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Does ESG performance enhance investment efficiency and firm performance? Evidence from Japan☆

Yusra Nazir [a], Xiaojing Cai [a,b], Tatsumasa Tennojiya [a,*]

[a] Graduate School of Humanities and Social Sciences, Okayama University, 3-1-1 Tsushima-naka, Kita-ku, Okayama 700-0583, Japan
[b] Graduate School of Economics, Kobe University, 2-1, Rokkodai, Nada-Ku, Kobe 657-8501, Japan

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ABSTRACT

This study examines the association between investment sensitivity to growth opportunities, firm performance, and environmental, social, and governance (ESG) performance in Japanese listed firms. To determine whether ESG performance is associated with a firm's investment sensitivity to growth opportunities rather than directly increasing investment levels, panel data covering the period from 2002 to 2023 and an investment-Q sensitivity framework are employed. To evaluate robustness and reduce endogeneity issues, high-dimensional fixed effects (HDFE), the System Generalized Method of Moments (GMM), and a difference-in-differences (DID) design based on Japan's post-2015 governance and disclosure environment are added to the baseline fixed-effects estimations. The findings show a positive association between investment-Q sensitivity and ESG performance, indicating a conditional association wherein firms with higher ESG performance are more receptive to expansion prospects. The findings, however, contradict the hypothesis that ESG performance and investment intensity are consistently associated. Stricter identification techniques diminish positive baseline associations, demonstrating sensitivity to model specification and cross-sectional firm variations. As a result, firm performance results are mixed. Governance-related factors are comparatively more consistently associated with investment outcomes across all ESG components. By focusing on ESG performance and capital allocation behavior under various economic scenarios rather than on whether ESG generally enhances firm outcomes, this study expands the ESG literature. The results imply that ESG serves more as a governance and information mechanism associated with investment sensitivity than as a reliable indicator of firm performance or investment efficiency.

1. Introduction

In recent years, environmental, social, and governance (ESG) factors have become increasingly integrated into corporate strategic decision-making, reflecting greater emphasis on transparency and sustainability-oriented governance. ESG performance captures firms' environmental management, social responsibility, and governance practices and is increasingly used to assess sustainability-related policies and disclosures. Prior research links ESG performance to firms' risk profiles, operational outcomes, and financial

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* Corresponding author.
E-mail address: tentatsu@okayama-u.ac.jp (T. Tennojiya).

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performance. However, evidence on its association with investment efficiency (IE) remains limited, particularly in institutional settings where governance structures, market discipline, and regulatory frameworks shape corporate investment behavior. More specifically, limited evidence exists on whether ESG performance is associated with firms' investment sensitivity to growth opportunities, an important indicator of the alignment between capital allocation and investment fundamentals.

This research measures ESG performance using the Refinitiv ESG scores obtained from corporations' disclosure-based assessments of ESG initiatives. These scores are considered indicators of ESG performance rather than precise evaluations of related spending. A key question in the literature is whether ESG performance primarily reflects underlying firm characteristics such as managerial quality, governance strength, or growth opportunities, or whether it serves as an effective monitoring mechanism that reduces information asymmetry and improves investment decisions. Since ESG scores are composite and disclosure-driven indicators, not direct measurements of investment activity, rigorous empirical identification is required to avoid confounding correlations with structural implications.

Furthermore, the study employs the investment-Q framework proposed by Biddle et al. (2009) and Chen et al. (2011), a common method for evaluating IE, to investigate this issue. The degree to which corporate investment reacts to shifts in Tobin's Q, a stand-in for growth opportunities, is captured by investment-Q sensitivity within this framework. Stronger sensitivity is not a direct indicator of efficiency, even though it can be interpreted as greater alignment between investment and firm fundamentals. Alternatively, it could also reflect market misvaluation, firm-specific traits, financing limitations, or lifecycle implications. Therefore, rather than being a conclusive measure of IE, this study views investment-Q sensitivity as a measure of investment sensitivity to growth opportunities.

Although earlier research has examined the relationship between ESG and performance, relatively less attention has been given to the influence of ESG performance on firms' investment response to economic fundamentals within a single empirical framework (Berg et al., 2022; Gillan et al., 2021). Furthermore, the external validity of findings across institutional settings is limited because the majority of currently available research focuses on Western countries and China (Friede, 2015; Liang and Renneboog, 2017). However, stakeholder-oriented governance, cross-shareholding arrangements, and long-term relational contracting offer a unique and unexplored context that significantly influences corporate behavior and monitoring incentives (Aoki, 2001; Barko, 2022; Jackson and Miyajima, 2007). These institutional characteristics impact firm incentives, monitoring systems, and disclosure policies, which may change the economic impact of ESG performance.

Recent developments further demonstrate the significance of the Japanese context. The rapid growth of ESG practices among Japanese companies can be attributed to governance and stewardship reforms such as the Corporate Governance Code and the Stewardship Code, which have strengthened shareholder monitoring and disclosure standards (Buchanan, 2022; Miyajima, 2022; Salgado et al., 2025). However, empirical evidence indicates that ESG performance relationships in Japan demonstrate nonlinear and institution-specific dynamics that represent the interplay between sustainability involvement and ownership structures (Broadstock et al., 2021; Gillan et al., 2021; Kuang, 2022). These features offer a useful context for investigating how ESG performance affects firm investment behavior outside traditional Western frameworks. Consequently, the findings of this study should be interpreted within Japan's post-governance reform environment, where the observed associations indicate institutional changes in monitoring and disclosure, relatively a collectively uniform ESG effect.

Based on these limitations, a significant knowledge gap exists regarding how ESG performance influences firms' capital allocation practices, rather than merely their overall performance outcomes. Most current research focuses on the direct relationship between ESG and company risk or profitability, generally ignoring the role of ESG as a conditioning factor that affects firms' response to underlying economic fundamentals (Berg et al., 2022; Gillan et al., 2021). The relationship between ESG performance and investment-Q sensitivity, which provides a more theoretical lens for evaluating capital allocation decisions, has received scant attention. Furthermore, the research rarely incorporates this investment channel with firm performance (FP) in a cohesive empirical framework, ignoring the dynamic relationship between operational outcomes, investment sensitivity, and sustainability practices. Although ESG metrics frequently represent wider firm characteristics rather than specific causal processes, identification issues exacerbate these constraints (Christensen et al., 2021). To fill this gap, this study evaluates the relationship between ESG performance and FP over a lengthy panel period (2002–2023) and investigates whether ESG performance influences firms' sensitivity to growth opportunities. The study provides a more accurate and institutionally based knowledge of how sustainability-related firm characteristics affect capital allocation behavior and firm outcomes by integrating ESG into a dynamic investment framework.

This research makes numerous significant contributions to the literature on corporate finance and ESG. First, rather than addressing ESG as a direct determinant of investment levels or firm outcomes, it employs ESG performance as a conditioning mechanism within the investment-Q sensitivity framework, extending the ESG-IE debate. This aligns with recent evidence that the effects of ESG are fundamentally state-dependent and context-specific (Christensen et al., 2021; Gillan et al., 2021). Second, aligned with research on ESG measurement heterogeneity and non-uniform effects across dimensions, the study additionally delineates ESG performance into aggregate and pillar-level components (environmental, social, and governance). This enables the analysis to capture heterogeneous transmission channels through which various sustainability dimensions influence corporate investment behavior (Berg et al., 2022; Friede, 2015). Thus, instead of assuming a single dominant ESG dimension, the study allows environmental, social, and governance channels to appear across outcomes and specifications. Third, it conducts a dual-dimensional evaluation of FP by utilizing both return on assets and asset turnover, which captures both profitability and operational efficiency and reduces dependence on single-proxy interpretations frequently employed in earlier ESG studies. Finally, in accordance with current recommendations in ESG empirical research, the empirical approach enhances identification through lag structures, high-dimensional fixed effects (HDFE), and System Generalized Method of Moments (GMM) estimations while preserving a cautious interpretation of results as conditional associations rather than strict causal effects (Arellano and Bover, 1995; Blundell and Bond, 1998; Christensen et al., 2021). In order to investigate whether the relationship between ESG performance and firm outcomes varies after the institutional reform, we further supplement the

baseline specifications with difference-in-differences (DID) analysis based on Japan's 2015 Corporate Governance reform. The results are interpreted as conditional associations rather than causal effects.

Based on Japan's unique institutional context, this study empirically evaluates the relationship between ESG performance and firm investment-Q sensitivity and FP. The research improves the current understanding of the relationship between ESG and corporate behavior by highlighting ESG as a conditioning factor associated with variation in firms' investment response to growth opportunities rather than a direct predictor of profitability. The results contribute to a more complex understanding of how capital allocation processes under stakeholder-oriented governance structures interact with company attributes associated with sustainability. Rather than assuming consistent impacts across firms or institutional settings, this study provides evidence on when and how ESG performance matters for investment behavior and FP.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature, develops the theoretical framework, and identifies the key research gaps this study seeks to address. Section 3 presents the research hypotheses. Section 4 describes the econometric methodology, variable construction, and data sources. Section 5 reports the empirical results and discusses their implications for FP and IE. Section 6 discusses the main findings. Finally, Section 7 presents the main conclusions and limitations of the study and provides recommendations for future research.

2. Literature review

ESG performance has become a major determinant of corporate behavior as firms increasingly integrate sustainability considerations into strategic and financial decision-making. Previous studies (Friede, 2015; Yoon et al., 2021; Zhou et al., 2022) have linked ESG performance to improved risk management, more stakeholder trust, and improved long-term firm outcomes. However, variations in measurement methods, institutional environments, and empirical methodology have rendered the evidence contradictory and context-dependent (Berg et al., 2022; Gillan et al., 2021). Particularly in non-Western institutional settings like Japan, where ownership structures and governance reforms may greatly influence capital allocation behavior, only a small body of research has examined how ESG performance affects firms' investment responses to economic fundamentals within a unified capital allocation framework (Biddle et al., 2009; Giese et al., 2019).

IE is the degree to which firms allocate capital to value-enhancing initiatives while avoiding both over- and under-investment due to agency conflicts and information frictions (Biddle and Hilary, 2006; Meckling and Jensen, 1976). The investment-Q sensitivity framework, which evaluates how firm investment responds to growth opportunities represented by Tobin's Q, is a widely used empirical technique for examining capital allocation behavior (Chen et al., 2011). Higher investment–Q sensitivity is typically understood under this theoretical framework as indicating improved alignment between investment decisions and firm fundamentals. Nevertheless, this metric may also reflect financial obstacles, value impacts, or firm-specific traits, and thus may not accurately indicate efficiency (Biddle et al., 2009; Stulz, 1990).

Reportedly, ESG performance may improve investment sensitivity by reducing information asymmetry and aligning managerial incentives with long-term objectives (Cheng et al., 2014; Jo and Harjoto, 2011). However, empirical evidence on the validity of these correlations in various institutional contexts and whether ESG affects not just investment levels but also an organization's openness to expansion opportunities remains inadequate. Although ESG is often considered a composite construct, recent research indicates that firm outcomes may be influenced by environmental, social, and governance factors through various channels. Therefore, it is not appropriate to assume that these factors will have consistent effects (Benlemlih et al., 2018; Ellili, 2022). While social performance may improve stakeholder relations and organizational resilience, environmental performance is frequently linked to operational efficiency and risk mitigation. Governance mechanisms are more closely correlated with monitoring efficacy, managerial discipline, and a decrease in agency conflicts. Depending on the outcome variable, empirical definition, and institutional framework, these distinctive mechanisms suggest that ESG aspects may demonstrate varying degrees of relevance.

Apart from investment behavior, previous studies suggest a generally positive correlation between ESG performance and FP, which is typically measured using the accounting-based metrics of efficiency and profitability, such as asset turnover (Assets_TO) and return on assets (ROA) (Friede, 2015; Giese et al., 2019). Through better use of resources and reduced agency conflicts, ESG-related improvements in risk management, stakeholder interactions, and governance quality may boost operational effectiveness and long-term value creation. Nevertheless, empirical results remain inconsistent and context-specific, reflecting differences in industry structure, institutional contexts, and ESG assessment frameworks (Berg et al., 2022; Friede, 2015). Consequently, the effects of ESG are not consistent across companies or environments, as they are influenced by both underlying economic conditions and methodology design. Furthermore, prior research has frequently concentrated on the association between ESG performance and FP, while lacking focus on how ESG affects investment sensitivity and capital allocation behavior (Biddle et al., 2009; Bilyay-Erdogan et al., 2024). While IE represents the mechanism by which firms allocate money toward growth opportunities, FP outcomes like profitability and operational efficiency reflect actual financial implications. Distinguishing these channels is crucial because ESG may influence the quality of investment decisions and organizations' response to economic opportunities, rather than consistently improving financial performance.

Theoretically, this study applies agency and stakeholder theories. Agency theory states that by reducing agency conflicts and information asymmetry, ESG-related governance practices may increase the effectiveness of decision-making (Meckling and Jensen, 1976). Stakeholder theory, on the other hand, argues that ESG participation enhances long-term value creation by addressing the interests of various stakeholders such as employees, investors, and communities (Freeman, 1984). Considered collectively, these perspectives imply that ESG performance may influence FP and the effectiveness of capital allocation through channels of incentive alignment and governance.

Japan offers a relevant institutional context for analyzing these associations. ESG integration into company strategy is encouraged

by the Corporate Governance Code and Stewardship Code, which have improved disclosure procedures, shareholder monitoring, and governance transparency. Simultaneously, Japanese companies operate within a stakeholder-oriented framework typified by concentrated institutional ownership, long-term relational contracts, and cross-shareholding arrangements. In contrast to Anglo-Saxon or state-dominated systems, these institutional characteristics may influence how capital allocation decisions relate to ESG performance by impacting monitoring intensity, ownership discipline, and management accountability (Aoki, 2001; Aoki et al., 2007; Kato, 2022; Miyajima, 2022).

In turn, by influencing monitoring intensity, ownership discipline, and managerial responsibility, these institutional features may shape the association between ESG performance and firms' capital allocation decisions and firm outcomes. Japan's Corporate Governance Code and Stewardship Code improved board monitoring, transparency, and shareholder involvement. Thus, governance-related ESG measures may more significantly influence capital allocation and investment discipline. However, it is not believed that these governance impacts would predominate everywhere, since social and environmental factors may function through various channels and produce diverse results depending on institutional periods and empirical specifications (Kato, 2022; Miyajima, 2022). Thus, based on these theoretical and empirical gaps, this study investigates the relationship between ESG performance and investment sensitivity to growth opportunities and FP in the Japanese institutional context. The next section develops the relevant hypotheses.

3. Hypothesis development

Agency and stakeholder theories offer a theoretical framework for understanding how ESG performance may influence firm investment behavior and performance results. ESG-related activities might improve monitoring quality, strengthen governance frameworks, and reduce information asymmetry, all of which could influence managerial decisions and capital allocation (Cheng et al., 2014; Jo and Harjoto, 2011; Meckling and Jensen, 1976). Stakeholder theory states that by improving stakeholder interactions and bolstering organizational legitimacy, ESG performance may also affect FP (Freeman, 1984).

According to Biddle et al. (2009) and Chen et al. (2011), the investment-Q framework measures IE as the degree to which firms adjust their investment decisions in response to growth opportunities. ESG performance may influence this process by improving disclosure quality, reducing funding hurdles, and strengthening governance frameworks that promote more deliberate investment decisions. Since they may operate through different mechanisms, the impacts of ESG features are expected to vary across institutional and company contexts (Berg et al., 2022; Friede, 2015; Giese et al., 2019). Therefore, rather than assuming that ESG directly increases investment levels, this study evaluates whether ESG performance is associated with firms' investment sensitivity to growth opportunities.

Thus, the first hypothesis is stated as follows:

H1. ESG performance is associated with firms' investment sensitivity to growth opportunities (Tobin's Q), including aggregate ESG performance and its individual dimensions.

Prior studies have examined the relationship between ESG performance and FP through various channels, including investment behavior, stakeholder participation, operational effectiveness, governance quality, and resource utilization (Eccles et al., 2014; Giese et al., 2019). However, the currently available evidence remains contradictory and appears to be impacted by empirical design, institutional setting, and ESG evaluation (Berg et al., 2022; Friede, 2015). Since profitability and operational efficiency reflect different aspects of firm outcomes, this study uses Assets_TO and ROA to evaluate FP.

Accordingly, the second hypothesis is proposed as follows:

H2. ***ESG performance is associated with firm performance as determined by return on assets and asset turnover.***

4. Data and methodology

Using a rigorous econometric methodology, this study examines the association between ESG performance, IE, and FP in Japanese listed firms from 2002 to 2023 using panel regression analysis. An ordinary least squares (OLS) estimation with year and industry fixed effects is employed in the baseline specification to account for common macroeconomic conditions and unobserved heterogeneity. Additional robustness and identification analyses are introduced separately in the following sections.

4.1. Data and variable selection

The study examines Japanese listed firms from 2002 to 2023 using data from the Tokyo Stock Exchange (TSE), which provides an appropriate institutional framework because of its shifting sustainability disclosure and corporate responsibility policies. Financial and utility firms (SIC 6000–6999) are excluded because of their distinct investment structures and regulatory frameworks, which may compromise comparability (Biddle et al., 2009; Chen et al., 2017). The dataset combines ownership and governance data from S&P Capital IQ, ESG performance data from Refinitiv Eikon DataStream, and firm-level financial and market data from COMPUSTAT Global, including corporate investment, Tobin's Q, ROA, asset turnover, cash flow, firm size, leverage, beta, sales growth, firm age, R&D variables, financial constraints, and Altman Z-score. This integrated database enables a consistent examination of FP, investment behavior, and ESG performance.

OLS with year and industry fixed effects is performed for the baseline estimation. While fixed effects account for unobserved variation across industries and time, ESG components are lagged by one year to reduce concerns about simultaneity (Baltagi, 2008;

Wooldridge, 2010). Following previous studies, Tobin's Q is employed to identify growth opportunities, investment–Q is employed to assess investment behavior, and ROA and asset turnover are employed to measure FP (Fama and French, 2002a).

To maintain consistency and enhance understanding of coefficients across model specifications, Refinitiv percentile-rank indicators (0–100) are converted into ratio form before the estimation. Only the coefficient scale is impacted by this linear transformation; statistical significance, model fit, and the underlying associations between variables remain unchanged (Berg et al., 2022; Gibson Brandon et al., 2021; Khan et al., 2016). Rather than representing direct ESG expenditures, the Environmental (ENV), Social (SOC), and Governance (GOV) components of the aggregate ESG score are viewed as indicators of ESG performance, disclosure quality, and sustainability practices. Table 1 summarizes the definitions and measurement methods of all variables employed in the research.

4.2. Econometric model

Pooled OLS is performed to estimate baseline models with year and industry fixed effects to examine the association between ESG

Table 1
Variable definitions and measurements.

Variable	Definition and measurement	Source(s)
1. **Dependent Variables**		
Corporate Investment (INV)	"The sum of annual increases in property, plants, equipment, inventory, and research and development (R&D) costs, all of which are standardized by dividing by the book value of the prior year's total assets" (Biddle et al., 2009; Chen et al., 2017; Ilyas et al., 2024).	Compustat Global
Investment Efficiency (IE)	This study evaluates investment behavior using the investment–Q sensitivity framework following Chen et al. (2017) and Ilyas et al. (2024). "Investment sensitivity to growth opportunities is captured using Tobin's Q as a proxy for growth expectations. Under this framework, stronger investment sensitivity to growth opportunities reflects closer alignment between investment decisions and firm fundamentals; however, it should not be interpreted as direct evidence of investment efficiency. The interaction between ESG performance and Tobin's Q is used to examine whether ESG performance is associated with differences in firms' investment sensitivity."	Compustat Global
Firm Performance (FP)	Two proxies were used for evaluation: I. ROA: "EBIT/Total Assets, evaluating profitability" (Bissoondoyal-Bheenick et al., 2023). II. "The Assets_TO ratio, which measures operational efficiency, is calculated as net sales divided by total assets. When combined, these measurements offer a multifaceted assessment of performance" (Patin et al., 2020).	Compustat Global
2. **Independent Variable**		
ESG performance	"ESG performance is measured using Refinitiv ESG scores, including the aggregate ESG score and its Environmental (ENV), Social (SOC), and Governance (GOV) pillar dimensions. Refinitiv reports ESG indicators as percentile-rank scores ranging from 0 to 100, where higher values indicate stronger ESG performance and disclosure practices. Before estimation, all ESG variables are converted into ratio form by dividing by 100 to maintain consistency with other ratio-based variables and improve coefficient interpretability across model specifications. Because this transformation is linear, it changes only the coefficient scale and interpretation and not statistical significance, model fit, or the underlying statistical relationship among variables. Therefore, estimated coefficients are interpreted with reference to normalized ESG measures while preserving the substantive economic relationship" (Gujarati, 2012).	Refinitiv Eikon DataStream
Variables	Definition and measurement	Source(s)
3. **Control Variables**		
Cash Flow (CF)	According to Bilyay-Erdogan et al. (2024), "it is calculated as the total of earnings before extraordinary items and depreciation/amortization, scaled by the book value of all assets from the previous year."	Compustat Global
Tobin's Q (Q)	Based on Ilyas et al. (2024), the calculation is "(Market Value of Equity−Book Value of Equity+Book Value of Total Assets)/Book Value of Total Assets."	Compustat Global
Firm Size (SIZE)	Calculated by "taking the natural logarithm of the total assets," it "takes into account the size of the operations" (Chen et al., 2017; Ilyas et al., 2024).	Compustat Global
Leverage (LEV)	"The proportion between long-term obligations and total asset book value shows how much capital the company has" (Chen et al., 2017; Ilyas et al., 2024).	Compustat Global
Financial Constraints (FIN_CONST)	The formula for Hadlock and Pierce's (2010) financial constraints index is calculated as $-0.0737 \times \text{Size} + 0.043 \times (\text{Firm Size})\hat{}2 - 0.040 \times \text{Firm Age}$ and is used to capture firms' financing constraints (Chen et al., 2017).	Compustat Global
R&D Missing Indicator (RD)	"If R&D expenditure data is missing, a dummy variable is set to 1; otherwise, it is set to 0" (Biddle et al., 2009).	Compustat Global
Z-Score	Calculated as follows: Z-Score = 0.012*X1 + 0.014*X2 + 0.033*X3 + 0.006*X4 + 0.999*X5, where X1 is working capital divided by total assets, X2 is retained earnings divided by total assets, X3 is earnings before interest and taxes divided by total assets, X4 is market value of equity divided by book value of total debt, and X5 is sales divided by total assets (Benlemlih & Bitar, 2018; Bilyay-Erdogan et al., 2024).	
Sales Growth	Calculated as the "yearly percentage growth in overall revenue or sales represents the company's growth trajectory" (Benlemlih et al., 2018).	Compustat Global
Firm Age (AGE)	Defined as "the number of years since the firm's establishment (or first listing where establishment information is unavailable)" (Benlemlih et al., 2018).	Compustat Global
R&D to Sales Ratio	Calculated as" research and development expenditure divided by total sales and used as a proxy for innovation intensity" (Ilyas et al., 2024).	Compustat Global
Beta	Measures a "firm's sensitivity to overall market movements and captures systematic risk" (Ilyas et al., 2024).	Compustat Global

performance, IE, and FP. The first model evaluates whether ESG performance is associated with firms' investment sensitivity to growth opportunities, and the second examines the relationship between ESG performance and FP using profitability and operational efficiency measures. Year and industry fixed effects are introduced to account for unobserved industry traits and typical time-specific shocks.

4.2.1. Model for investment efficiency (Model 1)

The following specification investigates the relationship between ESG performance, IE, and growth opportunities using a firm-level panel framework with fixed effects:

$$\boldsymbol{INV}_{i,t} = \boldsymbol{\alpha} + \boldsymbol{\beta 1} * \boldsymbol{Q}_{i,t-1} + \boldsymbol{\beta 2} * \boldsymbol{ESG}_{i,t-1} + \boldsymbol{\delta} * \boldsymbol{ESG}_{i,t-1} \times \boldsymbol{Q}_{i,t-1} + \boldsymbol{\beta 3} * \boldsymbol{Controls}_{i,t-1} + \boldsymbol{YearFE} + \boldsymbol{Industry\ FE} + \boldsymbol{\varepsilon}_{i,t} \quad (1)$$

where $\boldsymbol{INV}_{i,t}$ represents firm investment and is computed as annual changes in property, plant, equipment, inventory, and R&D expenditures scaled by lagged total assets to ensure comparability across firms of all sizes (Biddle et al., 2009; Fazzari et al., 1988). As a stand-in for $\boldsymbol{Q}_{i,t-1}$, Tobin's Q considers firm growth opportunities and anticipated investment demand (Myers, 2001). $\boldsymbol{ESG}_{i,t-1}$ is the lagged aggregate ESG score from Refinitiv, and the ENV, SOC, and GOV pillars are used for disaggregated analysis. Detailed definitions and measurements of all variables are reported in Table 1.

The degree to which ESG performance affects investment sensitivity to growth opportunities is captured by the interaction term $\boldsymbol{ESG}_{i,t-1} \times \boldsymbol{Q}_{i,t-1}$. According to the investment–Q framework, this specification assesses the effectiveness of capital allocation by exploring the responsiveness of investments to fundamentals rather than total investment levels (Biddle et al., 2009; Chen et al., 2017). Although a positive coefficient on δ indicates that firms with higher ESG performance make investment decisions that are more responsive to growth opportunities, this should not be interpreted as direct evidence of IE. While investment–Q sensitivity may also reflect financing conditions, valuation effects, and firm heterogeneity, the interaction term is interpreted in accordance with the investment–Q literature as conditional investment sensitivity and closer alignment between investment decisions and growth opportunities, not as conclusive evidence of higher IE (Biddle et al., 2009; Chen et al., 2011; Stulz, 1990). Rather, it shows that economic fundamentals and investing decisions are more closely aligned. Cash flow, firm size, leverage, financial constraints, Tobin's Q, and the Altman Z-score are examples of conventional firm-level investment determinants included in the vector $\boldsymbol{Controls}_{i,t-1}$. Macroeconomic shocks and sectoral heterogeneity are controlled for by using year and industry fixed effects.

4.2.2. Firm performance (Model 2)

The second specification evaluates how ESG performance directly affects FP:

$$\boldsymbol{FP}_{i,t} = \boldsymbol{\alpha} + \boldsymbol{\beta 1} * \boldsymbol{ESG}_{i,t-1} + \boldsymbol{\beta 2} * \boldsymbol{Controls}_{i,t-1} + \boldsymbol{YearFE} + \boldsymbol{Industry\ FE} + \boldsymbol{\varepsilon}_{i,t} \quad (2)$$

where $\boldsymbol{FP}_{i,t}$ is determined using two complementary proxies: Assets_TO, which measures operational efficiency, and ROA, which measures profitability (Chen. et al., 2017; Demsetz and Villalonga, 2001). Beyond using only one accounting indicator, this dual-measurement technique enables a more thorough evaluation of FP. $\boldsymbol{ESG}_{i,t-1}$ is a one-year lagged ESG score, which serve as measure of an firm's sustainability and governance quality and is commonly associated with more efficient resource use, lower risk exposure, and greater stakeholder confidence (Friede, 2015). To account for variations in risk, growth, and operational structure, the model includes several control variables, denoted as $\boldsymbol{Controls}_{i,t-1}$, including company size, leverage, beta, R&D intensity, sales growth, and firm age. ***Industry*** and ***year fixed effects*** account for structural differences between sectors and time-varying macroeconomic conditions.

5. Empirical results

Descriptive statistics are first examined to summarize the distributional characteristics of the variables utilized in the investment sensitivity and FP models. Table 2 provides summary statistics for the variables in the investment model, and Table 3 shows the data for the FP model. Examining the variance among firms and over time supports the suitability of the panel structure in evaluating differences in performance, investment behavior, and FP, consistent with other panel-based ESG research (Berg et al., 2022; Friede, 2015).

Table 2 reports the descriptive statistics of the IE model. As shown, substantial variation is evident in firm investment behavior. With a standard deviation of 0.047 and a mean value of investment (INV) of 0.022, considerable cross-sectional heterogeneity in firms' investment activity is evident. According to research on investment-Q sensitivity (Biddle et al., 2009; Chen et al., 2011), such variance provides a suitable context for analyzing variations in investment sensitivity to growth opportunities. These descriptive patterns should be viewed as preliminary evidence of investment decision variability and not as direct evidence of IE.

There is also significant diversity in ESG performance within the sample. With distinct distributions for its ENV, SOC, and GOV components, the average ESG score is 0.439. This pattern is consistent with evidence that ESG performance varies across firms and institutional settings, and reflects differences in disclosure and sustainability among Japanese firms (Berg et al., 2022). The comparatively wider range of governance scores is consistent with the growing significance of stewardship and governance improvements in Japan's business landscape. The control variables also demonstrate significant variation across firms. While leverage varies significantly, reflecting variations in capital structure and financial risk exposure, firm size has a wide distribution, demonstrating the presence of both medium- and large-sized firms. Financial constraints and the R&D missing indicator are included to

Table 2
Descriptive statistics: investment efficiency model.

VARIABLES	Obs.	Mean	Std. Dev.	Min.	Max.
INV	6824	0.022	0.047	−0.094	0.216
ESG t−1	6018	0.439	0.212	0.004	0.929
ENV t−1	6044	0.460	0.293	0.000	0.991
SOC t−1	6044	0.374	0.238	0.002	0.956
GOV t−1	6053	0.489	0.231	0.005	0.983
Q t−1	6824	1.851	1.554	0.401	14.971
CF t−1	6824	0.178	0.128	−0.331	0.956
SIZE t−1	6824	19.627	1.054	16.811	22.875
LEV t−1	6824	0.196	0.651	0.000	8.333
ROA t−1	6824	0.066	0.088	−0.450	0.344
FIN_CONST t−1	6824	3.058	3.424	0.387	26.029
RD Missing t−1	6824	0.161	0.367	0.000	1.000

Notes: Table 2 shows the descriptive statistics for the variables included in the IE model. Refinitiv is the source of ESG performance and its individual scores (ENV, SOC, and GOV), which were first presented as percentile-rank ratings between 0 and 100. To improve comparability with other continuous variables and coefficient interpretation, these scores are rescaled into ratio form by dividing by 100 as per standard empirical practice. This linear transformation does not change statistical significance, model fit, or underlying economic relationships (Berg et al#, 2022). Consequently, an average ESG score of 43.9 on the original Refinitiv scale corresponds to the reported means (e.g., ESG = 0.439). Moderate firm-level investment activity with significant cross-sectional variation is reflected in the mean investment rate (INV = 0.022). Governance has the highest average score among the subcomponents of aggregate ESG performance, which vary significantly between organizations. Overall, optimistic growth opportunities are indicated by the average Tobin's Q of 1.851. Sample validity is supported by control variables that show anticipated distributions. The 16.1% missing rate of the R&D missing indicator aligns with earlier firm-level disclosure data.

Table 3
Descriptive statistics: firm performance model.

VARIABLES	Obs.	Mean	Std. Dev.	Min.	Max.
ROA	7254	0.070	0.063	−0.118	0.206
Assets_TO	7254	0.777	0.441	0.018	1.920
ESG t−1	6760	0.432	0.212	0.004	0.929
ENV t−1	6760	0.447	0.293	0.000	0.991
SOC t−1	6760	0.366	0.238	0.002	0.956
GOV t−1	6760	0.489	0.233	0.004	0.983
Beta t−1	6760	0.988	0.422	0.010	2.190
LEV t−1	6760	0.328	1.129	0.000	8.333
RD t−1	6760	0.007	0.022	0.000	0.128
SIZE t−1	7202	19.802	1.037	16.811	22.875
Sales Gro t−1	6714	0.046	0.166	−0.472	1.506
AGEt−1	7172	63.845	29.560	1.000	141.0

Notes: The table shows the number of observations (Obs.), mean, minimum (Min.), maximum (Max.), and standard deviation (Std. Dev.). The environmental, social, and governance components of ESG are represented by ENV, SOC, and GOV. ESG stands for total ESG performance. There is a one-year lag (t–1) for all ESG and control variables.

highlight structural discrepancies and reporting differences commonly observed in firm-level datasets (Biddle and Hilary, 2006; Clarkson et al., 2008). Overall, these distributional patterns lend credibility to the use of multiple controls in ensuing multivariate estimations.

The profitability and operational efficiency data in Table 3 suggest notable variations in FP. ROA has a mean value of around 0.07 with a substantial range, whereas Assets_TO averages 0.777, showing variability in firms' abilities to utilize assets effectively. These patterns are consistent with previous studies showing cross-sectional differences in FP indicators (Fama and French, 2002b). The distribution of ESG variables in Table 3 shows persistent differences in firm sustainability performance and trends comparable to those observed in the investment model. Furthermore, changes in risk exposure, growth dynamics, and lifecycle stages—all significant factors influencing FP—are captured by variations in beta, sales growth, and firm age (Demsetz and Villalonga, 2001; Friede, 2015). Collectively, the descriptive statistics show significant differences in financial results, investment behavior, and ESG performance among firms. These descriptive statistics provide fundamental preliminary insights into sample characteristics, but do not establish causal or conditional associations. To determine whether ESG performance is related to investment sensitivity to growth opportunities and FP within a controlled multivariate framework, the regression analysis discussed next is conducted.

5.1. Baseline results

Table 4 shows the baseline regression results for examining the association between ESG performance and firm investment sensitivity to growth opportunities within the investment–Q framework. Stronger sustainability practices and ESG-related performance are indicated by higher values in the sub-indices of the ENV, SOC, and GOV scores (Berg et al., 2022; Friede, 2015; Gibson

Brandon et al., 2021; Khan et al., 2016). The stand-alone effect of Q_{t-1} on INV is positively significant, indicating that the sample firms enhance their investment in accordance with growth opportunities, which supports McLean et al. (2012) results.

In addition, the positive and statistically significant interaction term between ESG performance and Tobin's Q (ESG × Q) ($\beta = 0.005$, $p < 0.01$) confirms the positive association of ESG performance with firm investment sensitivity to growth opportunities. However, the stand-alone effect of ESG performance on investment is negative but weakly significant. This suggests that when the effect of growth opportunities is not considered, ESG performance does not appear to be associated with higher contemporaneous investment levels. Thus, an association between ESG performance and investment sensitivity depends on the availability of growth opportunities. One explanation is that short-term adjustment costs or resource reallocation impacts associated with ESG-related activities might temporarily limit investment intensity. This pattern aligns with research showing that regardless of whether long-term efficiency improvements are anticipated, sustainability transitions may cause short-term frictions (Eccles et al., 2014). The economic relevance of these estimates indicates that a one standard deviation (0.212) increase in ESGt−1 is associated with an improvement in investment sensitivity to growth opportunities of about 13%.[1] Similarly, an increase of one standard deviation in GOVt−1, SOCt−1, and ENVt−1 is associated with higher investment sensitivity to growth opportunities of approximately 21.5%, 12%, and 15.38%, respectively.[2]

According to the investment-Q framework, investment sensitivity to Tobin's Q is used to measure IE. Stronger investment sensitivity, as opposed to merely reflecting higher investment levels, indicates closer alignment between investment decisions and available growth opportunities. The results indicate a positive and statistically significant interaction term between ESG performance and Tobin's Q (ESG × Q = 0.005, $p < 0.01$). This implies that rather than immediately raising investment intensity, ESG performance affects how firms modify investment in response to growth opportunities. Based on these findings, ESG performance may operate as a conditional factor associated with increased investment sensitivity when firms experience more favorable economic opportunities. While acknowledging that investment–Q sensitivity may also reflect firm heterogeneity, financing conditions, or market valuation effects, rather than pure efficiency alone, this interaction should be interpreted cautiously as evidence of improved investment sensitivity and not as a direct measure of IE (Biddle et al., 2009; Chen et al., 2011). Comparing the positive interaction impact with the negative standalone ESG coefficient (−0.014, $p < 0.10$) also confirms that ESG does not consistently encourage investment across firms. Instead, when firms have more growth opportunities, as measured by Tobin's Q, ESG performance becomes economically significant. In these circumstances, firms with greater ESG performance are considered to be in a better position to turn investment opportunities into actual investment decisions. One argument might be that ESG practices boost governance quality, increase information openness, and reduce information asymmetry between investors and management, enabling firms to allocate capital more responsively and selectively rather than expanding investment indiscriminately. Agency theory, as mentioned above, emphasizes better monitoring and decision quality through improved information settings and aligns with this understanding (Meckling and Jensen, 1976).

Furthermore, the findings show conditional and heterogeneous impacts at the ESG dimension level. Environmental performance exhibits a positive and significant interaction with growth opportunities (ENV × Q = 0.004, $p < 0.01$), but a negative standalone association with investment (−0.017, $p < 0.01$). This indicates that environmental initiatives may involve short-term adjustment or compliance costs but become economically relevant when firms encounter attractive investment opportunities. Stakeholder-oriented activities may contribute to investment sensitivity under favorable growth conditions and may not directly affect investment levels. This is evidenced by the positive interaction, rather than the significant direct effect, between social performance and Tobin's Q (SOC × Q = 0.004, $p < 0.05$). In addition, governance performance exhibits a conditional pattern with a positive interaction effect (GOV × Q = 0.004, $p < 0.01$) and a negative direct association (−0.012, $p < 0.05$). This suggests that more robust governance mechanisms improve investment discipline and firms' capacity to align investment decisions with growth opportunities.

Overall, the findings confirm H1 and imply that rather than consistently greater investment levels, ESG performance is associated with improved investment sensitivity to growth opportunities. Under favorable investment conditions, activities related to sustainability may enhance the quality of capital allocation decisions, as indicated by the consistent relevance of interaction terms across aggregate and individual ESG attributes.

Table 5 presents the baseline estimates examining the association between ESG performance and FP using profitability (ROA) and operational efficiency (Assets_TO). The baseline estimates demonstrate a favorable association between aggregate ESG performance and both performance dimensions.

Aggregate ESG performance is positively and significantly associated with ROA ($\beta = 0.024$, $p < 0.01$). Environmental performance does not exhibit a statistically significant association with profitability at the individual dimension level, although social ($\beta = 0.019$,

[1] The coefficients of Q and ESG t−1 ×Q t−1 are 0.006 and 0.005, respectively. The mean value of ESG t−1 is 0.432. Collectively, this suggests that the investment-Q sensitivity for a mean value of ESG t−1 is (0.006 + 0.005 × 0.432 = 0.00816). When ESG t−1 increased by one standard deviation (0.212), it increased investment-Q sensitivity by 13% (e.g., from 0.00816 to 0.00922).

[2] The coefficients of Q, ENV t−1 ×Q t−1, SOC t−1 ×Q t−1, and GOV t−1 ×Q t−1 are 0.004, 0.004, and 0.004, respectively. The mean values of ENV t−1, SOC t−1, and GOV t−1 are 0.447, 0.366, and 0.489, respectively. On aggregate, this implies that the investment-Q sensitivity for mean values of ENV t−1, SOC t−1, and GOV t−1 is (0.006 + 0.004 × 0.447 = 0.0078), (0.006 + 0.004 × 0.366 = 0.0075), and (0.006 + 0.004 ×0.4892 = 0.008), respectively. When ENV t−1 increased by one standard deviation (0.293), it increased investment-Q sensitivity by 15.38% (e.g., from 0.0078 to 0.009). Likewise, when SOCt−1 increased by one standard deviation (0.233), investment-Q sensitivity increased by 12% (e.g., from 0.0075 to 0.0084). When GOVt−1 increased by one standard deviation (0.422), it increased investment-Q sensitivity by 21.5% (e.g., from 0.0079 to 0.0096).

Table 4
Impact of ESG performance on Investment Efficiency (Main Regression Results for Model 1).

VARIABLES	INV	INV	INV	INV
Q t−1	0.006***	0.006***	0.006***	0.006***
	(3.961)	(4.208)	(3.877)	(3.918)
ESG t−1 ×Q t−1	**0.005*** **			
	(2.854)			
ESG t−1	−0.014*			
	(−1.769)			
ENV t−1 ×Q t−1		**0.004*** **		
		(2.968)		
ENV t−1		−0.017***		
		(−2.951)		
SOC t−1 ×Q t−1			**0.004** **	
			(2.383)	
SOC t−1			−0.003	
			(−0.465)	
GOV t−1 ×Q t−1				**0.004*** **
				(2.768)
GOV t−1				−0.012**
				(−2.385)
CF t−1	−0.015*	−0.015*	−0.014*	−0.014*
	(−1.900)	(−1.856)	(−1.834)	(−1.748)
SIZE t−1	0.012***	0.012***	0.012***	0.012***
	(3.220)	(3.202)	(3.087)	(3.311)
LEV t−1	−0.013***	−0.014***	−0.013***	−0.013***
	(−5.304)	(−5.486)	(−5.126)	(−5.229)
ROA t−1	0.071***	0.071***	0.072***	0.072***
	(6.629)	(6.722)	(6.800)	(6.796)
FIN_CONST t−1	−0.000	−0.000	−0.000	−0.000
	(−0.623)	(−0.686)	(−0.733)	(−0.530)
RD_Missing t−1	0.026***	0.025***	0.026***	0.026***
	(7.341)	(7.314)	(7.389)	(7.355)
Constant	−0.243***	−0.241***	−0.235***	−0.244***
	(−3.357)	(−3.318)	(−3.250)	(−3.440)
Year FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Observations	6005	6031	6031	6040
R-squared	0.323	0.322	0.322	0.323
Adj R2	0.274	0.274	0.273	0.274

Notes: Table 4 shows the baseline regression results of the investment efficiency (IE) model using the investment–Q sensitivity framework with investment (INV) as the dependent variable. Model (1) employs aggregate ESG performance, whereas Models (2)–(4) examine the environmental (ENV), social (SOC), and governance (GOV) components individually. All explanatory variables have a one-year lag. Positive and significant interaction terms between ESG measures and Tobin's Q indicate that ESG performance increases a firm's sensitivity to growth opportunities. Instead of increased unconditional investment, this is associated with improved investment efficiency. Each standard has set impacts based on the year and industry. Robust t-statistics are presented in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

$p < 0.01$) and governance ($\beta = 0.023$, $p < 0.01$) performance are still positively and significantly associated with ROA. These findings suggest that environmental performance may take longer to manifest in accounting profitability, but governance quality and stakeholder-related practices are more readily associated with short-term financial performance. This finding is consistent with recent studies showing that environmental initiatives often include upfront implementation costs and delayed financial benefits, unlike governance and social behaviors (Clark et al., 2015; Friede, 2015).

The results indicate a more robust and consistent association for operational efficiency. All ESG dimensions show positive results, including environmental ($\beta = 0.002$, $p < 0.01$), social ($\beta = 0.004$, $p < 0.01$), and governance performance ($\beta = 0.001$, $p < 0.10$). Aggregate ESG performance is positively correlated with ASSET_TO ($\beta = 0.004$, $p < 0.01$). These results imply that operational capabilities and resource utilization are more significantly impacted by ESG performance than immediate profitability. Stronger ESG practices appear to enable firms to enhance internal procedures, strengthen stakeholder ties, and better use their resources.

The more significant and pronounced impacts of ASSET_TO compared to ROA suggest that ESG may provide value mainly through operational channels rather than quick financial returns. Operational gains are more systematic across sustainable dimensions, and profitability results remain dimension-specific.

Collectively, the findings support H2. The findings also show that the effects of ESG on performance are not consistent across all performance metrics. Instead, ESG affects FP in various ways, with higher-level ESG engagement contributing more consistently to operational efficiency and governance, and social dimensions contributing more to profitability.

Ultimately, baseline results show a positive association between ESG performance and both profitability (ROA) and operational efficiency (Assets_TO). These correlations, however, vary in strength and consistency among ESG dimensions and estimation methods, suggesting that the relationship between ESG and FP is context-dependent rather than uniform. However, these results should not be

Table 5
Impact of ESG Performance on Firm Performance with Asset Turnover and Return on Assets as Dependent Variables (Main Regression Results for Model 2).

VARIABLES	ROA	ROA	ROA	ROA	Assets_TO	Assets_TO	Assets_TO	Assets_TO
ESG t−1	**0.024*** **				**0.004*** **			
	(3.012)				**(4.354)**			
ENV t−1		−0.003				**0.002*** **		
		(−0.527)				**(3.199)**		
SOC t−1			**0.019*** **				**0.004*** **	
			(2.903)				**(4.679)**	
GOV t−1				**0.023*** **				**0.001***
				(3.528)				**(1.926)**
Beta t−1	−0.004	−0.002	−0.003	−0.003	−0.091**	−0.088**	−0.087**	−0.070*
	(−1.013)	(−0.582)	(−0.904)	(−0.867)	(−2.402)	(−2.303)	(−2.314)	(−1.793)
LEV t−1	−0.005***	−0.005***	−0.005***	−0.005***	−0.060**	−0.051*	−0.059**	−0.047
	(−4.083)	(−4.036)	(−4.037)	(−4.199)	(−2.049)	(−1.709)	(−2.014)	(−1.557)
RD t−1	−0.063	−0.031	−0.062	−0.055	−0.139	0.158	−0.207	0.525
	(−0.858)	(−0.425)	(−0.851)	(−0.738)	(−0.187)	(0.216)	(−0.273)	(0.672)
SIZE t−1	−0.001	0.002	−0.001	−0.001	−0.143***	−0.130***	−0.139***	−0.112***
	(−0.546)	(0.837)	(−0.317)	(−0.371)	(−6.978)	(−6.573)	(−6.828)	(−5.629)
Sales_Gro t−1	0.075***	0.076***	0.075***	0.075***	0.254***	0.273***	0.252***	0.255***
	(10.159)	(10.201)	(10.139)	(10.148)	(3.352)	(3.562)	(3.338)	(3.307)
AGE t−1	−0.000***	−0.000***	−0.000***	−0.000***	−0.000	−0.000	−0.000	0.000
	(−4.295)	(−3.935)	(−4.250)	(−4.145)	(−0.091)	(−0.170)	(−0.058)	(0.232)
Constant	0.114***	0.065	0.107**	0.102**	3.662***	3.468***	3.632***	3.104***
	(2.645)	(1.617)	(2.568)	(2.561)	(9.075)	(8.852)	(8.980)	(7.888)
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	6439	6439	6439	6439	6439	6439	6439	6439
R-squared	0.128	0.130	0.128	0.130	0.270	0.261	0.272	0.254
Adj R2	0.153	0.149	0.152	0.155	0.271	0.264	0.273	0.258

Notes: Return on assets (ROA) and asset turnover (Assets_TO) are the dependent variables used in this table for the baseline regression findings financial performance (FP) model. While the other models examine the environmental (ENV), social (SOC), and governance (GOV) components individually, models (1) and (5) employ aggregate ESG performance. Every explanatory factor has a one-year lag. The findings show that while the quantity and relevance differ among ESG components and performance metrics, ESG performance is associated with firm performance across profitability and operational efficiency dimensions. Each specification includes firm, industry, and year fixed effects. Robust t-statistics are presented in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

considered evidence of a consistent performance-enhancing impact. Instead of reflecting long-lasting within-firm effects over time, the observed relationships may partially capture variations between firms and reflect baseline pooled OLS estimates. Consequently, a context-dependent association emerges between ESG performance and FP, with operational performance metrics showing stronger and more consistent associations than accounting profitability. The stability of these associations under more stringent identification procedures is further assessed by the robustness assessments in the following section. The economic significance of the estimations indicates that a one standard deviation increase in ESGt−1, SOCt−1, and GOVt−1 is associated with about 7.27%, 6.46%, and 7.66% higher ROA, respectively.[3]

5.2. Robustness analysis

HDFE and the system GMM estimation are employed in additional analyses to evaluate the robustness of the baseline OLS results. These additional estimates investigate the stability of the baseline associations under other panel data specifications and more stringent restrictions for dynamic model structure and unobserved heterogeneity (Blundell and Bond, 1998; Wooldridge, 2010).

HDFE is used to simultaneously control for firm, industry, and year fixed effects. This method considers industry-level heterogeneity, unobserved time-invariant firm characteristics, and shared macroeconomic shocks that may jointly affect ESG performance and firm outcomes (Correia, 2016; Wooldridge, 2010). Compared to the baseline OLS specification, HDFE offers a stricter robustness assessment by focusing on within-firm variation over time. This enables examining whether the baseline associations are stable after correcting for numerous layers of fixed effects (Correia, 2016).

Table 6 shows the robustness results of the investment model using HDFE estimation with firm, industry, and year fixed effects. This approach provides a more stringent assessment by considering industry-specific investment patterns, common temporal impacts, and persistent firm features that may simultaneously affect ESG performance and investment behavior (Biddle et al., 2009; Fazzari et al., 1987; Myers, 2001).

[3] ESG, SOC, and GOV coefficients are 0.024, 0.019, and 0.023, respectively. The mean values of ESG, SOC, and GOV are 0.432, 0.447, and 0.489, respectively. The mean value of ROA is 0.07. A one standard deviation increase in ESG, SOC, and GOV (0.212, 0.238, and 0.233) is associated with an increase in ROA by 7.27%, 6.46%, and 7.66%, respectively.

Tobin's Q remains responsive to growth opportunities and is still positive and statistically significant across all specifications. More importantly, the interaction terms between growth opportunities and ESG performance (ESG × Q), ENV × Q, SOC × Q, and GOV × Q remain positive and statistically significant despite the addition of HDFE. The longevity of these interaction effects suggests that firms with stronger ESG performance show higher investment sensitivity to growth opportunities, whether accounting for within-firm heterogeneity or not. However, regardless of growth opportunities, the standalone ESG coefficients remain statistically weak or inconsistent across specifications, suggesting that ESG performance is not consistently associated with higher investment levels. Rather than unconditional increases in investment outcomes, the evidence indicates a conditional interpretation where ESG performance is associated with increased investment sensitivity to growth opportunities. Since investment–Q sensitivity may also capture other firm-level conditions influencing investment decisions, these results should be interpreted as reflecting more responsive capital allocation behavior rather than providing conclusive evidence of higher IE. This is aligned with the revised conceptual framework.

Overall, the HDFE estimates show that the association between ESG performance and investment sensitivity remains observable under more stringent empirical limitations and corroborate the durability of the baseline interaction findings.

Tables 7 and 8 present the robustness results for FP using HDFE estimation with firm, industry, and year fixed effects. This specification evaluates whether the baseline ESG–performance associations persist after accounting for unobserved firm characteristics and shared temporal consequences (Correia, 2016; Wooldridge, 2010).

When including HDFE controls, the positive association observed in the baseline estimates between ESG performance and profitability (ROA) becomes statistically insignificant. ESG and all individual ESG aspects become statistically insignificant across specifications, indicating that cross-sectional variations within firms, rather than sustained increases in profitability within firms, were primarily responsible for the previous association. These findings are consistent with other studies that demonstrate the ongoing influence of model definition and identification design on ESG–performance associations (Berg et al., 2022; Friede, 2015; Giese et al., 2019). They also align with findings indicating that once accounting profitability is adjusted for unobserved firm characteristics, ESG performance does not show a consistent within-firm relationship. While firm size and sales growth continue to exhibit positive and significant coefficients, validating the model's internal consistency, leverage remains adversely associated with ROA.

Similarly, the results for Assets_TO decrease with the stricter identification approach. While environmental performance becomes statistically insignificant and governance remains significant, aggregate ESG, social performance, and governance performance demonstrate negative associations. These results mean that regardless of whether frequent shocks and enduring firm characteristics are considered, the operational benefits associated with ESG performance observed in the baseline estimates are not always maintained. According to Eccles et al. (2014) and Flammer and Kacperczyk (2016), governance and ESG implementation may include short-term coordination, monitoring, and compliance costs that temporarily impact asset usage efficiency before potential longer-term advantages materialize. While sales growth continues to have a positive and statistically significant relationship with ASSET_TO, firm size remains negatively correlated with it.

Overall, compared to the findings for investment, the robustness analysis shows that the ESG–FP association is more conditional and specification-sensitive. The ESG–performance association appears to depend more strongly on cross-sectional variation and does not reliably persist within firms over time, whereas the investment–Q interaction is very robust across multiple specifications. These results only partially corroborate H2 and show that ESG performance is more reliably associated with investment sensitivity than with direct improvements in FP.

To further examine the robustness of the baseline findings, this study uses the two-step system GMM estimator established by Blundell and Bond (1998). Because system GMM enables estimation in conditions where outcomes may persist over time and where unobserved firm-level factors may affect model estimates, it is used as an additional robustness estimation technique for dynamic panel data (Blundell and Bond, 1998; Roodman, 2009). The two-step system GMM estimator employs internally formed lagged instruments and combines equations in first differences and levels to improve the efficiency of panel estimation. Compared to conventional estimators, the two-step procedure produces asymptotically more efficient estimates under heteroskedasticity and is implemented using a limited instrument structure to maintain estimation reliability (Blundell and Bond, 1998; Roodman, 2009). Standard diagnostic techniques such as the J-test for instrument validity and the Arellano–Bond AR(2) test for serial association are employed to assess the appropriateness of the model. This section reports and interprets these diagnostic data to assess whether the estimated specifications are suitable (Arellano and Bover, 1995; Hansen, 1982)

Table 9 shows the two-step system GMM estimates for the investment model based on investment sensitivity to growth opportunities. This specification employs internally produced instruments and lagged dependent variables to address potential endogeneity (Blundell and Bond, 1998).

The results show that the interaction term between ESG performance and growth opportunities (ESG × Q) remains positive and statistically significant ($\beta = 0.036$, $p < 0.05$), and the standalone coefficients of Tobin's Q and ESG remain statistically insignificant. This pattern suggests that ESG performance is associated with better investment sensitivity to growth opportunities rather than steadily rising investment levels. According to the individual-level estimates, GOV x Q ($\beta = 0.045$, $p < 0.05$), SOC × Q ($\beta = 0.036$, $p < 0.05$), and ENV × Q ($\beta = 0.029$, $p < 0.05$) all remain positive and significant. These results all support the idea that ESG performance is not a direct driver of investment intensity, but a conditional element associated with investment sensitivity.

The lagged dependent variable remains statistically insignificant across specifications whether growth forecasts and ESG-related factors are considered or not, suggesting little persistence in investment behavior. Model validity is supported by the diagnostic tests. Insignificant Hansen J-test statistics indicate that the instrument set is valid, while statistically significant AR(1) test statistics reflect the expected first-order serial correlation in the differenced residuals. In contrast, insignificant AR(2) test statistics indicate the absence of second-order serial correlation, supporting the validity of the moment conditions (Arellano & Bover, 1995; Blundell and Bond, 1998; Hansen, 1982). In addition, concerns regarding instrument proliferation are mitigated because the number of instruments

Table 6
Robustness Test: Results with High-Dimensional Fixed Effects for the Investment Efficiency Model.

VARIABLES	INV	INV	INV	INV
Q t−1	0.003**	0.004***	0.003**	0.003**
	(2.121)	(2.753)	(2.327)	(2.197)
ESG t−1 ×Q t−1	**0.005*** **			
	(3.376)			
ESG t−1	−0.003			
	(−0.494)			
ENV t−1 ×Q t−1		**0.006*** **		
		(3.970)		
ENV t−1		−0.004		
		(−0.909)		
SOC t−1 ×Q t−1			**0.005*** **	
			(2.852)	
SOC t−1			0.002	
			(0.307)	
GOV t−1 ×Q t−1				**0.004*** **
				(3.228)
GOV t−1				−0.009**
				(2.300)
CF t−1	−0.010	−0.011	−0.010	−0.009
	(−1.505)	(−1.581)	(−1.433)	(−1.376)
SIZE t−1	0.001	0.001	0.001	0.002**
	(1.108)	(1.048)	(0.806)	(2.017)
LEV t−1	−0.011***	−0.012***	−0.010***	−0.010***
	(−5.380)	(−6.187)	(−5.167)	(−5.122)
ROA t−1	0.077***	0.078***	0.078***	0.077***
	(7.587)	(7.670)	(7.729)	(7.818)
FIN_CONST t−1	−0.001**	−0.001**	−0.001**	−0.001**
	(−2.375)	(−2.575)	(−2.557)	(−2.148)
RD_Missing t−1	0.024***	0.023***	0.024***	0.025***
	(6.545)	(6.581)	(6.543)	(6.766)
Constant	−0.040*	−0.038*	−0.033	−0.054**
	(−1.694)	(−1.715)	(−1.429)	(−2.444)
Year FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Observations	6006	6032	6032	6041
R-squared	0.212	0.215	0.213	0.212
Adj R2	0.207	0.209	0.207	0.206

Notes: Models (2)–(4) examine the environmental (ENV), social (SOC), and governance (GOV) components individually, Model (1) utilizes aggregate ESG performance. All explanatory variables have a one-year lag. Robust t-statistics are presented in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

remains well below the number of cross-sectional units (Roodman, 2009). Overall, the system GMM estimates show that under various identification assumptions, ESG performance is associated with higher investment sensitivity to growth opportunities and generally comparable with the baseline and HDFE findings.

The two-step system GMM estimations for FP shown in Tables 10 and 11 employ ROA and Assets_TO, complementary measures of profitability and operational efficiency, as mentioned. To address possible endogeneity, the dynamic specification uses both lagged dependent variables and internally generated instruments (Blundell and Bond, 1998).

When ROA is employed as the profitability indicator, aggregate ESG remains positive and statistically significant ($\beta = 0.324$, $p < 0.01$). Social ($\beta = 0.207$, $p < 0.01$) and governance performance ($\beta = 0.122$, $p < 0.10$) remain positively associated with profitability across all ESG dimensions, and environmental performance is not statistically significant. These findings suggest that governance and stakeholder-related channels may be more closely associated with profitability outcomes, even though environmental initiatives may require longer implementation durations before financial advantages become apparent (Friede, 2015; Giese et al., 2019). The lagged ROA coefficient remains positive across all specifications, indicating consistent profitability.

The association is relatively stronger for operational efficiency measured through Assets_TO. All ESG dimensions including ENV ($\beta = 0.462$, $p < 0.01$), SOC ($\beta = 0.371$, $p < 0.05$), and GOV ($\beta = 0.943$, $p < 0.01$) maintain positive and statistically significant correlations, and aggregate ESG remains positively correlated with ASSET_TO ($\beta = 0.253$, $p < 0.05$). Persistence in operational outcomes is further demonstrated by the continuously positive lag-dependent variable. According to these results, operational capacity and resource utilization may be more strongly associated with ESG-related practices than short-term accounting profitability (Clark et al., 2015; Giese et al., 2019). First-order serial correlation is predicted by substantial AR(1) statistics; however, insignificant AR(2) statistics imply that second-order serial correlation is missing. The limited number of instruments minimizes concerns about instrument proliferation, and the validity of the instrument set is supported by insignificant Hansen J-statistics (Roodman, 2009).

Overall, the system GMM estimates continue to confirm a positive association between ESG performance and FP, especially for

Table 7
Robustness test: results with high-dimensional fixed effects for the return on assets model.

VARIABLES	ROA	ROA	ROA	ROA
ESG t−1	−0.000			
	(−0.520)			
ENV t−1		−0.000		
		(−0.365)		
SOC t−1			−0.000	
			(−0.391)	
GOV t−1				−0.000
				(−0.220)
Beta t−1	0.003	0.003	0.003	0.003
	(0.725)	(0.719)	(0.717)	(0.728)
LEV t−1	−0.010***	−0.010***	−0.010***	−0.009***
	(−2.617)	(−2.618)	(−2.616)	(−2.597)
RD t−1	0.025	0.023	0.025	0.024
	(0.237)	(0.222)	(0.242)	(0.228)
SIZE t−1	0.012***	0.012***	0.012***	0.012***
	(3.028)	(3.022)	(3.025)	(3.009)
Sales_Gro t−1	0.089***	0.089***	0.089***	0.089***
	(10.316)	(10.307)	(10.327)	(10.325)
AGE t−1	−0.000	−0.000	−0.000	0.000
	(−0.081)	(−0.169)	(−0.057)	(0.233)
Constant	−0.172**	−0.172**	−0.172**	−0.172**
	(−2.151)	(−2.157)	(−2.159)	(−2.151)
Year FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Observations	6438	6438	6438	6438
R-squared	0.438	0.438	0.438	0.438
Adj R2	0.269	0.259	0.270	0.262

Notes: Models (2)–(4) examine the environmental (ENV), social (SOC), and governance (GOV) components individually, whereas Model (1) employs aggregate ESG performance. All explanatory variables have a one-year lag. All specifications include firm, industry, and year fixed effects. Robust t-statistics are presented in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

operational efficiency, and are generally consistent with the baseline findings. Nonetheless, in comparison to the HDFE estimates, the size and importance of a number of ESG factors remain sensitive to specification selection. This discrepancy implies that rather than consistent within-firm changes over time, a portion of the observed ESG–performance association may reflect cross-sectional variations among firms. The results indicate a conditional and context-dependent interpretation of ESG–performance interactions rather than a consistent influence across all performance parameters, which is consistent with previous research (Berg et al., 2022; Friede, 2015; Giese et al., 2019).

5.3. Endogeneity test

Based on Japan's post−2015 governance and disclosure reforms, a DID analysis is conducted to provide an additional identification test and partially resolve endogeneity issues. While adjusting for common temporal effects and time-invariant firm heterogeneity, this method assesses whether changes in ESG-related outcomes differ consistently between treatment and control firms before and during the policy period (Angrist and Pischke, 2009; Bertrand et al., 2004). The DID approach reduces concern about missing time-invariant elements that could jointly affect ESG performance, investment decisions, and FP by comparing differential changes across groups over time. Here, instead of using the DID analysis as a rigorous causal design, it is employed as an additional identification technique.

Tables 12 and 13 show the DID estimates used as an additional identification analysis. When comparing changes in outcomes across treatment and control firms before and after the policy period, the DID framework considers observable firm characteristics and shared temporal patterns. This approach improves the baseline, HDFE, and system GMM estimations by providing additional evidence via a different identification procedure (Angrist and Pischke, 2009; Bertrand et al., 2004; Chen et al., 2018).

Regarding investment behavior, the findings show that the interaction terms between growth opportunities and ESG performance remain favorable following the reform period. After the governance changes, the triple interaction term (ESG × Q × Treat_Post_Event) is positive and statistically significant ($\beta = 0.005$, $p < 0.05$), indicating that treated firms are more receptive to investment opportunities. The social and governance aspects show similar post-period impacts, whereas the environmental interaction remains statistically insignificant. These results support the hypothesis that rather than consistently increasing investment levels, ESG performance is associated with more sensitive investment adjustment under favorable growth conditions.

Various performance measures exhibit contradictory patterns in the DID estimations for FP. Aggregate ESG and social performance remain positively associated with post-reform profitability (ROA), regardless of whether governance-related effects become statistically insignificant. Conversely, operational efficiency (Assets_TO) produces conflicting results, with some interaction factors becoming negative or insignificant after treatment. These findings demonstrate that ESG-related benefits are not consistently sustained across performance indicators despite accounting for group differences and policy timing.

Table 8
Robustness test: results with high-dimensional fixed effects for the asset turnover model.

VARIABLES	Assets_TO	Assets_TO	Assets_TO	Assets_TO
ESG t−1	**−0.001***			
	(−1.911)			
ENV t−1		−0.000		
		(−0.963)		
SOC t−1			**−0.000***	
			(−1.825)	
GOV t−1				**−0.001*****
				(−2.824)
Beta t−1	−0.001	−0.001	−0.001	−0.000
	(−0.051)	(−0.060)	(−0.092)	(−0.037)
LEV t−1	0.013	0.012	0.012	0.014
	(0.917)	(0.885)	(0.902)	(0.999)
RD t−1	−0.484	−0.504	−0.473	−0.474
	(−1.533)	(−1.603)	(−1.502)	(−1.502)
SIZE t−1	−0.093***	−0.093***	−0.093***	−0.094***
	(−5.595)	(−5.618)	(−5.580)	(−5.683)
Sales_Gro t−1	0.242***	0.242***	0.242***	0.242***
	(9.976)	(9.942)	(9.966)	(10.033)
AGE t−1	−0.000	−0.000	−0.000	0.000
	(−0.089)	(−0.181)	(−0.078)	(−0.172)
Constant	2.616***	2.608***	2.607***	2.635***
	(7.996)	(7.987)	(7.958)	(8.100)
Year FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Observations	6438	6438	6438	6438
R-squared	0.937	0.937	0.937	0.937
Adj R2	0.287	0.253	0.281	0.275

Notes: Using asset turnover (Assets_TO) as the dependent variable estimation, Table 8 presents robustness findings for the firm performance (FP) model. While Models (2)–(4) examine the environmental (ENV), social (SOC), and governance (GOV) components individually, Model (1) employs aggregate ESG performance. All explanatory variables have a one-year lag. All specifications include firm, industry, and year fixed effects. Robust t-statistics are presented in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Overall, the DID results provide more evidence that ESG performance is more likely to be associated with a firm's sensitivity to investment opportunities than with steady improvements in FP. However, post-treatment performance impacts are less significant and less consistent, indicating that ESG–performance associations remain dependent on outcome assessment, model specification, and institutional environment (Berg et al., 2022; Friede, 2015; Giese et al., 2019; Miyamoto and Nohara, 2023).

5.4. Further analysis

To improve identification and address endogeneity concerns, a further event-based analysis focused on Japan's 2015 Corporate Governance Code was conducted. Earlier studies report that ESG-related investment and engagement dramatically increased following the reform period, suggesting that Japanese firms have better integrated sustainability and governance processes (Miyamoto and Nohara, 2023). Rather than treating the shift as a purely exogenous causal event, this study examines whether the association between ESG performance and firm outcomes differs before and after the governance reform period. Firms are divided into pre- and post-event periods, with 2015 as the reference year. This technique enables assessing whether Japan's evolving governance framework has altered the relationship between ESG performance, investment sensitivity to growth opportunities, and FP. This specification complements, not replaces, the baseline, HDFE, GMM, and DID investigations (Blundell and Bond, 1998; Wooldridge, 2010).

Table 14 shows whether the association between ESG performance and investment sensitivity changes based on governance reforms. The interaction terms between ESG performance and growth opportunities remain positive and statistically significant in the post-event phase (ESG×Q = 0.005, ENV×Q = 0.005, SOC×Q = 0.005, GOV×Q = 0.004). Ultimately, they become statistically weak or insignificant in the pre-event period. Thus, based on the findings, rather than unconditional increases in investment, ESG performance became more closely associated with a firm's investment sensitivity to growth opportunities following the governance reform period. Rather than being direct evidence of increased IE, our findings should be considered a greater alignment between investment behavior and growth opportunities in accordance with the investment–Q framework (Biddle et al., 2009; Chen et al., 2011). Arguments that governance changes may enhance investment discipline and the quality of monitoring in Japan's institutional environment are also consistent with the comparatively stronger post−2015 associations (Miyamoto and Nohara, 2023).

Table 15 shows the association between profitability (ROA) and ESG performance over time. All ESG dimensions and aggregate ESG have statistically significant positive associations with ROA in the post-event period, while these relationships significantly deteriorate prior to the reform period.

Governance reforms may have improved the circumstances in which ESG performance is associated with profitability outcomes according to the greater post-event coefficients. However, the results should not be construed as evidence that ESG consistently boosts

Table 9
GMM results: using sensitivity to growth opportunities (Q) as a proxy of the investment efficiency model.

VARIABLES	INV	INV	INV	INV
INVt−1	0.291	0.218	0.101	0.235
	(1.340)	(1.100)	(0.520)	(1.040)
Q	−0.004	−0.013	−0.017	0.002
	(−0.29)	(0.890)	(−1.060)	(0.100)
ESG	0.157			
	(0.970)			
ESG × Q	**0.036****			
	(2.500)			
ENV		0.063		
		(0.580)		
ENV × Q		**0.029****		
		(2.070)		
SOC			0.034	
			(0.350)	
SOC × Q			**0.036****	
			(2.510)	
GOV				0.123
				(0.580)
GOV × Q				**0.045****
				(2.250)
Constant	0.506	0.142	0.066	0.118
	(0.640)	(0.240)	(0.130)	(0.130)
Baseline controls	YES	YES	YES	YES
Observations	5683	5683	5683	5683
Instruments	17	17	17	17
AR1	0.000	0.000	0.002	0.002
AR2	0.505	0.676	0.672	0.973
Hansen J.	0.891	0.675	0.752	0.528

Notes: Table 9 uses investment-Q sensitivity as an empirical investment efficiency (IE), which presents the two-step system GMM estimates for the IE model. While Models (2)–(4) examine the environmental (ENV), social (SOC), and governance (GOV) components individually and their associations with growth opportunities (Q), Model (1) incorporates aggregate ESG performance. All explanatory variables have a one-year lag. All specifications include baseline control variables. Estimation uses lagged dependent variables and internal instruments to handle possible endogeneity and reverse causality; the number of instruments is limited to prevent instrument proliferation. The Hansen J test of overidentifying limitations and Arellano-Bond AR(1) and AR(2) tests are performed to assess the validity of the model. Robust z-statistics are presented in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 10
GMM results: using return on assets as a proxy for firm performance.

VARIABLES	ROA	ROA	ROA	ROA
ROAt−1	0.406*	0.635	0.198	0.629***
	(1.730)	(1.330)	(0.660)	(3.11)
ESG	**0.324*****			
	(2.720)			
ENV		0.276		
		(1.490)		
SOC			**0.207*****	
			(2.930)	
GOV				**0.122***
				(1.71)
Constant	−0.158	−0.050	0.108	−0.023
	(0.050)	(−0.150)	(0.250)	(−0.070)
Baseline controls	YES	YES	YES	YES
Observations	6638	6638	6638	6638
Instruments	11	11	11	11
AR1	0.003	0.091	0.067	0.036
AR2	0.161	0.726	0.140	0.345
Hansen J.	0.225	0.454	0.247	0.755

Notes: Table 10 shows the two-step system GMM estimates model with return on assets (ROA) as the dependent variable. While Models (2)–(4) examine the environmental (ENV), social (SOC), and governance (GOV) components individually, Model (1) incorporates overall ESG performance. To capture profitability persistence over time, the lagged dependent variable is used. All specifications include baseline control variables. Robust z-statistics are presented in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 11
GMM results: using asset turnover as a proxy for firm performance.

VARIABLES	Assets_TO	Assets_TO	Assets_TO	Assets_TO
Assets_TOt−1	0.521***	0.462***	0.462***	0.750***
	(4.930)	(2.590)	(2.590)	(3.71)
ESG	**0.253****			
	(2.30)			
ENV		**0.462*****		
		(2.690)		
SOC			**0.371****	
			(2.410)	
GOV				**0.943*****
				(2.980)
Constant	3.428***	2.731***	3.451***	1.332
	(4.510)	(3.440)	(3.650)	(1.360)
Baseline controls	YES	YES	YES	YES
Observations	6684	6684	6684	6684
Instruments	23	23	23	13
AR1	0.000	0.001	0.001	0.000
AR2	0.717	0.798	0.798	0.357
Hansen J.	0.522	0.648	0.526	0.314

Notes: Table 11 shows the two-step system GMM estimates model with asset turnover (Assets_TO) as the dependent variable. While Models (2)–(4) examine the environmental (ENV), social (SOC), and governance (GOV) components individually, Model (1) incorporates overall ESG performance. The operational efficiency persistence over time is captured by the postponed dependent variable. All specifications include baseline control variables. Robust z-statistics are presented in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

profitability, because the effects are sensitive to specifications and remain associative in nature. Rather, they show that improved governance and transparency frameworks make the profitability-related advantages of ESG more apparent (Friede, 2015; Giese et al., 2019).

Table 16 examines ASSET_TO to assess operational performance. Both periods show positive and substantial associations between ESG performance and ASSET_TO; however, the post-event sample shows stronger effects associated with governance. These results indicate a stronger association between ESG performance and operational channels than with profitability findings. For example, after Japan's governance changes, resource utilization and operating discipline seem more strongly associated with governance-related ESG performance. Previous studies (Clark et al., 2015; Giese et al., 2019) show that sustainable strategies frequently manifest initially through operational efficiency before translating into more significant financial effects.

The event-based analyses provided additional evidence that following Japan's governance reforms, there was a stronger association between ESG performance and firm outcomes. However, the results remain conditional and should not be viewed as conclusive causal effects. Instead, they are evidence of shifting correlations under various institutional situations. There is no indication of significant multicollinearity in the correlation matrices of IE and FP models presented in Appendix Tables A2 and A3. The Augmented Dickey–Fuller (ADF) test is used to further assess panel stationarity. The findings are provided in Appendix Tables A4 and A5. At standard significance levels, all variables reject the null hypothesis of a unit root, supporting stationarity and decreasing concerns about spurious regression. Taken together, these diagnostic tests confirm the dependability of the empirical specification.

6. Discussion

Based on the findings, ESG performance is primarily associated with firm outcomes through a conditional capital allocation channel, not through continuously higher investment or FP. According to the investment-Q framework, ESG performance and Tobin's Q are positively associated, meaning that firms with higher ESG performance are more responsive to investment opportunities. Consistent with the investment–Q framework, the positive ESG × Q association indicates that firms with higher ESG performance demonstrate more investment sensitivity to growth opportunities. This conclusion is viewed as closer alignment between investment decisions and firm fundamentals and not as definitive evidence of improved IE (Biddle et al., 2009; Chen et al., 2011).

In addition, the results show that the direct effect of ESG performance on investment remains weak or inconsistent across specifications, despite the interaction being constant. This supports a more cautious interpretation that considers ESG performance not as a universal stimulus for investment growth, but as an enabling mechanism that improves sensitivity to favorable investment opportunities. This strategy is also supported by evidence that shows ESG performance depends more on institutional context and firm characteristics than on consistent economic benefits (Berg et al., 2022; Friede, 2015).

At the component level, governance-related impacts seem more consistent across investment specifications, but they do not consistently dominate. This outcome supports agency-based assertions that by improving monitoring quality and decreasing information asymmetry, governance systems promote more disciplined capital allocation decisions (Meckling and Jensen, 1976).

Table 12
DID results: using sensitivity to growth opportunities as a proxy for the investment efficiency model.

VARIABLES	INV	INV	INV	INV
ESGt−1	−0.004			
	(−0.787)			
ESGt−1 × Q t−1	0.003*			
	(1.761)			
ESGt−1 ×Q t−1 × Treat_Post_Event	**0.005****			
	(2.248)			
ENVt−1		−0.005		
		(−1.158)		
ENVt−1 × Q t−1		0.005***		
		(2.977)		
ENVt−1 × Q t−1 × Treat_Post_Event		**0.002**		
		(1.072)		
SOCt−1			−0.000	
			(−0.029)	
SOCt−1 × Q t−1			0.003	
			(1.322)	
SOCt−1 × Q t−1 × Treat_Post_Event			**0.005****	
			(2.011)	
GOVt−1				−0.010**
				(−2.488)
GOVt−1 × Q t−1				0.002*
				(1.738)
GOVt−1 × Q t−1 × Treat_Post_Event				**0.005****
				(2.540)
Treat_Post_Event	0.002	0.005	0.002	0.002
	(0.494)	(1.583)	(0.565)	(0.811)
Qt−1	0.003***	0.004***	0.004***	0.003***
	(2.613)	(2.928)	(2.764)	(2.714)
CFt−1	−0.009	−0.010	−0.009	−0.009
	(−1.361)	(−1.505)	(−1.324)	(−1.291)
SIZEt−1	0.001	0.001	0.001	0.001
	(0.911)	(0.745)	(0.654)	(1.442)
LEVt−1	−0.011***	−0.012***	−0.011***	−0.011***
	(−5.541)	(−6.200)	(−5.377)	(−5.406)
ROAt−1	0.076***	0.077***	0.077***	0.077***
	(7.700)	(7.760)	(7.812)	(7.934)
Z_Scoret−1	−0.001***	−0.001***	−0.001***	−0.001***
	(−2.885)	(−2.925)	(−2.964)	(−2.832)
RD_missing t−1	0.023***	0.023***	0.023***	0.024***
	(6.409)	(6.411)	(6.405)	(6.646)
Constant	−0.008	−0.005	−0.004	−0.015
	(−0.408)	(−0.246)	(−0.180)	(−0.785)
Observations	6006	6032	6032	6041
R-squared	0.216	0.217	0.216	0.217
Adj R2	0.211	0.212	0.210	0.211

Notes: Table 12 shows the DID estimations of the relationship between ESG performance and growth opportunities after Japan's post−2015 governance reforms. A proxy for investment efficiency (IE) is investment-Q sensitivity. The interaction factors (ESG × Q × Treat_Post_Event) indicate whether investment sensitivity associated with ESG varies before and after the reform. The findings show comparatively larger post-reform associations between investment sensitivity and ESG performance, especially for the governance metrics. All specifications include year and industry fixed effects. Robust t-statistics are presented in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Conversely, social and environmental factors exhibit more variable patterns, suggesting that ESG components operate through different economic channels and should not be viewed as having similar advantages. This disparity is particularly relevant in Japan's institutional context, where stewardship reforms and corporate governance initiatives have strengthened board accountability and monitoring.

The results regarding FP are less consistent. Positive associations found under the baseline estimates significantly wane under HDFE specifications, suggesting that cross-sectional variations rather than steady within-firm gains over time account for a portion of the ESG–performance association. System GMM findings continue to show positive associations, although specification selection remains relevant to the magnitude and significance. Consequently, the findings do not support the idea that ESG performance regularly boosts firm profitability or operational efficiency. Rather than contradicting evidence, this diversity among specifications appears to represent variations in how ESG performance is associated with firm outcomes. Investment-related results are relatively constant

Table 13
DID results: impact of ESG performance on Firm Performance with asset turnover and return on assets as dependent variables.

VARIABLES	ROA	ROA	ROA	ROA	Assets_TO	Assets_TO	Assets_TO	_Assets_TO
ESGt−1	0.022***				0.347***			
	(4.533)				(11.211)			
ESGt−1 × Treat_Post_Event	**0.026****				**−0.212*****			
	(2.396)				**(−2.976)**			
ENVt−1		−0.005				0.155***		
		(−0.998)				(7.017)		
ENVt−1 × Treat_Post_Event		**0.021***				0.056		
		(1.733)				(0.915)		
SOCt−1			0.017***				0.351***	
			(3.762)				(4.388)	
SOCt−1 × Treat_Post_Event			**0.018***				**−0.309*****	
			(1.938)				**(−2.872)**	
GOVt−1				**0.022*****				**0.120***
				(5.855)				**(1.894)**
GOVt−1 ×Treat_Post_Event				0.006				−0.116
				(0.697)				(−1.383)
Treat_Post_Event	−0.017***	−0.011	−0.012**	−0.003	0.168***	0.030	0.203***	0.152**
	(−2.670)	(−1.338)	(−2.224)	(−0.693)	(3.623)	(0.677)	(2.860)	(2.587)
Betat−1	−0.004	−0.002	−0.003	−0.003	−0.080***	−0.077***	−0.078**	−0.066*
	(−1.639)	(−0.583)	(−1.426)	(−1.419)	(−6.147)	(−5.844)	(−2.217)	(−1.850)
LEVt−1	−0.005***	−0.005***	−0.005***	−0.005***	−0.047***	−0.047***	−0.046***	−0.047***
	(−5.505)	(−4.085)	(−5.422)	(−5.566)	(−11.159)	(−10.853)	(−6.872)	(−7.054)
RDt−1	−0.076	−0.054	−0.070	−0.057	−0.150	−0.218	−0.073	−0.088
	(−1.328)	(−0.734)	(−1.227)	(−1.001)	(−0.544)	(−0.805)	(−0.166)	(−0.206)
SIZEt−1	−0.001	0.001	−0.001	−0.001	−0.125***	−0.117***	−0.122***	−0.105***
	(−1.110)	(0.750)	(−0.527)	(−0.728)	(−23.473)	(−22.118)	(−7.074)	(−6.317)
Sales_Grot−1	0.075***	0.076***	0.075***	0.075***	0.059	0.068*	0.058	0.063
	(10.843)	(10.208)	(10.829)	(10.853)	(1.635)	(1.917)	(1.227)	(1.341)
AGEt−1	−0.000***	−0.000***	−0.000***	−0.000***	−0.000	−0.000	−0.000	0.000
	(−8.193)	(−3.969)	(−8.040)	(−7.750)	(−0.455)	(−0.801)	(−0.116)	(0.114)
Constant	0.114***	0.070*	0.105***	0.102***	3.236***	3.125***	3.220***	2.885***
	(4.805)	(1.715)	(4.463)	(4.541)	(24.838)	(23.982)	(9.132)	(8.480)
Observations	6638	6638	6638	6638	6638	6638	6638	6638
R-squared	0.158	0.155	0.158	0.160	0.277	0.270	0.280	0.266
Adj R2	0.153	0.150	0.152	0.155	0.273	0.266	0.276	0.262

Notes: Table 13 shows the DID estimations of the association between ESG performance and Japan's governance reforms. Asset turnover (ASSET_TO) and return on assets (ROA) are used to measure firm performance (FP). ESG–performance associations before and after reform is captured by interaction terms. While information on operational efficiency is conflicting, the results show comparatively greater post-reform connections with profitability. All specifications include year and industry fixed effects. The t-statistics are presented in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

across the baseline, HDFE, system GMM, DID, and post-reform analyses, indicating that ESG performance is more reliably associated with firm capital allocation behavior and sensitivity to growth opportunities. However, the FP metrics highlight more variation. Particularly following governance changes, profitability (ROA) often exhibits greater and more enduring associations, suggesting that ESG-related governance quality, monitoring systems, and the integration of sustainability into strategy may have a more direct impact on long-term financial results. The relatively higher consistency of ROA compared to operational efficiency measures may indicate that ESG performance improvements in monitoring quality, stakeholder confidence, and strategic decision-making are reflected more gradually in profitability outcomes, even though operational efficiency remains more vulnerable to short-term implementation costs, organizational changes, disclosure requirements, and sustainability integration across firms (Berg et al., 2022; Giese et al., 2019; Gillan et al., 2021). Evidence that ESG provides value through various channels and that institutional context affects how sustainability policies translate into visible firm outcomes is consistent with this approach (Berg et al., 2022; Giese et al., 2019; Gillan et al., 2021).

The finding is further supported by the supplementary DID analysis based on Japan's post−2015 governance and disclosure reforms. Thus, rather than consistently improving FP, institutional reforms may enhance ESG performance through better governance and monitoring. The system GMM estimates are regarded as robustness results subject to conventional diagnostic validity constraints, and the DID analysis is considered an additional identification exercise rather than causal evidence (Angrist and Pischke, 2009; Roodman, 2009; Wooldridge, 2010).

From a practical perspective, the findings suggest that firms and policymakers should not treat ESG as universally value-enhancing. Instead, ESG practices appear more appropriate when integrated with governance discipline and when firms have meaningful growth opportunities. For investors, ESG signals may provide greater informational value when evaluated alongside firm fundamentals rather than as standalone indicators.

Table 14
ESG performance and investment efficiency before and after the 2015 governance reform.

Post-event					Pre-event			
VARIABLES	INV	INV	INV	INV	INV	INV	INV	INV
Qt−1	0.002	0.002*	0.002	0.002	0.006***	0.006***	0.006***	0.006***
	(0.967)	(1.713)	(1.208)	(1.038)	(3.605)	(3.441)	(3.582)	(3.580)
ESGt−1_P_Q	0.005**				0.000			
	(2.414)				(0.052)			
ESGt−1_P	0.004				−0.004			
	(0.563)				(−0.602)			
ENVt−1_P_Q		0.005***				0.003		
		(2.854)				(1.595)		
ENVt−1_P		0.002				−0.002		
		(0.289)				(−0.403)		
SOCt−1_P_Q			0.005**				0.000	
			(2.272)				(0.174)	
SOCt−1_P			0.004				0.002	
			(0.644)				(0.358)	
GOVt−1_P_Q				0.004*				0.001
				(1.872)				(0.436)
GOVt−1_P				−0.001				−0.010**
				(−0.197)				(−2.079)
CFt−1	0.012	0.013	0.014	0.016	−0.017**	−0.017**	−0.017**	−0.017**
	(1.206)	(1.292)	(1.428)	(1.597)	(−2.050)	(−2.118)	(−2.080)	(−2.037)
SIZEt−1	0.002	0.002*	0.002*	0.003**	0.000	−0.000	−0.000	0.001
	(1.648)	(1.769)	(1.694)	(2.459)	(0.320)	(−0.258)	(−0.210)	(0.729)
LEVt−1	−0.010***	−0.011***	−0.010***	−0.010***	−0.086	−0.084	−0.083	−0.091
	(−5.470)	(−6.215)	(−5.277)	(−4.920)	(−0.975)	(−0.940)	(−0.943)	(−0.993)
ROAt−1	0.061***	0.062***	0.063***	0.061***	0.070***	0.071***	0.071***	0.070***
	(4.196)	(4.305)	(4.406)	(4.340)	(6.304)	(6.348)	(6.356)	(6.342)
Z_Scoret−1	−0.000	−0.000	−0.000	−0.000	−0.002***	−0.002***	−0.002***	−0.002***
	(−1.213)	(−1.302)	(−1.298)	(−0.981)	(−3.210)	(−3.347)	(−3.331)	(−3.222)
RD_missingt−1	0.015***	0.014***	0.015***	0.017***	−0.011***	−0.010***	−0.011***	−0.012***
	(3.836)	(3.843)	(3.977)	(4.300)	(−3.359)	(−2.960)	(−3.356)	(−3.135)
Constant	−0.060**	−0.061**	−0.060**	−0.077***	−0.018	−0.004	−0.004	−0.025
	(−2.250)	(−2.380)	(−2.259)	(−3.008)	(−0.603)	(−0.134)	(−0.146)	(−0.932)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	2642	2668	2668	2677	3364	3364	3364	3364
R-squared	0.2720	0.2738	0.2692	0.2670	0.1540	0.1548	0.1540	0.1555
Adj R2	0.264	0.266	0.261	0.259	0.146	0.147	0.146	0.147

Note: Investment efficiency (IE) is proxied by investment-Q sensitivity. In contrast to investment levels, interaction terms (ESG_P × Q, ENV_P × Q, SOC_P × Q, and GOV_P × Q) describe whether ESG performance is associated with a firm's response to growth opportunities. The findings show that ESG-Q associations were more robust and statistically significant in the post-reform period. All parameters incorporate year and industry fixed effects. The t-statistics are presented in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

7. Conclusion

This study investigates the association between ESG performance, investment sensitivity to growth opportunities, and FP across Japanese listed firms between 2002 and 2023. It assesses whether ESG performance is associated with capital allocation and firm outcomes in Japan using baseline fixed effects estimations and additional analyses based on HDFE, system GMM, DID, and pre-post governance reform subsample analysis. The results offer some evidence supporting the suggested hypotheses. First, a positive association exists between ESG performance and investment sensitivity to growth opportunities (Q), meaning firms with better ESG performance demonstrate greater investment sensitivity to growth opportunities. The findings, however, suggest an association rather than a direct increase in investment levels, suggesting that as firms encounter better investment opportunities, ESG performance becomes more significant. After Japan's 2015 Corporate Governance reform, this association strengthened, especially through the social and governance dimensions, according to additional DID and sample-based analyses. This means that institutional changes related to governance may improve the alignment between investment decisions and growth opportunities.

Second, the evidence on FP is complex. Profitability (ROA) and ESG performance are positively and significantly associated, and this association strengthens in the post-reform period, indicating that governance changes may have enhanced firms' ability to convert ESG-related practices into profitable results. Baseline findings for ASSET_TO, a measure of operational efficiency, remain favorable; however, DID estimates indicate negative post-reform interaction effects for the social component and aggregate ESG. This trend implies that Japanese firms may have shifted from focusing on short-term asset utilization following the 2015 reform toward longer-term governance quality, stakeholder engagement, disclosure enhancements, and organizational changes associated with

Table 15
Panel A: ESG performance and firm performance through profitability before and after the 2015 governance reform.

	Post-event				Pre-event			
VARIABLES	ROA	ROA	ROA	ROA	ROA	ROA	ROA	ROA
ESGt−1_P	0.040***				0.011			
	(3.894)				(1.093)			
ENVt−1_P		0.009**				−0.011		
		(2.015)				(−1.622)		
SOCt−1_P			0.032***				0.006	
			(3.758)				(0.717)	
GOVt−1_P				0.033***				0.017**
				(3.546)				(2.394)
Betat−1	−0.013**	−0.013***	−0.013**	−0.012**	0.002	0.004	0.003	0.002
	(−2.323)	(−3.375)	(−2.205)	(−2.134)	(0.596)	(1.034)	(0.683)	(0.580)
LEVt−1	−0.005***	−0.005***	−0.005***	−0.005***	−0.111	−0.101	−0.110	−0.112
	(−3.635)	(−4.581)	(−3.548)	(−3.770)	(−1.439)	(−1.354)	(−1.429)	(−1.458)
RDt−1	−0.102	−0.066	−0.097	−0.086	−15.607	−20.970	−18.593	−7.051
	(−1.419)	(−1.163)	(−1.357)	(−1.170)	(−0.459)	(−0.627)	(−0.550)	(−0.210)
SIZEt−1	−0.001	0.001	−0.001	0.000	−0.001	0.002	−0.000	−0.001
	(−0.448)	(0.997)	(−0.230)	(0.073)	(−0.374)	(0.780)	(−0.175)	(−0.651)
Sales_Grot−1	0.087***	0.087***	0.087***	0.087***	0.068***	0.068***	0.068***	0.068***
	(6.832)	(7.376)	(6.841)	(6.739)	(8.223)	(8.230)	(8.211)	(8.212)
AGEt−1	−0.000**	−0.000***	−0.000**	−0.000**	−0.000***	−0.000***	−0.000***	−0.000***
	(−2.289)	(−3.432)	(−2.178)	(−1.987)	(−4.079)	(−3.822)	(−4.053)	(−4.069)
Constant	0.102*	0.062**	0.095*	0.074	0.114**	0.066	0.106**	0.120***
	(1.937)	(2.119)	(1.846)	(1.476)	(2.372)	(1.503)	(2.261)	(2.751)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	2779	2779	2779	2779	3859	3859	3859	3859
R-squared	0.1275	0.1158	0.1255	0.1276	0.1885	0.1892	0.1882	0.1910
Adj R2	0.119	0.107	0.117	0.119	0.182	0.183	0.182	0.185

Note: Table 15 shows the subsample evaluations of ESG performance and profitability before and after Japan's governance reform. Return on assets (ROA) determines firm performance (FP). The results demonstrate stronger and more statistically meaningful ESG–profitability associations in the post-reform period. Each standard has predetermined consequences based on the year and industry. The t-statistics are presented in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

sustainability. While promoting long-term profitability and strategic efficiency, these adjustments may initially increase coordination and compliance costs and decrease short-term operational turnover. According to the pre-post analysis, ESG remained positively associated with operational performance across both periods, although governance-related advantages were more noticeable during the reform period.

The findings show that ESG performance is more closely associated with firms' investment response to growth opportunities and profitability than to steady increases in operational efficiency. Further studies based on Japan's 2015 Corporate Governance Reform show that institutional reforms associated with governance supported profitability findings and reinforced the association between ESG performance and investment sensitivity. The benefits of operational efficiency, however, continued to be mixed across ESG dimensions, suggesting that ESG generates value through multiple channels and does not yield consistent results across all performance metrics. Accordingly, given suitable organizational and institutional conditions, ESG performance serves as a strategic governance and sustainability mechanism in the Japanese institutional system, supporting more disciplined capital allocation and long-term value creation.

Several limitations are acknowledged. First, rather than using direct ESG investment expenditures, the study employs Refinitiv ESG ratings to quantify ESG performance. Second, although additional estimations improve empirical identification, residual endogeneity concerns cannot be fully eliminated. Third, investment-Q sensitivity is not a direct indicator of IE; rather, it incorporates conditional investment sensitivity. To improve causal identification, future studies may use different efficiency metrics and take more direct advantage of institutional reforms.

CRediT authorship contribution statement

Yusra Nazir: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Xiaojing Cai:** Supervision, Funding acquisition, Conceptualization. **Tatsumasa Tennojiya:** Supervision, Funding acquisition, Conceptualization.

Table 16
Panel B: ESG performance and firm performance through operational efficiency before and after the 2015 governance reform.

	Post-event				Pre-event			
VARIABLES	Assets_TO	Assets_TO	Assets_TO	Assets_TO	Assets_TO	Assets_TO	Assets_TO	Assets_TO
ESGt−1_P	0.343***				0.366***			
	(3.598)				(3.815)			
ENVt−1_P		0.260***				0.142**		
		(3.575)				(2.048)		
SOCt−1_P			0.263***				0.387***	
			(3.371)				(4.454)	
GOVt−1_P				0.176**				0.076
				(2.299)				(1.181)
Betat−1	−0.154***	−0.165***	−0.147***	−0.143***	−0.039	−0.030	−0.038	−0.020
	(−3.459)	(−3.634)	(−3.283)	(−3.169)	(−0.997)	(−0.756)	(−0.978)	(−0.492)
LEVt−1	−0.048***	−0.047***	−0.047***	−0.049***	−1.071	−1.032	−1.081	−0.966
	(−7.787)	(−7.617)	(−7.680)	(−7.785)	(−0.995)	(−0.965)	(−1.008)	(−0.925)
RDt−1	0.166	0.256	0.232	0.410	74.440	−1.279	−25.775	18.859
	(0.368)	(0.584)	(0.506)	(0.876)	(0.259)	(−0.004)	(−0.090)	(0.064)
SIZEt−1	−0.120***	−0.119***	−0.113***	−0.100***	−0.129***	−0.112***	−0.128***	−0.099***
	(−6.610)	(−6.752)	(−6.399)	(−5.750)	(−6.573)	(−5.791)	(−6.546)	(−5.296)
Sales_Grot−1	0.206***	0.213***	0.203***	0.208***	−0.016	−0.004	−0.017	−0.008
	(2.998)	(3.068)	(2.969)	(2.984)	(−0.290)	(−0.079)	(−0.304)	(−0.144)
AGEt−1	−0.000	−0.000	−0.000	0.000	0.000	0.000	−0.000	0.000
	(−0.217)	(−0.501)	(−0.096)	(0.092)	(0.035)	(0.064)	(−0.005)	(0.335)
Constant	3.154***	3.193***	3.069***	2.801***	3.291***	2.997***	3.309***	2.733***
	(8.894)	(9.009)	(8.700)	(8.167)	(8.292)	(7.629)	(8.324)	(7.209)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	2779	2779	2779	2779	3859	3859	3859	3859
R-squared	0.306	0.306	0.301	0.294	0.259	0.247	0.265	0.244
Adj R2	0.299	0.300	0.295	0.288	0.253	0.241	0.259	0.238

Note: Table 16 includes the subsample ESG performance and operational efficiency before and after Japan's Corporate Governance reform. Firm Performance (FP) is measured using asset turnover (Assets_TO). The results demonstrate show a positive association between ESG and operational efficiency in both periods, even though governance-related effects become more statistically significant in the post-reform period. All specifications include year and industry fixed effects. The t-statistics are presented in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Declaration of Competing Interest

I confirm that this manuscript has not been published previously and is not under consideration for publication elsewhere. I also declare that the authors have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ribaf.2026.103582.

Data availability

Data will be made available on request.

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