmetry, thereby helping firms undertake projects with positive returns. However, its ability to curb overinvestment is relatively limited when overinvestment is driven by low reliance on external financing or by agency motives. Liu (2025) finds that strong ESG performance can improve managerial efficiency and significantly curb inefficient investment behavior, including both underinvestment and overinvestment. Therefore, this study proposes the following hypothesis:

H3: The performance of ESG and its pillars are negatively associated with firm underinvestment.

Methodology

Sample Selection and Data Sources

This study selects A-share listed firms from the Shanghai and Shenzhen stock exchanges in China as the research sample, covering the period from 2014 to 2024. Following prior studies, the original sample is screened as follows: first, firms designated as ST, *ST, or PT during the sample period are excluded. Second, firms in the financial and insurance industries are excluded. Third, observations with missing ESG ratings or financial data are excluded. In addition, all continuous variables are winsorized at the 1st and 99th percentiles to reduce the influence of extreme outliers. The final sample consists of 24,937 firm-year observations from 4,047 listed firms, forming an unbalanced panel dataset. ESG scores are obtained from the Sino-Securities Index Information Service Co., Ltd. (SNSI), and the financial data are sourced from the China Stock Market and Accounting Research (CSMAR) Database.

Variable Measurement

First, the measurement of investment efficiency follows the model proposed by Richardson (2006). The absolute value of the residuals estimated from the model is used to measure the degree of inefficient investment. A larger absolute residual indicates a greater deviation from the optimal level of investment and, therefore, lower investment efficiency. In this study, the positive residual and the absolute value of the negative residual are used to measure overinvestment and underinvestment, respectively. The model is specified as follows.

$$InvEff_{t} = \alpha_0 + \alpha_1 Growth_{t-1} + \alpha_2 Lev_{t-1} + \alpha_3 Cash_{t-1} + \alpha_4 Age_{t-1} + \alpha_5 Size_{t-1} + \alpha_6 Ret_{t-1} + \alpha_7 Inv_{t-1} + \sum Industry + \sum Year + \varepsilon \quad (3.1)$$

In Equation (3.1), $InvEff$ denotes investment inefficiency in year t, $\sum Industry$ and $\sum Year$ represent industry and year fixed effects, and ε is the residual term. The model also includes growth ($Growth$), financial leverage (Lev), cash holding ($Cash$), listing age (Age), asset size ($Size$), stock return (Ret), and investment expenditure (Inv).

Second, this study measures ESG performance using the SNSI ESG rating. Compared with international rating systems, the Sino-Securities ESG rating provides full coverage of Chinese A-share listed firms, making it particularly suitable for research in the Chinese context. In addition, its evaluation framework is more closely aligned with China's institutional setting and capital market environment. The ratings are updated quarterly and adjusted dynamically in response to major ESG events, enabling the index to capture changes in ESG performance in a timely manner. The overall ESG score and its pillar scores all range from 0 to 100, with higher values indicating better ESG performance.

Third, this paper controls for firm age (Age), firm size ($Size$), cash flow ($CashFlow$), growth capacity ($Growth$), leverage ratio (Lev), fixed asset ratio ($Fixed$), board size ($Board$). Table 1 provides the definitions and measurements of all variables.

Table 1
Variable definitions

Variables	Definition
Investment efficiency (InvEff)	Absolute residuals of the Richardson's regression model
ESG performance (ESG)	ESG performance is measured by the Sino-Securities ESG score.
Firm age (Age)	Natural logarithm of 1 plus the number of years for firm has been listed
Firm size (Size)	Natural logarithm of total assets
Cash flow (CashFlow)	Ratio of operating cash flows to total debt
Growth capacity (Growth)	Ratio of current year revenue minus previous year revenue to previous year revenue
Leverage (Lev)	Ratio of total liabilities to total assets
Fixed asset ratio (Fixed)	Ratio of fixed assets to total assets
Board size (Board)	Natural logarithm of the number of board directors

To examine the relationship between ESG performance and firm investment efficiency, this study employs a two-way fixed effects model. If the coefficient on ESG performance or its pillar variables is statistically significant, this indicates a significant relationship between ESG performance and firm investment efficiency. Based on Hypothesis H1, this study specifies the following two baseline regression models:

$$InvEff_{it} = \alpha_0 + \alpha_1 ESG_{it} + \alpha_2 Age_{it} + \alpha_3 Size_{it} + \alpha_4 CashFlow_{it} + \alpha_5 Growth_{it} + \alpha_6 Lev_{it} + \alpha_7 Fixed_{it} + \alpha_8 Board_{it} + \sum INDUSTRY + \sum YEAR + \varepsilon_{it} \quad (3.2)$$

$$InvEff_{it} = \alpha_0 + \alpha_1 E_{it} + \alpha_2 S_{it} + \alpha_3 G_{it} + \alpha_4 Age_{it} + \alpha_5 Size_{it} + \alpha_6 CF_{it} + \alpha_7 Growth_{it} + \alpha_8 Lev_{it} + \alpha_9 Fixed_{it} + \alpha_{10} Board_{it} + \sum INDUSTRY + \sum YEAR + \varepsilon_{it} \quad (3.3)$$

Furthermore, to test H2 and H3, this study decomposes inefficient investment into overinvestment and underinvestment, and the following models are specified:

$$OverInv_{it} = \alpha_0 + \alpha_1 ESG_{it} + \alpha_2 Age_{it} + \alpha_3 Size_{it} + \alpha_4 CashFlow_{it} + \alpha_5 Growth_{it} + \alpha_6 Lev_{it} + \alpha_7 Fixed_{it} + \alpha_8 Board_{it} + \sum INDUSTRY + \sum YEAR + \varepsilon_{it} \quad (3.4)$$

$$OverInv_{it} = \alpha_0 + \alpha_1 E_{it} + \alpha_2 S_{it} + \alpha_3 G_{it} + \alpha_4 Age_{it} + \alpha_5 Size_{it} + \alpha_6 CF_{it} + \alpha_7 Growth_{it} + \alpha_8 Lev_{it} + \alpha_9 Fixed_{it} + \alpha_{10} Board_{it} + \sum INDUSTRY + \sum YEAR + \varepsilon_{it} \quad (3.5)$$

$$UnderInv_{it} = \alpha_0 + \alpha_1 ESG_{it} + \alpha_2 Age_{it} + \alpha_3 Size_{it} + \alpha_4 CashFlow_{it} + \alpha_5 Growth_{it} + \alpha_6 Lev_{it} + \alpha_7 Fixed_{it} + \alpha_8 Board_{it} + \sum INDUSTRY + \sum YEAR + \varepsilon_{it} \quad (3.6)$$

$$UnderInv_{it} = \alpha_0 + \alpha_1 E_{it} + \alpha_2 S_{it} + \alpha_3 G_{it} + \alpha_4 Age_{it} + \alpha_5 Size_{it} + \alpha_6 CF_{it} + \alpha_7 Growth_{it} + \alpha_8 Lev_{it} + \alpha_9 Fixed_{it} + \alpha_{10} Board_{it} + \sum INDUSTRY + \sum YEAR + \varepsilon_{it} \quad (3.7)$$

Results and Discussion

Descriptive Statistics and Pearson Correlation Test

Table 2 presents the descriptive statistics of the variables. The mean value of the overall ESG score is 0.6825, indicating that the sample firms exhibit a relatively high level of ESG performance. Among the three ESG pillars, the governance pillar has the highest mean value (0.7882), whereas the environmental pillar has the lowest mean value (0.6138). The mean value of investment inefficiency is 0.0396, suggesting that the sample firms exhibit some

degree of inefficient investment on average. In addition, the control variables display reasonable distributions, supporting the subsequent empirical analysis.

Table 2
Summary statistics

Variable	N	Mean	SD	Min	Max
ESG	24937	0.6825	0.0837	0.4344	0.8760
E	24937	0.6138	0.0637	0.4675	0.7995
S	24937	0.7546	0.0699	0.5172	0.9290
G	24937	0.7882	0.0546	0.6080	0.8987
InvEff	24937	0.0396	0.0490	0.0004	0.2988
OverInv	24937	0.0186	0.0408	0	0.2387
UnderInv	24937	0.0197	0.0310	0	0.1691
Age	24937	2.2930	0.6757	1.0986	3.3673
Size	24937	22.3994	1.2443	20.1193	26.2899
Growth	24937	0.1389	0.3455	-0.5199	1.9990
CF	24937	0.0583	0.0735	-0.1460	0.2918
Lev	24937	0.4189	0.1928	0.0594	0.8702
Fixed	24937	0.2133	0.1530	0.0035	0.6792
Board	24937	2.1098	0.1960	1.6094	2.6391

Table 3 presents the Pearson correlation matrix of the main variables. Overall, the correlation coefficient between ESG and investment is −0.069 ($p < 0.01$), indicating that firms with better ESG performance tend to exhibit lower levels of inefficient investment. In addition, the variance inflation factor (VIF) results show that the mean VIF of all variables is 1.24, which is well below the commonly used threshold of 5, indicating that the model does not suffer from serious multicollinearity.

Table 3
Pearson correlation

	ESG	InvEff	Age	Size	Growth	CF	Lev	Fixed	Fixed
ESG	1								
InvEff	-0.069***	1							
Age	-0.121***	-0.118***	1						
Size	0.155***	-0.105***	0.402***	1					
Growth	-0.00600	0.187***	-0.100***	0.044***	1				
CF	0.114***	0.042***	-0.032***	0.100***	0.096***	1			
Lev	-0.147***	-0.043***	0.271***	0.461***	0.026***	-0.161***	1		
Fixed	-0.086***	0.035***	0.132***	0.150***	-0.045***	0.175***	0.116***	1	
Board	-0.012*	-0.045***	0.187***	0.269***	-0.00100	0.032***	0.133***	0.138***	1

Notes: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$; Standard errors are reported in parentheses

Baseline Regression

This section presents the baseline results on the effects of ESG performance and its three pillars on firm investment efficiency. The Hausman test yields a p-value of 0.000, thus rejecting the null hypothesis at the 1% significance level and supporting the use of a two-way fixed effects model. Table 4 reports the baseline regression results for ESG performance and the investment efficiency. As shown in column (1), the coefficient on the overall ESG performance is −0.0303 ($p < 0.01$), indicating that better ESG performance is associated with a lower degree of investment inefficiency and, therefore, higher investment efficiency. This finding suggests that strong ESG performance helps improve firm investment efficiency, thereby supporting Hypothesis H1. The finding is consistent with stakeholder theory, which posits that better ESG performance can strengthen stakeholder relationships, improve internal governance, and enhance external financial support, thereby creating more favorable conditions for investment decisions. This result is also in line with Bilyay-Erdogan et al. (2024), who document a significant positive relationship between ESG performance and investment efficiency.

Table 4
ESG performance and investment efficiency

	(1) InvEff	(2) InvEff	(3) InvEff	(4) InvEff
ESG	-0.0303***			
	(0.0048)			
E		-0.0224***		
		(0.0061)		
S			-0.0230***	
			(0.0060)	
G				-0.0262***
				(0.0075)
Age	-0.0065***	-0.0060***	-0.0063***	-0.0061***
	(0.0007)	(0.0007)	(0.0007)	(0.0007)
Size	-0.0027***	-0.0031***	-0.0031***	-0.0032***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Growth	0.0238***	0.0239***	0.0240***	0.0240***
	(0.0015)	(0.0015)	(0.0015)	(0.0015)
CF	0.0196***	0.0184***	0.0181***	0.0188***
	(0.0058)	(0.0058)	(0.0058)	(0.0058)
Lev	0.0065***	0.0094***	0.0094***	0.0066**
	(0.0025)	(0.0025)	(0.0025)	(0.0026)
Fixed	0.0047	0.0048	0.0043	0.0045
	(0.0032)	(0.0032)	(0.0032)	(0.0032)
Board	-0.0078***	-0.0076***	-0.0075***	-0.0081***
	(0.0019)	(0.0019)	(0.0019)	(0.0019)
Cons	0.1444***	0.1443***	0.1484***	0.1553***
	(0.0091)	(0.0091)	(0.0096)	(0.0101)
N	24936	24936	24936	24936
R^2	0.1339	0.1325	0.1326	0.1325
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes

Notes: *p < 0.10, **p < 0.05, ***p < 0.01; Standard errors are reported in parentheses

Further, columns (2) to (4) show that the coefficients on all three ESG pillars are significantly negative, thereby supporting the pillar-level hypotheses of Hypothesis H1. Specifically, the coefficient on environmental performance is −0.0224 ($p < 0.01$), suggesting that stronger environmental performance is associated with a lower degree of investment inefficiency. Firms' active engagement in environmental responsibility not only reflects regulatory compliance and reputational benefits, but may also improve the quality of investment decisions through more efficient resource allocation. This finding is consistent with Rehman et al. (2024), who show that environmental innovation improves corporate investment efficiency and that lower information asymmetry further strengthens this effect. Second, the coefficient on social performance is −0.0230 ($p < 0.01$), indicating that improvements in social performance also significantly reduce investment inefficiency. By fulfilling social responsibilities, firms can strengthen their relationships with key stakeholders and thereby create more favorable conditions for investment decisions. Guo et al. (2024) likewise find that better CSR performance improves investment efficiency by reducing agency costs and easing financing constraints. Third, the coefficient on the governance pillar is −0.0262 ($p < 0.01$), which is the largest in absolute value among the three pillars. This suggests that governance performance plays the strongest role in improving investment efficiency. A higher level of corporate governance can more effectively constrain managerial opportunism and reduce resource misallocation and inefficient investment caused by agency conflicts. This result is consistent with Liu (2025), who finds that strong ESG performance helps strengthen governance effectiveness and thereby enhances overall investment quality. In addition, the baseline regression model controls for a range of firm characteristics that may affect investment efficiency, and the signs of the control variables are broadly consistent with theoretical expectations.

Table 5 reports the regression results for the effects of ESG performance on firm overinvestment. As shown in column (1), the coefficient on the overall ESG performance is −0.0011, but it is not statistically significant. This indicates that overall ESG performance does not significantly reduce firm overinvestment. Accordingly, Hypothesis H2 is not supported for the overall ESG performance. Overinvestment is often driven by managerial overconfidence, the misuse of free cash flow, and internal agency conflicts. Although ESG performance may improve resource allocation to some extent, it may be more effective in alleviating financing constraints and information asymmetry, whereas its ability to curb overinvestment arising from managerial bias or opportunistic behavior appears limited. This finding is broadly consistent with Zamir et al. (2020), who show that CSR disclosure in emerging Asian markets mainly helps alleviate underinvestment but has only a limited effect on overinvestment that is less dependent on external financing.

Table 5
ESG performance and overinvestment

	(1) OverInv	(2) OverInv	(3) OverInv	(4) OverInv
ESG	-0.0011			
	(0.0036)			
E		-0.0115**		
		(0.0048)		
S			-0.0072	
			(0.0046)	
G				0.0141**
				(0.0055)
Age	-0.0053***	-0.0053***	-0.0054***	-0.0051***
	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Size	0.0007**	0.0009***	0.0008***	0.0005*
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Growth	0.0214***	0.0214***	0.0214***	0.0215***
	(0.0012)	(0.0012)	(0.0012)	(0.0012)
CF	0.0267***	0.0271***	0.0268***	0.0259***
	(0.0049)	(0.0049)	(0.0049)	(0.0049)
Lev	0.0120***	0.0120***	0.0120***	0.0137***
	(0.0018)	(0.0018)	(0.0018)	(0.0019)
Fixed	-0.0028	-0.0027	-0.0029	-0.0028
	(0.0027)	(0.0027)	(0.0027)	(0.0027)
Board	-0.0046***	-0.0045***	-0.0045***	-0.0044***
	(0.0015)	(0.0015)	(0.0015)	(0.0015)
Cons	0.0154**	0.0178***	0.0180***	0.0066
	(0.0063)	(0.0063)	(0.0065)	(0.0070)
N	24936	24936	24936	24936
R^2	0.0739	0.0742	0.0740	0.0742
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes

Notes: *p < 0.10, **p < 0.05, ***p < 0.01; Standard errors are reported in parentheses

After decomposing ESG into its three pillars, the results reveal substantial heterogeneity across dimensions. First, the coefficient on the environmental pillar is −0.0115 ($p < 0.05$), indicating that better environmental performance significantly reduces corporate overinvestment. By contrast, the coefficient on the social pillar is −0.0072 and statistically insignificant, suggesting that social responsibility activities may be more likely to improve the firm's external environment by strengthening stakeholder relationships and enhancing firm reputation, but may not strongly constrain overinvestment driven by managerial incentives (Kao et al., 2014). In addition, the coefficient on the governance pillar is 0.0141 ($p < 0.05$), indicating that better governance performance is associated with a higher level of overinvestment. One possible interpretation is that, in the context of China's capital market, firms with stronger governance are often larger and have greater access to financing, which may support strategic expansion or higher investment intensity under optimistic managerial expectations (Ding et al., 2019; Zhang et al., 2016). Taken together, the results support Hypothesis H2 only for the environmental pillar.

Table 6 reports the regression results for the effects of ESG performance on firm underinvestment. As shown in column (1), the coefficient on the overall ESG performance is −0.0229 ($p < 0.01$), indicating that better ESG performance is associated with lower levels of underinvestment. This suggests that ESG performance helps improve firms' capital allocation and reduce underinvestment arising from financing constraints, thereby supporting Hypothesis H3. This result is broadly consistent with stakeholder theory and information asymmetry theory. Firms with stronger ESG performance tend to exhibit greater information transparency and more stable stakeholder relationships, both of which help improve external financing conditions and access to resources, thereby providing the funding needed for positive-NPV projects. Benlemlih and Bitar (2018) likewise argue that strong ESG performance helps strengthen stakeholder trust and thus reduces underinvestment caused by financing constraints.

Table 6
ESG performance and underinvestment

	(1) UnderInv	(2) UnderInv	(3) UnderInv	(4) UnderInv
ESG	-0.0229***			
	(0.0029)			
E		-0.0079**		
		(0.0036)		
S			-0.0094***	
			(0.0036)	
G				-0.0352***
				(0.0045)
Age	-0.0016***	-0.0012***	-0.0014***	-0.0015***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Size	-0.0029***	-0.0034***	-0.0034***	-0.0031***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Growth	-0.0001	-0.0000	0.0000	-0.0001
	(0.0007)	(0.0007)	(0.0007)	(0.0007)
CF	-0.0069**	-0.0082**	-0.0082**	-0.0067**
	(0.0033)	(0.0033)	(0.0032)	(0.0033)
Lev	-0.0068***	-0.0045***	-0.0045***	-0.0084***
	(0.0015)	(0.0015)	(0.0015)	(0.0015)
Fixed	0.0111***	0.0111***	0.0109***	0.0109***
	(0.0018)	(0.0018)	(0.0018)	(0.0018)
Board	-0.0023**	-0.0022**	-0.0022*	-0.0027**
	(0.0011)	(0.0011)	(0.0011)	(0.0011)
Cons	0.1109***	0.1089***	0.1108***	0.1287***
	(0.0054)	(0.0055)	(0.0057)	(0.0061)
N	24936	24936	24936	24936
R^2	0.0857	0.0829	0.0831	0.0858
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes

Notes: *p < 0.10, **p < 0.05, ***p < 0.01; Standard errors are reported in parentheses

This study further examines the effects of the three ESG pillars, and the results support Hypothesis H3 across all three pillars. First, the coefficient on the environmental pillar is −0.0079 ($p < 0.05$), suggesting that better environmental performance helps alleviate

underinvestment. Stronger environmental performance can enhance corporate compliance, reduce environmental risk and regulatory uncertainty, and thereby improve access to financing. Second, the coefficient on the social pillar is −0.0094 ($p < 0.01$), indicating that social performance can improve firms' relationships with major stakeholders and thus strengthen external financing support. This finding is consistent with Samet and Jarboui (2017), who show that strong CSR performance helps alleviate underinvestment by improving information transparency and external financing conditions. Third, the coefficient on the governance pillar is −0.0352 ($p < 0.01$), indicating that governance performance plays the strongest role in alleviating underinvestment. Stronger governance performance usually reflects more effective board oversight and better protection of shareholder rights, which help improve investment decision quality and reduce underinvestment associated with managerial conservatism. Consistent with this, García-Sánchez and García-Meca (2018) find that corporate governance mechanisms are effective in constraining inefficient investment decisions and that managerial ability can reduce underinvestment.

Robustness Checks

To ensure the robustness of the baseline results, this study conducts several additional tests. Table 7 reports the robustness check results. First, column (1) uses the investment efficiency measure proposed by Biddle et al. (2009) as an alternative proxy to avoid relying on a single measurement approach. The coefficient on ESG performance remains consistent in sign and significance with the baseline results, suggesting that the main findings are not sensitive to the measure of investment efficiency. Second, column (2) excludes sample observations from 2020 and 2021 to mitigate the potential influence of the COVID-19 pandemic. The results show that the coefficient on ESG performance remains significantly negative, suggesting that the finding that ESG performance improves investment efficiency is not driven by the pandemic period. Third, column (3) adds managerial ownership (Mngmhld) and institutional investor ownership (InsInvestor) as additional control variables to reduce potential omitted variable bias. The results show that the coefficient on ESG performance remains significantly negative, indicating that the positive effect of ESG performance on investment efficiency is robust to the inclusion of additional governance related factors. Overall, the coefficients obtained from all robustness checks remain consistent with the baseline results, providing additional support for the reliability of the main findings.

Table 7
Robustness checks

	(1) InvEff_B	(2) InvEff	(3) InvEff
ESG	-0.0350***	-0.0397***	-0.0301***
	(0.0046)	(0.0052)	(0.0048)
Age	-0.0040***	-0.0059***	-0.0066***
	(0.0007)	(0.0007)	(0.0008)
Size	-0.0007*	-0.0036***	-0.0031***
	(0.0004)	(0.0005)	(0.0005)
Growth	0.0291***	0.0266***	0.0238***
	(0.0017)	(0.0017)	(0.0015)
CashFlow	0.0250***	0.0149**	0.0188***
	(0.0060)	(0.0068)	(0.0059)
Lev	0.0157***	0.0046	0.0067***

	(0.0023)	(0.0029)	(0.0025)
Fixed	-0.0014	0.0082**	0.0044
	(0.0035)	(0.0035)	(0.0032)
Board	-0.0071***	-0.0043**	-0.0083***
	(0.0019)	(0.0022)	(0.0019)
Mngmhld			-0.0003
			(0.0030)
InsInvestor			0.0043*
			(0.0023)
Cons	0.0992***	0.1623***	0.1512***
	(0.0082)	(0.0106)	(0.0097)
N	24936	19366	24936
R^2	0.1034	0.0738	0.1342
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes

Notes: *p < 0.10, **p < 0.05, ***p < 0.01; Standard errors are reported in parentheses

To address potential endogeneity concerns, several additional tests are conducted, and the results are reported in Table 8. First, there may be a reverse causal relationship between ESG performance and investment efficiency. Firms with higher ESG performance may adopt more standardized investment decision-making processes, while firms with higher investment efficiency may generate more stable cash flows that enhance their ability to engage in ESG activities. To mitigate the potential reverse causality, lagged ESG scores are used as explanatory variables. As shown in column (1), the coefficient on lagged ESG remains significantly negative, indicating that ESG performance continues to reduce investment inefficiency after controlling for the time-lag effect. Second, the relationship between ESG performance and investment efficiency may be affected by sample selection bias. ESG ratings are limited to firms covered by rating agencies, and these firms usually have better disclosure quality. To correct for this potential bias, the Heckman two-stage selection model is employed. Column (2) reports that the IMR coefficient is significantly positive, suggesting that sample selection bias may exist. However, the coefficient on ESG performance remains significantly negative, indicating that the main results are robust after correcting for selection bias. Third, investment inefficiency may exhibit dynamic persistence, and the baseline results may also be affected by omitted variable bias. To address these concerns, the System GMM estimator is employed for dynamic panel data analysis. As reported in column (3), the coefficient on ESG performance remains significantly negative, consistent with the baseline findings. Moreover, the AR(2), Sargan, and Hansen test support the validity of the model specification and the instrumental variables. Overall, the results consistently support the conclusion that ESG performance significantly reduces investment inefficiency.

Table 8
Endogeneity tests

	(1) InvEff	(2) InvEff	(3) InvEff
L.ESG	-0.0299***		
	(0.0050)		
L.InvEff			0.2410***
			(0.0532)
ESG		-0.0270***	-0.3904***
		(0.0040)	(0.1140)
Age	-0.0067***	-0.0085***	-0.0151***
	(0.0008)	(0.0006)	(0.0031)
Size	-0.0022***	-0.0000	0.0071***
	(0.0005)	(0.0006)	(0.0028)
Growth	0.0230***	0.0229***	0.0110***
	(0.0016)	(0.0009)	(0.0019)
CashFlow	0.0121*	0.0275***	0.0236***
	(0.0062)	(0.0045)	(0.0072)
Lev	0.0034	-0.0053*	-0.0343***
	(0.0027)	(0.0029)	(0.0118)
Fixed	0.0048	0.0059**	-0.0156**
	(0.0034)	(0.0025)	(0.0061)
Board	-0.0071***	-0.0083***	-0.0053*
	(0.0020)	(0.0016)	(0.0030)
IMR		0.0126***	
		(0.0023)	
AR(1)			0.000
AR(2)			0.916
Sargan			0.543
Hansen			0.558
Cons	0.1341***	0.0726***	0.1974***
	(0.0097)	(0.0145)	(0.0366)
N	20287	24903	20287
R^2	0.1370	0.1344	
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes

Notes: *p < 0.10, **p < 0.05, ***p < 0.01; Standard errors are reported in parentheses

Conclusion and Implications

Using a sample of Chinese A-share listed firms, this study examines the effect of ESG performance on corporate investment efficiency and further explores the heterogeneous roles of the environmental, social, and governance pillars. The results show that overall ESG performance significantly improves firm investment efficiency and that all three pillars exert significant positive effects, with the governance pillar playing a relatively stronger role. When distinguishing between different forms of investment inefficiency, the findings show that ESG performance does not significantly reduce overinvestment, and only the environmental pillar exhibits a significant negative effect. This suggests that ESG performance is not effective in constraining overinvestment driven by managerial opportunism or the misuse of free cash flow. By contrast, ESG performance plays a more significant role in alleviating underinvestment, and all three pillars significantly reduce the level of underinvestment.

These findings provide new empirical evidence on the mechanisms through which ESG performance improves firms' resource allocation efficiency.

Based on the above findings, this study offers the following policy implications. First, firms should place greater emphasis on the role of ESG in improving investment efficiency and integrate ESG into strategic planning and investment decision-making. From a theoretical perspective, ESG practices can influence managerial behavior by strengthening internal governance and improving transparency. Better governance structures help managers make investment decisions based on long-term fundamentals rather than short-term opportunistic motives, thereby reducing agency conflicts and inefficient capital allocation. At the same time, more credible ESG disclosure can mitigate information asymmetry between firms and external capital providers, which improves financing conditions and makes it easier for firms to undertake positive-NPV projects. This mechanism is particularly important in the case of underinvestment, where financially constrained firms may forgo profitable investment opportunities due to limited external funding. Second, government authorities should continue to improve the institutional environment that supports ESG implementation. In particular, regulators should strengthen ESG disclosure requirements and reporting standards to enhance the consistency and credibility of ESG information. When ESG information is more standardized, it can serve as a more effective signal of managerial quality and long-term sustainability, thereby guiding capital toward firms with more efficient investment policies. In addition, supportive policy tools such as green finance incentives, tax incentives, and ESG subsidies can reduce the cost burden associated with ESG adoption and encourage firms to incorporate sustainability considerations into their investment strategies. Third, financial institutions should incorporate ESG performance more systematically into credit assessment, risk pricing, and lending decisions. ESG performance provides useful information beyond traditional financial indicators, as it reflects a firm's governance quality and risk control capacity. Banks and other lenders can use ESG signals to identify firms with stronger long-term potential, while providing greater credit support to those that face financing frictions but show credible improvements in ESG performance.

Research Limitations and Future Research Directions

Despite providing new empirical evidence on the relationship between ESG performance and firm investment efficiency, this study has several limitations. First, ESG ratings may be subject to measurement inconsistencies across rating agencies. Future research could combine data from multiple rating agencies to develop a more comprehensive measure of ESG performance. Second, this study is conducted in the context of China's capital market, and the generalizability of the findings to other institutional settings remains to be tested. Future studies could examine the underlying mechanisms in a cross-country comparative setting to enhance the external validity of the findings.

Conflict of Interest

All authors declare that they have no conflicts of interest.

Data availability

The data are available from the corresponding author upon reasonable request.

Ethical approval

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

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