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How does environmental, social, and governance (ESG) performance determine investment mix? New empirical evidence from BRICS

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ABSTRACT

Integrating environmental, social, and governance (ESG) principles into investment decisions has garnered increased attention in the business landscape. Thus, the current study aims to investigate the intricate interplay between ESG performance and investment patterns (capital vs. environmental) within the corporate setting. This study sought to identify the influence of ESG scores on earnings-driven investments (capital investment) and environmental investments, exploring potential trade-offs and implications for corporate decision-making. The analysis was conducted by sampling nonfinancial sector enterprises from BRICS nations from 2010 to 2022. For regression analysis, system generalized method of moments (GMM) was employed to address endogeneity concerns. The findings revealed a significant positive correlation between ESG performance and earnings-driven investments (capital investment). However, a negative relationship emerged between ESG scores and environmental investments, signifying potential trade-offs between financial profitability and dedicated environmental spending within companies. Other variables, including firm size, debt ratios, cash holdings, and CO_2 emissions, significantly impacted investment patterns. The study's outcomes provide valuable guidance for corporate managers navigating sustainable investment strategies. Emphasizing earnings-driven investments, particularly capital projects, with a high ESG focus could align financial objectives with sustainable practices, enhancing long-term viability and stakeholder trust. The study's insights contribute to the broader discourse on responsible corporate practices and sustainability. The findings shed light on the complexities of balancing financial objectives with environmental responsibilities, emphasizing the need for a balanced approach reconciling financial goals with ESG commitments. This study contributes novel insights by dissecting the nuanced relationships between ESG performance and investment decisions. The analysis provides a novel perspective on companies' trade-offs between the investment mix and pursuing ESG performance.

1. Introduction

In recent years, environmental, social, and governance (ESG) considerations have emerged as pivotal to investment decisions across various industries (Li, Ba, et al., 2023; Zhang et al., 2022). Investors' growing emphasis on ESG criteria reflects a paradigm shift in evaluating corporate performance beyond traditional financial metrics (He, et al., 2023). Understanding how ESG performance influences investment strategies, especially in deciphering its implications on resource allocation within corporations, is crucial. This study explores the correlation between ESG-focused investments and the subsequent shift in corporate focus from environmental initiatives toward capital investments, driven by the pursuit of sustainable, long-term returns. We explore the evolving dynamics of investment preferences and the potential trade-offs or synergies between ESG commitments and profit-centric capital allocation strategies. By delineating the mechanisms through which ESG considerations affect investment decisions, this study provides valuable insights for investors and corporations navigating the intersection of sustainable practices and financial returns.

The role of ESG criteria in shaping investment choices has gained

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prominence recently as investors recognize their significance in assessing a company's long-term viability and risk management (Li, Ba, et al., 2023). This heightened attention to ESG performance has led to a paradigm shift in investment behavior, with more investors considering nonfinancial metrics alongside traditional financial indicators. This study investigates how ESG criteria influence corporate decision-making, particularly in investment allocation. This study explores how emphasizing ESG principles shifts the corporate focus from environmental-oriented investments to capital investments, a strategic move intended to generate earnings and financial returns.

ESG performance refers to how well a company manages and operates in ESG areas. The environmental aspect assesses a company's impact on the environment, including measures related to carbon emissions, resource usage, waste management, renewable energy adoption, pollution control, and ecological sustainability. Social factors consider a company's relationships and impacts on society. This involves evaluating labor practices, employee relations, diversity and inclusion, community engagement, human rights, and product safety. Governance reflects the quality of a company's leadership, internal controls, shareholder rights, transparency, ethical standards, and adherence to laws and regulations (Wang, Lin, et al., 2023). The investment mix refers to allocating funds or resources to different types of investments in a portfolio. It typically involves diversifying investments across various asset classes or specific sectors. In this study, capital investment involves allocating funds for acquiring physical assets or long-term investments to generate income or enhance a company's operations (Farooq, et al., 2024). Capital investment (CAP) comprises infrastructure development, machinery purchases, and property acquisitions, among others, to increase productivity and profitability. Similarly, environmental investments (EINV) are directed toward environmentally sustainable initiatives and projects, including investments in renewable energy sources, ecofriendly technologies, pollution control measures, waste reduction programs, and other projects to reduce the company's environmental impact (Yang, 2023).

This study explores how a company's ESG performance influences its investment mix, particularly whether a strong ESG focus shifts the corporate focus from traditional capital investments toward more environmentally oriented investments. This shift might involve reevaluating resource allocation, prioritizing sustainability initiatives, and balancing profitability with environmental considerations. This study comprehensively analyzed BRICS countries from 2010 to 2022, using a system generalized method of moments (GMM) model for regression analysis. This research aimed to understand the relationship between ESG performance and investment allocation within these nations. The key findings revealed intriguing insights. First, it was observed that ESG performance exhibited a negative correlation with environmental investment. This suggests that as companies focused more on improving their ESG performance, they tended to reduce investments specifically targeted at environmental initiatives.

Conversely, the study found a positive relationship between ESG performance and capital investment. This indicates that higher ESG performance was associated with increased capital investments, indicating a potential shift from environmentally centered investments to those aimed at generating income and bolstering operations. These relationships remained consistent even after incorporating various control variables, such as firm size, debt ratio, cash holdings, and CO_2 emissions, into the analysis, suggesting the observed connections between ESG performance and investment allocations persisted despite these influencing factors. Overall, the study's findings underscore a noteworthy trend among BRICS nations, wherein a strong commitment to ESG influences companies to allocate more capital toward earning-based investments while reducing dedicated investments toward environmental initiatives.

This study makes a theoretical contribution by showing a nuanced relationship between ESG performance and investment allocation. It sheds light on how companies, particularly in BRICS countries, adjust their investment strategies in response to ESG considerations. This extends existing corporate finance and sustainability theories, providing insights into how ESG factors influence investment decisions. By revealing the negative correlation between ESG performance and environmental investment and the positive correlation with capital investment, this study contributes to understanding corporate trade-offs between sustainability initiatives and income-generating investments. This enriches the discourse on corporate decision-making in terms of balancing profitability and sustainability goals. Practically, the empirical analysis conducted from 2010 to 2022 among BRICS countries offers region-specific insights into the relationship between ESG performance and investment mix.

This empirical evidence contributes to filling a gap in understanding how ESG considerations impact investment decisions in these emerging economies. The study's use of a system GMM model and including various control variables enhances the robustness of its findings. The consistent relationships observed between ESG performance and investment allocations, despite controlling for influencing factors such as firm size, debt ratio, cash holdings, and CO_2 emissions, strengthen the reliability of the study's conclusions. The study's findings also offer practical guidance to companies operating in BRICS nations. It provides insights into how a strong focus on ESG performance might influence investment decisions. This knowledge could aid corporate strategists and decision-makers align ESG initiatives with overall investment planning. The study's implications are significant for policymakers and regulatory bodies. Understanding the dynamics between ESG performance and investment allocation may guide policy formulation that seeks a balance between sustainability goals and economic growth and adjustments to incentivize environmentally conscious investments without hindering overall economic development.

The remainder of this paper is structured as follows. Section 2 is a theoretical literature review of ESG performance and investment decisions. Section 3 provides an empirical review of prior studies on similar relationships between ESG performance and the investment mix. Section 4 presents the data and methods that outline the methodology adopted for data collection, variable selection, and the analytical approach. Section 5 presents the study's results, and section 6 interprets and contextualizes the study's results. Section 7 summarizes the key findings and their implications.

2. Theoretical review

Some theories support the theoretical linkages between ESG performance and the investment mix. For instance, stakeholder theory posits that businesses should consider the interests of all stakeholders, not just shareholders (Freeman, 1984). When ESG performance improves, companies may prioritize capital investments that generate profits and align with stakeholder values. They might invest in projects that enhance employee well-being or community development. A greater focus on ESG can enhance capital investment, which improves the company's financial performance and yields more returns for shareholders and stakeholders. In the case of environmental investment, ESG advancements might lead to less environmental investment as companies, aiming for overall sustainability, allocate resources toward capital investments that indirectly benefit the environment, such as adopting more energy-efficient technologies, rather than specific environmental projects. Additionally, a higher ESG focus may alleviate the pressure on enterprises to achieve environmental sustainability, potentially reducing their inclination to invest in environmental technologies (Liu, et al., 2024).

The modern portfolio theory (MPT) posited by Markowitz (1952) guides the theoretical relationship between the underlying variables. According to MPT, investors seek a balance between risk and return; therefore, improved ESG performance could attract investors favoring sustainable investments (Yin, et al., 2023), leading companies to allocate more capital toward projects with strong ESG credentials to

enhance long-term returns. Similarly, in the case of environmental investment, ESG-oriented capital investment might indirectly benefit the environment. For instance, allocating capital toward ecofriendly technologies could decrease the need for separate environmental-focused investments, thereby reducing environmental investment. Thus, a stronger ESG performance tends to shift enterprise investment portfolios away from environmental-focused initiatives toward income-driven investments, namely capital investment.

Trade-off theory suggests that companies often menage in a balancing act when allocating resources, particularly between conflicting objectives (Modigliani & Miller, 1958). In ESG performance and investment allocation, a company's improved ESG performance can influence its investment decisions. When ESG performance is stronger, companies might prioritize projects that offer immediate financial returns, i.e., capital investments. This strategic shift aligns with satisfying shareholder demands for profitability, considering that improved ESG performance might attract investors seeking sustainable yet profitable ventures. However, this shift toward capital investments may come at the expense of specific environmental initiatives. Companies that aim for immediate financial gains to satisfy shareholder demands or to bolster their financial performance might allocate resources toward projects that promise quicker and more tangible financial returns. While these projects might indirectly benefit the environment, they are not necessarily exclusively focused on direct environmental initiatives. In essence, enhancing ESG performance could result in reprioritizing investments toward those that offer both financial profitability and some indirect positive environmental impact. This could potentially lead to a trade-off wherein environmental-focused investments receive less attention or resource allocation than income-driven capital investments.

According to the general concept of behavioral finance, behavioral biases such as social responsibility preferences may lead investors to favor companies with strong ESG performance. Thus, companies responding to investor preferences might allocate more capital toward projects that enhance their ESG position. However, this same behavioral bias might reduce EINV as companies opt for projects that produce immediate financial gains aligned with ESG principles rather than direct environmental initiatives. Resource dependence theory posits that improved ESG performance could strengthen a company's relationships with critical resources, such as access to capital (Pfeffer & Salancik, 1978). Consequently, companies might allocate more capital toward projects that maintain or enhance these resource dependencies. Explaining the impact on environmental investment, this increased reliance on critical resources could divert the focus from specific EINV toward capital projects that indirectly benefit the environment while serving other strategic resource-related objectives. These theories provide different lenses for understanding how ESG performance influences capital and EINV, showcasing the intricate interplay between sustainability considerations and financial decision-making.

3. Empirical review

Some empirical studies have explored the nexus between ESG performance and investment allocation. Zhou et al. (2022) scrutinized the impact of ESG metrics on the market value of Chinese enterprises. This study establishes regression and mediation models by employing financial performance as a mediator, revealing that enhanced ESG performance bolsters market value, with financial performance acting as a significant mediator. Additionally, operational capacity emerges as a key mediator in the pathway between ESG performance and market value, particularly in state-owned listed companies. Such an increase in market value and firm performance boosts financial reserves, which further positively affects capital investment. Li, Ba, et al. (2023) investigated the impact of ESG rating events on innovation in Chinese A-share listed companies, finding that robust ESG performance and high financial investment behavior correlate with heightened corporate innovation. Additionally, external factors such as industrial structure, property rights protection, regional financial development, and internal factors, such as firm scale and capital reservoirs, significantly influence this relationship. Zehir and Aybars (2020) evaluated European and Turkish stock portfolios based on ESG scores. While specific portfolios showcased performance above market returns through the Fama–French three-factor model, the comprehensive findings indicated the absence of a significant relationship between socially responsible investing and overall portfolio performance.

In particular, Kotsantonis et al. (2016) aimed to determine how companies prioritizing ESG initiatives often outperform competitors through competitive advantages and superior investor returns. The analysis highlights the widespread misperceptions surrounding ESG investing, showing that companies committed to ESG principles demonstrate financial outperformance, attract long-term shareholders, and benefit from increased operating efficiency and market expansion. Chen, Li, Xu, et al. (2023) assessed the impact of ESG performance on the cost of equity capital in Chinese A-Share companies from 2010 to 2020, showing that strong ESG performance markedly lowers the cost of equity capital. This reduction in equity financing can enable enterprises to access more funds, thereby enhancing their investment capacity. Their study further identifies mediating effects where ESG both directly and indirectly diminishes equity costs by mitigating market risk and enhancing equity diversification for enterprises. Al-Hiyari et al. (2023) investigated the relationship between ESG performance and firm investment efficiency in emerging economies, finding a positive association between ESG performance and investment efficiency. Moreover, the analysis finds a moderating role of board cultural diversity, indicating a mitigated impact of ESG performance on investment efficiency in settings prone to overinvestment.

Prolonging the discussion, Bai et al. (2022) examined how ESG performance among Chinese listed companies impacts their financing constraints. The findings from panel data analysis from 2013 to 2020 reveal that strong ESG performance not only directly eases financing constraints but also attracts institutional investors, positively signaling the market, albeit with less impact in primary industries. The study also indicates institutional investors' distinct ESG preferences, especially pronounced in nonstate-owned companies and those in secondary and tertiary industries. Naeem et al. (2022) scrutinized the influence of ESG performance on financially sensitive corporations in environmentally sensitive industries. The analysis reveals a significantly positive correlation between overall ESG performance and corporate financial metrics such as return on equity and Tobin's Q. Furthermore, the study distinguishes a stronger impact of ESG performance on financial outcomes in developed countries than emerging economies. A similar impact of ESG performance on capital investment can be expected because of the interconnectivity of decisions.

Another literature stream suggests a relationship between ESG performance and environmental investment. Khalil et al. (2022) examined the impact of traditional and environmental innovations on firms' financial value and environmental responsibility across ten Asian economies. They found that, while traditional innovation positively affects market valuation, it significantly harms the environment through increased carbon emissions. Conversely, investments in environmental innovation positively impact both financial performance and environmental sustainability, indicating the importance of ecofriendly practices for market advantage and reduced environmental impact. Zhou et al.'s (2023) analysis of the link between ESG performance and sustainability through firm innovation in Bangladesh's manufacturing sector confirmed that higher ESG performance enhances both innovation and sustainability outcomes, underscoring the pivotal role of ESG initiatives in firm sustainability. Tan and Zhu (2022) scrutinized the impact of ESG ratings, focusing on a quasinatural experiment using the 2015 SynTao Green Finance Agency ratings. The study revealed a significant link between higher ESG scores and enhanced corporate green innovation in Chinese A-share listed companies and how these ratings facilitate green innovation by mitigating financial constraints. Li, Lian, and Xu (2023)

established a theoretical framework demonstrating how corporate ESG influences the spillover effects of green innovation in China's A-share listed enterprises from 2012 to 2020. The analysis confirms significant spillover effects within industries, finding that while industrial companies face constraints, nonindustrial counterparts benefit from ESG-driven green innovation, ultimately guiding peer enterprises toward improved sustainability practices.

Similarly, Wang et al. (2022) investigated the impact of ESG performance on investment efficiency through an analysis of Chinese A-share listed companies over the period 2011–2020, finding that strong ESG performance notably enhances investment efficiency. Erdogan et al. (2023) examined the relationship between firms' ESG involvement and investment efficiency, analyzing 1094 firms across 21 European countries from 2002 to 2019. The analysis revealed a significant positive association between overall ESG engagement and investment efficiency. A gap in the literature becomes evident from extensive empirical studies and analyses on the relationship between ESG performance and various aspects of firm behavior and outcomes. While these studies provide valuable insights into how ESG performance influences market value, innovation, financing constraints, investment efficiency, and other firm-level decisions, there remains an underexplored area regarding the specific impact of ESG factors on investment mix, particularly in the areas of capital investment volume and environmental investment. Therefore, the current research study fills this gap by developing the following hypotheses.

H1. ESG performance has a significant positive relationship with capital investment.

H2. ESG performance has a significant negative relationship with environmental investment.

4. Data and methods

4.1. Data and sample description

We conduct the empirical analysis on non-financial sector enterprises operating within the 5 BRICS (Brazil, Russia, India, China, and South Africa) economies, studying their performance from 2010 to 2022. The study utilized a comprehensive dataset comprising 18,902 firm-year observations, forming the basis for rigorous regression analysis. To ensure robustness and account for potential temporal shifts due to the COVID-19 pandemic, the sample was divided into two distinct spans: pre-COVID (2010–2019) and post-COVID (2020–2022). This division aimed to investigate any variations or robustness in the observed relationships before and after the pandemic, thereby enhancing the study's reliability and validity. The division of the dataset into pre- and post-COVID periods (2010–2019 and 2020–2022, respectively) aimed to capture potential shifts in corporate behaviors and investment patterns due to the COVID-19 pandemic. This division allows for a nuanced understanding of how ESG performance might have influenced investment decisions before and after this significant global event. Similarly, the motivation for selecting the BRICS economies includes as BRICS economies represent a substantial portion of the global economy and exhibit diverse economic, social, and environmental landscapes. The selection of BRICS nations allows for a comprehensive analysis encompassing emerging markets with varying degrees of industrial development, regulatory frameworks, and sustainability challenges. Therefore, analyzing the data of these economies helps provide a broader understanding of how ESG considerations impact investment decisions in diverse socio-economic contexts. The data of variables were obtained from Thomson Reuters DataStream.

4.2. Variables description

In current settings of research, investment mix is a dependent variable which was segregated into capital investment and environmental investment. We measure the capital investment as a ratio of capital expenditures to total assets. This ratio provides a quantitative assessment of how much a company is investing in its capital assets relative to the size of its overall asset base. This ratio is calculated by taking the total capital expenditures made by a company during a specific period (which could include investments in machinery, equipment, infrastructure, or other long-term assets) and dividing it by the company's total assets. This ratio offers insights into the proportion of a company's resources allocated towards acquiring or improving long-term assets concerning the entirety of its asset base. A higher ratio might indicate that a larger portion of the company's assets is being allocated to capital investments, signifying potential long-term growth or expansion strategies. Conversely, a lower ratio might suggest relatively fewer resources allocated to capital expenditures in relation to the overall asset size. We follow the studies of Honda (2023), and Farooq et al. (2024) to measure the capital investment.

Similarly, environmental investment was measured by a ratio of environmental R&D expenditures to total expenditures. This metric provides a quantitative assessment of the allocation of resources towards environmental research and development relative to the company's overall expenditure. Environmental R&D expenditures typically encompass investments made by a company specifically aimed at researching and developing environmentally friendly technologies, processes, or solutions. These expenses might include funds directed towards developing renewable energy sources, improving waste management systems, reducing carbon emissions, or enhancing eco-friendly production methods. Expressing environmental investment as a ratio to total expenditures helps in understanding the proportion of the company's overall expenses dedicated explicitly to environmental R&D initiatives. A higher ratio signifies a greater allocation of the company's expenditure towards environmental innovation and sustainability-focused R&D efforts, showcasing a commitment to developing eco-friendly technologies or processes. Conversely, a lower ratio suggests a smaller proportion of total expenses directed towards environmental R&D, indicating potentially fewer resources allocated to developing or improving environmentally sustainable practices within the organization. Chen, Li, Xu, et al. (2023), and Yang (2023) utilized the similar measurement for environmental investment.

ESG (Environmental, Social, and Governance) performance, a key explanatory variable in the study, encompasses various aspects of a company's operations related to environmental sustainability, social responsibility, and governance practices. To dissect and analyze this overarching construct, the study utilizes three distinct sub-indices including environmental performance, governance performance, and social performance. To quantify these sub-indices, the study utilizes proxy variables extracted from each pillar score. These proxy variables represent the individual scores or assessments related to each sub-index of ESG performance. The environmental performance evaluates a company's performance in managing environmental risks, minimizing ecological footprints, and adopting environmentally sustainable practices. It measures factors such as carbon emissions, energy efficiency, waste management, and adherence to environmental regulations. The governance performance focuses on assessing the quality of a company's governance structure and practices. It encompasses factors like board independence, transparency in financial reporting, adherence to ethical standards, and the effectiveness of risk management and internal controls. Similarly, the social performance evaluates a company's social impact and engagement with stakeholders. It encompasses measures related to labor practices, employee relations, community engagement, diversity and inclusion, human rights, and product safety. The measurement of ESG performance was extracted from recent literature (Al-Hiyari, et al., 2023; Chen, Li, Zeng, & Zhu, 2023; Yin et al., 2023).

In the realm of corporate sustainability, two crucial yet distinct metrics, Environmental investment and ESG (Environmental, Social, and Governance) Performance, offer distinct insights into a company's commitment to sustainable practices. Environmental investment

revolves around specific expenditures channeled into research and development (R&D) endeavors aimed at fostering environmentally friendly technologies and solutions. This metric, measured as a ratio of environmental R&D expenses to total expenditures, provides a focused assessment of a company's financial dedication to eco-friendly innovations. Conversely, ESG Performance encapsulates a broader spectrum, evaluating a company's operations across environmental sustainability, social responsibility, and governance practices. The measurement of ESG is based on sub-indices representing environmental, social, and governance pillars using proxy variables, and provides a multidimensional evaluation of a company's sustainability efforts. While environmental investment concentrates solely on R&D expenses for environmental sustainability, ESG performance delves deeper, assessing not just environmental impact but also social engagement and governance standards, offering a holistic view of a company's responsible practices. Despite their interconnectedness within the sustainability narrative, the nuanced measurement and scope differentiate these metrics. Table 1 shows the brief measurement of variables.

4.3. Econometric models and methodology description

To articulate the interrelationships between variables, the study formulates the subsequent equations

$$CAP_{it} = \beta_{\circ} + \gamma_1 CAP_{it-1} + \alpha_1 ENS_{it} + \alpha_2 GNS_{it} + \alpha_3 SPS_{it} + \beta_1 FRS_{it} + \beta_2 DER_{it} + \beta_3 COH_{it} + \beta_4 CO2_{it} + \mu_i + \varphi_t + \varepsilon_{it} \quad \text{(Eq.1)}$$

$$EINV_{it} = \beta_{\circ} + \gamma_1 CAP_{it-1} + \alpha_1 ENS_{it} + \alpha_2 GNS_{it} + \alpha_3 SPS_{it} + \beta_1 FRS_{it} + \beta_2 DER_{it} + \beta_3 COH_{it} + \beta_4 CO2_{it} + \mu_i + \varphi_t + \varepsilon_{it} \quad \text{(Eq.2)}$$

Equation (1) and Equation (2) represent regression models where the variables on the right-hand side (independent variables) are used to predict or explain the dependent variables. In these equations, CAP is capital investment, EINV is environmental investment, ENS is environmental score, GNS is governance score, SPS is social score, FRS is firm size, DER is debt ratio, COH is cash holdings, and CO2 is CO2 emissions respectively. The model aims to assess how changes in the explanatory variables (such as environmental, governance, and social scores, along with financial metrics and CO2 emissions) impact capital and environmental investments while controlling for cross-section (i) and time-specific (t) effects. Other symbols like α, β, γ are coefficients or parameters applied to each variable in the equation, indicating the magnitude and direction of their impact on the dependent variables.

Table 1
Variables of study.

Acronyms	Variables	Measurement	Role	Reference
CAP	Capital investment	Capital expenditures/ total assets	Dependent	(Ajide & Ibrahim, 2021; Biddle et al., 2024; Farooq et al., 2024)
EINV	Environmental investment	Environmental R&D expenditures/ total expenditures	Dependent	(Biddle, et al., 2024; Farooq et al., 2024; Yang, 2023)
ENS	Environmental performance	Environment Pillar Score	Independent	Zhang, et al. (2022)
GNS	Governance performance	Governance Pillar Score	Independent	Zhang, et al. (2022)
SPS	Social performance	Social Pillar Score	Independent	Zhang, et al. (2022)
FRS	Firm size	Log (total assets)	Control	Farooq, et al. (2024)
DER	Debt ratio	Total debt/total assets	Control	Farooq, et al. (2024)
COH	Cash holdings	Cash & cash equivalents/total assets	Control	Honda (2023)
CO2	CO2 emissions	CO2 Equivalents Emission Total	Control	Farooq, et al. (2023)

Source: previous studies.

The methodology of this study involves several steps to ensure the reliability and validity of the analysis. The study begins by assessing cross-sectional dependencies among the data using various econometric techniques. The Breusch-Pagan LM test (Breusch & Pagan, 1980), Pesaran Scaled LM test, and Pesaran CD test (Pesaran, 2004) are applied to examine if there's any dependency among the different entities or cross-sectional units (like companies in this case). The findings from these tests are presented in Table 2. The significant p-values from these tests reject the null hypothesis, indicating the presence of cross-sectional dependency among the entities. Following the assessment of cross-sectional dependency, the study proceeds to examine endogeneity within the model. Endogeneity refers to situations where independent variables are correlated with the error term, potentially biasing the estimation results. The study employs the Wald test to test for endogeneity. The results of this test are reported in Table 3. The analysis reported in Table 3 infers the presence of endogeneity (i.e., significant results), it suggests that some independent variables might be endogenous, requiring a different modeling approach to address this issue.

Owing to the identification of endogeneity in the model, the study adopts the system generalized method of moments (GMM) model. The System GMM model is a dynamic panel data estimation technique that helps address endogeneity issues by utilizing lagged values of variables as instruments to control for potential endogeneity (Arellano & Bover, 1995). This model allows for more robust estimation when endogeneity is present in the data. GMM is well-suited for dynamic panel data models, which involve analyzing data with both time-series and cross-sectional dimensions. It efficiently handles issues arising from time dynamics, such as lagged effects and unobserved individual heterogeneity. GMM allows for addressing endogeneity concerns by using lagged values of variables as instruments. It addresses the correlation between independent variables and the error term, a common issue in panel data analysis that could bias estimates. By incorporating lagged variables as instruments, GMM can help mitigate endogeneity concerns and produce consistent estimates. In the current analysis, where endogeneity has been identified as an issue, the use of the System GMM model allows for the incorporation of lagged variables as instruments, which helps mitigate endogeneity concerns and provides more reliable estimates. Additionally, GMM's suitability for dynamic panel data and its robustness to various data-related issues make it a proficient choice for addressing endogeneity and producing accurate results in this context. The studies of Chen and Xie (2022) Razak et al. (2023) utilized the system GMM model for exploring the similar themes of research.

By utilizing these methodological steps, the study aims to ensure the reliability of the analysis by addressing issues such as cross-sectional dependencies and endogeneity. The adoption of the System GMM model, prompted by the identification of endogeneity, aims to provide

Table 2
Cross-section dependence test.

Test	Statistics	d.f.	Probability
Breusch-Pagan LM	602753.600	77,815	0.000
Pesaran scaled LM	1329.643	–	0.000
Bias-corrected scaled LM	1313.184	–	0.000
Pesaran CD	576.748	–	0.000

Note: the significant probability values($p \leq 0.05$) of all tests reject the null hypothesis and probe the existence of cross-sectional dependency.
Source: self-calculation.

Table 3
Endogeneity test.

Test	Value	d.f.	Probability
F-statistic	369.273	(7, 1171)	0.000
Chi-square	2584.917	7	0.000
Normalized Restriction (=0)			
C (1)		0.475	0.230
C (2)		2.350	0.000
C (3)		0.000	0.000
C (4)		0.305	0.000
C (5)		−0.035	0.028
C (6)		0.054	0.044
C (7)		0.104	0.071

Note: The significant probability values ($p \leq 0.10$) reveals the presence of endogeneity.
Source: author's own estimation.

more accurate and reliable estimates while accounting for potential biases in the data.

5. Results presentation

5.1. Descriptive and correlation analyses

Table 4 shows the descriptive analysis of variables. The mean values provide a central tendency measure across the variables in the dataset. The capital investment (CAP) variable demonstrates a mean value of 0.335, with values ranging from 0.001 to 0.903. These values shows the average amount of capital expenditures made on acquisition of capital assets by enterprises. Environmental investment (EINV) has a mean value of 0.251, fluctuating between 0 and 0.894. These values show the environmental concern of sampled enterprises. Similarly, environmental (ENS), governance (GNS), and social (SPS) performance scores hover around 56 to 60, showcasing variability from 6.81 to 97.54 across different entities. For control variables, firm Size (FRS) maintains an average of 8.079, exhibiting minimal variation from 5.679 to 10.325. Debt Ratio (DER) sits at an average of 0.278, with slight fluctuations between 0.001 and 0.903. Cash Holdings (COH) average 0.127, varying from 0.003 to 0.893, while CO2 emissions display an average of 2.781, ranging from 0 to 3.510. These mean values provide a snapshot of the central tendencies within each variable, outlining their typical levels and the range of variation observed across the dataset. Table 5 presents the correlation analysis among variables. Additionally, a multicollinearity test was conducted, and the resulting Variance Inflation Factor (VIF) values are reported in the bottom row of Table 5. The obtained VIF values affirm the absence of multicollinearity issues among the variables.

5.2. Regression analysis

Table 6 reports the main regression analysis. This estimated coefficient values denote the impact of various independent variables on the respective dependent variable. In model 1 (capital investment as a dependent variable), the estimated coefficient values of ESG performance including Environmental (ENS), Governance (GNS), and Social (SPS) performance scores display significant impacts on capital investment, emphasizing their positive association with capital investment decisions. For control variables, firm size (FRS) and debt ratio (DER) demonstrate significant positive relationships with capital investment, albeit with varying magnitudes and directions. However, cash holdings (COH) and CO2 emissions exhibit a negative association with capital investment, suggesting that higher cash reserves might lead to reduced capital investment. In model 2, (environmental investment as DV), Environmental (ENS), Governance (GNS), and Social (SPS) performance scores significantly impact environmental investment negatively, indicating that higher scores in these areas are associated with lower environmental investment. Both models include industry fixed effects and have considerable explanatory power, as reflected in the adjusted R-squared values. The standard errors of regression (S.E.) are relatively low, indicating good precision in the estimation. Additionally, the models show some autocorrelation (AR) in the error terms, and the Hansen Test results suggest no evidence of specification errors in the models.

5.3. Robustness analysis

The sample is partitioned into two distinct periods: pre-COVID (2010–2019) and post-COVID (2020–2022), enabling separate regression analyses. The results from these analyses reveal notable differences in coefficient patterns. The estimated coefficients (shown in Table 7) demonstrate consistent patterns and significance levels before the COVID period. This consistency across variables signifies stability in the relationships between predictors and outcomes during this time frame. In contrast, the coefficients' signs and significance levels (shown in Table 8) exhibit slight alterations in the post-COVID analysis. Changes in the relationships between predictors and outcomes suggest potential shifts in investment behaviors or influencing factors after the onset of the COVID spread. These alterations prompt a closer examination of the evolving dynamics between variables in the post-COVID era.

6. Results discussion

This study aims to determine the impact of ESG performance on the investment mix, including capital investment and environmental investment. We employ the system GMM model and report the regression results in Table 6. The estimated coefficient values infer that all variables of ESG performance, including ESG scores, have a significant positive relationship with capital investment. The positive relationship between ESG performance scores and earning-based investment (capital investment) is because higher ESG scores, especially in governance and social dimensions, might indicate better management practices and

Table 4
Descriptive analysis.

Variables	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis
CAP	0.335	0.303	0.903	0.001	0.250	0.323	1.936
EINV	0.251	0.185	0.894	0.000	0.214	1.142	3.512
ENS	56.908	59.010	97.410	6.810	20.581	−0.287	2.361
GNS	57.310	59.920	97.540	5.530	21.276	−0.244	2.110
SPS	60.327	61.450	96.860	1.230	19.604	−0.452	2.776
FRS	8.079	7.994	10.325	5.679	0.904	0.207	2.164
DER	0.278	0.271	0.903	0.001	0.192	0.430	2.607
COH	0.127	0.103	0.893	0.003	0.098	0.041	3.452
CO2	2.781	2.6703	3.510	0.000	0.307	0.956	3.784

Acronyms: CAP = capital investment, EINV = environmental investment, ENS = environmental score, GNS = governance score, SPS = social score, FRS = firm size, DER = debt ratio, COH = cash holdings, CO2=CO2 emissions.
Source: own calculation.

Table 5
Correlation analysis.

Variables	CAP	EINV	ENS	GNS	SPS	FRS	DER	COH	CO2
CAP	1.000								
EINV	−0.065	1.000							
ENS	0.012	0.009	1.000						
GNS	−0.014	0.026	0.195	1.000					
SPS	−0.044	−0.013	0.551	0.275	1.000				
FRS	0.020	−0.014	0.284	0.062	0.175	1.000			
DER	0.209	−0.040	−0.013	−0.005	−0.003	−0.035	1.000		
COH	−0.190	−0.024	0.013	0.097	−0.018	−0.108	−0.162	1.000	
CO2	0.313	−0.020	0.030	−0.001	0.045	0.272	0.004	0.001	1.000
Multicollinearity test									
VIF	3.681	3.881	4.002	3.321	2.919	3.041	4.004	3.881	2.818

Acronyms: CAP = capital investment, EINV = environmental investment, ENS = environmental score, GNS = governance score, SPS = social score, FRS = firm size, DER = debt ratio, COH = cash holdings, CO2═CO2 emissions.
Source: own calculation

Table 6
Effect of ESG performance on investment mix.

Variables	System GMM (generalized method of moments)			
	Capital investment as DV		Environmental investment as DV	
	Coefficients	Probability	Coefficients	Probability
Constant	0.669***	0.000	0.215***	0.000
CAP & EINV (-1)	0.321***	0.000	0.134***	0.000
ENS	0.122***	0.000	−0.094***	0.000
GNS	0.379**	0.075	−0.425***	0.000
SPS	0.667***	0.014	−0.428***	0.035
FRS	0.517***	0.000	0.225**	0.054
DER	0.255***	0.000	0.215*	0.104
COH	−0.586***	0.000	0.1407	−0.178
CO2	−0.266***	0.000	0.640***	0.000
Years fixed effect	Yes		Yes	
Industry fixed effect	Yes		Yes	
No. of Observations	18,902		18,902	
Adjusted R^2	0.391		0.386	
S.E. of regression	0.050		0.041	
AR (1)	0.166		0.169	
AR (2)	0.009		0.021	
Hansen Test	0.213		0.391	

Acronyms: CAP = capital investment, EINV = environmental investment, ENS = environmental score, GNS = governance score, SPS = social score, FRS = firm size, DER = debt ratio, COH = cash holdings, CO2═CO2 emissions.
Note: ***, **, * report the level of variable significance at 1 %, 5 %, and 10 % relatively.
Instrument specification: CAP(-2) ENS(-1) GNS(-1) SPS(-1) FRS(-1) DER(-1) COH(-1) CO2(-1).
Source: self-calculation.

Table 7
Robustness analysis-effect of ESG performance on investment mix before COVID.

Variables	System GMM (generalized method of moments)			
	Capital investment as DV		Environmental investment as DV	
	Coefficients	Probability	Coefficients	Probability
Constant	0.002***	0.060	0.013***	0.033
CAP & EINV (-1)	0.986***	0.000	0.967***	0.000
ENS	1.940***	0.047	−0.118***	0.000
GNS	2.145***	0.006	−0.118***	0.000
SPS	1.510***	0.008	−0.192***	0.000
FRS	0.481***	0.022	0.110***	0.002
DER	0.286***	0.006	0.116***	0.011
COH	−0.826***	0.000	0.611**	0.057
CO2	−0.423***	0.042	0.924***	0.002
Industry fixed effect	Yes		Yes	
No. of Observations	14,540		14,540	
Adjusted R^2	0.399		0.388	
S.E. of regression	0.042		0.112	
AR (1)	0.138		0.203	
AR (2)	0.000		0.001	
Hansen Test	0.205		0.125	

Acronyms: CAP = capital investment, EINV = environmental investment, ENS = environmental score, GNS = governance score, SPS = social score, FRS = firm size, DER = debt ratio, COH = cash holdings, CO2═CO2 emissions.
Note: ***, **, * report the level of variable significance at 1 %, 5 %, and 10 % relatively.
Instrument specification: CAP(-2) ENS(-1) GNS(-1) SPS(-1) FRS(-1) DER(-1) COH(-1) CO2(-1).
Source: self-calculation.

stakeholder engagement. Companies with stronger governance structures and robust social initiatives may increase investor confidence and equity financing (Chen, Li, Zeng, & Zhu, 2023). Such an increase in equity financing may further drive capital investment because investors often prioritize companies with strong governance and social responsibility, allocating more resources to projects that generate immediate financial returns, which fall under capital investment. In another channel, ESG scores emphasizing ESG might align more with immediate financial gains (Shin, et al., 2023). Capital investments often yield quicker returns than environmental initiatives, which generally involve longer payback periods. Therefore, companies aiming to satisfy short-term financial targets might emphasize capital investments more, positively impacting ESG scores.

In contrast, the analysis shows a negative relationship between ESG performance and environmental investment. Companies might face trade-offs between financial commitments and environmental initiatives due to financial constraints. Strong ESG scores could indicate prioritizing meeting financial commitments, potentially resulting in lower allocations toward EINV. Moreover, external pressures from investors or markets favoring short-term profitability could influence companies to prioritize earning-based investments over environmental initiatives, despite having strong ESG scores (Hsu & Chen, 2023). This external influence might sway decision-making toward projects with more immediate financial returns, reducing investment in environmental projects. While seemingly contradictory, the negative relationship between ESG scores and environmental investment might be a product of company strategies to balance financial objectives with broader sustainability goals. It could reflect the challenges companies face in simultaneously optimizing financial performance and environmental sustainability, potentially leading to prioritizing immediate financial returns over long-term environmental goals.

While no prior studies have specifically examined the correlation between ESG performance and investment mix, a relevant contribution was made by Al-Hiyari et al. (2023), whose work indicated a positive

Table 8
Robustness analysis-effect of ESG performance on investment mix after COVID.

Variables	System GMM (generalized method of moments)			
	Capital investment as DV		Environmental investment as DV	
	Coefficients	Probability	Coefficients	Probability
Constant	0.126***	0.007	0.192***	0.008
CAP & EINV (-1)	0.918***	0.000	0.919***	0.000
ENS	0.062***	0.028	0.399	0.541
GNS	2.871	0.282	−1.291	0.780
SPS	0.053***	0.021	−0.073***	0.022
FRS	0.072***	0.007	0.048	0.399
DER	0.088***	0.016	−0.006	0.228
COH	−0.082***	0.031	−0.012***	0.028
CO2	−0.552***	0.024	0.178*	0.094
Industry fixed effect	Yes		Yes	
No. of Observations	4362		4362	
Adjusted R^2	0.190		0.188	
S.E. of regression	0.022		0.129	
AR (1)	0.280		0.133	
AR (2)	0.004		0.006	
Hansen Test	0.128		0.195	

Acronyms: CAP = capital investment, EINV = environmental investment, ENS = environmental score, GNS = governance score, SPS = social score, FRS = firm size, DER = debt ratio, COH = cash holdings, CO2═CO2 emissions.
Note: ***, **, * report the level of variable significance at 1 %, 5 %, and 10 % relatively.
Instrument specification: CAP(-2) ENS(-1) GNS(-1) SPS(-1) FRS(-1) DER(-1) COH(-1) CO2(-1).
Source: self-calculation.

relationship between ESG performance and capital investment efficiency. This analysis extends their finding by introducing a novel dimension of examining environmental investment. This study adds a new insight by exploring how ESG performance influences both capital and environmental investment, expanding the understanding of ESG's impact on diverse investment categories.

For control variables, firm size and debt ratio are positive, while cash holdings and CO_2 emissions show a negative relationship with capital investment. The positive relationship between firm size and capital investment suggests that larger companies invest more in capital assets, as they typically have more resources and capabilities that allow them to undertake larger-scale projects or expansions that require higher capital investments (Farooq, et al., 2024). Similarly, a positive relationship between the debt ratio and capital investment implies that companies with higher debt levels tend to allocate more funds to capital investments. This could be due to leveraging debt as a source of financing for long-term projects, especially when companies seek external funding to fuel growth or expansion (Farooq, et al., 2023). The negative relationship between cash holdings and capital investment suggests that companies with larger cash reserves allocate fewer funds to capital investments. High cash reserves could indicate a conservative approach or liquidity preferences, resulting in lower investments in capital assets as maintaining higher cash balances is prioritized (Yang, et al., 2017). Similarly, the negative relationship between CO_2 emissions and capital investment suggest that companies facing higher emission levels tend to allocate less toward capital investments. This relationship indicates an environmental focus wherein companies with higher emissions allocate fewer resources to capital-intensive projects, potentially opting for initiatives that reduce their environmental footprint (Farooq, et al., 2023).

In the case of environmental investment, the positive relationship between firm size and environmental investment suggests that larger companies allocate more resources to environmental initiatives. Larger firms often have greater financial capabilities and operational scale, allowing them to invest more substantially in environmentally focused projects, such as sustainability programs, green technologies, or eco-friendly practices (Lin, et al., 2019). Similarly, a positive relationship between debt ratio and environmental investment indicates that companies with higher debt levels might allocate more toward environmental initiatives. Higher debt levels suggest access to additional funding sources, allowing companies to invest in environmentally sustainable practices or technologies as part of their operational strategy or compliance with environmental regulations (Xiang, et al., 2022). Initially, the positive relationship between CO_2 emissions and environmental investment may seem counterintuitive, although it could suggest that companies with higher emissions are more inclined to invest in environmental initiatives to mitigate their environmental impact. These investments might encompass projects aimed at reducing emissions, adopting cleaner technologies, or implementing sustainability measures as part of their corporate responsibility commitment (Wang, Su, & Mao, 2023).

This study underscores the complex interplay between ESG performance, financial metrics, and investment decisions. The unexpected negative relationship between ESG scores and EINV suggests the need for a more nuanced approach to balancing financial goals with environmental sustainability. The temporal shifts post-COVID hint at evolving dynamics and the importance of adaptability in investment strategies during changing circumstances. These insights provide valuable guidance for stakeholders navigating the intricacies of sustainable investment decisions within a dynamic business landscape.

7. Conclusions and policies

This study examines the complex relationship between ESG performance and enterprise investment portfolios. The empirical analysis was conducted on BRICS nations from 2010 to 2022, and a system GMM model was employed for regression analysis. This study illuminates the significant impact of ESG scores on investment allocations, with a positive association between ESG performance and capital investment and a negative association between ESG performance and EINV. This illustrates the nuanced trade-offs that companies face between financial objectives and dedicated environmental spending. Financial metrics such as firm size, debt ratios, cash holdings, and CO_2 emissions substantially influence investment patterns, delineating the multifaceted considerations guiding capital and EINV. The temporal dynamics observed before and after COVID reflect evolving investment behaviors and the need for adaptive strategies during changing externalities. The methodological robustness, supported by the system GMM analysis and the absence of multicollinearity, indicates the findings' reliability. These insights provide valuable guidance for stakeholders navigating the complexities of sustainable investment strategies, emphasizing the need for a balanced approach that reconciles financial goals with environmental stewardship in a dynamic business landscape.

7.1. Policy recommendations

Specific policy recommendations based on the study's findings are as follows. First, it is recommended that standardized and comprehensive reporting frameworks for ESG factors be encouraged, enhancing transparency and comparability among companies, and aiding investors in assessing sustainability performances. It is also recommended EINV be incentivized while companies focus on high ESG performance. This could be achieved by implementing policies or incentives such as tax credits, grants, or subsidies for ecofriendly initiatives. This step could encourage companies to allocate resources to environmentally sustainable projects. Another recommendation is that corporate managers strive for a balanced integration of ESG principles into their decision-making processes. While bolstering governance and social responsibility, there is a need to reassess ESG frameworks to ensure they equally prioritize environmental sustainability and financial profitability. Strengthening corporate governance guidelines would promote a balance between financial returns and sustainable practices and encourage boards to integrate ESG considerations into strategic

decision-making, fostering long-term sustainability alongside financial goals. Corporate managers should recognize the potential risks of singularly focusing on immediate financial returns at the expense of EINV. To ensure long-term viability, they should mitigate these risks by implementing adaptive strategies that accommodate financial priorities and environmental responsibilities.

By intensifying the focus on earnings-driven investments, specifically capital projects, in a high ESG-focused environment, corporate managers can strategically position their companies to capitalize on opportunities aligned with financial goals and sustainable practices, enhancing long-term value creation and stakeholder trust. These policy recommendations foster an environment conducive to sustainable investment practices while addressing the complexities highlighted in this study. Implementing such policies could harmonize financial objectives with environmental and social responsibilities, fostering a more sustainable and resilient business landscape.

7.2. Limitations and the future research agenda

This study focused on a specific set of variables within a limited timeframe, possibly limiting the generalizability of findings across different industries or regions. Another limitation of the current study is the measurement error of ESG performance. ESG metrics are multifaceted and subject to varying measurement methodologies. Limitations in ESG measurement frameworks might have constrained this study. Future studies should explore industry-specific nuances in the relationship between ESG, financial metrics, and investment choices. Similarly, different sectors might exhibit distinct patterns in how ESG considerations influence investment decisions. It is recommended that impact assessments be conducted to evaluate the actual outcomes of ESG-focused investments on financial performance and environmental/social impacts. This provides empirical evidence of the tangible benefits of integrating ESG considerations into investment decisions.

CRediT authorship contribution statement

Zhichao Yu: Supervision, Data curation, Conceptualization, Writing – review & editing. **Umar Farooq:** Conceptualization, Data curation, Writing – original draft. **Mohammad Mahtab Alam:** Writing – review & editing, data arrangement and analysis, discussion on results. **Jiapeng Dai:** comments handlings; proofreading, Conceptualization.

Declaration of competing interest

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

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