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# INVESTIGATING ESG'S INFLUENCE ON EUROPEAN LISTED REAL ESTATE MARKET PERFORMANCE

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**Abstract.** This study employs Bloomberg data from six European listed markets to investigate the extent to which the performance of real estate companies can be explained by the Environmental, Social and Governance (ESG) attributes at the corporate level. By accounting for firm-level characteristics, we utilise Pedroni's Cointegration and Granger Causality methods to examine long-term cointegration and causal relationships. Additionally, we construct panel regression models to explore the role of ESG attributes in determining firm-level performance. Key findings reveal no statistical evidence that ESG attributes depress the performance of listed real estate companies, as indicated by raw return, Sharpe ratio, and Tobin's *q*. Notably, the causality analysis uncovers that certain ESG attributes indeed Granger-cause the performance indicators. For instance, higher environmental, social, and governance performance scores, as measured by the three aggregate Bloomberg ESG scores, lead to superior returns on both raw and risk-adjusted bases in the long run.

**Keywords:** ESG, Tobin's *q*, real estate, panel cointegration.

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## 1. Introduction

Since the signing of the Paris Agreement at the United Nations COP21 conference in 2015, institutional investors face mounting pressure from governments, regulators, and various stakeholders to contribute to carbon reduction and climate mitigation efforts (Brounen et al., 2021). The real estate sector is of particular concern, as it accounts for an estimated 36% of global greenhouse gas (GHG) emissions and consumes approximately one-third of the world's total energy (World Green Building Council, 2021; Vrensen et al., 2020). Consumption levels are expected to rise by more than a quarter by 2050 under current projections (Ooi & Dung, 2019). Therefore, the carbon profile of institutional real estate investment portfolios is crucial for achieving 2050 climate targets, underscoring the importance of adopting strategies to mitigate GHG emissions. This urgency has catalysed a global shift in investment mandates, with Environmental, Social, and Governance (ESG) considerations becoming central to investment assessment, rivalling traditional financial metrics in significance (Cloutier, 2020; Alareeni & Hamdan, 2020).

Interest in the relationship between ESG criteria and corporate financial performance can be traced back to the 1970s when Corporate Social Responsibility (CSR) emerged as a critical tool for decision-making and risk evaluation (Friede et al., 2015). Since then, capital allocation choices and assessments of expected returns and investment risk have increasingly relied on the disclosure of information not only within the financial domain but across economic, social, and environmental dimensions (Czerwińska & Kaźmierkiewicz, 2015). Consequently, the prominence of ESG measures has grown in the real estate sector worldwide (Cloutier, 2020). In numerous jurisdictions, ESG is now regarded as a critical component of investment decision-making, driven by the potential for enhanced returns, improved risk profiling, reduced information asymmetry, and alignment with climate goals (Friede et al., 2015; Vrensen et al., 2020; Cloutier et al., 2021). As Cloutier (2020) argues, ESG is no longer a trend but a "new norm" in real estate investment, offering not only risk mitigation but also opportunities for value creation.

The movement towards responsible investment practices has been marked by increased transparency and

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engagement with stakeholders regarding ESG initiatives. Market forces and industry frameworks, such as the Task Force on Climate-related Financial Disclosures, encourage property owners to evaluate and disclose climate risks to investors and other stakeholders. The volume of ESG data collected and voluntarily reported by firms continues to grow, as evidenced by the rise in signatories to the UN Principles of Responsible Investment. As of March 2020, 3,826 institutions worldwide, with $121.3 trillion in assets under management, consider ESG issues in their decision-making processes, up from just 734 institutions managing $21 trillion in 2010 (Yuan et al., 2022). Additionally, organisations like GRESB and the European Public Real Estate Association [EPRA] (2024) facilitate ESG disclosure by providing comprehensive databases that enhance the visibility and accessibility of ESG information across real estate markets (Cloutier, 2020).

Regulatory bodies are also playing an increasingly active role in ESG oversight. In 2021, the European Union (EU) introduced the EU Sustainable Finance Taxonomy, and the United States Securities and Exchange Commission followed with enhanced requirements for monitoring and disclosure of ESG-related activities and GHG risks. These regulatory frameworks establish screening criteria to help companies, investors, and other stakeholders evaluate the environmental impact of financial products. Such regulations have elevated ESG's role within the real estate industry, with the Counsellors of Real Estate ranking ESG as the third most influential issue impacting real estate in 2022, up from tenth in previous years (Robinson & McIntosh, 2022).

Despite clear progress, ESG adoption within mainstream financial markets has not undergone a paradigm shift, largely due to fragmented ESG criteria (Friede et al., 2015). Feng and Wu (2023) note that while investors are increasingly integrating ESG factors into their business decisions, there remains significant disagreement among ESG data providers regarding rating methodologies, resulting in inconsistencies (Christensen et al., 2022). Moreover, Yuan et al. (2022) caution that rapid growth in ESG interest may lead to unintended consequences, with studies showing conflicting results (Hoepner & McMillan, 2009; Revelli & Viviani, 2013).

A recent investigation by Newell and Marzuki (2022) revealed significant variation in ESG practices across ninety-nine real estate markets, with environmental sustainability lagging behind other transparency dimensions. While some progress has been made, the pace remains insufficient, particularly at the global level, where greater emphasis on climate risk mitigation, resilience, and zero-carbon strategies is needed in real estate investment. Robinson and McIntosh (2022) conducted an extensive literature review on ESG in commercial real estate, highlighting a focus on environmental criteria with limited research on social and governance aspects. They identified significant gaps in understanding the impact of governance on private markets and its broader societal implications. Alareeni and Hamdan (2020) further echo these findings, noting that most studies have examined individual ESG dimensions, such as environmental or social disclosure, rather than a holistic approach.

The vast growth in ESG data availability has fuelled research in real estate, but much of it pertains to Real Estate Investment Trusts (REITs) and is heavily concentrated in the United States (Brounen et al., 2021; Cajias et al., 2014; Devine et al., 2024; Eichholtz et al., 2012; Fuerst, 2015; Sah et al., 2013). Given this context, the current research aims to fill a critical gap in the literature by analysing the influence of firm-level ESG attributes on the financial performance of listed real estate companies across six major European stock markets, chosen for their maturity in ESG development. Specifically, this study examines the extent to which ESG policies causally impact real estate company performance, considering firm-specific characteristics and country-specific differences. To the best of our knowledge, no research to date has comprehensively and critically examined the lead-lag relationships between ESG metrics and the financial performance of the listed real estate sector using actual market data. This analysis is essential as it could enhance understanding of the dynamics between ESG components and financial outcomes, providing valuable insights for various stakeholders. Utilising Bloomberg data and company financial reports, this study applies Pedroni's Cointegration and Granger Causality methods to explore long-run and short-run relationships between ESG attributes and stock performance. Additionally, panel regression models investigate the degree to which ESG factors explain firm-level performance. These analyses offer valuable insights into the ESG attributes that influence the stock performance of European and U.K. real estate markets over time.

Over the past decade, ESG research in real estate has matured considerably, producing a growing body of empirical evidence across both listed and private markets. Recent studies have moved beyond simple ESG-performance correlations to more sophisticated analyses incorporating risk-adjusted returns, cost of capital, and investor behaviour (e.g., Brounen et al., 2021; Devine et al., 2024; Aroul et al., 2022). This has repositioned ESG as a core strategic consideration in real estate finance rather than a peripheral concern. Moreover, datasets and disclosure practices have improved, allowing for more granular, firm-level investigations of ESG impacts. Despite this progress, important analytical and empirical gaps remain. Much of the existing literature focuses disproportionately on U.S. REITs or singular ESG components, particularly environmental performance (e.g., energy efficiency, carbon emissions), with relatively less attention to governance and social dimensions in tandem (Lo et al., 2026). Furthermore, studies that examine causal directionality – whether ESG leads or lags financial performance – are rare. Few papers utilise longitudinal, multi-country European data with consistent, high-frequency financial and ESG variables at the firm level. Our study addresses this void by employing panel

cointegration and Granger causality techniques to uncover long-run equilibrium and lead-lag dynamics in the European listed property sector.

The European context also merits distinct analytical attention. With the introduction of regulatory instruments such as the EU Taxonomy and the Corporate Sustainability Reporting Directive, the region has become a global testing ground for ESG policy transmission into firm behaviour. Unlike voluntary ESG regimes in other jurisdictions, the EU's mandatory standards create a different incentive structure that likely alters how ESG relates to firm performance. Our cross-country dataset enables us to explore whether these institutional forces shape ESG-financial outcomes in ways that diverge from more studied markets such as the U.S. or Asia-Pacific. In light of the recent evolution of the field, we have refined the review of relevant studies to focus on current debates, methodological innovations, and emerging inconsistencies – such as variation in ESG ratings, ESG's lagged impact on firm value, and differential effects across ESG dimensions. By situating our research within these contemporary scholarly conversations, we aim to contribute analytically and empirically to the next generation of ESG-real estate research.

While the relationship between ESG and corporate financial performance is well documented in general CSR-CSP literature, its nuanced application to the real estate sector – especially in the European context – remains underexplored. What makes real estate distinct is its intrinsic physicality, locational fixity, and heavy energy/resource usage, which make ESG concerns not merely reputational but operational and financial in nature. Unlike manufacturing or tech sectors where ESG might be peripheral to core operations, ESG in real estate directly intersects with asset value, tenant behaviour, regulatory compliance, and investment liquidity. Thus, ESG may exert a more tangible and measurable impact on performance in real estate than in other sectors.

Moreover, Europe presents a uniquely fertile testing ground for ESG-financial performance linkages due to its advanced regulatory landscape, such as the EU Sustainable Finance Disclosure Regulation and the EU Taxonomy Regulation. These frameworks compel real estate firms to report detailed sustainability metrics, providing a richer empirical setting than most U.S.-based studies, where ESG disclosure remains typically voluntary. This geographic distinction allows us to examine whether regulatory maturity amplifies or moderates the ESG-performance relationship – an angle that remains largely absent in the extant literature.

Lastly, our methodology advances existing literature by applying a triangulated empirical framework combining panel cointegration tests, Granger causality models, and dynamic panel regressions. This approach allows us not only to test for correlation, but to evaluate temporal and causal directionality between ESG attributes and financial performance. These methods offer stronger inferential power than static cross-sectional models commonly used in ESG studies, and those that adopt a contemporaneous time-series approach. As such, the study moves beyond identifying "if" ESG matters and contributes to understanding "how" it matters within the European listed real estate context.

Regarding the study's theoretical framing, stakeholder theory, signalling theory, and the resource-based view are particularly relevant to listed real estate firms due to the sector's unique combination of physical asset ownership, regulatory exposure, and public market valuation. From a stakeholder theory perspective, listed real estate firms engage with a broad range of stakeholders, including tenants, regulators, communities, investors, and lenders (Freeman, 1984; Eichholtz et al., 2013). ESG initiatives such as energy efficiency improvements, governance reforms, and health and safety standards directly influence tenant satisfaction, regulatory approval, and asset utilisation (McCord et al., 2020; Lo et al., 2026). Given the immobile and long-lived nature of real estate assets, ESG practices are likely to generate gradual but durable financial effects, making the sector especially suitable for examining long-run ESG–performance relationships.

Signalling theory is also highly relevant because real estate asset valuation depends heavily on expectations regarding asset quality, regulatory compliance, and long-term income stability. ESG disclosure reduces information asymmetry and serves as an important signal to investors and capital markets (Yu et al., 2018). In European listed real estate markets, where ESG disclosure is increasingly mandatory, ESG signals may influence investor perception, liquidity, and risk pricing before being reflected in accounting-based measures such as Tobin's $q$. This suggests that ESG may affect market-based and risk-adjusted returns earlier than firm fundamentals. From a resource-based perspective, ESG capabilities – such as energy-efficient buildings, governance quality, and stakeholder engagement – represent strategic firm-specific assets that are difficult to replicate (Barney, 1991). However, because these resources are embedded in physical assets and regulatory environments, their financial benefits are likely to emerge over longer horizons. Listed real estate firms therefore differ from both private property vehicles and non-real-estate firms, as their assets are illiquid and capital intensive while their equity remains continuously priced in public markets. Consequently, ESG initiatives may initially affect market sentiment and risk-adjusted returns before influencing operating efficiency and asset values over time. These characteristics justify the use of panel cointegration and causality approaches to capture dynamic, bidirectional, and long-run ESG–performance relationships in listed real estate markets.

The remainder of the paper is structured as follows: Section two presents a focused literature review on the role of ESG within listed real estate; Section three outlines the data and methodology; Section four discusses the empirical findings; and Sections five and six provide a discussion, conclusions, and recommendations based on the results.

## 2. Literature review

### 2.1. The interrelationship between ESG and listed real estate

The growing body of academic and industry research into ESG considerations within the real estate sector underscores an intensified focus on how ESG measures impact listed real estate performance. This emphasis is motivated by enduring concerns regarding real estate's environmental impact, with increasing recognition that ESG factors are integral to investment mandates. Nevertheless, despite extensive international literature on ESG and financial performance, particularly with respect to environmental aspects, critical gaps persist. Specifically, the research on the social and governance dimensions of ESG within the real estate sector remains nascent, particularly in the context of European listed real estate (Friede et al., 2015; Robinson & McIntosh, 2022). Furthermore, significant empirical questions remain about how ESG attributes influence financial performance across the diverse real estate markets within Europe. Given the proliferation of research examining ESG transparency, corporate financial decision-making, and firm performance, this review selectively addresses literature that elucidates the connection between ESG dimensions and financial outcomes in real estate. In particular, it highlights the implications of ESG criteria for listed real estate firms.

### 2.2. ESG and investment in real estate

The heightened focus on climate change and greenhouse gas emissions has transformed public awareness and reshaped the investment landscape. Within the real estate sector, the significance of ESG measures has evolved rapidly, becoming an essential consideration in investment decisions. This evolution reflects a broader trend in which financial markets increasingly account for ESG dimensions, utilising non-financial data to inform decisions (Hudson, 2019; Cloutier, 2020). This focus on ESG is exemplified by an expanding research agenda that investigates the real estate market's engagement with Corporate Social Responsibility (CSR), Responsible Property Investment (RPI), and, most recently, ESG frameworks. As the role of ESG within real estate investment grows, researchers have sought to elucidate how ESG factors influence corporate performance across various contexts.

However, despite a burgeoning interest in ESG, the evidence regarding its impact on financial performance is not unequivocal. This ambiguity is due to challenges related to data availability, variations in metrics, and inconsistent reporting practices. Although ESG's role within real estate is increasingly acknowledged, research on sustainable real estate investment remains fragmented. Consequently, the effect of ESG variables on firm-level economic performance continues to be a complex and contested subject.

### 2.3. Financial performance and ESG

While ESG remains relatively novel in REITs literature, the broader concept of ESG-linked economic performance is well-established. Early empirical studies in this area reveal mixed findings, reflecting the inherent complexities of ESG. The interconnectedness between ESG metrics and investment returns is laden with nuances that are often intangible and challenging to quantify over both short- and long-term horizons (Orlitzky et al., 2003).

The real estate sector, increasingly attuned to global trends in sustainability, has seen numerous studies examining energy efficiency, sustainability, and "greenness" within the context of REIT performance (Sah et al., 2013; Eichholtz et al., 2012; Hsieh et al., 2020). For instance, Eichholtz et al. (2012) found that U.S. REITs with higher energy efficiency and sustainability standards exhibited enhanced financial performance. Similarly, Fuerst (2015) identified a positive association between sustainability scores and market performance across North America, Asia, and Europe. However, Mariani et al. (2018) reported that sustainability-oriented REIT portfolios in Europe could negatively impact Return on Assets (ROA) and Return on Equity (ROE), likely due to the additional costs of certification. In Singapore, Ooi and Dung (2019) observed that "green" real estate portfolios correlated with improved operating performance, while Hsieh et al. (2020) found that greener portfolios often entailed higher equity costs in the short term but yielded long-term financial benefits through greater community and investor engagement. Their study further noted that larger REITs tend to engage more actively in green projects, which aligns with Frank and Ghosh's (2012) findings of a positive relationship between REIT size and institutional investment, attributable to responsible investment practices.

### 2.4. ESG in the European real estate sector

The European real estate sector has witnessed a significant transformation in its approach to ESG considerations, driven by increasing regulatory scrutiny and investor demand for sustainability-focused strategies. Newell and Marzuki (2022) highlight that ESG practices in European real estate markets are among the most developed globally, particularly in environmental sustainability and governance transparency. This progress is underpinned by stringent European Union (EU) regulations such as the EU Sustainable Finance Taxonomy (The European Parliament and the Council of the European Union, 2020), which establishes clear guidelines for evaluating the environmental impact of financial activities, including real estate investment. The integration of ESG principles is not only a regulatory imperative but also a strategic priority, as evidenced by studies demonstrating the correlation between robust ESG practices and improved financial performance in listed real estate companies (Eichholtz et al., 2012; Fuerst, 2015; McCord et al., 2018). Furthermore, European real estate firms have adopted frameworks such as the Global Real Estate Sustainability Benchmark (GRESB) to standardise ESG reporting and enable meaningful comparisons across markets, fostering greater transparency and accountability (Lo et al., 2022b; Newell et al., 2023).

In addition, the adoption of ESG principles in Europe's real estate sector has been catalysed by the continent's leadership in global sustainability initiatives, such as the Paris Agreement (United Nations, 2015) and the European Green Deal (European Commission, 2019). These frameworks emphasise decarbonization and energy efficiency, compelling the real estate industry to prioritise sustainable construction, retrofitting, and renewable energy adoption, amongst others. For instance, GRESB's annual ESG benchmark has been widely embraced by European real estate firms, providing an industry-standard methodology to evaluate environmental and social impacts (Brounen et al., 2021). Moreover, regional initiatives such as the EU Energy Performance of Buildings Directive (The European Parliament and the Council of the European Union, 2018) have incentivised energy-efficient practices through stricter building codes and the implementation of near-zero energy building standards (Cloutier, 2020). European markets have also led in fostering stakeholder engagement and improving transparency in ESG reporting, with a notable rise in companies voluntarily disclosing their sustainability practices (Friede et al., 2015). However, disparities persist across countries, as some markets, particularly in Eastern Europe, lag in ESG adoption compared to their Western counterparts. This perhaps underlines the need for more harmonised policies and enhanced collaboration across regions to achieve more consistent ESG integration in the European real estate sector.

The European Public Real Estate Association and the European Association for Investors in Non-Listed Real Estate Vehicles [INREV] (2023a) have played pivotal roles in advancing ESG practices in the European real estate sector. EPRA's Sustainability Best Practices Recommendations (sBPR) (EPRA, 2024) provide a standardised framework for ESG reporting, enhancing transparency and facilitating industry benchmarking with a focus on metrics such as energy efficiency, greenhouse gas emissions, water consumption, and waste management (EPRA, 2024). Similarly, INREV's Sustainability Reporting Guidelines and ESG Framework support the integration of ESG considerations into non-listed real estate strategies, promoting standardised disclosures and sustainable investment practices across Europe (INREV, 2023b). These initiatives have elevated ESG's prominence in the European real estate market, fostering accountability and enabling investors to better assess the environmental and social impact of their portfolios.

Both the UK and EU governments have implemented a range of policies and regulatory frameworks to promote ESG practices in the real estate sector. In the UK, the government has introduced the Minimum Energy Efficiency Standards (UK Government, 2015), requiring landlords to improve the energy performance of commercial and residential properties. The UK Green Building Council (2019) and initiatives such as the Future Homes Standard (Ministry of Housing, Communities & Local Government, 2019) further encourage the adoption of sustainable construction practices and decarbonisation goals. Additionally, financial regulators such as the Financial Conduct Authority have strengthened ESG disclosure requirements for real estate investment trusts and institutional investors. In the EU, ESG promotion is largely driven by the aforementioned European Green Deal and the EU Taxonomy Regulation, which classifies environmentally sustainable economic activities. Real estate firms must report how their activities align with taxonomy criteria, especially in terms of energy efficiency, climate resilience, and social responsibility. The Sustainable Finance Disclosure Regulation (The European Parliament and the Council of the European Union, 2020) also mandates greater transparency from asset managers and developers regarding sustainability risks and ESG performance. Together, these policy instruments in the UK and EU aim to integrate ESG principles into real estate decision-making processes, incentivise green investments, and ensure that the built environment contributes to climate and social goals. Despite these advances, real estate firms in Europe face several challenges in adopting ESG practices. Chief among them is the absence of standardised ESG metrics, which hampers data comparability and complicates investment decision-making. High retrofitting costs – especially for older properties – also remain a significant barrier.

## 2.5. Governance and operational efficiency

Examining the governance dimension within real estate, existing literature presents mixed results. For example, while Bauer et al. (2010) found that governance does not significantly influence financial performance, Chong et al. (2016) argue that robust corporate governance enhances performance, suggesting that governance is indeed a crucial factor for REITs. Other studies reinforce this position: Anglin et al. (2013) demonstrated that strong governance standards add value for investors, while more recent research by Kouaib et al. (2022) indicated that higher governance scores amplify the positive impact of CEO overconfidence on firm performance. Turning to operational efficiency, Beracha et al. (2019a) examined how efficiency influences performance and stock returns within U.S. equity REITs. They observed that operationally efficient REITs experience better financial outcomes and reduced risk. Subsequent research by Beracha et al. (2019b) supported this finding, noting that operational efficiency is positively correlated with firm value.

## 2.6. ESG disclosure and transparency

For REITs, ESG disclosure has emerged as a critical issue, with significant implications for investors and industry participants alike. Despite growing emphasis on disclosure, the relationship between ESG transparency and firm performance remains inconclusive. Research highlights the challenges posed by data quality inconsistencies and varying ESG criteria (Christensen et al., 2022). Nonetheless, studies such as Chiang et al. (2017) and Feng and Wu (2023) suggest that enhanced ESG disclosure can lower capital costs by mitigating risks and increasing access to

credit. In Europe, Brounen et al. (2021) found that investors place a premium on firms with robust ESG ratings, reinforcing the financial value of transparency.

Further research explores correlations between ESG disclosure scores and financial performance. Almeyda and Darmansyah (2019) found that higher ESG transparency is positively associated with ROA and ROC, although the impact on stock price and Price-to-Earnings (P/E) ratios was not significant. Similarly, An et al. (2011) contend that corporate transparency correlates with REIT growth, as it reduces information-related constraints on external financing. Devos et al. (2019) reported that REITs increasingly disclose ESG information to enhance capital market access, a finding consistent with the broader literature on transparency's financial benefits (Chiang et al., 2017). Lo et al. (2026) provided robust statistical evidence that, within Latin America's listed real estate sector, governance disclosure enhances firm value, as measured by both the Sharpe ratio and Tobin's *q*.

The regulatory landscape has also evolved, with policymakers focusing on ESG data transparency to promote sustainable practices. Studies indicate that such transparency can bolster corporate valuation and mitigate information asymmetry between firms and stakeholders. Yu et al. (2018) suggest that ESG disclosure adds value beyond conventional accounting data, while Hammami and Zadeh (2020) identify audit quality and media exposure as key drivers of transparency. Their findings underscore the potential of ESG disclosure to facilitate better resource allocation, ultimately contributing to enhanced corporate sustainability and financial performance.

However, some scholars question whether ESG disclosure uniformly enhances firm value. Cordazzo et al. (2020) assert that non-financial disclosures may not consistently generate financial benefits, particularly when disclosure is minimal. Cek and Eyupoglu (2020) argue that social and governance aspects exert distinct impacts on economic performance, a perspective supported by Tamimi and Sebastianelli (2017), who found that governance domains generally achieve higher transparency than environmental aspects. Additionally, Bonson and Bednarova (2015) propose that ESG transparency varies significantly across industry sectors, with certain sectors exhibiting higher levels of ESG disclosure than others. These disparities underscore a key challenge within ESG research, which often neglects to investigate the interdependencies among ESG domains.

The fragmented nature of ESG research in real estate underscores the need for more integrated approaches. Although industry standards and regulatory frameworks increasingly emphasize ESG as a driver of sustainable investment, empirical evidence regarding its financial impact remains complex and often contradictory. The evolving discourse on ESG highlights the importance of developing robust methodologies to assess its influence on listed real estate, paying particular attention to the individual contributions of E, S, and G factors that shape these outcomes, and the potential for reverse causation within these relationships.

## 3. Data and methodology

Understanding the link between ESG practices and firm-level financial performance requires a robust conceptual foundation. Theoretically, stakeholder theory posits that firms engaging in ESG initiatives can enhance legitimacy, attract capital, reduce reputational and regulatory risks, and build stronger relationships with key stakeholders, which may translate into superior financial performance over time. Similarly, signalling theory suggests that ESG disclosures reduce information asymmetries, enhancing investor confidence and market valuation. From a resource-based view, ESG strategies can serve as valuable, rare, and inimitable capabilities that strengthen a firm's long-term competitive advantage. However, these mechanisms may operate with lags, or reverse causality may emerge – for instance, financially stronger firms may have more resources to invest in ESG, complicating identification of directionality. Given these dynamics, our empirical strategy is designed to reflect three interrelated challenges: (i) the potential non-stationarity and long-run relationships between ESG and performance; (ii) the bidirectional causality and time-lagged feedback loops between variables; and (iii) firm-specific heterogeneity and endogeneity. To address the first, we employ Pedroni (2004) panel cointegration tests, which assess whether ESG and financial performance variables move together over time, even if they are individually non-stationary. Cointegration is conceptually appropriate in our context: ESG investments often yield benefits over extended periods, especially in capital-intensive sectors like real estate, where improvements in building energy efficiency, transparency, and governance may only materialise financially years later.

To capture the second and third challenges, we utilise panel Granger causality testing within a Vector Autoregression (VAR) framework and apply the Arellano-Bond Generalised Method of Moments (GMM) estimator. These dynamic models address key econometric problems in ESG research: (a) the presence of lagged dependent variables, (b) reverse causality between ESG and firm performance, and (c) unobserved firm-level effects that could confound results. GMM allows us to use lagged instruments to isolate exogenous variation, thereby helping to distinguish correlation from causation under the assumption that past values of ESG and performance variables are valid instruments. We use difference-GMM due to its suitability for panels with more cross-sections than time periods and have conducted diagnostic tests (e.g. Arellano-Bond tests for AR(1) and AR(2)) to confirm the validity of our estimators.

This framework also reflects the intuition that ESG and CSP are not static but evolve as part of a dynamic interplay. Firms may initially invest in ESG as a risk management strategy or in response to regulation. Over time, these investments might enhance stakeholder trust, reduce capital costs, or improve market perception – thereby improving financial performance. Conversely, improved performance might provide firms with "financial slack" to support further ESG investments. These mutually reinforc-

ing dynamics justify the use of both cointegration and GMM models to explore short-term shocks and long-run adjustments.

The sample of stock markets utilised within this study are derived from Bloomberg for the listed real estate markets within the U.K., France, the Netherlands, Germany, Sweden and Switzerland. These markets have been selected primarily on the basis of their maturity of ESG development, data availability as well as market capitalisation, liquidity, sectoral diversity and transparency. ESG attributes that are considered relevant to financial performance of listed real estate include (i) energy usage, (ii) GHG emissions, (iii) water consumption, (iv) policy on green certified buildings, (v) gender diversity, (vi) health and safety of employees and buildings, (vii) communities engagement, (viii) corporate policies and governance obtained from Bloomberg over the period 2010–2022. In total, 61 listed real estate firms are examined, which are tracked by the indexes of EPRA. In relation to data on ESG, it is worth emphasising that they are categorised into (i) disclosure and (ii) performance attributes. The former measures the degree of transparency of the company in revealing their ESG standards over a financial year, whereas the latter, known as BESG pillar score/percentile indicates the actual ESG performance of the company as measured by Bloomberg[1]. Table 1 depicts the definitions of the financial attributes as well as the ESG variables under investigation in the study, which are provided by Bloomberg.

The quantitative analysis of this study consists of two main components. First we test whether, and to what extent, the performance of the companies, measured by raw return, Sharpe and Tobin's *q*, can be attributed to or explained by the implementation of ESG policies at the corporate level after accounting for firm-level characteristics including but not limited to market capitalisation, leverage ratio (LTV), ownership characteristics, return on equity, revenue, dividend yields etc. Secondly, we determine whether the ESG attributes are cointegrated with the performance of the companies and whether there is a lead-lag relationship between the two groups of variables.

**Table 1.** Description of the variables

| | Variable | Definition |
|---|---|---|
| Dependent variables | Raw Return (RAW) | Defined as the year-on-year return of the stock before tax |
| | Sharpe Ratio (Sharpe) | Defined as the year-on-year return of the stock divided by the standard deviation of the quarterly returns over a one year period |
| | Tobin's *q* | Ratio of the market value of a firm to the replacement cost of the firm's assets. The Q ratio is useful for the valuation of a company. It is based in the hypothesis that in the long run the market value of a company should roughly equal the cost of replacing the company's assets |
| Financial variables | Market Capitalisation (CAP) | Monetary value of all outstanding shares stated in the pricing currency. Capitalisation is a measure of corporate size. Note that the variable is logarithmically transformed |
| | Loan to Value (LTV) | Leverage ratio in percentage that defines the total amount of debt relative to assets. This enables comparisons of leverage to be made across different companies. Calculated as: Total Debt x 100 / Total Assets |
| | Growth in Revenue (REV) | The year-on-year rate of change in revenue, which is defined as the amount of sales generated by a company after the deduction of sales returns, allowances, discounts, and sales based taxes. |
| | Return on Common Equity (ROE) | It is a measure of a corporation's profitability by revealing how much profit a company generates with the money shareholders have invested, in percentage. It is defined as net income available for common shareholders divided by average total common equity |
| | Dividend Yield (DY) | Sum of gross dividend per share amounts that have gone ex-dividend over the prior 12 months, divided by the current stock price |
| ESG variables[2] | Inverse of Energy Consumption per Market Cap (INV_ ENERGY) | The inverse of total Energy Consumption in thousands of megawatt hours (MWh) divided by market cap. This includes energy directly consumed through combustion in owned or controlled boilers, furnaces, vehicles, or through chemical production in owned or controlled process equipment. It also includes energy consumed as electricity |
| | Greenhouse Gas Emission per Market Cap(INV_GHG) | The inverse of total emission of greenhouse gas (GHG) per market cap, if available, otherwise total carbon dioxide (CO2) emissions in millions of metric tonnes<br>Total GHG emissions is the sum of Scope 1 GHG emissions + Scope 2 GHG emissions<br>Total CO2 emissions is the sum of Direct CO2 Emissions + Indirect CO2 Emissions |

[1] While Bloomberg ESG data is widely used in empirical research and provides valuable coverage of firms' environmental, social, and governance disclosures, it is important to note certain limitations. ESG reporting remains largely unstandardised across firms and countries, particularly in emerging markets, which can introduce inconsistencies in data quality and comparability. In our study, we have examined the data to ensure data consistency and comparability.

*End of Table 1*

| | Variable | Definition |
|---|---|---|
| ESG variables[2] | Water Consumption per Market Cap (WATER) | Total amount of water per market cap used to support a company's operational processes, in thousands of cubic meters |
| | Percentage of Women in Workforce (WOMEN) | Number of women employed at the company expressed as a percentage of the total number of company employees |
| | Health and Safety Policy (HS) | Indicates whether the company has at policy level recognized its health and safety risks and responsibilities and is making any effort to improve the management of employee health and/or employee safety. It is a binary dummy variable equal to one if such policy exists, zero otherwise |
| | Green Certified Building (GCB) | Indicates whether the company has developed a policy that recognises the importance of building energy efficiency. It is a binary dummy variable equal to one if such policy exists, zero otherwise |
| | Community Spending per Market Cap (COMMUNITY) | Amount of money per market cap spent by the company on community-building activities, in millions. This includes both cash and in-kind donations if given in a monetary value, and excludes employee contributions and money raised through events |
| | Governance Disclosure Score (G_DS) | Proprietary Bloomberg score based on the extent of a company's Governance data disclosure, as a pillar of ESG data. The score ranges from 0 for companies that do not disclose any of the Governance data included in the score, to 100 for those that disclose every data point. This score measures the amount of Governance data a company reports publicly, and does not measure the company's performance on any data point |
| | Social Disclosure Score (S_DS) | Proprietary Bloomberg score based on the extent of a company's Social data disclosure, as a pillar of ESG data. The score ranges from 0 for companies that do not disclose any of the Social data included in the score, to 100 for those that disclose every data point. This score measures the amount of Social data a company reports publicly, and does not measure the company's performance on any data point |
| | Environmental Disclosure Score (E_DS) | Proprietary Bloomberg score based on the extent of a company's Environmental data disclosure, as a pillar of ESG data. The score ranges from 0 for companies that do not disclose any of the Environmental data included in the score, to 100 for those that disclose every data point. This score measures the amount of Environmental data a company reports publicly, and does not measure the company's performance on any data point |
| | ESG Disclosure Score (ESG_DS) | Proprietary Bloomberg score based on the extent of a company's ESG data disclosure, as a pillar o ESG data. The score ranges from 0 for companies that do not disclose any of the ESG data included in the score, to 100 for those that disclose every data point. This score measures the amount of ESG data a company reports publicly, and does not measure the company's performance on any data point |
| | BESG Environmental Pillar Percentile (ENV_S) | Bloomberg Environmental and Social scoring peer group percentile ranking based on the proprietary Bloomberg Environmental score. Values are 0–100% |
| | Bloomberg's Social Pillar Score (S_S) | Proprietary Bloomberg score ranging from 0 to 10 evaluating the company's aggregated Social performance |
| | BESG Governance Pillar Percentile (G_S) | Bloomberg ESG scoring peer group percentile ranking based on the proprietary Bloomberg Governance pillar score. Values are 0–100% |

[2] In this study, Bloomberg ESG Disclosure Scores measure the extent of a company's transparency in reporting environmental, social, and governance information. The scores are constructed using publicly available data from annual reports, sustainability reports, company websites, and regulatory filings, covering more than 120 ESG indicators. The methodology evaluates whether relevant ESG information is disclosed, focusing on the breadth of disclosure rather than the quality of ESG performance itself. Scores range from 0 to 100, with higher scores indicating more comprehensive disclosure relative to industry peers. Therefore, the ESG Disclosure Score reflects corporate transparency and reporting commitment rather than actual ESG performance. By contrast, Bloomberg ESG Pillar Percentile Scores assess a company's actual ESG performance relative to industry peers across Environmental, Social, and Governance dimensions. Bloomberg collects extensive ESG data, including metrics such as carbon emissions, workforce diversity, and board composition, from publicly available corporate disclosures. Individual ESG indicators are evaluated using parametric scoring models and aggregated into issue scores, theme scores, and ultimately pillar scores for each ESG dimension. These scores are calculated on a scale from 0 to 10 and subsequently converted into percentile rankings within the same industry classification. A higher percentile score therefore indicates relatively stronger ESG performance compared with peer firms.

### 3.1. Cointegration and causal effects

To econometrically explore the ESG performance drivers that affect each listed real estate submarket, cointegration and causality testing will be undertaken. Return/performance (R) will be examined for the sample listed real estate company, alongside time series for the ESG variables ($ESG, ESG_2, \ldots\ldots ESG_n$). In our study, the subsets of ESG include (i) inverse of energy usage per market cap, (ii) inverse of GHG emissions per market cap, (iii) inverse of water consumption per market cap, (iv) green certified buildings, (v) gender diversity, (vi) health and safety of employees and buildings, (vii) community engagement, (viii) corporate policies and governance. It should be highlighted that inverse operator is employed on some of the abovementioned variables as it would make interpretation of results more straightforward, that is to examine whether or not a reduction in the consumption of resources (e.g., energy and water) could lead to an enhanced financial performance. Prior to undertaking the cointegration and causality tests, we conduct IPS tests (Im et al., 2003) to check for unit roots within the panels. The null hypothesis of the IPS test states that all panels (individual time series within the panel) contain unit roots, indicating non-stationarity. Conversely, the alternative hypothesis posits that at least some panels are stationary. This test is particularly useful in heterogeneous panels where cross-sectional units may exhibit different properties. By applying the IPS test, we ensure that our data meet the assumptions required for subsequent econometric analyses, such as panel cointegration and causality tests. Non-stationary data can lead to spurious regression results. In our analysis, any variables found to be non-stationary at level are transformed through differencing to achieve stationarity.

To determine whether long term equilibrium relationships exist between each pair of *R* and ESG, we utilise the Cointegration method for panel data developed by Pedroni (2004) which is mathematically represented by the equation below:

$$R_{it} = \alpha_i + \sum \beta_{ji} ESG_{jit} + e_{it,} \quad (1)$$

where $e_{it} = p_i e_{i(t-1)} + w_{it}$ is the estimated residual from the panel regression with $w_{it}$ being the white-noise error term, assumed to be independently and identically distributed with zero mean and constant variance. $\alpha_i$ is a constant term and $\beta_{ji}$ represents the slope coefficient associated with the ESG variable *j* for firm *i*. Cointegration is particularly appropriate in the listed real estate context, where ESG investments are unlikely to generate immediate payoffs but may influence firm performance cumulatively over time. Standard panel regressions applied to non-stationary variables risk producing spurious results; therefore, establishing cointegration allows us to test whether ESG and performance variables move together in a stable long-run equilibrium despite short-term deviations (Lo et al., 2021, 2022a, 2022c, 2022d, 2024; McCord et al., 2019). The Pedroni's method considers seven test statistics, which are based upon the estimated residuals of the above long run model, with the null hypothesis being no cointegration in the heterogeneous panels. The first set of tests are called "within dimension" (i.e., panel tests) whereas the other is known as "between dimension" (i.e., group tests). The former considers common temporal factors and permits heterogeneity among members, while the latter allows for parameter heterogeneity across members. The seven statistics of Pedroni's are normally distributed with the null hypothesis of $p_i$ being unity. If the statistics is greater than the appropriate critical values, then the null hypothesis of no integration between the variables should be rejected.

Conditional on the existence of cointegration, we implement panel Granger causality tests to investigate the direction of the relationship between ESG attributes and financial performance. This step is critical given the long-standing concern in ESG research that causality may run in both directions: ESG engagement may improve performance, but financially stronger firms may also possess greater resources to invest in ESG initiatives. Granger causality analysis within a panel VAR framework enables us to distinguish short-run and long-run lead–lag relationships, providing insight into whether ESG acts as a driver, an outcome, or part of a feedback loop with firm performance. According to Holtz-Eakin et al. (1988), the time-stationary VAR model is given by:

$$R_{it} = \alpha_0 + \sum_{j=1}^{m} \alpha_i R_{it-i} + \sum_{j=1}^{m} \gamma_j ESG_{it-j} + f_{xi} + u_{it}; \quad (2a)$$

$$ESG_{it} = \beta_0 + + \sum_{j=1}^{m} \beta_i R_{it-i} + \sum_{j=1}^{m} \delta_j ESG_{it-j} + f_{xi} + v_{it}; \quad (2b)$$

where *I* = 1, 2, 3,..., *n* represents cross-sectional panel members for the sample listed companies, and $u_{it}$ and $v_{it}$ are the residual terms for the equations. $\alpha_i$ and $\gamma_j$ are parameters to be estimated. $f_{yi}$ and $f_{xi}$ captures the fixed effects for the panel member *i*. However, since the lagged dependent variables are likely correlated with the residuals and terms on the fixed effects, the estimates of the above equations could be biased under OLS. Therefore, we remove the fixed effects by differencing, which yields the following equations:

$$\Delta R_{it} = \sum_{j=1}^{m} \alpha_j \Delta R_{it-j} + \sum_{j=1}^{m} \gamma_j \Delta ESG_{it-j} + \Delta u_{it}; \quad (3a)$$

$$\Delta ESG_{it} = \sum_{j=1}^{m} \beta_j \Delta R_{it-j} + \sum_{j=1}^{m} \delta_j \Delta ESG_{it-j} + \Delta v_{it}; \quad (3b)$$

$\alpha_j$ and $\gamma_j$ are parameters to be estimated for each performance and ESG variable. It should be noted that after differencing, an issue of simultaneity could arise given that the correlation between the lagged endogenous variables and the differenced error term. Furthermore, the error terms could be heteroscedastic since heterogeneous errors might be present across different panel members. To overcome these problems, we employ an instrumental

**Table 2.** Analytical framework and relationship between econometric methods

| Stage of analysis | Purpose | Relationship to subsequent stage |
|---|---|---|
| Im–Pesaran–Shin (IPS) panel unit root test | To examine whether ESG variables and performance indicators are stationary or contain unit roots | Establishes the order of integration of variables before conducting panel cointegration analysis. Non-stationary variables integrated at the same order are required for Pedroni cointegration tests |
| Pedroni panel cointegration test | To investigate whether ESG attributes and listed real estate performance indicators share a long-run equilibrium relationship across firms and countries | If cointegration exists, dynamic long-run relationships between ESG factors and performance measures can be meaningfully examined using causality and dynamic panel estimation techniques |
| Panel Granger causality test | To determine the direction of causality between ESG attributes and firm performance indicators | Builds upon the cointegration framework by identifying whether ESG factors predict future firm performance, whether performance influences ESG adoption, or whether bidirectional causality exists |
| Generalised method of moments (GMM) estimation | To estimate the dynamic impact of ESG factors on listed real estate performance while controlling for endogeneity, firm heterogeneity, and persistence in performance measures | Final stage of the empirical framework. GMM incorporates lagged dependent variables and endogenous regressors identified in earlier analyses |

variable estimation procedure to estimate the models, which should produce more consistent estimates of the coefficients. According to Easterly et al. (1997), the second or more lagged values of the variables might be utilised as instruments assuming that $u_{it}$ and $v_{it}$ are not serially correlated. The joint hypothesis $\gamma_j = 0$ and $\beta_j = 0$ is tested to determine whether causality exists.

To address firm-level heterogeneity, dynamic adjustment, and endogeneity concerns, we complement the causality analysis with dynamic panel regressions estimated using the Arellano–Bond Generalised Method of Moments (GMM) (Arellano & Bond, 1991). Listed real estate firms differ systematically in size, leverage, ownership structure, and regulatory exposure, all of which may influence both ESG engagement and performance. Moreover, performance measures are inherently dynamic, with current outcomes dependent on past values. The GMM framework allows us to control for unobserved firm-specific effects, incorporate lagged dependent variables, and mitigate simultaneity bias by using internal instruments derived from lagged values. Compared to other estimation procedures, the GMM method offers superior efficiency and consistency. The test statistics follow a Chi-squared distribution with the degree of freedom equal to k-m, where k is the number of regressors. To ensure the validity and robustness of the dynamic panel regression models employed in this study, we conducted Arellano-Bond tests for autocorrelation on the residuals of the differenced equations. The Arellano-Bond test is designed to detect first-order (AR(1)) and second-order (AR(2)) serial correlation, which are critical diagnostics for dynamic panel models estimated using the GMM[3]. Table 2 describes the overall analytical framework and relationship between the econometric methods employed in the study.

## 3.2. Company-level performance and ESG

We also explore how company-level ESG attributes affect performance of the sample real estate companies within a panel data framework. Tobin's $q$ ($Q_{i,t}$) (alongside raw return and risk-adjusted return) is used as the principal measure for gauging a firm's (i) performance at time t, which is commonly defined as the ratio of the market value of a company's equity and liabilities to its corresponding book values. Mathematically, it is given by:

$$Tobin's\,q\left(Q_{i,t}\right) = \frac{Equity\,Market\,Value + Liabilities\,Market\,Value}{Equity\,Book\,Value + Liabilities\,Book\,Value}. \quad (4)$$

Historically, firms with high Tobin's $q$ have been found to be more favourable investment opportunities (Lang et al., 1989; Lang & Stulz, 1994) or exhibit better growth potential (Brainard & Tobin, 1968; Tobin, 1969). In order to test whether, and to what degree, company-specific attributes affect the firm's performance, an equation, in stacked form, linking the performance indicators and a spectrum of company-level attributes is estimated (see Eq. (5) below). The attributes to be examined include (1) the market capitalisation of the company (*Cap*), which is measured by the multiplication of share price and number of shares outstanding; (2) leverage ratio (*L*), which is defined as total debt/total asset; (3) dividends (*D*), which can be represented by total dividends over earnings in a given financial year; (4) ownership (*O*), which captured the shareholding ratio of the largest owner of the

[3] It should be emphasised that no single econometric technique is sufficient to capture the complexity of ESG–performance interactions in listed real estate markets. Specifically, panel regressions alone identify contemporaneous associations but cannot distinguish long-run equilibrium from short-term co-movement. Cointegration tests establish long-run relationships but do not reveal causal direction. Granger causality identifies temporal precedence but does not control for firm-specific heterogeneity (Lo et al., 2023). By integrating these methods, the empirical strategy allows for a more comprehensive and internally consistent assessment of ESG effects across different time horizons and performance dimensions.

firm; (5) return on equity (*ROE*), which measures the profitability of the company, (6) corporate structure (*V*), which is a binary variable equal to one if the company in question is a REIT, zero otherwise. The selection of these company-level variables is based on a recent study by Haran et al. (2021), which identifies key determinants of financial performance within the European listed real estate sector.

$$Q_{i,t} = c + Cap_{i,t} + L_{i,t} + D_{i,t} + O_{i,t} + ROE_{i,t} + V_{i,t} + ESG_{i,t} + \sum C + e, \quad (5)$$

where $c$ is a constant and $\sum C$ is a spectrum of control variables, including the business focus of the firm, country of domicile and sector of the firm etc. $e$ is an error term. We develop three sets of models based on Eq. (5) with each set focussed exclusively on one performance indicator. Within each set of models, 14 equations are derived with each equation examining one ESG attribute in addition to the control variables (Models 1–14 for raw return; Models 15–28 for Sharpe ratio; and Models 29–42 for Tobin's *q*). All tests are conducted on a quarterly basis.

### 3.3. Descriptive analysis

Table 3 summarises the composition of real estate companies across six European countries. The U.K. hosts the largest group with 25 companies and an 88% REIT share, achieving an average annual return of 8.81%. Switzerland, France, and the Netherlands have a 100% REIT composition, with Switzerland showing the highest average return at 13.79%. Germany and Sweden contribute with significant market capitalizations of £66.93 billion and £56.88 billion, respectively. Overall, the 61 companies achieve a combined market capitalization of £254.42 billion and an average return of 9.45%

Table 4 showcases the correlation coefficients between the three performance indicators and the ESG indicators. An interesting observation is that both raw return and Sharpe exhibit a slight negative correlation with all the ESG indicators, implying a short-term divergence between financial performance and the company's ESG development. However, Tobin's *q* demonstrates a strong positive correlation with all the ESG indicators, with correlation coefficients exceeding 0.70, underscoring their close interconnection.

**Table 3.** Composition of sample companies

| | Number of real estate companies | Percentage of REITs | Average annual return (Sample period) | Total market capitalisation (Billions GBP) |
|---|---|---|---|---|
| The U.K. | 25 | 84% | 8.81% | 83.36 |
| France | 6 | 100% | 9.69% | 25.59 |
| Germany | 9 | 0% | 8.32% | 66.93 |
| The Netherlands | 4 | 100% | 8.51% | 10.73 |
| Sweden | 13 | 0% | 9.33% | 56.88 |
| Switzerland | 4 | 0% | 13.79% | 10.93 |
| Total | 61 | 51% | 9.45% | 254.42 |

**Table 4.** Correlation matrix (Aggregate level)

| | Raw | Sharpe | Tobin's *q* | Env | Social | Gov |
|---|---|---|---|---|---|---|
| Env | –0.14 | –0.32 | 0.82 | 1 | | |
| Social | –0.17 | –0.35 | 0.70 | 0.79 | 1 | |
| Gov | –0.17 | –0.33 | 0.83 | 0.74 | 0.64 | 1 |
| ESG | –0.16 | –0.33 | 0.78 | 0.72 | 0.65 | 0.80 |

In addition, it is worth noting that the three ESG series exhibit a high degree of correlation among themselves, indicating that growth in one ESG indicator coincides with growth in the others.

## 4. Empirical results and findings

Table 5 depicts the results of the IPS tests, which confirm that all financial performance variables (RAW, Sharpe, Tobin's *q*) are non-stationary at level but become stationary at first difference, enabling robust econometric analysis. ESG variables such as INV_ENERGY and G_DS exhibit the strongest stationarity at the first difference, ensuring reliability in long-term relationship testing.

**Table 5.** Results of IPS unit root tests

| Variable | Level | First difference |
|---|---|---|
| RAW | 0.5509 (0.7091) | –3.7847 (0.0001)*** |
| Sharpe Ratio | 0.0101 (0.5040) | –2.7740 (0.0028)*** |
| Tobin's *q* | 0.4312 (0.6669) | –3.4187 (0.0003)*** |
| INV_ENERGY | –5.4877 (0.0000)*** | –9.0241 (0.0000)*** |
| INV_GHG | 3.4055 (0.9997) | –14.025 (0.0000)*** |
| INV_WATER | 1.5919 (0.9443) | –13.925 (0.0000)*** |
| COMMUNITY | 1.0307 (0.8487) | –11.397 (0.0000)*** |
| WOMEN | 3.2079 (0.9993) | –4.1409 (0.0000)*** |
| E_DS | –0.5557 (0.2892) | –2.2670 (0.0117)** |
| S_DS | 3.2183 (0.9994) | –5.3925 (0.0000)*** |
| G_DS | 3.9012 (0.9996) | –3.3475 (0.0004)*** |
| ESG_DS | 2.1020 (0.9822) | –5.8503 (0.0000)*** |
| E_S | 3.0420 (0.9988) | –3.2106 (0.0007)*** |
| S_S | 0.7638 (0.7775) | –11.5122 (0.0000)*** |
| G_S | –1.6452 (0.0501)* | –14.6606 (0.0000)*** |

*Notes*: ** and *** indicate statistical significance at the 5% and 1% level respectively.

**Table 6.** Results of Pedroni's cointegration tests for Raw return, Sharpe and Tobin's *q*

| Pedroni (Raw return) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Variable | Panel v-stat | Panel rho-stat | Panel PP-stat | Panel ADF-stat | Group rho-stat | Group PP-stat | Group ADF-stat |
| INVERSE_ENERGY | 4.9619*** | –14.4958*** | –14.1543*** | –3.6678*** | –3.5367*** | –9.8848*** | –5.0309*** |
| INVERSE_GHG | 4.8859*** | –16.0941*** | –14.8396*** | –3.9827*** | –3.5941*** | –10.2634*** | –5.0505*** |
| INVERSE WATER | 5.3928*** | –9.7833*** | –8.8599*** | –3.4070*** | –2.8298*** | –8.6779*** | –3.8030*** |
| COMMUNITY | 2.6381*** | –12.2414*** | –10.6556*** | –1.7525*** | –3.5827*** | –7.9941*** | –3.4415*** |
| WOMEN | 4.2481*** | –10.5327*** | –9.9368*** | –5.8189*** | –4.2752*** | –10.8001 | –6.4821*** |
| HS | 2.1478*** | –6.9452*** | –6.5201*** | –4.1543*** | –3.5188*** | –6.6595*** | –4.4673*** |
| GB | 4.9292*** | –14.2314*** | –13.6954*** | –5.2511*** | –5.0866*** | –9.1129*** | –4.5723*** |
| E_DS | 6.5438*** | –18.3145*** | –18.1201*** | –7.5195*** | –8.1609*** | –14.8134*** | –7.2585*** |
| S_DS | 7.2125*** | –18.2943*** | –17.9053*** | –7.6603*** | –8.1312*** | –15.2810*** | –8.0257*** |
| G_DS | 7.0572*** | –17.7615*** | –17.8070*** | –7.9956*** | –8.6493*** | –14.4014*** | –7.6883*** |
| ESG_DS | 7.2326*** | –18.3652*** | –17.8010*** | –7.8667*** | –8.6358*** | –14.8952*** | –8.1306*** |
| E_S | 2.7812*** | –4.9974*** | –7.5888*** | –3.4080*** | –2.0254** | –7.5393*** | –3.1831*** |
| S_S | 1.9148** | –4.5365*** | –6.7514*** | –3.5511*** | –1.7288** | –7.1172*** | –3.5827*** |
| G_S | 3.9185*** | –5.0957 | –7.4746*** | –3.8873*** | –1.9174** | –6.7939*** | –3.2641*** |
| Pedroni (Sharpe) | | | | | | | |
| Variable | Panel v-stat | Panel rho-stat | Panel PP-stat | Panel ADF-stat | Group rho-stat | Group PP-stat | Group ADF-stat |
| INVERSE_ENERGY | –0.2664 | –12.8955*** | –13.3912*** | –6.6024*** | –4.9694*** | –13.3143*** | –5.7066*** |
| INVERSE_GHG | –1.0750 | –14.1984*** | –14.1622*** | –6.9093*** | –5.1339 | –14.3739*** | –5.3444*** |
| INVERSE_WATER | 4.0939*** | –0.5217 | –5.2609*** | –0.4210*** | 3.7716*** | 0.2373*** | 3.5200*** |
| COMMUNITY | –0.4127 | –7.9163*** | –8.0888*** | –2.7345*** | –3.0005*** | –7.8167*** | –2.4112*** |
| WOMEN | 2.3107** | 4.2476 | 5.4031 | 2.7895 | 6.1915 | 4.9746 | 2.4072 |
| HS | 1.4725* | –9.7805*** | –9.1313*** | –3.1181*** | –5.4328*** | –8.9783*** | –2.8680*** |
| GB | –253.6821 | 0.9373 | 0.6079 | 1.3549 | 2.6614 | –0.0456 | 0.3730 |
| E_DS | 1.7449 | –17.6974*** | –16.6182*** | –8.1913*** | –9.8816*** | –16.5700*** | –7.1914*** |
| S_DS | 4.4598*** | –17.7228*** | –17.6919 | –9.4641*** | –9.9548*** | –18.5548*** | –8.1520*** |
| G_DS | 1.0455 | –16.8145*** | –16.2390** | –8.1475*** | –10.3036*** | –16.7051*** | –7.6179*** |
| ESG_DS | 3.9807*** | –18.5438*** | –17.6473*** | –9.0891*** | –10.4003*** | –16.9611*** | –7.8040*** |
| E_S | –1.0289 | –7.4888*** | –13.6860*** | –5.2517*** | –3.8668*** | –13.7683*** | –4.9239*** |
| S_S | –2.4674 | –6.7589*** | –11.7246*** | –4.3331*** | –3.0901*** | –11.2812*** | –3.8204*** |
| G_S | –1.2346 | –7.2981*** | –12.1907*** | –4.2818*** | –3.7172*** | –12.0003*** | –4.1986*** |
| Pedroni (Tobin's *q*) | | | | | | | |
| Variable | Panel v-stat | Panel rho-stat | Panel PP-stat | Panel ADF-stat | Group rho-stat | Group PP-stat | Group ADF-stat |
| INVERSE_ENERGY | 0.7683 | –3.5677*** | –4.9051*** | –5.3755*** | 1.1077 | –4.7878*** | –7.0300*** |
| INVERSE_GHG | 0.5306 | –3.4085*** | –4.4022*** | –4.4948*** | 1.7163 | –3.8335*** | –5.4923*** |
| INVERSE_WATER | 0.4872 | –1.9099** | –3.9736*** | –4.2762*** | 1.6174 | –3.6557*** | –4.9199*** |
| COMMUNITY | 0.1866 | 0.2650 | 0.8641 | –4.3345*** | 2.4173 | 0.7338 | –4.3442*** |
| WOMEN | –106.7092 | –1.9369** | –5.1577*** | –6.0768*** | 1.6483 | –5.4996*** | –10.4930*** |
| HS | 1.1561 | –4.6019*** | –7.7348*** | –2.2074** | –0.3828 | –3.3432*** | –4.1149*** |
| GB | 0.4269 | –3.1362*** | –4.3961*** | –4.4639*** | 0.6615 | –2.8042*** | –6.5886*** |
| G_DS | –0.5708 | –5.2210*** | –8.8999*** | –4.8711*** | 0.2235 | –4.9217*** | –9.3021*** |
| E_DS | 0.2526 | –6.4742*** | –10.5204*** | –6.9689*** | 0.2289 | –6.8081*** | –10.9773*** |
| S_DS | 0.0539 | –6.2480*** | –9.6668*** | –5.6390*** | 0.6391 | –5.3773*** | –9.6956*** |
| ESG_DS | –0.1649 | –6.3707*** | –9.9154*** | –6.2427*** | 0.3880 | –6.1408*** | –10.1098*** |
| E_S | 0.7309 | –7.2336*** | –11.4607*** | –6.0727*** | 0.7449 | –4.1041*** | –11.0662*** |
| S_S | 7.0540*** | –6.4157*** | –10.5350*** | –5.6895*** | 0.8517*** | –4.4837*** | –11.5628*** |
| G_S | 2.2871 | –7.7851*** | –12.4927*** | –7.2370*** | 0.7214 | –4.1652*** | –12.3262*** |

*Notes*: *, ** and *** indicate statistical significance at the 10%, 5% and 1% level respectively.

Table 6 reports the results of the Pedroni cointegration tests for raw return, Sharpe ratio and Tobin's *q* respectively. The tests are conducted based on the rule that the *null* hypothesis of no cointegration between a given pair of time series is rejected if the test statistics have large negative values, except for the panel-v test which rejects the null when the test statistics is a large positive value. Examination of the results of the seven statistics for each pair of time series reveals that all financial and ESG attributes are cointegrated with the performance attributes, except for WOMEN, and GB which are not cointegrated with Sharpe, and COMMUNITY which shows no long-run cointegrating relationship with Tobin's *q*. Hence, we conduct the Causality tests within the framework of Error Correction Model for the pairs of time series that are cointegrated. It is worth noting that robust cointegration between G_DS and Tobin's *q* across all dimensions (panel v-stat, panel rho-stat, etc.) is observed. This finding solidifies governance metrics as critical long-term determinants of firm valuation. Environmental metrics (e.g., INV_ENERGY and INV_GHG) also exhibit significant cointegration, albeit with slightly weaker panel test results, indicating their importance in sustainability-focused performance outcomes.

### 4.1. GMM estimation and causality results

The overall results of the Granger causality tests on the ESG attributes and performance time series are summarised and presented in Table 7. A number of noteworthy and interesting findings can be observed across the attributes examined. First, the inverse of energy use per market cap Granger-causes raw return and Sharpe ratio in the long term, implying that a reduction in energy use at corporate level could lead to better financial performance. Bi-directional short-term causality is also detected when Tobin's *q* is used as the performance indicator, despite the long-term lead-lag relationship being statistically insignificant at the 5% level.

Second, we do not find any statistically robust evidence that suggests a reduction in GHG emission could lead to superior financial performance in the real estate sector based on the results of the causality tests with the coefficients of the EC terms being either positive or statistically insignificant at the 5% level. However, the opposite causation seems to hold across all performance indicators. In other words, a growth in financial performance is likely to result in real estate firms adopting measures to reduce GHG emission.

**Table 7.** Summary of panel data causality tests

| | Y | | | | | |
|---|---|---|---|---|---|---|
| | Raw | | Sharpe | | Tobin's *q* | |
| Causality | Short term | Long term | Short term | Long term | Short term | Long term |
| INV_ENERGY →Y | No | Yes | Yes | Yes | Yes | No |
| Y→ INV_ENERGY | No | No | No | No | Yes | No |
| INV_GHG→Y | No | No | No | No | No | No |
| Y→ INV_GHG | Yes | Yes | Yes | Yes | No | Yes |
| INV_WATER→ Y | Yes | No | Yes | No | No | No |
| Y→ INV_WATER | No | No | No | No | No | No |
| WOMEN→Y | Yes | Yes | Yes | No | Yes | No |
| Y→WOMEN | Yes | Yes | No | No | No | Yes |
| COMMUNITY → Y | No | No | No | No | No | No |
| Y→ COMMUNITY | No | No | No | No | No | No |
| E_DS→ Y | No | Yes | No | Yes | No | Yes |
| Y→ E_DS | No | Yes | No | Yes | Yes | No |
| S_DS→ Y | No | Yes | No | Yes | No | No |
| Y→ S_DS | No | No | No | No | No | No |
| G_DS→ Y | No | Yes | No | Yes | No | Yes |
| Y→ G_DS | No | Yes | Yes | Yes | No | Yes |
| ESG_DS→ Y | No | Yes | No | Yes | No | No |
| Y→ ESG_DS | Yes | Yes | No | Yes | No | No |
| E_S→ Y | No | Yes | No | Yes | No | No |
| Y→ E_S | Yes | No | Yes | No | No | Yes |
| S_S→ Y | No | Yes | No | Yes | No | No |
| Y→ S_S | No | No | No | Yes | No | Yes |
| G_S→ Y | No | Yes | No | Yes | No | No |
| Y→ G_S | No | No | No | No | No | No |

Third, water consumption per market cap does not seem to have any significant causal association with company's performance. The findings of the causality tests for this attribute only reveal raw return exhibiting a short-term impact with other performance indicators displaying insignificant statistical relationships with it both in the short- and long-run. Fourth, gender diversity, measured by the percentage of women in workforce Granger-causes raw return and Tobin's *q* in the long-run. Indeed, the attribute is Granger-caused by the performance variables in both the long- and short-run, confirming a bi-directionality of the causal linkages. Fifth, the amount of community spending per market cap is found to have no statistically significant causal relationship with any of the three performance variables, both in the short and long-run and across the time lags examined.

We further investigate the three disclosure scores of the ESG aspects of the sample companies and their lead-lag interaction with the performance attributes. It is discernible from the results that environmental disclosure scores do have a significant causal impact on the performance of firm in the long-run, with the environmental attribute Granger-causing the time series on raw return, Sharpe ratio as well as Tobin's *q*. For the reverse causation, we observe that raw return and Sharpe ratio leads the disclosure score in the long-run with a lag length of two units, whilst a higher raw return and Tobin's *q* tend to increase the disclosure score in the short-run.

In relation to social disclosure score, it is found to Granger-cause raw returns and the Sharpe ratio with a lag length of two units, but not the Tobin's *q* in the long-run. Further, the governance disclosure score exhibits a long-term bi-directional causal link with all the three performance indicators, reflecting their predictive power for real estate firm valuation. On the other hand, the aggregate ESG disclosure is observed to have bi-directional causal interconnections with raw return and Sharpe ratio, but not with Tobin's *q* in the long run.

Last but not least, it is evident from the results that over a longer time horizon, E_S, S_S and G_S all Granger-cause raw return and Sharpe, but not Tobin's *q*, seemingly implying that companies that work on improving ESG development might generate superior returns in the long-run. The statistically optimal lag lengths range from one to two periods for most of the causal relationships. It is further noteworthy that Sharpe and Tobin's *q* Granger-cause E_S and S_S, signalling the inclination of some real estate firms that when they have achieved better financial performance, they are indeed willing to allocate more resources to enhance the environmental and social standards within their organisations. To enhance presentation of our findings, Figures 1–2 depict the long-term causal relationship for each pair of variables examined.

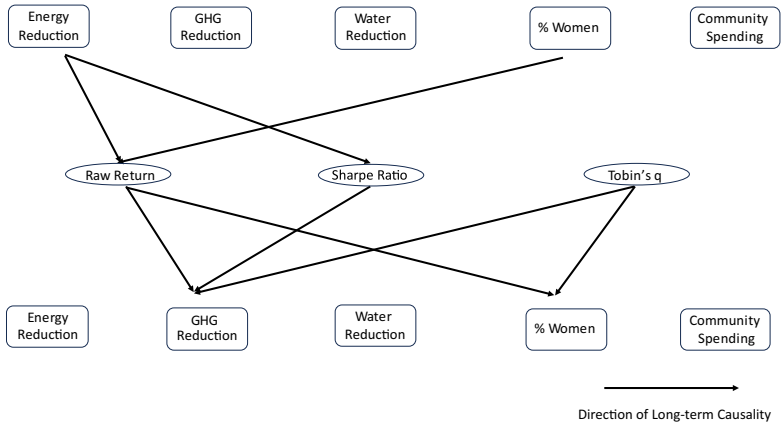



**Figure 1.** Graphic depiction of the long-term causal relationships between individual ESG variables and financial performance

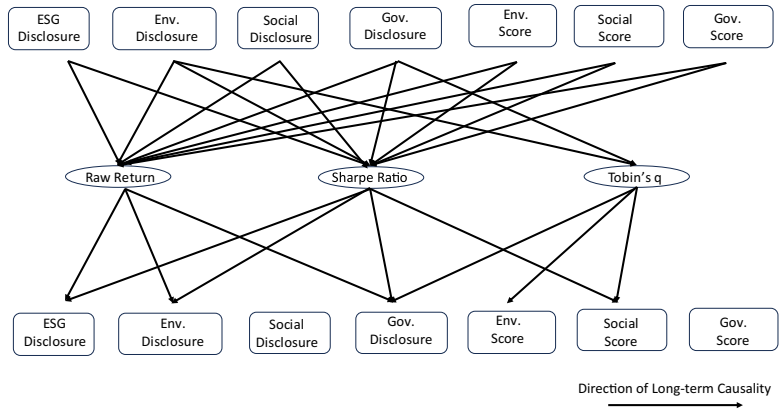



**Figure 2.** Graphic depiction of the long-term causal relationships between aggregate ESG scores and financial performance

The results of the panel causality tests, as summarised in Table 6, provide important insights into the short-term and long-term relationships between key ESG variables and financial performance indicators (Raw Return, Sharpe Ratio, and Tobin's *q*). For instance, the inverse of energy consumption (INV_ENERGY) exhibits significant long-term causality with both Sharpe Ratio and Tobin's *q*, indicating that energy efficiency investments align with improved financial stability and market valuation in the long run. Similarly, governance disclosure scores (G_DS) show significant long-term causality with all three financial performance measures, suggesting that greater transparency in governance practices fosters investor confidence and enhances performance outcomes. These findings highlight the critical role of ESG factors in shaping both short-term and sustained financial success.

Interestingly, while several ESG variables exhibit long-term causality with financial metrics, short-term causal relationships are less consistent across the sample. For example, the results indicate that greenhouse gas emissions (INV_GHG) and water consumption (INV_WATER) lack significant short-term impacts on Raw Return and Sharpe Ratio but display some evidence of causality for Tobin's *q* over extended periods. These outcomes underscore the need for REITs and non-listed real estate firms to prioritise long-term ESG strategies that yield cumulative benefits over time, rather than focusing solely on immediate financial returns. This reinforces the importance of adopting holistic sustainability frameworks and aligning corporate goals with environmental and governance standards to drive enduring value creation.

## 4.2. Panel regression models

In addition to the abovementioned Cointegration and Causality Models, we develop 42 panel regression models to examine the effect of the various ESG attributes on the performance of the listed real estate companies (Table 8). The analysis, based on the 5% statistical significance level, reveals that a majority of ESG attributes do not exhibit any statistically significant negative effects on raw return, Sharpe, and Tobin's *q* with the exceptions of INV_WATER, G_DS and G_S which are found to depress the magnitude of Tobin's *q*. More specifically, a one-unit increase in G_DS is associated with a 0.0004 reduction in the Sharpe ratio, while a one-unit increase in G_S corresponds to a 0.0086 decline in Tobin's *q*. Notably, a one-unit increase in ESG_DS is associated with a 0.42-point increase in Tobin's *q*, highlighting the critical role of transparency in strengthening firm valuation.

**Table 8.** Results of panel regression models (Raw return, Sharpe, Tobin's *q*)

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 | Model 10 | Model 11 | Model 12 | Model 13 | Model 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Constant | –13.892 | –23.119 | –25.191 | –45.641 | –20.530 | –19.524 | –22.484 | –20.793 | –21.868 | –27.812 | –24.302 | –30.753 | –34.935 | –38.426 |
| | (0.3046) | (0.1142) | (0.0890)* | (0.0728)* | (0.0827)* | (0.1164) | (0.1439) | (0.0598)* | (0.0991)* | (0.0449)** | (0.0356)** | (0.1727) | (0.5115) | (0.0758)* |
| Market Cap | 0.3424 | 0.6497 | 0.9262 | 1.5346 | 0.6836 | 0.5580 | 0.8690 | 0.9120 | 0.7135 | 0.9802 | 0.9423 | 1.5085 | 1.5660 | 2.2596 |
| | (0.5319) | (0.2597) | (0.1615) | (0.1389) | (0.1590) | (0.2827) | (0.1536) | (0.0644)* | (0.2039) | (0.0908)* | (0.0739)* | (0.1225) | (0.1078) | (0.0192)** |
| LTV | 0.16456 | 0.1584 | 0.1227 | 0.1741 | 0.1454 | 0.1442 | 0.1776 | 0.1679 | 0.154914 | 0.1608 | 0.1649 | 0.3317 | 0.3647 | 0.3429 |
| | (0.0050)*** | (0.0082)*** | (0.0314)** | (0.0684)* | (0.0006)*** | (0.0006)*** | (0.0005) | (0.0000)*** | (0.0005)*** | (0.0003)*** | (0.0001)*** | (0.0055)*** | (0.0025)** | (0.0021)*** |
| ROE | 0.2449 | 0.3051 | 0.2841 | 0.2993 | 0.2026 | 0.2413 | 0.2103 | 0.2213 | 0.2084 | 0.2000 | 0.2139 | 0.2367 | 0.2229 | 0.2639 |
| | (0.0001)*** | (0.0000)*** | (0.0000)*** | (0.0017)*** | (0.0006)*** | (0.0001)*** | (0.0020)*** | (0.0003)*** | (0.0004)*** | (0.0007)*** | (0.0000)*** | (0.0267)** | (0.0453)** | (0.0053)*** |
| REV Growth | 0.0073 | 0.0193 | 0.0143 | 0.0483 | 0.0235 | 0.0262 | 0.0360 | 0.0170 | 0.0219 | 0.0201 | 0.0177 | 0.0173 | 0.0172 | 0.0170 |
| | (0.7329) | (0.3919) | (0.4541) | (0.1543) | (0.1696) | (0.1292) | (0.1665) | (0.2979) | (0.2242) | (0.2624) | (0.1671) | (0.4914) | (0.5115) | (0.4786) |
| Dividend Yield | –1.5912 | –1.6055 | –1.5703 | –1.2740 | –1.6146 | –1.5940 | –1.6097 | –1.6287 | 1.6166 | –1.6376 | –1.6351 | –1.7282 | –1.7935 | –1.5104 |
| | (0.0000)*** | (0.0000)*** | (0.0000)*** | (0.0002)*** | (0.0000)*** | (0.0000)*** | (0.0000)*** | (0.0000)*** | (0.0000)*** | (0.0000)*** | (0.0000)*** | (0.0000)*** | (0.0000)*** | (0.0000)*** |
| INV_ENERGY | 6.01E-07 | | | | | | | | | | | | | |
| | (0.3455) | | | | | | | | | | | | | |
| INV_GHG | | 2.04E-08 | | | | | | | | | | | | |
| | | (0.7625) | | | | | | | | | | | | |
| INV_WATER | | | 3.06E-06 | | | | | | | | | | | |
| | | | (0.1013) | | | | | | | | | | | |
| COMMU-NITY | | | | -935.36 | | | | | | | | | | |
| | | | | (0.7954) | | | | | | | | | | |
| GB | | | | | –1.0533 | | | | | | | | | |
| | | | | | (0.2022) | | | | | | | | | |
| HS | | | | | | 0.8978 | | | | | | | | |
| | | | | | | (0.4369) | | | | | | | | |
| WOMEN | | | | | | | –0.0653 | | | | | | | |
| | | | | | | | (0.0592)* | | | | | | | |
| G_DS | | | | | | | | –0.0881 | | | | | | |
| | | | | | | | | (0.0512)* | | | | | | |
| S_DS | | | | | | | | | –0.0246 | | | | | |
| | | | | | | | | | (0.5567) | | | | | |
| E_DS | | | | | | | | | | –0.0438 | | | | |
| | | | | | | | | | | (0.1385) | | | | |
| ESG_DS | | | | | | | | | | | –0.0779 | | | |
| | | | | | | | | | | | (0.0887)* | | | |
| E_S | | | | | | | | | | | | –0.7716 | | |
| | | | | | | | | | | | | (0.1578) | | |

*Continue Table 8*

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S_S | | | | | | | | | | | | | –0.5717 (0.1045) | |
| G_S | | | | | | | | | | | | | | –1.7369 (0.0079)*** |
| Country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| REIT dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| AR1 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| AR2 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs | 1217 | 1206 | 915 | 559 | 1608 | 1612 | 1381 | 1667 | 1640 | 1640 | 1667 | 732 | 719 | 780 |
| Periods | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 28 | 28 | 28 |
| Crosssections | 50 | 53 | 44 | 23 | 56 | 56 | 53 | 55 | 55 | 55 | 55 | 36 | 36 | 36 |
| $R^2$ | 0.7255 | 0.7117 | 0.7199 | 0.7564 | 0.7133 | 0.7144 | 0.7105 | 0.7124 | 0.7112 | 0.7116 | 0.7119 | 0.7210 | 0.7217 | 0.7241 |
| Adj $R^2$ | 0.7100 | 0.6952 | 0.699167 | 0.7259 | 0.7012 | 0.7023 | 0.6962 | 0.7007 | 0.6993 | 0.6996 | 0.7006 | 0.7023 | 0.7026 | 0.7068 |
| Prob(F) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| DW | 1.9681 | 1.9015 | 1.9179 | 1.8831 | 1.9512 | 1.9328 | 1.9231 | 1.9461 | 1.9477 | 1.9475 | 1.9465 | 1.9187 | 1.9245 | 1.9199 |
| | Model 15 | Model 16 | Model 17 | Model 18 | Model 19 | Model 20 | Model 21 | Model 22 | Model 23 | Model 24 | Model 25 | Model 26 | Model 27 | Model 28 |
| Constant | –3.4603 (0.0409)** | –3.3134 (0.0443)** | –4.2850 (0.0171)** | –7.4571 (0.0401)** | –3.5091 (0.0183)** | –3.5091 (0.0183)** | –3.2693 (0.0642)* | –3.1718 (0.0263)** | –3.7456 (0.0282)** | –2.7447 (0.1116) | –3.0402 (0.0500)** | –0.6953 (0.7929) | –1.2637 (0.6381) | –0.8965 (0.7169) |
| Market Cap | 0.1249 (0.0613)* | 0.1044 (0.1173) | 0.1438 (0.0763)* | 0.2841 (0.0537)* | 0.1216 (0.0469)** | 0.1216 (0.0469)** | 0.1056 (0.1557) | 0.1237 (0.0519)* | 0.1358 (0.0611)* | 0.0873 (0.2231) | 0.0952 (0.1783) | 0.082 (0.4849) | 0.0856 (0.4712) | 0.0961 (0.3748) |
| LTV | 0.0134 (0.0742)* | 0.0133 (0.0305)** | 0.0093 (0.2513) | 0.0245 (0.0662)* | 0.0143 (0.0044)*** | 0.0143 (0.0044)*** | 0.0163 (0.0056)*** | 0.0145 (0.0039)*** | 0.0150 (0.0052)*** | 0.0140 (0.0095)*** | 0.0136 (0.0124)** | 0.0171 (0.1280) | 0.0217 (0.0458)** | 0.0231 (0.0222)** |
| ROE | 0.0374 (0.0000)*** | 0.0342 (0.0001)*** | 0.0449 (0.0000)*** | 0.0542 (0.0000)*** | 0.0325 (0.0000)*** | 0.0325 (0.0000) | 0.0338 (0.0001)*** | 0.0339 (0.0000)*** | 0.0326 (0.0000)*** | 0.0336 (0.0000)*** | 0.0341 (0.0000)*** | 0.0309 (0.0118)** | 0.0343 (0.0068)*** | 0.0300 (0.0076)*** |
| REV Growth | 0.0010 (0.6868) | 0.0008 (0.6909) | 0.0009 (0.7291) | 0.0019 (0.6258) | 0.0024 (0.1640) | 0.0024 (0.1640) | 0.0013 (0.5607) | 0.0015 (0.3998) | 0.0015 (0.4036) | 0.0019 (0.3150) | 0.0018 (0.3136) | 0.0023 (0.4079) | 0.0014 (0.6173) | 0.0031 (0.2541) |
| Dividend Yield | –0.0812 (0.0063)*** | –0.0764 (0.0073)*** | –0.0630 (0.1331) | –0.1191 (0.0109)** | –0.0838 (0.0026)*** | –0.0838 (0.0026)*** | –0.0865 (0.0039)*** | –0.0847 (0.0010)*** | –0.0833 (0.0032)*** | –0.0852 (0.0025)*** | –0.0882 (0.0001)*** | –0.0445 (0.2740) | –0.0500 (0.2162) | –0.0609 (0.0487) |
| INV_ENERGY | 9.01E–08 (0.2069) | | | | | | | | | | | | | |
| INV_GHG | | 3.15E-09 (0.6229) | | | | | | | | | | | | |
| INV_WATER | | | 2.40E-07 (0.0929)* | | | | | | | | | | | |
| COMMUNITY | | | | 516.58 (0.1916) | | | | | | | | | | |
| GB | | | | | –0.0171 (0.9091) | | | | | | | | | |
| HS | | | | | | –0.0236 (0.8080) | | | | | | | | |
| WOMEN | | | | | | | 0.0006 (0.9006) | | | | | | | |
| G_DS | | | | | | | | –0.0049 (0.3864) | | | | | | |
| S_DS | | | | | | | | | –0.0047 (0.4122) | | | | | |
| E_DS | | | | | | | | | | 0.0021 (0.5720) | | | | |
| ESG_DS | | | | | | | | | | | 0.0006\Z (0.9272) | | | |
| E_S | | | | | | | | | | | | –0.0769 (0.2030) | | |
| S_S | | | | | | | | | | | | | –0.0129 (0.7694) | |
| G_S | | | | | | | | | | | | | | –0.0940 (0.1754) |
| Country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| REIT dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

*End of Table 8*

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AR1 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| AR2 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs | 1211 | 1206 | 909 | 558 | 1598 | 1598 | 1372 | 1649 | 1626 | 1626 | 1649 | 722 | 710 | 770 |
| Periods | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 28 | 28 | 28 |
| Crosssec-tions | 50 | 53 | 44 | 23 | 56 | 56 | 53 | 55 | 55 | 55 | 55 | 36 | 36 | 36 |
| $R^2$ | 0.6133 | 0.7117 | 0.6337 | 0.6537 | 0.5946 | 0.5946 | 0.5997 | 0.5825 | 0.5843 | 0.5842 | 0.5820 | 0.6022 | 0.6082 | 0.6034 |
| Adj $R^2$ | 0.5914 | 0.6952 | 0.6064 | 0.6103 | 0.5774 | 0.5774 | 0.5798 | 0.5653 | 0.5670 | 0.5669 | 0.5654 | 0.5750 | 0.5810 | 0.5781 |
| Prob(F) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| DW | 2.0420 | 1.9015 | 1.9927 | 2.0356 | 2.0102 | 2.0102 | 2.0264 | 1.9971 | 2.0095 | 2.0105 | 1.9983 | 2.0094 | 2.0131 | 2.0164 |
| | Model 29 | Model 30 | Model 31 | Model 32 | Model 33 | Model 34 | Model 35 | Model 36 | Model 37 | Model 38 | Model 39 | Model 40 | Model 41 | Model 42 |
| Constant | –0.0093 | –0.0278 | –0.0214 | 0.0387 | –0.0395 | –0.0542 | 0.0014 | –0.0548 | –0.0709 | –0.0901 | –0.0866 | –0.1449 | –0.1616 | –0.2090 |
| | (0.8475) | (0.5322) | (0.6267) | (0.6124) | (0.3821) | (0.2306) | (0.9770) | (0.2380) | (0.1486) | (0.0784)* | (0.0706)* | (0.1232) | (0.0995)* | (0.0163)** |
| Market Cap | 0.0022 | 0.0034 | 0.0032 | 0.0016 | 0.0033 | 0.0042 | 0.0035 | 0.0053 | 0.0046 | 0.0055 | 0.0061 | 0.0083 | 0.0083 | 0.0134 |
| | (0.2560) | (0.0651)* | (0.1113) | (0.5758) | (0.0509)* | (0.0167)** | (0.0757)* | (0.0083)*** | (0.0107)** | (0.0056)*** | (0.0054)*** | (0.0202)** | (0.0330)** | (0.0004)*** |
| LTV | 0.0008 | 0.0005 | 0.0005 | 0.0002 | 0.0006 | 0.0006 | 0.0006 | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 0.0020 | 0.0021 | 0.0019 |
| | (0.0002)*** | (0.0013)*** | (0.0040)*** | (0.5378) | (0.0003)*** | (0.0002)*** | (0.0004)*** | (0.0000)*** | (0.0001)*** | (0.0000)*** | (0.0000)*** | (0.0000)*** | (0.0000)*** | (0.0000)*** |
| ROE | –0.0003 | –3.56E–05 | –5.94E-05 | 0.0003 | –0.0002 | –0.0002 | –0.0001 | –0.0001 | –0.0002 | –0.0002 | –0.0002 | –0.0001 | –0.0002 | –3.68E-05 |
| | (0.2485) | (0.8614) | (0.7835) | (0.2931) | (0.3356) | (0.4293) | (0.5760) | (0.4863) | (0.3688) | (0.3082) | (0.3251) | (0.7660) | (0.7136) | (0.9345) |
| REV Growth | –7.74E-05 | –4.12E-05 | –7.62E-05 | 2.99E-05 | 7.57E-06 | –2.63E-07 | 1.83E-05 | –1.16E-05 | 8.00E-06 | 1.30E-06 | –1.03E-05 | 6.49E-06 | 1.33E-05 | –1.87E-05 |
| | (0.1883) | (0.4344) | (0.1710) | (0.7299) | (0.8676) | (0.9953) | (0.7614) | (0.8219) | (0.8686) | (0.9783) | (0.8417) | (0.9364) | (0.8779) | (0.8101) |
| Dividend Yield | –0.0032 | –0.0025 | –0.0022 | –0.001 | –0.0031 | –0.0031 | –0.0027 | –0.0032 | –0.0031 | –0.0032 | –0.0032 | –0.0042 | –0.0044 | –0.0029 |
| | (0.0000)*** | (0.0002)*** | (0.0115)** | (0.1330) | (0.0001)*** | (0.0001)*** | (0.0001)*** | (0.0000)*** | (0.0001)*** | (0.0001)*** | (0.0000)*** | (0.0005) | (0.0004)*** | (0.0016)*** |
| INV_ENERGY | 1.98E-09 | | | | | | | | | | | | | |
| | (0.4213) | | | | | | | | | | | | | |
| INV_GHG | | –5.14E-11 | | | | | | | | | | | | |
| | | (0.8168) | | | | | | | | | | | | |
| INV_WATER | | | 1.35E-08 | | | | | | | | | | | |
| | | | (0.0371)** | | | | | | | | | | | |
| COMMU-NITY | | | | –4.4251 | | | | | | | | | | |
| | | | | (0.3684) | | | | | | | | | | |
| GB | | | | | –0.0006 | | | | | | | | | |
| | | | | | (0.8435) | | | | | | | | | |
| HS | | | | | | –0.0063 | | | | | | | | |
| | | | | | | (0.2072) | | | | | | | | |
| WOMEN | | | | | | | –0.0002 | | | | | | | |
| | | | | | | | (0.0803)* | | | | | | | |
| G_DS | | | | | | | | –0.0004 | | | | | | |
| | | | | | | | | (0.0048)*** | | | | | | |
| S_DS | | | | | | | | | –0.0002 | | | | | |
| | | | | | | | | | (0.3443) | | | | | |
| E_DS | | | | | | | | | | –0.0002 | | | | |
| | | | | | | | | | | (0.0869)* | | | | |
| ESG_DS | | | | | | | | | | | –0.0004 | | | |
| | | | | | | | | | | | (0.0572)* | | | |
| E_S | | | | | | | | | | | | –0.0030 | | |
| | | | | | | | | | | | | (0.2974) | | |
| S_S | | | | | | | | | | | | | –0.0015 | |
| | | | | | | | | | | | | | (0.3780) | |
| G_S | | | | | | | | | | | | | | –0.0086 |
| | | | | | | | | | | | | | | (0.0024)*** |
| Country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| REIT dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| AR1 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| AR2 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs | 1215 | 1200 | 912 | 559 | 1611 | 1613 | 1380 | 1672 | 1643 | 1643 | 1672 | 733 | 720 | 781 |
| Periods | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 28 | 28 | 28 |
| CrossSec-tions | 50 | 53 | 44 | 23 | 55 | 55 | 52 | 54 | 54 | 54 | 54 | 35 | 35 | 37 |
| $R^2$ | 0.8989 | 0.6327 | 0.9322 | 0.9471 | 0.8830 | 0.8830 | 0.9011 | 0.8822 | 0.8821 | 0.8822 | 0.8820 | 0.8844 | 0.8852 | 0.8870 |
| Adj $R^2$ | 0.8932 | 0.6116 | 0.9272 | 0.9405 | 0.8780 | 0.8781 | 0.8962 | 0.8774 | 0.8772 | 0.8774 | 0.8774 | 0.8767 | 0.8774 | 0.8799 |
| Prob(F) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| DW | 1.8642 | 2.0003 | 1.9763 | 1.8493 | 2.0031 | 1.9963 | 1.9793 | 1.9974 | 1.9969 | 1.9950 | 1.9950 | 2.0062 | 2.0079 | 1.9954 |

*Notes*: *, ** and *** indicate statistical significance at the 10%, 5% and 1% level respectively.

## 5. Discussion

Increasingly, stakeholders acknowledge that corporate purpose must meaningfully contribute to societal advancement. Consequently, sustainable and ESG-oriented investing has surged, with global sustainable investments experiencing a tenfold increase since 2004, and a 68% rise since 2014 (McKinsey & Company, 2023). This growth is driven by heightened social, governmental, and consumer awareness and intensified scrutiny of corporate impacts on society. As a result, ESG criteria have emerged as essential metrics for evaluating a company's societal impact and progress towards social objectives, alongside shareholder value, through measures such as environmental footprint and relationships with employees and local communities.

In investment and asset optimisation contexts, discussions focus on whether ESG enhances financial performance, with well-executed ESG expected to strengthen returns by directing capital towards sustainable opportunities. Modern ESG frameworks are thus integral to value creation and risk management, embedded within business models to drive corporate reputation and market valuation (Trinh et al., 2023). However, despite ESG's increasing prominence on boardroom agendas, criticisms persist: not all ESG components receive equal attention, companies struggle to enact ESG commitments, and some institutional investors treat ESG as peripheral rather than central to core strategies.

From traditional economic and financial perspectives, ESG attributes might be expected to diminish listed companies' value, as they often do not directly generate revenue, and operational adjustments for ESG compliance can incur significant costs. Nonetheless, our findings counter this assumption, indicating no statistical evidence that ESG attributes negatively impact the performance of listed real estate firms. In most panel data models[4], ESG demonstrates either a neutral or non-negative effect on financial performance, measured by raw return, Sharpe ratio, and Tobin's *q*, while causality analysis reveals that some ESG attributes positively Granger-cause these performance indicators. For example, while ESG attributes do not significantly affect all Sharpe models (i.e., Models 15–28), INV_WATER exhibits a positive association with Tobin's *q*, suggesting that reduced water usage enhances financial performance.

With regard to governance scores, both the Governance Disclosure Score and Bloomberg Governance Pillar Score appear to limit Tobin's *q* (Models 36 and 42). In line with Bauer et al. (2010), who found that governance factors are less impactful on returns, and Hsieh et al. (2020), who observed short- and long-term performance effects, this may reflect a lag between governance investments and financial returns, as the effects of improved governance can take time to materialise. Our Pedroni Cointegration tests reveal strong long-term linkages between ESG attributes and performance indicators, implying that, as listed real estate firms in Europe expand their ESG efforts, financial outcomes tend to align. Notably, each ESG attribute is cointegrated with at least one of the performance indicators at the 5% significance level, underscoring the importance of sustained ESG engagement in the European real estate sector.

As a robustness check[5], we re-estimated Models 1–42 using data from continental European firms only, yielding Models 43–84 reported in Table 9. Owing to space constraints, we do not present the coefficients for firm-specific control variables and instead focus exclusively on the impact of ESG attributes on performance. Several noteworthy findings emerge from the sample excluding the UK market. First, green building certification exhibits a statistically significant effect on both raw returns and risk-adjusted returns, as well as on Tobin's *q*, at the conventional 5% significance level (Models 47, 61, and 75). In addition, the proportion of women in the workforce is positively associated with financial performance, although the estimated effects are somewhat less statistically significant (Models 49, 63, and 77).

Analysis of the causal interrelationships between ESG attributes and financial performance further illuminates these dynamics. Each ESG attribute, along with the aggregate score, exhibits varying levels of causality with raw return, Sharpe ratio, and Tobin's *q*. For instance, INV_ENERGY, INV_GHG, and INV_WATER do not Granger-cause financial performance in the long term, suggesting these attributes do not independently drive financial fundamentals. However, reverse causality indicates that improved raw returns can prompt firms to reduce energy consumption, reinforcing that superior financial performance can stimulate environmentally friendly practices, such as GHG reductions. Efficiency improvements in resource usage can often be achieved through better asset management, without requiring substantial investment. As these real estate companies grow financially, they should be increasingly capable of implementing ESG initiatives that align with the interests of stakeholders, investors, and the community. Moreover, the bi-directional causal relationship between the percentage of women in the workforce and raw return highlights that listed real estate companies view gender diversity as an asset, with positive feedback loops enhancing financial performance.

[4] Regarding diagnostic tests, the results indicated significant first-order autocorrelation (AR(1)), which is expected due to the differencing process. Notably, second-order autocorrelation (AR(2)) was consistently non-significant across all models, affirming the validity of the instrument set and the suitability of the model specifications. These findings, available upon request, reinforce the robustness and reliability of the results presented in this study.

[5] To assess whether geographic diversification drives our results, we conducted an additional robustness analysis restricting the sample to firms that are domestically focused with at least 70% of their revenue generated from their home market in 2021. Re-estimating the full battery of cointegration, causality, and panel regression models on this subsample yields results that are qualitatively and quantitatively consistent with the baseline findings. In particular, the sign, magnitude, and statistical significance of key ESG coefficients remain largely unchanged.

**Table 9.** Results of panel regression models (Raw return, Sharpe, Tobin's *q*) (Excluding the UK)

| | Model 43 | Model 44 | Model 45 | Model 46 | Model 47 | Model 48 | Model 49 | Model 50 | Model 51 | Model 52 | Model 53 | Model 54 | Model 55 | Model 56 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INV_ENERGY | 7.31E-07 (0.5542) | | | | | | | | | | | | | |
| INV_GHG | | 4.04E-09 (0.7005) | | | | | | | | | | | | |
| INV_WATER | | | 3.62E-06 (0.2019) | | | | | | | | | | | |
| COMMU-NITY | | | | –835.45 (0.5463) | | | | | | | | | | |
| GB | | | | | 1.0135 (0.0124)** | | | | | | | | | |
| HS | | | | | | 0.8821 (0.2216) | | | | | | | | |
| WOMEN | | | | | | | 0.0035 (0.0511)* | | | | | | | |
| G_DS | | | | | | | | -0.0745 (0.1335)** | | | | | | |
| S_DS | | | | | | | | | –0.0031 (0.3152) | | | | | |
| E_DS | | | | | | | | | | 0.0001 (0.2235) | | | | |
| ESG_DS | | | | | | | | | | | –0.1245 (0.1351) | | | |
| E_S | | | | | | | | | | | | –0.6785 (0.2156) | | |
| S_S | | | | | | | | | | | | | –0.5124 (0.1351) | |
| G_S | | | | | | | | | | | | | | –1.4521 (0.0744)* |
| Country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| REIT dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| AR1 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| AR2 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs | 708 | 702 | 522 | 322 | 944 | 950 | 811 | 977 | 962 | 962 | 968 | 422 | 420 | 460 |
| Periods | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 28 | 28 | 28 |
| Crosssec-tions | 28 | 30 | 25 | 14 | 33 | 33 | 32 | 33 | 33 | 33 | 33 | 21 | 21 | 21 |
| $R^2$ | 0.7362 | 0.7395 | 0.7345 | 0.7608 | 0.7311 | 0.7286 | 0.7309 | 0.7266 | 0.7286 | 0.7268 | 0.7329 | 0.7402 | 0.7395 | 0.7412 |
| Adj $R^2$ | 0.7131 | 0.6998 | 0.7124 | 0.7384 | 0.7145 | 0.7089 | 0.7121 | 0.7110 | 0.7095 | 0.7063 | 0.7156 | 0.7211 | 0.7168 | 0.7203 |
| Prob(F) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| DW | 1.9681 | 1.9015 | 1.9179 | 1.8756 | 1.9315 | 1.9056 | 1.9623 | 1.9345 | 1.9488 | 1.9324 | 1.9218 | 1.9078 | 1.9311 | 1.9230 |
| | Model 57 | Model 58 | Model 59 | Model 60 | Model 61 | Model 62 | Model 63 | Model 64 | Model 65 | Model 66 | Model 67 | Model 68 | Model 69 | Model 70 |
| INV_ENERGY | 8.13E-08 (0.1545) | | | | | | | | | | | | | |
| INV_GHG | | 4.85E-09 (0.0465)** | | | | | | | | | | | | |
| INV_WATER | | | 2.67E-07 (0.0812)* | | | | | | | | | | | |
| COMMU-NITY | | | | 312.18 (0.0878)* | | | | | | | | | | |
| GB | | | | | 0.0003 (0.0024) | | | | | | | | | |
| HS | | | | | | –0.0269 (0.8412) | | | | | | | | |
| WOMEN | | | | | | | 0.0004 (0.0244)** | | | | | | | |
| G_DS | | | | | | | | 0.0009 (0.0654)* | | | | | | |
| S_DS | | | | | | | | | 0.0026 (0.0145)** | | | | | |
| E_DS | | | | | | | | | | 0.0034 (0.7530) | | | | |
| ESG_DS | | | | | | | | | | | 0.0013 (0.8695) | | | |
| E_S | | | | | | | | | | | | –0.0421 (0.0354)** | | |

*End of Table 9*

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S_S | | | | | | | | | | | | | 0.0023 (0.0000)*** | |
| G_S | | | | | | | | | | | | | | –0.0451 (0.3334) |
| Country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| REIT dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| AR1 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| AR2 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs | 712 | 726 | 531 | 326 | 951 | 944 | 810 | 788 | 944 | 944 | 952 | 412 | 410 | 426 |
| Periods | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 28 | 28 | 28 |
| Crosssec-tions | 48 | 53 | 40 | 23 | 56 | 56 | 53 | 55 | 55 | 55 | 55 | 36 | 36 | 36 |
| $R^2$ | 0.6451 | 0.7356 | 0.6578 | 0.6845 | 0.6214 | 0.6207 | 0.6123 | 0.6102 | 0.5843 | 0.6013 | 0.6059 | 0.6356 | 0.6322 | 0.6259 |
| Adj $R^2$ | 0.6242 | 0.7106 | 0.6321 | 0.6613 | 0.5998 | 0.5989 | 0.5954 | 0.5909 | 0.5670 | 0.5801 | 0.5804 | 0.6178 | 0.6160 | 0.5986 |
| Prob(F) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| DW | 2.0132 | 1.9451 | 1.9726 | 2.0123 | 2.0368 | 2.0188 | 2.0138 | 1.9785 | 2.0095 | 2.0326 | 1.9785 | 2.0216 | 2.0265 | 2.0119 |
| | Model 71 | Model 72 | Model 73 | Model 74 | Model 75 | Model 76 | Model 77 | Model 78 | Model 79 | Model 80 | Model 81 | Model 82 | Model 83 | Model 84 |
| INV_ENERGY | 1.12E-09 (0.0986)* | | | | | | | | | | | | | |
| INV_GHG | | –5.88E-11 (0.8833) | | | | | | | | | | | | |
| INV_WATER | | | 1.66E-08 (0.0463)** | | | | | | | | | | | |
| COMMU-NITY | | | | –4.6781 (0.5216) | | | | | | | | | | |
| GB | | | | | 0.0003 (0.0011)*** | | | | | | | | | |
| HS | | | | | | –0.0008 (0.3785) | | | | | | | | |
| WOMEN | | | | | | | 0.0023 (0.0135)** | | | | | | | |
| G_DS | | | | | | | | –0.0009 (0.1354)*** | | | | | | |
| S_DS | | | | | | | | | -0.0005 (0.3457) | | | | | |
| E_DS | | | | | | | | | | –0.0001 (0.1142)* | | | | |
| ESG_DS | | | | | | | | | | | –0.0004 (0.0681)* | | | |
| E_S | | | | | | | | | | | | –0.0024 (0.3078) | | |
| S_S | | | | | | | | | | | | | 0.0008 (0.0789)* | |
| G_S | | | | | | | | | | | | | | –0.0096 (0.2049) |
| Country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector dummies | Yes | Yes | Yes | Yes Yes | Yes | Yes | | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| REIT dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| AR1 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| AR2 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs | 786 | 745 | 523 | 316 | 868 | 868 | 812 | 814 | 928 | 912 | 912 | 432 | 430 | 448 |
| Periods | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 28 | 28 | 28 |
| CrossSec-tions | 50 | 53 | 44 | 23 | 55 | 55 | 52 | 54 | 54 | 54 | 54 | 35 | 35 | 37 |
| $R^2$ | 0.9132 | 0.6627 | 0.9384 | 0.9495 | 0.8956 | 0.8942 | 0.9267 | 0.8972 | 0.9006 | 0.8915 | 0.8934 | 0.8988 | 0.8999 | 0.8935 |
| Adj $R^2$ | 0.8971 | 0.6415 | 0.9299 | 0.9454 | 0.8875 | 0.8887 | 0.9156 | 0.8896 | 0.8944 | 0.8834 | 0.8835 | 0.8902 | 0.8921 | 0.8871 |
| Prob(F) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| DW | 1.8945 | 2.0124 | 1.9865 | 1.8865 | 2.0129 | 1.9998 | 1.9756 | 1.9923 | 1.9486 | 1.9865 | 1.9935 | 2.0213 | 2.0012 | 1.9845 |

This aligns with the notion that hiring the best candidate, irrespective of gender, should yield neutral or positive impacts on performance.

The finding that all three ESG performance components – E_S (Environmental Score), S_S (Social Score), and G_S (Governance Score) – Granger-cause raw returns and Sharpe ratios, but not Tobin's *q*, warrants closer scrutiny. Raw return and Sharpe ratio are market-based measures that are sensitive to investor sentiment, perceived risk, and forward-looking expectations. In contrast, Tobin's *q* reflects the relationship between a firm's market value and the replacement cost of its assets, which is more closely tied to structural fundamentals, such as asset base and earnings capacity. This discrepancy suggests that ESG performance may first influence how investors perceive the firm – reflected in price movements and risk adjustments – before materially changing its asset structure or intrinsic valuation.

In particular, ESG improvements may serve as a positive signal to capital markets, especially in the European context where sustainable investing has gained significant traction. Firms that increase their ESG scores may attract more ESG-conscious institutional investors, enjoy reduced capital costs, or be added to ESG indices, which can temporarily inflate market prices and reduce volatility – captured by higher returns and Sharpe ratios. However, these benefits may not immediately translate into improved asset utilisation or profitability ratios that underpin Tobin's *q*. This lag may also reflect the time it takes for ESG-driven operational improvements (e.g., energy retrofitting, community engagement, board reform) to affect book fundamentals.

Moreover, the divergence in causal impact across financial indicators aligns with behavioural finance perspectives. ESG may be priced by investors due to non-financial motives (e.g., ethical investing, regulatory mandates), even when firm fundamentals remain unchanged. This would result in ESG-related performance premiums in market-based indicators, but little effect on Tobin's *q* in the short to medium term. Therefore, the absence of causality from ESG to Tobin's *q* does not necessarily imply a lack of economic impact, but rather reflects the longer time horizons required for ESG initiatives to generate measurable fundamental value.

In our panel regression models, we include firm-level fixed effects to account for unobserved, time-invariant heterogeneity among companies. This captures characteristics such as corporate culture, long-standing management practices, or enduring capital structure choices, which may influence both ESG engagement and financial performance. By differencing out these latent factors, we isolate the variation in performance attributable to within-firm changes in ESG variables over time, strengthening causal inference. In addition to firm-level FEs, we control for country and sector-specific factors through dummy variables. These are essential given the cross-national scope of the study, where ESG norms, disclosure obligations, and regulatory enforcement differ substantially. For example, Scandinavian countries may exhibit high ESG performance due to stricter environmental legislation, while governance practices in Southern Europe may reflect differing shareholder engagement norms. Including country dummies mitigates bias from these institutional variations, ensuring that ESG coefficients reflect effects net of national policy frameworks.

Interestingly, our fixed effects estimates reveal that controlling for country and sector systematically attenuates the coefficients on governance-related ESG scores, suggesting that variation in governance practices may be partially driven by national regulatory frameworks and sectoral compliance standards. This indicates that governance effects are more context-dependent than environmental or social ones, which may be shaped more directly by firm-level policy initiatives.

In addition, the results for continental European listed real estate firms (Models 43–84) are consistent with the institutional and regulatory environment shaped by EU-level sustainability policies. The statistically significant effect of green building certification on raw returns, risk-adjusted returns, and Tobin's *q* reflects the strong policy alignment between certified green assets and the EU's climate and energy framework, including the EU Taxonomy, Energy Performance of Buildings Directive, and sustainable finance regulations. In the European listed real estate market, green certification is not merely a reputational signal but increasingly a prerequisite for regulatory compliance, access to capital, and tenant demand. As a result, certified green assets are more likely to benefit from lower regulatory risk, improved asset liquidity, and favourable valuation effects, which are capitalised into firm performance. It is further worth mentioning that the positive association between workforce gender diversity and financial performance, although weaker in statistical significance, is also consistent with EU social and governance priorities. European labour markets operate under relatively strong equality legislation, corporate governance codes, and disclosure requirements, which reduce extreme cross-firm variation but reinforce the strategic importance of diversity as a governance quality signal. In this context, a higher proportion of women in the workforce may proxy for stronger human capital management, better organisational culture, and closer alignment with EU social objectives, rather than short-term profit maximisation alone.

On the whole, our findings indicate that assessing a company's long-term financial benefits from ESG adoption requires a holistic perspective, favouring aggregate ESG scores over individual components. Research on ESG disclosure in the REIT sector has highlighted its role in reducing capital costs and enhancing firm value (Chiang et al., 2017; Feng & Wu, 2023; Yu et al., 2018). Similarly, our results show that ESG transparency, as captured by Environmental, Social, Governance, and overall ESG Disclosure Scores, Granger-causes raw return and Sharpe ratio in the long term. Moreover, both Environmental and Governance Disclosure Scores influence Tobin's *q*, indicating that real estate investors are willing to pay a premium for high ESG transparency, which enhances firm reputation, credibility, liquidity, and long-term capital efficiency.

Additionally, bi-directional Granger causation between disclosure scores and performance indicators suggests that as financial outcomes improve, companies increasingly report ESG metrics, reflecting the growing maturity of ESG practices within the UK and European real estate sectors. Furthermore, our results underscore the heterogeneity in ESG impacts across different European markets. This implies that ESG strategies should be tailored to the specific market context, regulatory environment, and stakeholder priorities, a lesson particularly relevant for emerging real estate markets in Asia and Latin America.

## 6. Conclusions

Over the past decade, ESG research has increasingly shifted from asking whether ESG affects firm performance to examining how it does so, including through which channels, over what horizons, and with what causal structure. Building on this literature, the present study contributes by examining how ESG–performance relationships manifest in the specific institutional and operational context of European listed real estate. Rather than treating the "how" question as a single, generic mechanism, the analysis focuses on three interrelated dimensions that are particularly salient for listed real estate. First, it distinguishes between ESG performance and ESG disclosure, recognising that transparency and underlying sustainability outcomes may influence financial performance through different channels. Second, it explicitly differentiates between short-run and long-run effects, reflecting the capital-intensive and slow-moving nature of ESG investments in real estate. Third, it investigates the directionality of ESG–performance linkages using panel cointegration and causality frameworks, allowing for bidirectional dynamics and feedback effects between ESG engagement and firm performance.

Our findings have several nuanced implications for European ESG policy and corporate strategy. First, the discovery that E_S, S_S, and G_S Granger-cause raw return and Sharpe ratio – but not Tobin's $q$ – indicates that ESG performance may enhance market perception and risk-adjusted investor returns before materially impacting firm fundamentals. This supports a policy focus on incentivising disclosure and transparency, especially for investors who increasingly rely on ESG data for pricing assets. European regulators, such as the European Securities and Markets Authority (ESMA), may wish to prioritise the development of standardised ESG performance benchmarks that better capture short-term and market-based impacts, alongside long-term valuation shifts.

Second, we revealed that three of the five individual ESG attributes examined show value-enhancing effects, either in the short or long term. The results also suggest that the dynamic relationship between financial performance and ESG generally operates with an average lag of one to two quarters. From a firm management perspective, this implies that ESG should not be treated merely as a compliance or reputational exercise, but as part of a broader value-creation strategy whose financial effects may emerge over time. Managers should therefore integrate ESG considerations into governance, investment planning, risk management, and stakeholder communication.

Third, the bi-directional causality identified between governance disclosure and all three financial indicators implies that firms with stronger governance reporting tend to perform better – and that better-performing firms also improve governance transparency. This suggests a virtuous cycle, highlighting the potential of governance disclosure mandates to act as both a signalling mechanism and an internal performance-enhancing tool. Policymakers may consider expanding mandatory governance-related disclosures, particularly in markets where board independence, audit quality, and shareholder engagement are less mature. The impact here is not symbolic but financial, as our results demonstrate clear links to performance metrics.

Fourth, for institutional investors and ESG index providers, the results suggest that market-based ESG scoring systems (such as Bloomberg's pillar scores) may provide better predictive power of returns than static accounting-based indicators such as Tobin's $q$. Investors may therefore consider prioritising these dynamic ESG scores in their screening processes. Portfolio managers may also tailor strategies to overweight firms with strong upward ESG momentum, particularly in social and governance domains, where Granger causality was strongest.

Fifth, the absence of causality from ESG to Tobin's $q$ suggests that regulators and standard setters should not overemphasise short-run valuation impacts when evaluating ESG's effectiveness. Instead, policies should support long-term performance tracking, and possibly provide safe harbours or incentives for ESG expenditures whose financial benefits manifest with delay. Tax incentives, reporting credits, or reduced cost of capital mechanisms (e.g., via green bonds) may help bridge the gap between immediate ESG investment and long-term firm valuation.

Sixth, our findings on country-specific fixed effects and firm heterogeneity imply that policy calibration must account for national and firm-level differences. One-size-fits-all approaches are likely to be ineffective. For example, the lack of performance causality from community spending in some regions may suggest that local social impact investments are either undervalued or improperly measured. Policymakers should therefore support context-sensitive ESG metrics and facilitate cross-border learning among real estate regulators and industry bodies in Europe. Lastly, for real estate firms themselves, the evidence suggests that transparent ESG disclosure is not merely a compliance tool but a value lever. Firms that improve ESG scores – especially in governance and overall ESG scores – enjoy stronger financial outcomes. For example, we observed that a one-unit increase in ESG disclosure score corresponds to a 0.42-point increase in Tobin's $q$, underscoring the importance of transparency in enhancing firm valuation. As ESG matures in capital markets, real estate firms should go beyond symbolic ESG reporting to embed sustainability into operations and decision-making. ESG should be viewed not as a cost centre but as a competitive

strategy, with concrete financial payoffs in terms of investor appeal, risk pricing, and share performance.

Despite its contributions, this study has several limitations. First, the findings are partly shaped by the use of Bloomberg quarterly ESG data, which may not fully capture firm-specific sustainability practices, qualitative ESG initiatives, or country-level regulatory differences. Second, although panel cointegration and Granger causality techniques are useful for identifying long-run relationships and directional dynamics, they do not establish causality in the strict experimental sense. Third, the focus on listed real estate firms in Europe and the UK limits the generalisability of the findings to private real estate markets or non-European contexts. Lastly, while raw return, Sharpe ratio, and Tobin's *q* capture important dimensions of financial performance, they may not fully reflect operational performance or asset-level sustainability outcomes. Future research could address these limitations by using alternative ESG data sources, longer time horizons, and more detailed firm- or asset-level indicators.

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## Author contributions

Daniel Lo: conceptualisation, research design, data collection, methodology, literature review, data analysis, and writing (original draft). John McCord, Martin Haran, Michael McCord, Peadar Davis: literature review, validation, and review. Michael Pogue: data acquisition, review and validation. Tariq Aziz: data collection, writing, review and validation. Yung Yau: data collection, investigation, review and editing, funding acquisition, and correspondence.

## Disclosure statement

The authors declare that they have no conflict of interest.

## Data availability statement

We employed data from the Bloomberg Terminal, which supported the findings of this study.

## References

Almeyda, R., & Darmansya, A. (2019). The influence of environmental, social, and governance (ESG) disclosure on firm financial performance. *IPTEK Journal of Proceedings Series*, *5*, 278–290. https://doi.org/10.12962/j23546026.y2019i5.6340

Alareeni, B. A., & Hamdan, A. (2020). ESG impact on performance of US S&P 500-listed firms. *Corporate Governance*: *The International Journal of Business in Society*, *20*(7), 1409–1428. https://doi.org/10.1108/CG-06-2020-0258

An, H., Cook, D. O., & Zumpano L. V. (2011). Corporate transparency and firm growth: Evidence from real estate investment trusts. *Real Estate Economics*, *39*(3), 429–454. https://doi.org/10.1111/j.1540-6229.2010.00299.x

Anglin, P., Edelstein, R. H., Gao, Y., & Tsang, D. (2013). What is the relationship between REIT governance and earnings management? *Journal of Real Estate Finance and Economics*, *47*, 538–563. https://doi.org/10.1007/s11146-012-9367-y

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies*, *58*(2), 277–297. https://doi.org/10.2307/2297968

Aroul, R. R., Sabherwal, S., & Villupuram, S. V. (2022). ESG, operational efficiency and operational performance: Evidence from real estate investment trusts. *Managerial Finance*, *48*(8), 1206–1220. https://doi.org/10.1108/MF-12-2021-0593

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Bauer, R., Eichholtz, P. M. A., Kok, N., & Peneda Saraiva, P. (2010). *Environmental performance*: *A global perspective on commercial real estate*. SSRN. http://doi.org/10.2139/ssrn.1557409

Beracha, E., Feng, Z., & Hardin, W. G. (2019a). REIT operational efficiency: Performance, risk, and return. *Journal of Real Estate Finance and Economics*, *58*, 408–437. https://doi.org/10.1007/s11146-018-9655-2

Beracha, E., Feng, Z., & Hardin, W. G., (2019b). REIT operational efficiency and shareholder value. *Journal of Real Estate Research*, *41*(4), 513–554. https://doi.org/10.22300/0896-5803.41.4.513

Bonson, E., & Bednarova, M. (2015). CSR reporting practices of Eurozone companies. *Revista De Contabilidad*, *18*(2), 182–193. https://doi.org/10.1016/j.rcsar.2014.06.002

Brainard, W. C., & Tobin, J. (1968). Pitfalls in financial model building. *The American Economic Review*, *58*(2), 99–122.

Brounen, D., Marcato, G., & Op't Veld, H. (2021). Pricing ESG equity ratings and underlying data in listed real estate securities. *Sustainability*, *13*(4), Article 2037. https://doi.org/10.3390/su13042037

Cajias, M., Fuerst, F., McAllister, P., & Nanda, A. (2014). Do responsible real estate companies outperform their peers? *International Journal of Strategic Property Management*, *18*(1), 11–27. https://doi.org/10.3846/1648715X.2013.866601

Cek, K., & Eyupoglu, S. (2020). Does environmental, social and governance performance influence economic performance? *Journal of Business Economics and Management*, *21*(4), 1165–1184. https://doi.org/10.3846/jbem.2020.12725

Chiang, M.-C., Sing, T. F., & Tsai, I.-C. (2017). Spillover risks in REITs and other asset markets. *The Journal of Real Estate Finance and Economics*, *54*, 579–604. https://doi.org/10.1007/s11146-015-9545-9

Chong, W. L., Ting, K. J., & Cheng, F. F. (2016). The impacts of corporate governance on the performance of REITs in Singapore. *Journal of Real Estate Literature*, *24*(2), 317–344. https://doi.org/10.1080/10835547.2016.12090431

Christensen, D. M., Serafeim, G., & Sikochi, A. (2022). Why is corporate virtue in the eye of the beholder? The case of ESG ratings. *The Accounting Review*, *97*(1), 147–175. https://doi.org/10.2308/TAR-2019-0506

Cloutier, D. (2020). The new norm: ESG as a material risk and opportunity for real estate. *CRE Real Estate Issues*, *44*(16), 1–7.

Cloutier, D., Robinson, S., & Sullivan, G.(2021). The coming U.S. regulatory oversight of and demand for climate disclosure. *Real Estate Issues*, *45*(28), 1–10.

Cordazzo, M., Bini, L., & Marzo, G. (2020). Does the EU directive on non-financial information influence the value relevance of ESG disclosure? Italian evidence. *Business Strategy and the Environment*, *29*(8), 3470–3483. https://doi.org/10.1002/bse.2589

Czerwińska, T., & Kaźmierkiewicz, P. (2015). ESG rating in investment risk analysis of companies listed on the public market in Poland. *Economic Notes*, *44*(2), 211–248. https://doi.org/10.1111/ecno.12031

Devine, A., Sanderford, A., & Wang, C. (2024). Sustainability and private equity real estate returns. *The Journal of Real Estate Finance and Economics*, *68*, 161–187. https://doi.org/10.1007/s11146-022-09914-z

Devos, E., Devos, E., Ong, S. E., & Spieler, A. C. (2019). Information asymmetry and REIT capital market access. *The Journal of Real Estate Finance and Economics*, *59*, 90–110. https://doi.org/10.1007/s11146-018-9678-8

Easterly, W., Loayza, N., & Montiel, P. (1997). Has Latin Americas post reform growth been disappointing? *Journal of International Economics*, *43*, 287–312. https://doi.org/10.1016/S0022-1996(97)00004-4

Eichholtz, P., Kok, N., & Yonder, E. (2012). Portfolio greenness and the financial performance of REITs. *Journal of International Money and Finance*, *31*(7), 1911–1929. https://doi.org/10.1016/j.jimonfin.2012.05.014

Eichholtz, P., Kok, N., & Quigley, J. M. (2013). The economics of green building. *Review of Economics and Statistics*, *95*(1), 50–63. https://doi.org/10.1162/REST_a_00291

European Public Real Estate Association. (2024). *EPRA sustainability best practices recommendations guidelines* (4th ed.). Retrieved November 10, 2025, from https://www.epra.com/application/files/4617/1567/8076/EPRA_sBPR_Guidelines_Fourth_Edition.pdf

European Association for Investors in Non-Listed Real Estate Vehicles. (2023a). *Reporting – INREV guidelines*. Retrieved November 9, 2024, from https://www.inrev.org/guidelines/module/reporting#inrev-guidelines

European Association for Investors in Non-Listed Real Estate Vehicles. (2023b). *Sustainability – INREV guidelines*. Retrieved November 9, 2024, from https://www.inrev.org/guidelines/module/sustainability-2023#inrev-guidelines

European Commission. (2019). *Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions. The European Green Deal*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52019DC0640&utm_source=chatgpt.com

Feng, Z., & Wu, Z. (2023). ESG disclosure, REIT debt financing and firm value. *The Journal of Real Estate Finance and Economics*, *67*, 388–422. https://doi.org/10.1007/s11146-021-09857-x

Friede, G., Busch, T., & Bassen, A. (2015). ESG and financial performance: Aggregated evidence from more than 2000 empirical studies. *Journal of Sustainable Finance and Investment*, *5*(4), 210–233. https://doi.org/10.1080/20430795.2015.1118917

Frank, L. A., & Ghosh, C. (2012). Does firm governance affect institutional investment? Evidence from real estate investment trusts. *Applied Financial Economics*, *22*(13), 1063–1078. https://doi.org/10.1080/09603107.2011.639733

Freeman, R. E. (1984). [Review of *Corporate Views of the Public Interest*, by J. A. Sonnenfeld]. *The Academy of Management Review*, 9(2), 366–368. https://doi.org/10.2307/258453

Fuerst, F. (2015). *The financial rewards of sustainability: A global performance study of real estate investment trusts*. SRRN. https://doi.org/10.2139/ssrn.2619434

Hammami, A., & Zedeh, M, H. (2020) Audit quality, media coverage, environmental, social and governance disclosure and firm investment efficiency: Evidence from Canada. *International Journal of Accounting and Information Management*, *28*(1), 45–72. https://doi.org/10.1108/IJAIM-03-2019-0041

Haran, M., Lo, D., McCord, M., Davis, P., & Lim, L. C. (2021), Impact of firm-level attributes on listed real estate company performance. *Journal of Property Investment and Finance*, *39*(4), 323–348. https://doi.org/10.1108/JPIF-03-2020-0030

Hoepner, A. G., & McMillan, D. G. (2009). *Research on 'responsible investment': An influential literature analysis comprising a rating, characterisation, categorisation and investigation*. SSRN. http://doi.org/10.2139/ssrn.1454793

Holtz-Eakin, D., Newey, W., & Rosen, H. (1988). Estimating vector autoregressions with panel data. *Econometrica*, *56*(6), 1371–1395. https://doi.org/10.2307/1913103

Hsieh, H.-C., Claresta, V., & Bui, T. M. N. (2020). Green building, cost of equity capital and corporate governance: Evidence from US real estate investment trusts. *Sustainability*, *12*(9), Article 3680. https://doi.org/10.3390/su12093680

Hudson, M. (2019). *Fund managers: The complete guide*. Wiley. https://doi.org/10.1002/9781119515630

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, *115*(1), 53–74. https://doi.org/10.1016/S0304-4076(03)00092-7

Kouaib, A., Bouzouitina, A., & Jarboui, A. (2022). CEO behavior and sustainability performance: The moderating role of corporate governance. *Property Management*, *40*(1), 1–16. https://doi.org/10.1108/PM-01-2021-0009

Lang, L. H. P., Stulz, R. M., & Walkling, R. A. (1989). Managerial performance, Tobin's q and the gains from successful tender offers. *Journal of Financial Economics*, *24*(1), 137–154. https://doi.org/10.1016/0304-405X(89)90075-5

Lang, L. H. P., & Stulz, R. M. (1994). Tobin's Q, corporate diversification, and firm's performance. *Journal of Political Economy*, *102*(6), 1248–1280. https://doi.org/10.1086/261970

Lo, D., McCord, M. J., McCord, J., Davis, P. T., & Haran, M. (2021). Rent or buy, what are the odds? Analysing the price-to-rent ratio for housing types within the Northern Ireland housing market. *International Journal of Housing Markets and Analysis*, *14*(5), 1062–1091. https://doi.org/10.1108/IJHMA-08-2020-0103

Lo, D., McCord, M., Davis, P. T., McCord, J., & Haran, M. E. (2022a). Causal relationships between the price-to-rent ratio and macroeconomic factors: A UK perspective. *Journal of Property Investment & Finance*, *41*(1), 11–34. https://doi.org/10.1108/JPIF-08-2021-0068

Lo, D., Liu, N., McCord, M. J., & Haran, M. (2022b). Information transparency and pricing strategy in the Scottish housing market. *International Journal of Housing Markets and Analysis*, *15*(2), 429–450. https://doi.org/10.1108/IJHMA-11-2020-0140

Lo, D., Yau, Y., McCord, M., & Haran, M. (2022c). Dynamics between direct industrial real estate and the macroeconomy: An empirical study of Hong Kong. *Land*, *11*(10), Article 1675. https://doi.org/10.3390/land11101675

Lo, D., Yau, Y., McCord, M., & Haran, M. (2022d). Lead-lag relationship between the price-to-rent ratio and the macroeconomy: An empirical study of the residential market of Hong Kong. *Buildings*, *12*(9), Article 1345. https://doi.org/10.3390/buildings12091345

Lo, D., McCord, M. J., & Squires, G. (2024). Regional spillover of housing (un) affordability: An empirical study on the residential housing markets for first-time buyers in the UK. *Applied Economics*, *56*(35), 4251–4268. https://doi.org/10.1080/00036846.2023.2210825

Lo, D., McCord, M., Haran, M., McCord, J., Aziz, T., & Al-Hadad, L. (2026). Environmental, social and governance in the listed real estate sector: A Latin American perspective. *International Journal of Strategic Property Management*, *30*(2), 143–165. https://doi.org/10.3846/ijspm.2026.25599

Mariani, M., Amoruso, P., Caragnano, A., & Zito, M. (2018). Green real estate: Does it create value? Financial and sustainability analysis on European green REITs. *International Journal of Business and Management*, *13*(7), 80–92. https://doi.org/10.5539/ijbm.v13n7p80

McCord, M. J., MacIntyre, S., Bidanset, P., Lo, D., & Davis, P. (2018). Examining the spatial relationship between environmental health factors and house prices: $NO_2$ problem? *Journal of European Real Estate Research*, *11*(3), 353–398. https://doi.org/10.1108/JERER-01-2018-0008

McCord, M., Lo, D., McCord, J., Davis, P. T., & Haran, M. (2019). Measuring the cointegration of housing types in Northern Ireland. *Journal of Property Research*, *36*(4), 343–366. https://doi.org/10.1080/09599916.2019.1688851

McCord, M., Lo, D., Davis, P. T., Hemphill, L., McCord, J., & Haran, M. (2020). A spatial analysis of EPCs in The Belfast Metropolitan Area housing market. *Journal of Property Research*, *37*(1), 25–61. https://doi.org/10.1080/09599916.2019.1697345

McKinsey & Company. (2023). *2023 ESG report*: *Accelerating sustainable and inclusive growth for all*. https://www.mckinsey.com/~/media/mckinsey/about%20us/social%20responsibility/2023%20esg%20report/mckinsey-and-company-2023-esg-report.pdf

Newell, G., & Marzuki, M. J. (2022). The increasing importance of environmental sustainability in global real estate investment markets. *Journal of Property Investment and Finance*, *40*(4), 411–429. https://doi.org/10.1108/JPIF-01-2022-0005

Newell, G., Nanda, A., & Moss, A. (2023). Improving the benchmarking of ESG in real estate investment. *Journal of Property Investment and Finance*, *41*(4), 380–429. https://doi.org/10.1108/JPIF-10-2021-0084

Ooi, J. T. L., & Dung, D. D. Q. (2019). Finding superior returns in green portfolios: Evidence from Singapore REITs. *Journal of Sustainable Real Estate*, *11*(1), 191–215. https://doi.org/10.22300/1949-8276.11.1.191

Orlitzky, M., Schmidt, F. L., & Rynes, S. L. (2003). Corporate social and financial performance: A meta-analysis. *Organization Studies*, *24*(3), 403–441. https://doi.org/10.1177/0170840603024003910

Pedroni, P. (2004). Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric Theory*, *20*(3), 597–627. https://doi.org/10.1017/S0266466604203073

Revelli, C., & Viviani, J. L. (2013). The link between SRI and financial performance: Effects and moderators. *Management International*, *17*(2), 105–122. https://doi.org/10.7202/1015403ar

Robinson, S., & McIntosh, M. G. (2022). A literature review of environmental, social, and governance (ESG) in commercial real estate. *Journal of Real Estate Literature*, *30*(1–2), 54–67. https://doi.org/10.1080/09277544.2022.2106639

Sah, V., Miller, N., & Ghosh, B. (2013). Are green REITs valued more? *Journal of Real Estate Portfolio Management*, *19*(2), 169–177. https://doi.org/10.1080/10835547.2013.12089948

Tamimi, N., & Sebastianelli, R. (2017). Transparency among S&P 500 companies: An analysis of ESG disclosure scores. *Management Decision*, *55*(8), 1660–1680. https://doi.org/10.1108/MD-01-2017-0018

The European Parliament, & the Council of the European Union. (2018). *Directive* (*EU*) *2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency* (*Text with EEA relevance*). https://eur-lex.europa.eu/eli/dir/2018/844/oj/eng

The European Parliament, & the Council of the European Union. (2020). *Regulation* (*EU*) *2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation* (*EU*) *2019/2088* (*Text with EEA relevance*). https://eur-lex.europa.eu/eli/reg/2020/852/oj/eng

Trinh, H. H., McCord, M., Lo, D., & Squires, G. (2023). Do green growth and technological innovation matter to infrastructure investments in the era of climate change? Global evidence. *Applied Economics*, *55*(35), 4108–4129. https://doi.org/10.1080/00036846.2022.2125493

Tobin, J. (1969). A general equilibrium approach to monetary theory. *Journal of Money, Credit and Banking*, *1*(1), 15–29. https://doi.org/10.2307/1991374

UK Government. (2015). *The energy efficiency* (*private rented property*) (*England and Wales*), *Regulations 2015*. https://www.legislation.gov.uk/uksi/2015/962/contents

UK Green Building Council. (2019). *Net zero carbon buildings*: *A framework definition*. https://ukgbc.org/resources/net-zero-carbon-buildings-a-framework-definition/

United Nations. (2015). *Paris Agreement*. https://unfccc.int/sites/default/files/resource/Paris_agreement-English.pdf

Vrensen, H. J., Schoenmaker, D., Bienert, S., & Wein, J. (2020). Managing climate change-related risks in global real estate. *Real Estate Issues*, *44*(23), 1–11.

World Green Building Council. (2021). *Annual Report* (*2021*). https://worldgbc.org/wp-content/uploads/2022/08/WorldGBC-2021-Annual-Report.pdf

Yu, E. P.-y., Guo, C. Q., & Luu, B. V. (2018). Environmental, social and governance transparency and firm value. *Business Strategy and the Environment*, *27*(7), 987–1004. https://doi.org/10.1002/bse.2047

Yuan, X., Li, Z., Xu, J., & Shang, L. (2022). ESG disclosure and corporate financial irregularities – Evidence from Chinese listed firms. *Journal of Cleaner Production*, *332*, Article 129992. https://doi.org/10.1016/j.jclepro.2021.129992