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The effects of real earnings management on the relationship between ESG performance and investment efficiency

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Abstract

Purpose – Environmental, social and governance (ESG) performance not only attracts public attention for its long-term sustainability but also helps companies improve investment decisions and avoid manipulative practices related to real earnings management (REM). This study, in an emerging economy context, examines how the relationship between strong ESG performance and investment efficiency influences REM levels.

Design/methodology/approach – This study analyzes 609 Thai listed companies drawn from nonfinancial sectors for the period from 2019 to 2023. The results demonstrate the robustness of the least squares dummy variable (LSDV) regression and generalized method of moments (GMM) techniques.

Findings – We find that strong ESG performance and lower REM positively enhance investment efficiency, with strong ESG performance specifically mitigating both overinvestment and underinvestment. A lower REM level positively influences the relationship between strong ESG performance and investment efficiency by reducing overinvestment. Our findings suggest that in an emerging economy, strong ESG performance, together with investment efficiency, serves as a critical mechanism for improving capital allocation, fostering transparency and increasing investor trust in firms with lower REM.

Originality/value – To the best of our knowledge, this study is the first to provide evidence of the relationship between strong ESG performance and investment efficiency as well as the reduction of overinvestment, supports and constraints on firms that engage less in the manipulation of their real earnings.

Keywords Environmental, Social, Governance pillars, ESG performance, Real earnings management, Investment efficiency, Investment inefficiency, Overinvestment, Underinvestment

Paper type Research paper

1. Introduction

In recent years, there has been growing recognition of the environmental, social, and governance (ESG) performance in investment decisions (Chininga *et al.*, 2024; Lian and Weng, 2024). Strong ESG performance significantly strengthen corporate investment efficiency by improving transparency and mitigating ineffective investments, and attracting greater market attention (Lian and Weng, 2024). ESG ratings also allow external users, particularly investors, to assess a company's financial stability, risk mitigation, and long-term sustainability, making better investment decisions (Chininga *et al.*, 2024; Khemir *et al.*, 2019). ESG performance firms provide reporting quality to improve investment decisions more efficiently (Maiyarni *et al.*, 2024). The emerging economy literature finds that the evaluation of investment effectiveness mainly relies on EM practices (Shen *et al.*, 2015), which is used to meet short-term financial targets (Jevasuwan and Wongsorntham, 2024). Nevertheless, firms that engage in real earnings management (REM) face an increase in investment inefficiency, particularly of overinvestment issues (Bhutta *et al.*, 2022). This is because the quality of financial information and investment behavior make it more susceptible to investment inefficiency (Biddle *et al.*, 2009). While REM is considered a critical factor in mitigating ineffective investment in developed economies (Assad *et al.*, 2023), it is also positively associated with increased debt costs (Kim *et al.*, 2020) and distort investor perceptions

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(Li, 2019; Roychowdhury, 2006). Firms that engage in REM often experience higher information asymmetry and agency problems (Abad *et al*., 2018). This may lead to inefficient investments that are detrimental to shareholders' interests (Jensen and Meckling, 1976). Information asymmetry suggests that a lack of transparency and reliability between managers and external stakeholders creates ineffective investment decisions (Abad *et al*., 2018; Benlemlih and Bitar, 2018). This study examines how REM levels moderate the relationship between ESG performance and investment efficiency, focusing on its role in mitigating inefficient investment, information asymmetry and agency conflicts. We propose the following research questions:

RQ1. What is the effect of strong ESG performance on investment efficiency through mitigating overinvestment and underinvestment in emerging economy firms?

RQ2. What is the effect of REM on investment efficiency by mitigating overinvestment and underinvestment in emerging economy firms?

RQ3. How do REM levels affect the relationship between strong ESG performance and investment efficiency by mitigating overinvestment and underinvestment in emerging economies such as Thailand?

We predict that firms with strong ESG performance and lower REM levels enhance investment efficiency by reducing inefficient investment. First, we argue that strong ESG performance improves investment efficiency by mitigating both overinvestment and underinvestment. Firms with ESG performance disclosures enhance investment allocation (Chininga *et al*., 2024; Khemir *et al*., 2019) by lowering inefficient investments and transaction costs (Lian and Weng, 2024; Wang *et al*., 2022). Our second argument is that firms with lower REM levels enhance investment efficiency by mitigating both overinvestment and underinvestment. Lower REM firms are better positioned to optimize investment decisions by mitigating overinvestment (Bhutta *et al*., 2022). Third, ESG performance enables investors to evaluate a company's financial strength, risk management, and long-term sustainability (Bilyay-Erdogan *et al*., 2024), thereby enhancing investment efficiency (Maiyarni *et al*., 2024). We, therefore, expect that the relationship between ESG performance and investment efficiency would be stronger for emerging economy firms engage less in REM.

This study makes the following contributions to the literature: First, we examined the effect of ESG performance on investment efficiency by mitigating overinvestment and underinvestment in emerging economies (Chininga *et al*., 2024; Khemir *et al*., 2019; Lian and Weng, 2024; Maiyarni *et al*., 2024). Second, we investigate the effect of lower REM levels on investment efficiency by reducing overinvestment and underinvestment (Bhutta *et al*., 2022; Shen *et al*., 2015). Finally, by extending the literature on ESG performance (e.g. Chininga *et al*., 2024; Khemir *et al*., 2019; Lian and Weng, 2024; Maiyarni *et al*., 2024) and REM (e.g. Bhutta *et al*., 2022; Shen *et al*., 2015), we further explore how REM levels strengthen the relationship between ESG performance and investment efficiency by reducing inefficiencies. This is an important contribution because REM is commonly less regulated in emerging economies, such as Thailand (Charoenwong and Jiraporn, 2009; Kunsrison, 2021).

The remainder of the paper proceeds as follows: Section 2 outlines the background on ESG in Thailand. Section 3 presents our theoretical framework. Section 4 reviews the empirical literature and formulates our hypotheses. Section 5 details the research design. Section 6 presents and discusses the empirical findings. Section 7 provides robustness checks, and the final section includes with a summary and conclusion.

2. Background of ESG in Thailand

The revolution of ESG in Thailand began in 1999 when the Thailand Institute of Directors launched the corporate governance concept for listed companies to address the Asian financial

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crisis. By 2015, corporate sustainability reporting (CSR) and corporate governance were merged into the ESG framework using the global reporting initiative (GRI) guidelines (Suttipun, 2023). The Stock Exchange of Thailand (SET) adopted these standards, requiring listed firms to actively engage in sustainability activities and publicly disclose their ESG performance (Katisart *et al*., 2023). In 2018, the SET launched the Thailand Sustainability Investment (THSI) and SETTHSI Index to entice investors by listing ESG-disclosing and responsible investment businesses (Sucharitakul, 2019). In emerging economies, such as BRICS [1] nations, ESG frameworks and performance disclosures are needed to promote responsible investment, stakeholders, and regulators (Cherian and Seranmadevi, 2024). Unlike in developed economies, ESG adoption is mandated and supported by strong legal systems and enforcement mechanisms (Davis and Lescott, 2019). ESG adoption in Thailand has been driven by foreign capital, holding 40% of the market value, and local factors, such as SET mandates and the Sufficiency Economy Philosophy (SEP)[2] (Shone, 2016; Sucharitakul, 2019). There are several reasons we chose Thailand as the case in our study. First, Thailand is one of the few Asian developing nations with mandatory ESG disclosure, especially for public companies. Second, the Thai government has strongly promoted the ESG framework through King Rama IX's SEP. Third, Thailand has a changing ESG scene that allows for comparison with other emerging and developed countries. Finally, market inefficiencies in Thailand increase investment distortions and the potential for REM.

3. Theoretical framework

A growing body of research has investigated the roles of ESG performance and REM in enhancing investment efficiency. Studies on ESG (e.g. Chininga *et al.*, 2024; Khemir *et al.*, 2019; La Rosa *et al*., 2018; Lian and Weng, 2024; Lin *et al*., 2023; Maiyarni *et al.*, 2024; Wang *et al.*, 2022) generally highlight ESG and its impact on investment efficiency, while research on REM (e.g. Abad *et al.*, 2018; Assad *et al.*, 2023; Chang *et al*., 2018; Roychowdhury, 2006; Shen *et al.*, 2015) provides conflicting results on how REM influences investment decisions across both emerging and developed economies. Firms with higher information asymmetry often experience inefficient resource allocation and greater agency problems, particularly those with less engagement in ESG activities (Zhu *et al.*, 2024). In such cases, the effect of ESG performance on investment efficiency may reduce overinvestment while leaving underinvestment with high information asymmetry (Bilyay-Erdogan *et al*., 2024).

This study draws on agency theory and information asymmetry (Jensen, 1986; Jensen and Meckling, 1976) to explain how strong ESG performance enhances investment efficiency by mitigating inefficient investments, particularly in firms with lower REM levels. Through the lens of agency theory, strong ESG performance may differ depending on managerial incentives and firm-specific characteristics (Suttipun, 2021). While REM plays an alternative role in investment decisions and helps lower information asymmetry (Abad *et al.*, 2018; Chang *et al.*, 2018; Kim *et al.*, 2020; Li, 2019), strong ESG disclosures, by enhancing transparency and stakeholder trust, reduce both asymmetries and agency problems (La Rosa *et al.*, 2018; Lin *et al.*, 2023; Wang *et al.*, 2022; Zhu *et al.*, 2024). In emerging economies, the need for firms to disclose high-quality ESG information and improve investment efficiency is by engaging less in REM.

4. Empirical literature and hypotheses development

4.1 ESG performance and investment efficiency

Our first argument is that ESG performance enhances investment efficiency, drawing on insights from agency theory and the perspective of information asymmetry. Agency theory suggests that firms may deviate from their optimal investment levels—leading to investment inefficiency—due to conflicts between managers and shareholders (Myers, 1977). Strong ESG performance increases the transparency of corporate information, thereby reducing

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information asymmetry between stakeholders (Benlemlih and Bitar, 2018; Chen *et al*., 2024). The notion of information asymmetry also suggests that a high ESG rating can improve investment efficiency (Benlemlih and Bitar, 2018), lower transaction costs, and avoid agency problems (Lin *et al*., 2023; Wang *et al*., 2022). In developed markets, sustainable practices are associated with lower information asymmetry and agency problems, possibly reducing debt costs (La Rosa *et al*., 2018). In emerging economies, ESG initiatives positively increase corporate financial performance (Chininga *et al*., 2024) and more efficient investment decisions (Maiyarni *et al*., 2024). In Thailand, where ESG disclosure remains voluntary, board composition and corporate characteristics play a role in shaping ESG performance (Suttipun, 2021). Nevertheless, some scholars argue that prioritizing ESG activities may divert resources away from financial concerns, leading to a negative impact on short-term performance and profitability (Stubbs and Rogers, 2013). Additionally, firms that focus only on environmental performance might not use their investments effectively (Chininga *et al*., 2024), which shows the need for a more holistic approach to ESG performance (Khemir *et al*., 2019). While ESG performance mitigates overinvestment, it leaves underinvestment with higher information asymmetry (Bilyay-Erdogan *et al*., 2024). Our first hypothesis (H1) and its sub-hypotheses are as follows:

H1. Firms with strong ESG performance strengthen a positive impact on investment efficiency.

H1a. Firms with strong ESG performance strengthen the positive impact of investment efficiency by reducing overinvestment.

H1b. Firms with strong ESG performance strengthen the positive impact of investment efficiency by reducing underinvestment.

4.2 REM and investment efficiency

Second, lower REM levels improve investment efficiency, reducing both overinvestment and underinvestment. REM practices commonly include sales manipulation through deep discounts or extended credit terms (Gunny, 2010); overproduction, which lowers the cost of goods sold, boosts margins, and increases inventory (Cohen and Zarowin, 2010); and discretionary expense reduction in research and development, advertising, and/or maintenance costs (Zang, 2012). Such manipulations increase earnings or decrease expenses, while misrepresenting a company's financial performance and misleading investors to assess its true value and potential risks (Cohen *et al*., 2008; Roychowdhury, 2006). Agency theory states that managers intending to manipulate real earnings may prioritize their personal interests over shareholders, creating agency conflicts of interest (Jensen and Meckling, 1976). In emerging economies, REM increases investment expenditures (Shen *et al*., 2015), affects investment inefficiency (Bhutta *et al*., 2022) and distorts investment behavior, making firms more susceptible to overinvestment and underinvestment (Biddle *et al*., 2009). Charoenwong and Jiraporn's (2009) study indicates that Singaporean and Thai firms manage their earnings to avoid reporting losses and negative income. In Thailand, REM practices have also been brought about by an increase in governance mechanisms and regulations (Kunsrison, 2021) as well as political crises requiring REM (Jevasuwan and Wongsorntham, 2024). Similarly, in developed economies, companies prone to either overinvestment or underinvestment may engage in REM (Assad *et al*., 2023). Abad *et al*. (2018) found that Spanish-listed firms viewed REM as a strategy to present their earnings to investors, while increasing information asymmetry. We propose the following hypotheses and sub-hypotheses:

H2. Firms with lower REM levels have a positive impact on their investment efficiency.

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H2a. Firms with lower REM levels strengthen the positive impact of investment efficiency by reducing overinvestment.

H2b. Firms with lower REM levels strengthen the positive impact of investment efficiency by reducing underinvestment.

4.3 The effect of REM's level on the ESG performance and investment efficiency

In addition to the individual effects of ESG performance and REM on investment efficiency, we investigate whether the relationship between strong ESG performance and investment efficiency could potentially lower the level of REM. By extending prior research (e.g. Bhutta *et al.*, 2022; Chininga *et al.*, 2024; Khemir *et al.*, 2019; Lian and Weng, 2024; Shen *et al.*, 2015), particularly Maiyarni *et al.* (2024), we anticipate that lower REM firms may benefit more from the potential relationship between strong ESG performance and investment efficiency, reducing overinvestment and underinvestment. From the perspective of agency theory, strong ESG performance helps to reduce agency problems (Maiyarni *et al.*, 2024; Zhu *et al.*, 2024) and benefits managers by creating positive investments, addressing investment inefficiency, allocating resources (Bhutta *et al.*, 2022), and reducing transaction costs (Wang *et al.*, 2022). In emerging economies where long-term sustainability policies are emphasized, overinvestment and underinvestment may distort information about investment efficiency (Shen *et al.*, 2015). Therefore, the third hypothesis and sub-hypotheses are set as follows:

H3. The relationship between strong ESG performance and investment efficiency is stronger for firms with lower REM.

H3a. The relationship between strong ESG performance and investment efficiency, in terms of reduced overinvestment, is stronger for firms with lower REM.

H3b. The relationship between strong ESG performance and investment efficiency, in terms of reduced underinvestment, is stronger for firms with lower REM.

5. Research design

5.1 Data: sample selection and data collection

Data were collected from the SETSMART database of the Stock Exchange of Thailand (SET), covering ESG disclosures, financial statements, key financial statistics, and corporate announcements from 2019 to 2023. Based on the objectives of the study, we selected seven of the eight industry sectors that have publicly disclosed ESG performance, aligned with the Global Reporting Initiative (GRI) guidelines and SET requirements (Stock Exchange of Thailand, 2015, 2022). We also ensure any discrepancies in their ESG disclosures derive from companies' operations rather than reporting inconsistencies. The initial dataset comprised 908 firm-year observations. We excluded 149 observations from the financial sector because of its unique reporting practices and regulatory obligations, resulting in 759 observations. After removing eight (8) observations with missing ESG performance data and 142 with missing financial data, the final sample comprises 609 non-financial firm-year observations. This final dataset ensures robust analysis of the relationship between strong ESG performance and investment efficiency influencing REM levels (Table 1).

For the data collection process, we used the Refinitiv ESG Materiality Matrix to ensure the appropriate weighting of ESG factors pertinent to the industry (Refinitiv, 2022). Firstly, we employed ESG pillar themes for data collection and weight methods to collect ESG information from sustainability reports (see Appendix 1). Secondly, we employed the materiality matrix to standardize category weights, thereby ensuring consistency in the ESG score calculations across the 609 sample firms. Finally, we determined the ratings for the ESG

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Table 1. Number of samples

Panel A: Total observation and selection steps

Observations selection step	Number of observations	Reason for exclusion
Total observations from SETSMART database	908	Initial data set from 2019–2023
Less: Financial observations	149	Due to unique financial reporting requirements
Observations with missing ESG	8	Missing a key variable for ESG performance
Non-financial observations	*751*	Observation remaining
Less: Observations with missing financial information	142	Missing variables are necessary for the analysis
Final sample	*609*	Complete ESG and financial data available

Panel B: Distribution of the sample size across different industry sectors

Industry sectors	Final sample	Percentage of firms
Agriculture and food industry (AGR)	60	10
Consumer products (CON)	50	8
Financial services (FIN)	–	–
Industrial products (IND)	110	18
Property and construction (PRC)	118	19
Resources (RES)	61	10
Services (SER)	160	26
Technology (TECH)	50	8
	609	*100%*

Source(s): Authors' own work

pillars by assigning weights to category ratings based on their importance as indicated in the companies' sustainability reports. This process had three steps: adding up the category weights, choosing new category weights, and finding the ESG pillars (see Appendix 2).

5.2 Research methodology: model specification and definitions of variables

5.2.1 Model specification. Using Least Squares Dummy Variable (LSDV) regression, we propose the following model to test the individual effects of ESG performance and lower REM levels on investment efficiency:

$$\begin{aligned} InvEff_{i,t} = {} & \beta_0 + \beta_1 ESG_{i,t} + \beta_2 REM_{i,t} + \beta_3 MTB_{i,t} + \beta_4 PROF_{i,t} + \beta_5 TANG_{i,t} + \beta_6 FSIZE_{i,t} \\ & + \beta_7 FAGE_{i,t} + \beta_8 LOSS_{i,t} + \beta_9 INDUSTRYDUMMIES_{i,t} \\ & + \beta_{10} YEARDUMMIES_{i,t} + \varepsilon_{i,t} \end{aligned} \tag{1}$$

Where InvEff represents the investment efficiency. Based on our predictions, both REM and ESG have a positive and significant effect on investment efficiency. β_1 and β_2 were expected to be positive and significant, respectively. The remaining control variables could have an impact on investment efficiency and the ESG's intrinsic elements. We use Pearson correlation in regression to analyze groups of variables and fixed-effect regression of investment efficiency on ESG, REM, MTB, PROF, TANG, FSIZE, FAGE, LOSS, year dummies, and industry dummies for the 2019–2023 panel data. We propose the following model using Least Squares

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Dummy Variable (LSDV) regression to test the impact of ESG performance and investment efficiency on lower REM levels.

$$InvEff_{i,t} = \beta_0 + \beta_1 ESG_{i,t} + \beta_2 REM_{i,t} + \beta_3 (ESG_{i,t} \times REM_{i,t}) + \beta_4 MTB_{i,t} + \beta_5 PROF_{i,t} + \beta_6 TANG_{i,t} + \beta_7 FSIZE_{i,t} + \beta_8 FAGE_{i,t} + \beta_9 LOSS_{i,t} + \beta_{10} INDUSTRYDUMMIES_{i,t} + \beta_{11} YEARDUMMIES_{i,t} + \varepsilon_{i,t} \quad (2)$$

where ESG × REM represents the interaction effect. Following the concepts of Gomariz and Ballesta (2014), coefficient β_1 measures the effect of ESG on investment efficiency for firms that have REM levels and are lower than the median. The sum of the coefficients on the main effect and its interaction effect, $\beta_1 + \beta_3$, quantifies the effect of ESG on investment efficiency for firms that have higher REM levels, which is higher than the median. Thus, if the effect of ESG performance on investment efficiency is stronger for firms that engage less in REM, coefficient β_3 will be positive and statistically significant.

5.2.2 Definitions of variables: dependent variables. Investment efficiency (InvEff), the main dependent variable, refers to the efficiency of capital allocation, which is measured as the absolute value of the residuals of the investment model multiplied by −1. Following Biddle *et al.* (2009), we evaluate investment efficiency based on sales growth, with deviations including overinvestment and underinvestment. The model is shown below:

$$Investment_{i,t} = \beta_0 + \beta_1 SalesGrowth_{i,t} + \varepsilon_{i,t} \quad (3)$$

Where $Investment_{i,t}$ is the net increase in tangible and intangible assets scaled by lagged total assets. $SalesGrowth_{i,t-1}$ is the percentage increase or decrease in sales for firm *i* during period *t–2* to *t–1*. We estimate the model cross-sectionally by industry and year. The residuals of the regression model represent the differences between actual and projected investment levels and serve as proxies for investment efficiencies.

Overinvestment and underinvestment, the sub-dependent variables, are measured using residuals from the investment efficiency model. Positive residuals (multiplied by −1) refer to overinvestment—where actual investment exceeds the optimal level—while negative residuals indicate underinvestment, or investment below the optimal level (Gomariz and Ballesta, 2014). These sub-dependent variables are used in additional analysis, and their definitions are provided in Table 2.

5.2.3 Definitions of variables: independent variables. ESG is the total score of the environmental, social, and governance pillars, and is an independent variable. We gathered ESG information from the sustainability reports of the sample using the Refinitiv Eikon format to calculate the total scores for each pillar, using the Refinitiv magnitude matrix (Refinitiv, 2022). ESG scores from 0.70 to 1.00, indicated stronger ESG performance and transparency, which are expected to positively influence investment efficiency for firms that are less likely to engage in REM.

5.2.4 Definitions of variables: moderating variable as proxy for REM. REM is a firm's manipulation of real earnings. In this study, REM is used as a moderating variable and proxied by three established models, following Roychowdhury (2006), Cohen *et al.* (2008), and Cohen and Zarowin (2010). First, we calculate abnormal cash flow from operations (REM_CFO) by estimating normal CFO levels and subtracting them from actual CFO. The model is as follows:

$$\frac{CFO_{it}}{A_{it-1}} = \alpha_i \left(\frac{1}{A_{it-1}}\right) + \beta_{1i} \left(\frac{Sales_{it}}{A_{it-1}}\right) + \beta_{2i} \left(\frac{\Delta Sales_{it}}{A_{it-1}}\right) + \varepsilon_{it}$$

Second, we evaluate abnormal production costs (REM_PROD) by calculating the expected production costs and comparing them to the actual value. Production costs are determined by

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Table 2. Definition and measurement of variables

Variable type	Variable name	Definition	Measurement/Formula	Source
Main dependent variable	Investment efficiency (InvEff)	Efficiency of capital allocation	Absolute value of residuals from the investment model, multiplied by −1 (Biddle *et al*., 2009)	SETSMART database
Sub-dependent variable	Overinvestment	Investment beyond the optimal level	Positive residuals from the investment model, multiplied by −1	Manual calculation
	Underinvestment	Investment below the optimal level	Negative residuals from the investment model (Gomariz and Ballesta, 2014)	
Independent variable	ESG performance (ESG)	The total scores across environmental, social, and governance pillars	ESG score from 0.00 to 1.00, based on the Refinitiv ESG materiality matrix (Refinitiv, 2022)	Sustainability reports, SETSMART database
Moderating variable	Real earnings management (REM) or REM_Aggregate	Firm manipulation of real earnings through activities	Sum of three abnormal components: CFO, PROD, and SGA.	SETSMART database
	REM_CFO	Abnormal cash flow from operations	Estimated using Roychowdhury (2006) model	
	REM_PROD	Abnormal production costs	Estimated using Cohen and Zarowin (2010) model	
	REM_SGA	Abnormal discretionary expenses	Estimated using Cohen *et al*. (2008) model	
Control variable	Market-to-book value (MTB)	Firm market valuation relative to book value	Market value of equity/ book value of equity	SETSMART database
	Profitability (PROF)	Return on assets	Earnings before interest and taxes/Total assets	
	Tangibility (TANG)	Proportion of tangible assets	Tangible fixed assets /Total assets	
	Firm size (FSIZE)	Firm scale	Natural logarithm of total assets	
	Firm age (FAGE)	Length of firm operation	Natural logarithm of firm age	
	LOSS	Pass financial loss	Dummy variable: 1 if firms reported any loss in the previous year and 0 otherwise	

Source(s): Authors' own work

adding the expenses of goods sold and changes in inventory (Cohen *et al*., 2008; Roychowdhury, 2006). The model is as follows:

$$\frac{Prod_{it}}{A_{it-1}} = \alpha_i \left(\frac{1}{A_{it-1}}\right) + \beta_{1i}\left(\frac{Sales_{it}}{A_{it-1}}\right) + \beta_{2i}\left(\frac{\Delta Sales_{it}}{A_{it-1}}\right) + \beta_{3i}\left(\frac{\Delta Sales_{it}}{A_{it-1}}\right) + \varepsilon_{it}$$

Following Roychowdhury (2006) and Cohen *et al*. (2008), abnormal discretionary expenses (REM_SGA) are computed by estimating normal discretionary expenses and subtracting them

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from actual values. Discretionary expenses include research and development, advertising and selling, and general and administrative expenses.

$$\frac{DiscExp_{it}}{A_{it-1}} = \alpha_i\left(\frac{1}{A_{it-1}}\right) + \beta_{1i}\left(\frac{Sales_{it}}{A_{it-1}}\right) + \varepsilon_{it}$$

Finally, we construct an aggregate REM measure by summing the standardized values of REM_CFO, REM_PROD, and REM_SGA, as suggested by Cohen *et al.* (2008). We then re-run the regressions and the generalized method of moments (GMM) procedure (Roodman, 2009) to confirm the robustness of our results.

5.2.5 Definitions of variables: control variables. We measure our control variables, including market-to-book value (MTB), profitability (PROF), tangibility (TANG), firm size (FSIZE), firm age (FAGE), and loss (LOSS). This study employs a mix of dependent, independent, moderating, and control variables to examine the hypothesized relationships in the models. Table 2 provides a self-contained summary of all variable definitions and measurement methods.

6. Empirical findings and discussion

6.1 Empirical findings: descriptive statistics

Table 3 presents the results of the descriptive statistics. The sample's investment efficiency (InvEff) has a mean value of −0.060 and a median value of −0.143. Overinvestment has a mean of −0.166 and median of −0.143, whereas underinvestment has a mean of −0.107 and median of 0.000. The overall ESG pillar scores had a mean of 0.806 and median of 0.846. According to the sustainability value, ESG performance ranges from 0% to 100%, and the mean value should be over 70% to be considered strong (good) ESG performance (Refinitiv, 2022). In this study, our sample achieved strong ESG performance, ranking from 77% to 89%, with a mean value of 0.806 (80.6%). In addition, the mean (median) values of our control variables were MTB = 1.662 (2.030), PROF = 4.825 (4.710), TANG = 1.780 (1.460), FSIZE = 8.551 (8.280), and FAGE = 2.965 (3.060).

Table 4 represents the Pearson correlation matrix results for investment efficiency, ESG performance, and REM. The three REM proxies—REM_CFO, REM_PROD, and REM_

Table 3. Descriptive statistics

	Observation No.	Mean	Median	Minimum	Maximum	Std. Deviation
Continuous variables						
InvEff	3,045	−0.060	−0.143	−0.710	3.600	0.397
Overinvestment	2,140	−0.166	−0.143	−0.710	0.000	0.163
Underinvestment	905	−0.107	0.000	−3.600	0.000	0.309
REM_CFO	3,045	0.433	0.500	−5.020	0.880	0.421
REM_PROD	3,045	−0.816	−0.657	−7.170	0.000	0.754
REM_SGA	3,045	−0.292	−0.290	−0.820	−0.010	0.115
REM_Aggregate	3,045	0.692	0.605	0.090	4.220	0.377
ESG	3,045	0.806	0.846	0.161	0.890	0.125
MTB	3,045	1.662	2.030	0.280	2.680	0.698
PROF	3,045	4.825	4.710	0.670	10.510	1.725
TANG	3,045	1.780	1.460	−4.460	11.420	2.579
FSIZE	3,045	8.551	8.280	4.720	14.920	1.629
FAGE	3,045	2.965	3.060	−1.100	4.570	0.596
Dichotomous variable			1			0
Loss	2,780	2,538	91.30%		242	8.70%

Source(s): Authors' own work

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Table 4. Correlation matrix

	InvEff	Overinv	Underinv	REM_ CFO	REM_ PROD	REM_ SGA	Aggr	ESG	MTB	PROF	TANG	FSIZE	FAGE	LOSS
InvEff	1.000													
Overinvestment	0.056*	1.000												
Underinvestment	−0.022***	0.148	1.000											
REM_CFO	−0.057***	−0.046**	−0.005***	1.000										
REM_PROD	0.023**	−0.011***	0.017**	0.089*	1.000									
REM_SGA	0.026**	−0.009***	0.045**	0.458	0.282	1.000								
REM_Aggregate	−0.036***	0.048**	0.003***	−0.288***	−0.877***	−0.150***	1.000							
ESG	0.029**	0.053*	−0.004***	0.029**	0.025**	0.085*	0.020**	1.000						
MTB	−0.099***	−0.555***	−0.259**	0.090*	0.031**	0.050*	−0.051***	−0.063***	1.000					
PROF	−0.132***	−0.019***	0.037**	0.404	0.280	0.719	−0.140***	0.042**	0.029**	1.000				
TANG	0.038**	−0.069***	0.056*	0.238	0.212	0.500	−0.148***	0.018**	0.089*	0.426	1.000			
FSIZE	0.021**	−0.031***	0.053*	0.440	0.303	0.968	−0.164***	0.071*	0.063*	0.749	0.545	1.000		
FAGE	0.015**	0.013**	0.003***	0.056*	0.034**	0.123	−0.019***	0.000***	−0.058***	0.120	0.014**	0.126	1.000	
LOSS	−0.021***	−0.249***	−0.029***	0.118	0.002***	0.023**	−0.058***	−0.087***	0.270	0.025**	0.113	0.043**	0.047**	1.000

Note(s): See Table 2 for definitions of the variables
* = statistically significant at less than 0.10 level
** = statistically significant at less than 0.05 level
*** = statistically significant at less than 0.01 level
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SGA—show significant positive correlations with investment efficiency. This evidence indicates that higher REM levels are associated with greater investment efficiency. There is a positive relationship between ESG and investment efficiency, supporting our assumptions. The matrix also reveals positive correlations between investment efficiency and control variables, including MTB, PROF, TANG, FSIZE, and FAGE. Overall results show no evidence of multicollinearity issues, as all reported correlations are below 0.8. Thus, our regression estimates are valid and reliable.

6.2 Empirical findings: regression analysis

Table 5 presents the regression analysis results for equation (1). We first test the effect of ESG performance on investment efficiency. All the coefficients in the four modules (REM_CFO, REM_PROD, REM_SGA, and REM_Aggregate) were positive and significant ($p < 0.001$). These results confirm our hypothesis (H1) that firms with strong ESG performance have a positive impact on investment efficiency. This indicates that firms with strong ESG performance enhance investment efficiency, consistent with the findings of Khemir *et al.* (2019) and Chininga *et al.* (2024). The results also consist with Consistent with Bilyay-Erdogan *et al.* (2024) that overall ESG engagement has a positive impact on investment efficiency in developed economies.

Table 5. Regression of investment efficiency on ESG, REM and control variables

	1	2	3	4
ESG	0.094**	0.077*	0.093**	0.071*
	(0.012)	(0.012)	(0.012)	(0.012)
REM_CFO	0.139***			
	(0.027)			
REM_PROD		0.028		
		(0.013)		
REM_SGA			0.187***	
			(0.070)	
REM_Aggregate				0.071*
				(0.020)
MTB	0.070*	0.067	0.067*	0.068*
	(0.014)	(0.014)	(0.014)	(0.014)
PROF	0.400***	0.407***	0.374***	0.420***
	(0.008)	(0.008)	(0.008)	(0.008)
TANG	−0.053	−0.062	−0.074	−0.060
	(0.004)	(0.004)	(0.004)	(0.004)
FSIZE	−0.288***	−0.222***	−0.316***	−0.211***
	(0.010)	(0.009)	(0.010)	(0.009)
FAGE	−0.016	−0.024	−0.018	−0.027
	(0.016)	(0.016)	(0.016)	(0.016)
LOSS	−0.006	−0.007	0.001	0.001
	(0.023)	(0.023)	(0.023)	(0.023)
R Square	*0.096*	*0.085*	*0.098*	*0.089*
Adjusted R^2	*0.084*	*0.072*	*0.086*	*0.077*
F	*8.007*	*6.931*	*8.192*	*7.297*
P < F	*0.000*	*0.000*	*0.000*	*0.000*
Industry dummies	*Yes*	*Yes*	*Yes*	*Yes*
Year dummies	*Yes*	*Yes*	*Yes*	*Yes*
Observations	*608*	*608*	*608*	*608*

Note(s): See Table 2 for definitions of the remaining variables
* = statistically significant at less than 0.10 level
** = statistically significant at less than 0.05 level
*** = statistically significant at less than 0.01 level
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We further examine the effect of REM on investment efficiency. At the conventional level, REM_PROD was not significant, whereas REM_CFO, REM_SGA, and REM_Aggregate were positive and significant ($p < 0.001$) (Table 5). This finding implies that firms with lower REM levels strengthen their investment efficiency, supporting hypothesis (H2). Consistent with Bhutta *et al.* (2022), lowering REM allows firms to optimize their investment decisions more efficiently. Our results are also consistent with Assad *et al.* (2023), who find that in developed economies, lowering REM enhances investment decisions more effectively.

Furthermore, in Table 6, we divide our sample into overinvestment and underinvestment cases. In the overinvestment case, the findings confirm our hypothesis (H1a) that firms with strong ESG performance strengthen the positive impact of investment efficiency on reducing overinvestment problems. Consistent with Bilyay-Erdogan *et al.* (2024), strong ESG performance enables firms to mitigate investment inefficiencies, particularly overinvestment. Furthermore, the underinvestment case reveals all coefficients to be positive and statistically significant, suggesting that firms with strong ESG performance enhance investment efficiency by reducing underinvestment. Thus, H1b is supported. Firms that prioritize ESG initiative investments reduce investment inefficiency (overinvestment and underinvestment) (Chininga *et al.*, 2024), thereby avoiding information asymmetry and agency conflicts (Lin *et al.*, 2023).

For REM, two proxy models (REM_CFO and REM_SGA) show positive and significant coefficients for overinvesting firms (Table 6). For underinvesting firms, only REM_CFO presents a positive and significant coefficient, while REM_PROD, REM_SGA, and REM_Aggregate show negative and insignificant results. Thus, H2a and H2b are not supported. Contrary to our prediction, the findings imply that lower REM levels do not have a significant impact on investment efficiency through the reduction of either overinvestment or underinvestment. Firms with lower REM may encounter difficulties in effectively reducing investment inefficiencies. Consistent with Bhutta *et al.*'s (2022) findings, REM increases investment inefficiencies—particularly overinvestment—in emerging economies.

We further analyze the interaction effect between the ESG and investment efficiency on the level of REM, equation (2). We expect the coefficients to be positive and significant for the relationship between ESG performance and investment efficiency. It is observed that ESG and ESG*REM show a positive and significant coefficient ($p < 0.01$) in the investment efficiency model. Table 7 shows that the ESG coefficient is 0.113 ($p < 0.01$). For firms with strong ESG performance, the ESG coefficient is 0.113 ($p < 0.01$). For those firms with higher REM, the ESG effect is lower ($\beta_3 < 0$), and its effect shows $\beta_1 + \beta_3 = 0.034$ ($p < 0.01$). We note that firms with lower REM have an ESG effect (0.113) on investment efficiency compared to firms with higher REM (0.034). The results confirm our hypothesis (H3) and support our prediction that the relationship between strong ESG performance and investment efficiency is stronger for firms with lower REM. Lower REM firms could potentially improve investment efficiency by prioritizing strong ESG performance.

The REM (aggregate) and ESG*REM coefficients were significantly positive and negative ($p < 0.01$) in the overinvestment and underinvestment scenarios, respectively. For overinvested firms, Table 7 shows that the ESG performance coefficient was 0.083 ($p < 0.01$). For overinvested firms with higher REM, the ESG effect is lower ($\beta 3 < 0$), and its effect is $\beta 1 + \beta 3 = -0.005$ ($p < 0.01$). We note that firms with lower REM show an ESG effect (0.083) on reducing overinvestment problems, which is higher than firms with higher REM (-0.005). The results confirm H3a, suggesting that firms with strong ESG performance enhance their investment efficiency by reducing overinvestment and lowering REM. For underinvested firms, on the other hand, strong ESG performance does not have a significant effect on reducing underinvestment even when REM is low. The results do not support H3b.

6.3 Discussion

While our empirical study highlights the effects of REM levels on the relationship between ESG performance and investment efficiency in an emerging economy, the results call for a

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Table 6. Regression of overinvestment and underinvestment on ESG, REM, and control variables

	Overinvestment				Underinvestment			
	1	2	3	4	5	6	7	8
ESG	0.123**	0.081*	0.092**	0.080*	0.273***	0.233***	0.240***	0.223***
	(0.012)	(0.011)	(0.011)	(0.011)	(0.023)	(0.023)	(0.023)	(0.023)
REM_CFO	0.140**				0.225**			
	(0.020)				(0.046)			
REM_PROD		0.028				0.018		
		(0.012)				(0.024)		
REM_SGA			0.124*				0.118	
			(0.067)				(0.106)	
REM_Aggregate				−0.005				0.056
				(0.013)				(0.025)
MTB	0.035	0.036	0.032	0.038	0.027	0.044	0.043	0.047
	(0.020)	(0.020)	(0.020)	(0.020)	(0.072)	(0.073)	(0.073)	(0.073)
PROF	0.424***	0.430***	0.411***	0.435***	0.311***	0.315***	0.295***	0.330***
	(0.007)	(0.008)	(0.008)	(0.008)	(0.011)	(0.011)	(0.011)	(0.011)
TANG	−0.076	−0.082	−0.089	−0.080	−0.005	−0.008	−0.013	−0.006
	(0.004)	(0.004)	(0.004)	(0.004)	(0.007)	(0.007)	(0.007)	(0.007)
FSIZE	−0.218***	−0.162**	−0.226***	−0.158**	−0.192*	−0.080	−0.143	−0.080
	(0.009)	(0.009)	(0.010)	(0.009)	(0.014)	(0.013)	(0.015)	(0.013)
FAGE	−0.023	−0.026	−0.022	−0.025	0.025	0.017	0.013	0.011
	(0.014)	(0.015)	(0.015)	(0.015)	(0.023)	(0.024)	(0.024)	(0.024)
LOSS	0.036	0.028	0.027	0.028	0.022	0.017	0.013	0.013
	(0.027)	(0.027)	(0.027)	(0.027)	(0.042)	(0.043)	(0.043)	(0.043)
R Square	*0.115*	*0.104*	*0.109*	*0.103*	*0.132*	*0.100*	*0.106*	*0.103*
Adjusted R^2	*0.098*	*0.087*	*0.092*	*0.086*	*0.092*	*0.059*	*0.064*	*0.062*
F	*6.783*	*6.044*	*6.398*	*6.001*	*3.301*	*2.414*	*2.558*	*2.484*
P > F	*0.000*	*0.000*	*0.000*	*0.000*	*0.002*	*0.017*	*0.012*	*0.014*
Industry dummies	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Year dummies	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	*426*	*426*	*426*	*426*	*181*	*181*	*181*	*181*

Note(s): See Table 2 for definitions of the remaining variables
* = statistically significant at less than 0.10 level
** = statistically significant at less than 0.05 level
*** = statistically significant at less than 0.01 level
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Table 7. Regression of investment efficiency on ESG, REM, and interaction

	Investment efficiency	Overinvestment	Underinvestment
ESG	0.113***	0.083*	0.170*
	(0.007)	(0.011)	(0.026)
REM_Aggregate	0.069*	0.079*	0.059
	(0.020)	(0.018)	(0.025)
ESG*REM_Aggregate	−0.079*	−0.088*	−0.124
	(0.000)	(0.000)	(0.001)
MTB	0.065	0.032	0.056
	(0.014)	(0.020)	(0.073)
PROF	0.427***	0.461***	0.351***
	(0.008)	(0.007)	(0.011)
TANG	−0.073	−0.088	0.001
	(0.004)	(0.0040)	(0.007)
FSIZE	−0.177***	−0.129*	−0.056
	(0.010)	(0.009)	(0.013)
FAGE	−0.032	−0.028	0.010
	(0.016)	(0.014)	(0.024)
LOSS	−0.002	0.031	0.015
	(0.023)	(0.027)	(0.043)
R Square	*0.106*	*0.123*	*0.112*
Adjusted R^2	*0.092*	*0.104*	*0.066*
F	*7.858*	*6.482*	*2.419*
P < F	*0.000*	*0.000*	*0.013*
Industry dummies	*Yes*	*Yes*	*Yes*
Year dummies	*Yes*	*Yes*	*Yes*
Observations	*608*	*426*	*181*

Note(s): ESG*REM represents the interaction effect
See Table 2 for definitions of the remaining variables
* = statistically significant at less than 0.10 level
** = statistically significant at less than 0.05 level
*** = statistically significant at less than 0.01 level
Source(s): Authors' own work

broader discussion on the practical implications of strong ESG performance, financial transparency, and managerial discretion. Consistent with prior studies (e.g. Chininga *et al.*, 2024; Khemir *et al.*, 2019; Maiyarni *et al.*, 2024), we find that strong ESG performance improves investment efficiency by mitigating overinvestment and underinvestment, corroborating Hypotheses H1, H1a, and H1b. Theoretically, ESG practices reduce information asymmetries (Lin *et al.*, 2023) and transaction costs (Wang *et al.*, 2022). Agency theory supports our finding that transparency and alignment of stakeholder interests help mitigate inefficient investment and agency conflicts (Myers, 1977). Similarly, in developed markets, sustainable practices reduce information asymmetry and agency costs (La Rosa *et al.*, 2018), which investors and markets reward through improved investment efficiency (Davis and Lescott, 2019).

We, further, find that lower REM levels significantly enhance investment efficiency, supporting Hypothesis H2. Firms with lower REM allocate resources more effectively (Bhutta *et al.*, 2022), lowering information asymmetry and agency costs (Myers, 1977). Similarly, in developed economies, lowering REM allows firms to optimize their investment decisions more effectively (Assad *et al.*, 2023). Nevertheless, contrary to our expectations, lower REM does not significantly reduce either overinvestment (H2a) or underinvestment (H2b). Firms with REM practices may experience higher inefficiencies—both overinvestment and underinvestment—which may result in inefficient capital allocations (Bhutta *et al.*, 2022), higher information asymmetry (Modigliani and Miller, 1958) and agency problems

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(Myers, 1977). Our results contrast with those of developed economies, where Assad *et al.* (2023) discovered a negative relationship between lower REM and investment inefficiencies, both overinvestment and underinvestment.

By extending previous studies on ESG performance (e.g. Chininga *et al.*, 2024; Khemir *et al.*, 2019; Lian and Weng, 2024; Maiyarni *et al.*, 2024) and REM (e.g. Bhutta *et al.*, 2022; Shen *et al.*, 2015), we find that lower REM levels significantly strengthen the relationship between ESG performance and investment efficiency (H3) by reducing overinvestment (H3a). In emerging economies, where investment efficiency is often driven by the mitigation of information asymmetries and agency conflicts (Lin *et al.*, 2023), ESG performance practices signal transparency and accountability for investment inefficiency (Zhu *et al.*, 2024), which lowers both information asymmetries and agency costs (Jensen and Meckling, 1976). Firms can justify certain ESG investment decisions (Zhu *et al.*, 2024), improve resource allocation (Bhutta *et al.*, 2022), and decrease transaction costs (Wang *et al.*, 2022). Nonetheless, contrary to our prediction, the effect of lower REM levels on the relationship between ESG performance and investment efficiency has limited evidence of mitigating underinvestment (H3b). There is some relevance between our findings and those of Aboud and Diab (2018), who found a positive relationship between ESG disclosure and firm value in the context of the Egyptian economy. Our findings highlight the role of transparency in promoting investment decisions—particularly in emerging economies like Thailand, where ESG disclosures are growing public and regulatory attention.

7. Robustness check

Our findings may be affected by the availability of the associated omitted variables. Additionally, some observable or unobservable firm characteristics may have a simultaneous effect on both investment efficiency and ESG practices, particularly when there is a lower (higher) level of REM. To address potential endogeneity problems, we employed three methods: the alternative model proposed by Chen *et al.* (2011), change analysis, and the generalized method of moments (GMM) procedure (Roodman, 2009).

7.1 Alternative investment efficiency model

We conduct alternative investment efficiency tests using Chen *et al.*'s (2011) model to evaluate the reliability of our findings. We include an additional variable, negative (NEG), to determine whether the relationship between investment and sales growth differs depending on whether growth is positive or negative.

$$Investment_{i,t} = \beta_0 + \beta_1 NEG_{i,t-1} + \beta_2 SalesGrowth_{i,t-1} + \beta_3 NEG_{i,t-1} * SalesGrowth_{i,t-1} + \varepsilon_{i,t} \quad (4)$$

Where $NEG_{i,t-1}$ is a dummy variable that takes the value "1" if sales growth is negative and 0 otherwise. Investment efficiency and the remaining variables are defined in Equation (1).

Table 8 reveals the regression analysis results for Equation (1) using this investment efficiency proxy Equation (4), which are similar to those reported in previous tables. Firms with strong ESG performance enhance investment efficiency, reducing both overinvestment and underinvestment problems. Firms with lower REM levels improve investment efficiency and have a greater ability to reduce overinvestment problems than underinvestment. This evidence confirms the validity of our results and estimations.

7.2 Change analysis

We conduct a change analysis to address potential endogeneity issues using the following model:

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Table 8. Regression of investment efficiency on ESG, REM, and control variables

	Investment efficiency	Overinvestment	Underinvestment
ESG	0.070*	0.114**	0.223***
	(0.012)	(0.010)	(0.023)
REM_Aggregate	0.074*	0.078*	0.056
	(0.020)	(0.018)	(0.025)
MTB	0.068*	0.035	0.047
	(0.014)	(0.020)	(0.073)
PROF	0.420***	0.454***	0.330***
	(0.008)	(0.007)	(0.011)
TANG	−0.061	−0.080	−0.006
	(0.004)	(0.004)	(0.007)
FSIZE	−0.210***	−0.155**	−0.080
	(0.009)	(0.008)	(0.013)
FAGE	−0.027	−0.028	0.011
	(0.016)	(0.014)	(0.024)
LOSS	0.002	0.031	0.013
	(0.023)	(0.027)	(0.043)
R Square	*0.089*	*0.116*	*0.103*
Adjusted R^2	*0.077*	*0.099*	*0.062*
F	*7.333*	*6.872*	*2.484*
P < F	*0.000*	*0.000*	*0.014*
Industry dummies	*Yes*	*Yes*	*Yes*
Year dummies	*Yes*	*Yes*	*Yes*
Observations	608	427	181

Note(s): See Table 2 for definitions of the remaining variables
* = statistically significant at less than 0.10 level
** = statistically significant at less than 0.05 level
*** = statistically significant at less than 0.01 level
Source(s): Authors' own work

$$\Delta InvEff_{i,t} = ESG_{i,t} + \Delta REM_{i,t} + \Delta MTB_{i,t} + \Delta PROF_{i,t} + \Delta TANG_{i,t} + \Delta FSIZE_{i,t} + \Delta FAGE_{i,t} + \Delta LOSS_{i,t}\varepsilon_{i,t} \quad (5)$$

Where $\Delta InvEff_{i,t}$ is the first difference of the investment efficiency, determined by the absolute residuals of the investment model. Overinvestment and underinvestment are identified by the positive and negative residuals of the investment model (Gomariz and Ballesta, 2014). The ESG score—our main variable of interest—is the total score of ESG pillars measured in the first year using the Refinitiv Eikon format (Refinitiv, 2022). Control variables represent the first differences from the continuous variables used in Equation (1). Table 9 shows the regression results indicate that ESG practices are positively associated with investment efficiency by reducing overinvestment and underinvestment. These findings are consistent with our previously reported results, demonstrating the role of strong ESG performance in improving investment efficiency by reducing investment inefficiencies.

7.3 Generalized method of moments (GMM)

To carry out the generalized method of moments (GMM) analysis, we employ a dynamic panel data model to estimate investment efficiency, overinvestment, and underinvestment as instrumental variables, following the methods proposed by Arellano and Bond (1991) and Blundell and Bond (1998). We propose the following model.

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Table 9. Regression of investment efficiency on ESG (First year), REM, and control variables

	Investment efficiency	Overinvestment	Underinvestment
ESG (First year)	0.021*	0.030*	0.070**
	(0.012)	(0.017)	(0.023)
ΔMTB	0.023	−0.020	0.045
	(0.014)	(0.031)	(0.073)
ΔPROF	0.057	0.048	0.036
	(0.008)	(0.012)	(0.011)
ΔTANG	−0.006	−0.003	−0.001
	(0.004)	(0.006)	(0.007)
ΔFSIZE	−0.032	−0.025	−0.009
	(0.009)	(0.013)	(0.013)
ΔFAGE	−0.010	−0.010	0.005
	(0.016)	(0.023)	(0.024)
ΔLOSS	−0.003	0.009	0.009
	(0.023)	(0.042)	(0.043)
R Square	*0.084*	*0.050*	*0.100*
Adjusted R^2	*0.073*	*0.034*	*0.064*
F	*7.869*	*3.134*	*2.764*
P < F	*0.000*	*0.003*	*0.010*
Industry dummies	*Yes*	*Yes*	*Yes*
Year dummies	*Yes*	*Yes*	*Yes*
Observations	*608*	*427*	*181*

Note(s): InvEff = change in the absolute value of residuals from the investment model multiplied by – 1; Overinvestment = change in positive residuals from the investment model multiplied by – 1; Underinvestment = change in negative residuals from the investment model (Gomariz and Ballesta, 2014); ESG = total scores across environmental, social, and governance pillars, as measured using Refinitiv Eikon format and Refinitiv magnitude matrix (Refinitiv, 2022); ΔMTB = change in the market-to-book ratio (market value of equity/book value of equity; ΔPROF = change in profitability (earnings before interest and taxes/total assets); ΔTANG = change in asset tangibility (tangible fixed assets/total assets); ΔFSIZE = change in firm size (natural logarithm of the total assets); ΔFAGE = change in firm age (natural logarithm of the firm's age); and ΔLOSS = change in a dummy variable that evaluates "1" if the firms reported any loss in the previous financial years and 0 otherwise

* = statistically significant at less than 0.10 level

** = statistically significant at less than 0.05 level

*** = statistically significant at less than 0.01 level

Source(s): Authors' own work

$$InvEff_{\text{it}} = \alpha_i + \beta_1 ESG_{it} + \beta_2 REM_{it} + \beta_3 (ESG_{it} \times REM_{it})$$
$$+\beta_4 MTB_{it} + \beta_5 PROF_{it} + \beta_6 TANG_{it} + \beta_7 FSIZE_{it}$$
$$+\beta_8 FAGE_{it} + \beta_9 LOSS_{it} + \varepsilon_{it} \quad (6)$$

where α_i refers to the firm-specific fixed effects capturing unobserved heterogeneity across firms. The same control variables from the main models were included in this analysis. We conducted a test for second-order correlation and found no statistically significant second-order serial correlations in the residuals. The Sargan statistics for overidentifying limitations in the estimations are not statistically significant, as indicated by AR (2) in Tables 10 and 11. This implies that the instruments employed in the dynamic system GMM specifications are valid and are not correlated with the error term (Roodman, 2009). The GMM results in Table 10 support our main findings (Equation 2), confirming that lower REM significantly influences the relationship between ESG performance and investment efficiency. The robustness check

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Table 10. GMM Estimation of the effect of ESG performance and REM on investment efficiency

Variables	Investment efficiency				
ESG	0.022*	0.021***	0.021*	0.020***	0.022***
	(0.013)	(0.005)	(0.011)	(0.004)	(0.007)
REM_CFO	0.085***				
	(0.018)				
REM_PROD		0.011			
		(0.011)			
REM_SGA			0.200***		
			(0.069)		
REM_Aggregate				0.038***	0.074***
				(0.009)	(0.021)
ESG*REM_Aggregate					−0.001**
					(0.000)
MTB	−0.011	−0.009	−0.009	−0.005	0.025
	(0.031)	(0.029)	(0.031)	(0.027)	(0.016)
PROF	0.054***	0.055***	0.051***	0.058***	0.067***
	(0.010)	(0.011)	(0.010)	(0.010)	(0.007)
TANG	−0.005	−0.006	−0.006	−0.006	−0.007*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
FSIZE	−0.046***	−0.035***	−0.048***	−0.033**	−0.030***
	(0.013)	(0.013)	(0.016)	(0.014)	(0.006)
FAGE	−0.003	−0.009	−0.005	−0.010	−0.017*
	(0.015)	(0.015)	(0.014)	(0.014)	(0.010)
LOSS	−0.010	−0.012	−0.008	−0.014	0.004
	(0.019)	(0.020)	(0.019)	(0.017)	(0.023)
Industry dummies	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Year dummies	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
AR(1)	*−2.538***	*−2.521***	*−2.521***	*−2.521***	*−2.607****
AR(2)	*1.651*	*1.205*	*1.599*	*1.004*	*0.132*
Sargan Test	*569.870*	*571.934*	*566.826*	*570.442*	*562.278*
Observations	*595*	*595*	*595*	*595*	*595*

Note(s): See Table 2 for definitions of the remaining variables
* = statistically significant at less than 0.10 level
** = statistically significant at less than 0.05 level
*** = statistically significant at less than 0.01 level
Source(s): Authors' own work

results in Table 11 further support these findings, particularly through the mitigation of overinvestment. Therefore, the estimations are valid and consistent with the primary analysis.

8. Summary and conclusion

Considering growing concerns about ESG performance in emerging economies, we examine how ESG performance and REM affect investment efficiency and whether lower REM levels influence this relationship by reducing inefficient investment. Using five-year panel data of Thai listed firms (609) (2019–2023), we find that strong ESG performance enhances investment decisions by reducing both overinvestment and underinvestment. While lower REM improves investment efficiency, it is negatively associated with inefficiencies. investment. By extending prior studies, we discover that lower REM strengthens the relationship between strong ESG performance and investment efficiency, with more pronounced effects on mitigating overinvestment than underinvestment.

Our findings have important applications. For investors, firms with strong ESG performance and lower REM offer more efficient resource allocation and minimize information asymmetry and agency costs. For managers, balancing ESG performance with

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Table 11. GMM Estimation of the effect of ESG performance and ERM on overinvestment and underinvestment

Variables	Overinvestment					Underinvestment				
ESG	0.023**	0.022***	0.023***	0.022***	0.019***	0.080***	0.069***	0.071***	0.065***	0.058*
	0.006	0.005	0.006	0.005	0.003	0.020	0.020	0.017	0.022	0.033
REM_CFO	0.088**					0.102***				
	0.014					0.035				
REM_PROD		0.005					0.004			
		0.013					0.028			
REM_SGA			0.170***					0.126		
			0.053					0.095		
REM_Aggregate				0.026***	0.024**				0.020**	0.020*
				0.010	0.010				0.010	0.011
ESG*REM					−0.001**					0.000
					0.000					0.000
MTB	0.001	0.006	−0.004	0.009	0.012	0.013	0.029	0.029	0.032	0.041
	0.041	0.039	0.042	0.038	0.037	0.060	0.063	0.059	0.060	0.063
PROF	0.047***	0.049***	0.047***	0.051***	0.052***	0.033***	0.033**	0.030**	0.034**	0.036**
	0.014	0.015	0.015	0.016	0.015	0.012	0.015	0.013	0.014	0.014
TANG	−0.009*	−0.010*	−0.011**	−0.010*	−0.010*	−0.002	−0.002	−0.003	−0.002	−0.002
	0.005	0.006	0.006	0.005	0.006	0.009	0.010	0.010	0.010	0.010
FSIZE	−0.032***	−0.019	−0.031**	−0.019	−0.015	−0.017	−0.006	−0.014	−0.006	−0.003
	0.011	0.013	0.014	0.013	0.014	0.014	0.014	0.018	0.015	0.015
FAGE	−0.013	−0.018	−0.016	−0.019	−0.019	0.001	−0.002	−0.004	−0.004	−0.005
	0.020	0.020	0.018	0.020	0.019	0.033	0.031	0.031	0.031	0.031
LOSS	0.000	−0.004	−0.003	−0.005	−0.005	0.018	0.009	0.007	0.006	0.005
	0.033	0.031	0.028	0.029	0.029	0.038	0.039	0.035	0.034	0.035
Industry dummies	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Year dummies	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
AR (1)	*−2.528***	*−2.527***	*−2.543***	*−2.525***	*−2.514***	*−2.456***	*−2.527***	*−2.532***	*−2.517***	*−2.548***
AR (2)	*1.282*	*0.917*	*1.156*	*0.802*	*0.776*	*−0.235*	*0.140*	*0.211*	*0.177*	*0.170*
Sargan Test	*404.898*	*407.994*	*407.320*	*407.768*	*403.620*	*167.734*	*168.207*	*167.384*	*168.079*	*167.153*
Observations	*413*	*413*	*413*	*413*	*413*	*168*	*168*	*168*	*168*	*168*

Note(s): See Table 2 for definitions of the remaining variables
* = statistically significant at less than 0.10 level
** = statistically significant at less than 0.05 level
*** = statistically significant at less than 0.01 level
Source(s): Authors' own work

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transparent and reliable reporting ensures investment decisions meet value-enhancing goals while minimizing REM. The findings inform policymakers that enhancing ESG disclosure frameworks helps reduce REM and promote long-term sustainability. Finally, our results provide empirical evidence for researchers that lower REM strengthens the positive impact of ESG performance and investment efficiency. Future research should explore whether this impact differs between emerging and developed economies to enhance the generalizability of our findings.

Overall, our study sheds light on the global attention to ESG-driven investment efficiency at lower REM levels. Drawing on evidence from Thailand, our results provide significant implications for other emerging economies where ESG adoption and financial reporting remain a challenge. The results also extend to developed economies, where ESG integration is more advanced but REM remains a concern. Policymakers in both contexts benefit by enhancing ESG reporting requirements, promoting transparency, and discouraging REM to support more efficient investment and resource allocation.

Notes

1. Brazil, Russia, India, China and South Africa are emerging economies (Cherian and Seranmadevi, 2024).
2. The Royal Initiative of the "Philosophy of Sufficiency Economy" (The Chaipattana Foundation, 2017)

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Appendix 1

Table A1. ESG performance themes and materiality matrix

Pillar	Category	Themes	Weight method
Environmental	Emission	Emissions	Industry median
		Waste	Industry median
		Biodiversity	Transparency weights
		Environmental management systems	Industry median
	Innovation	Product innovation	Transparency weights
		Green revenues, research and development (R&D), and capital expenditures (CapEx)	Industry median
	Resource use	Water	Industry median
		Energy	Industry median
		Sustainable packaging	Transparency weights
		Environmental supply chain	Transparency weights
Social	Community	A company's commitment to being a good citizen, protecting public health, and respecting business ethics	Transparency weights
	Human rights	Human rights	
	Product responsibility	Responsible marketing	
		Product quality	
		Data privacy	
	Workforce	Diversity and inclusion	
		Career development and training	
		Working conditions	
		Health and safety	
Governance	CSR strategy	CSR strategy	Count of data points in each governance category/all data points in governance pillar
		ESG reporting and transparency	
	Management	Structure (independence, diversity, committees)	
		Compensation	
	Shareholders	Shareholder rights	
		Takeover defenses	

Note(s): Industry median = Materiality weighting is to be based on the relative proportion that a particular sector contributes to the overall gross number in the full ESG universe
Transparency weights = Boolean data points with "Yes" as 1 or "No" as 0
A value of 1 is assigned if answer is positive and 0 otherwise
Source(s): ESG score and materiality matrix (Refinitiv, 2022, page 10)

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Table A2. Data collection—ESG materiality matrix

Industry sectors	No.	Environmental pillar			Social pillar				Governance pillar			Total ESG pillar scores
		Emission	Innv	Resource use	Human rights	Prod. Resp	Workfc	Comm	Mgmt	Shrhl	CSR strategy	
Pillar weight		*0.29*	*0.47*	*0.24*	*0.36*	*0.21*	*0.24*	*0.19*	*0.67*	*0.21*	*0.13*	*0.29*
Agriculture and food industry (AGR)	60	0.67	0.16	0.03	0.66	0.19	0.04	0.01	0.41	0.08	0.02	0.86
Consumer products (CON)	50	0.62	0.13	0.03	0.73	0.18	0.04	0.01	0.36	0.07	0.01	0.82
Industrial products (IND)	110	0.64	0.14	0.03	0.73	0.19	0.04	0.01	0.39	0.08	0.02	0.85
Property and construction (PRC)	118	0.63	0.14	0.03	0.73	0.18	0.04	0.01	0.33	0.07	0.01	0.80
Resources (RES)	61	0.60	0.13	0.03	0.71	0.18	0.04	0.01	0.32	0.06	0.01	0.77
Services (SER)	160	0.64	0.14	0.03	0.72	0.18	0.04	0.01	0.35	0.07	0.01	0.82
Technology (TECH)	50	0.72	0.17	0.03	0.74	0.20	0.04	0.01	0.38	0.08	0.02	0.89
Total	*609*											

Note(s): Innv. = Innovation; Prod. Resp. = Product responsibility; Workfc. = Workforce; Comm. = Community; Mgmt. = Management; Shrhl. = Shareholder
Source(s): Authors' own work

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Table A3. Data collection description and calculation criteria

Score rank	Description	Total pillar score
0.00 ≤ 0.25	Indicates poor relative ESG performance and insufficient transparency in publicly reporting material ESG data	*Step 1:* Sum of the category weights for each pillar—Environmental Social and Governance
0.25 ≤ 0.50	Indicates satisfactory ESG performance with a moderate level of transparency in reporting material ESG data	*Step 2:* Calculate new category weights by dividing each category's weight by the total weight of its respective pillar—Environmental, Social, and Governance
0.50 ≤ 0.75	Indicates good ESG performance and above-average level of transparency in reporting material ESG.	*Step 3:* Multiply each category's score by its new category weight to calculate the overall pill score.
0.75 ≤ 1.00	Indicates excellent ESG performance with a high degree of transparency in publicly reporting material ESG data	

Source(s): Authors' own work, adapted from the ESG pillar score (Refinitiv, 2022, page 7)

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