



Does Green Innovation Affect Firm Misvaluation in European Countries? Evidence from Environmentally Sensitive Firms

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〈Abstract〉

This study examines the relationship between green innovation and firm misvaluation using panel data from environmentally sensitive firms between 2003 and 2021. Using firm fixed-effects models, we analyze how green innovation relates to deviations of stock prices from fundamental values. The results indicate a positive association between green innovation and firm misvaluation. However, the evidence for undervalued firms is weak and often statistically insignificant, whereas the relationship is more pronounced among overvalued firms. We also examine heterogeneity across firm types. While there is limited evidence of stronger effects among business-to-consumer (B2C) firms, the association between green innovation and misvaluation appears more consistent among business-to-business (B2B) firms. Overall, the findings suggest that green innovation may be associated with pricing deviations from model-implied values in European environmentally sensitive industries.

Keywords: Green innovation, Firm misvaluation, Overvaluation, Undervaluation, B2B, B2C

JEL Classification: G32, G34

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녹색 혁신이 기업가치 괴리에 미치는 영향에 관한 연구: 유럽 환경 민감 기업을 중심으로

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〈 요약 〉

본 연구는 2003년부터 2021년까지의 기간 동안 환경 민감 산업에 속한 기업을 대상으로 녹색 혁신과 기업 가치 괴리 간의 관계를 분석하였다. 고정효과 모형을 활용한 실증분석 결과, 녹색 혁신은 기업 가치 괴리와 유의한 양(+)의 관계를 가지는 것으로 나타났다. 그러나 기업의 가치평가 수준에 따라 이러한 관계에는 차이가 존재하였다. 구체적으로, 저평가된 기업에서는 해당 관계의 통계적 유의성이 제한적으로 나타난 반면, 과대평가된 기업에서는 보다 뚜렷하고 일관된 양(+)의 관계가 확인되었다. 또한 기업 유형에 따른 이질성을 분석한 결과, B2C 기업에서는 녹색 혁신과 기업 가치 괴리 간의 관계가 제한적으로 나타난 반면, B2B 기업에서는 보다 강건하고 일관된 결과가 도출되었다. 이러한 분석 결과는 유럽의 환경 민감 기업 맥락에서 녹색 혁신이 기업의 내재가치와 시장가격 간의 괴리와 밀접하게 관련될 수 있음을 시사한다.

핵심 단어 : 녹색혁신, 기업가치 괴리, 과대평가, 과소평가, B2B, B2C

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1. Introduction

The need to balance economic growth with environmental sustainability has become an increasingly urgent challenge in the global economy (Chen et al., 2023b; Guo et al., 2023). Because environmentally sensitive industries (ESIs), including manufacturing, mining, energy, and chemicals, generate substantial environmental impacts, they face heightened regulatory scrutiny (Aastvedt et al., 2021; Ben-Nasr et al., 2021; Garcia et al., 2017; Naeem et al., 2022; Zaman et al., 2021). As a result, regulators across developed and emerging economies increasingly pressure firms to enhance environmental performance and transparency (Guo et al., 2023; He and Qiu, 2025; Wang, 2025).

Green innovation—defined as the development of new technologies, products, processes, or practices that reduce environmental harm and conserve resources (Huang et al., 2023; Wang, 2025)—has emerged as a strategic response to these environmental challenges. In ESIs, green innovation plays a critical role in helping firms meet regulatory requirements, address stakeholder expectations, and strengthen environmental performance and reputational capital (Guo et al., 2023; Lv et al., 2023).

Although prior research has examined green innovation and firm performance (Aastvedt et al., 2021; Cheng, Q et al., 2025; Liu et al., 2024), as well as ESG performance and firm misvaluation (Yang et al., 2024; Wang et al., 2024), studies directly investigating the effect of green innovation on firm misvaluation remain scarce. Existing research has primarily examined general innovation, aggregate ESG measures, or related market outcomes, with limited evidence on how green innovation relates to firm misvaluation in European ESIs. Given Europe's distinct regulatory environment and stakeholder expectations, a comprehensive cross-sectoral analysis is warranted. Restricting the analysis to European firms is a deliberate methodological choice rather than a limitation. European countries share relatively comparable institutional conditions regarding environmental regulation, ESG disclosure requirements, and financial reporting standards. This reduces cross-country heterogeneity that could otherwise obscure the relationship between green innovation and firm misvaluation. Limiting the sample to a more homogeneous regulatory environment allows the analysis to isolate the association between green innovation and valuation outcomes more clearly.

Firm-level customer orientation represents an additional yet underexplored factor that may shape how markets interpret green innovation. Business-to-consumer (B2C) firms interact directly with end consumers and may use green innovation to strengthen brand image and attract environmentally conscious customers (Rahman et al., 2020; Rehman, 2025). In contrast, business-to-business (B2B) firms typically emphasize operational

efficiency, regulatory compliance, and supply chain relationships. These differences suggest that market reactions to green innovation may vary systematically across B2B and B2C firms, particularly in environmentally sensitive European industries.

Motivated by these considerations, this study examines the association between green innovation and firm misvaluation in European ESIs. Drawing on stakeholder theory and signaling theory, we examine how green innovation may contribute to overvaluation or undervaluation under conditions of information asymmetry and heterogeneous stakeholder interpretations. Specifically, we address three research questions: (1) Is green innovation associated with firm misvaluation in European ESIs? (2) Does this association differ between overvalued and undervalued firms? (3) Is this association moderated by customer orientation (B2B vs. B2C)?

This study contributes to the literature in several ways. First, we examine the association between green innovation and firm misvaluation in environmentally sensitive European industries. Unlike prior research that focuses on firm performance or single industries, our analysis highlights how green innovation is associated with deviations between market prices and model-implied values in ESIs operating under distinct regulatory and stakeholder pressures.

Second, we develop a theoretical framework that combines stakeholder theory and signaling theory to explain how green innovation may generate systematic misvaluation. By emphasizing information asymmetry and heterogeneous stakeholder interpretations, this framework explains why green innovation may lead to both overvaluation and undervaluation rather than uniform valuation effects.

Third, we investigate whether customer orientation (B2B vs. B2C) contributes to heterogeneity in the green innovation - misvaluation relationship. Although prior studies emphasize sectoral and regional heterogeneity, they pay limited attention to how market orientation influences valuation patterns. Our findings indicate that the association between green innovation and misvaluation differs between B2B and B2C firms.

Fourth, we conduct a comprehensive cross-sectoral analysis of the association between green innovation and misvaluation within Europe's regulatory environment. By focusing on European ESIs, we capture institutional features, including stringent environmental regulation and ESG disclosure requirements, that are not fully reflected in studies focusing on other regions or individual industries.

Fifth, we document empirical patterns in the relationship between green innovation and misvaluation. The analysis does not aim to establish causal relationships but instead presents descriptive evidence based on available data.

Finally, we explicitly distinguish between overvaluation and undervaluation in

examining green innovation. This perspective extends the literature by highlighting that the association between green innovation and misvaluation may differ across valuation states because of heterogeneous market responses.

Overall, this study contributes to the literature by providing evidence on the relationship between firm misvaluation and green innovation in European ESIs. Building on prior ESG valuation research, we examine green innovation as a potential source of valuation deviations and explore heterogeneity across valuation types (undervaluation versus overvaluation) and customer orientation (B2B versus B2C). The findings indicate that the association between green innovation and valuation patterns varies across market contexts. These insights are relevant for business managers seeking to understand market perceptions of green innovation, investment professionals seeking to improve valuation assessment in environmentally sensitive industries, and policymakers designing regulatory frameworks to enhance market transparency.

Given data limitations and identification challenges, the results should be interpreted as evidence of empirical associations rather than causal relationships.

The remainder of the paper is organized as follows: Section 2 reviews the relevant literature and discusses expected empirical patterns; Section 3 describes the European data and methodology; Section 4 presents and analyzes the empirical findings; and Section 5 concludes with a discussion of the findings, implications, and future research directions.

2. Literature review and hypothesis development

2.1 Literature review

2.1.1 Green innovation and firm value

Addressing global environmental concerns requires a fundamental shift in business strategy, particularly among companies operating in environmentally sensitive industries (ESIs; Guo et al., 2023; Huang et al., 2023). These firms face heightened scrutiny regarding their environmental impacts and increasing pressure from regulators and the public to adopt sustainable practices, especially in highly polluting sectors (Fiorillo et al., 2022; He & Qiu, 2025; Liu, L. et al., 2024; Na and Kim, 2023).

Green innovation—the development of new or enhanced procedures, goods, services, or management systems that improve environmental sustainability—has emerged as a critical strategic response (Bauweraerts et al., 2022; Fiorillo et al., 2022). Green innovation is increasingly viewed as a source of competitive advantage (Liu, X. et al., 2024; Rahman

et al., 2024) rather than solely as a compliance mechanism (Cheng, Q. et al., 2025; Guo et al., 2023). Green innovation can improve operational efficiency, strengthen environmental performance, enhance reputational capital, and create new market opportunities (Huang et al., 2023; Rahman et al., 2024).

However, the outcomes and long-term trajectory of green innovation are often complex and unpredictable (Quan et al., 2025; Sirin, 2025; Wang, 2025). Such initiatives often require sustained investment in both skilled personnel and capital (Bauweraerts et al., 2022; Zhou et al., 2023). Together with technological and environmental externalities (Aastvedt et al., 2021; Lv et al., 2023) and the public-good characteristics of green innovation (Guo et al., 2023), these factors generate substantial risks and uncertainties that complicate the financial implications of green innovation (Wang, 2025; Fiorillo et al., 2022).

Empirical findings are mixed. Some studies find that green innovation enhances environmental performance and generates economic benefits through efficiency gains and technological advances (Rehman, 2025). Similarly, stakeholder theory suggests that meeting environmental stakeholder expectations can enhance reputation, competitiveness, and long-term cost-effectiveness (Khan et al., 2024; Liu, L. et al., 2024; Rahman et al., 2020).

However, studies adopting traditional, cost-based perspectives emphasize compliance burdens, resource diversion, and uncertain returns from green innovation. These concerns, together with externalities and risk exposure, may produce negative or ambiguous effects on corporate performance (Aastvedt, 2021; Guo et al., 2024; Wang, 2025). This inconsistency complicates analysts' and investors' assessment of green innovation's value, underscoring the complexity and uncertainty surrounding its outcomes (Bedford et al., 2021; Fiorillo et al., 2022).

Related research on intangible and unpredictable asset valuation suggests that information asymmetry and investor underreaction can contribute to misvaluation (Sirin, 2025). Although some studies directly examine the value of green innovation (Lv et al., 2023), most focus on specific national contexts (Liu et al., 2024) or specialized industries (Cheng, Q. et al., 2025). Evidence suggests that markets may undervalue green innovation or its knowledge spillovers when they perceive such investments as risky or resource-diverting (Fiorillo et al., 2022; Sirin, 2025).

Furthermore, broader ESG research shows that sustainability performance is associated with equity misvaluation and other financial outcomes, particularly when information asymmetry or inconsistent ESG assessments are present (Garcia et al., 2017; Khan et al., 2024; Lin et al., 2023; Park et al., 2023; Yang et al., 2024). Nevertheless, the financial market consequences of green innovation remain insufficiently understood because ESG

is a multifaceted construct, and green innovation constitutes only one of its components (Xiao et al., 2025). This gap is particularly evident in research on market-level mechanisms that extend beyond stock liquidity and crash risk (Ben-Nasr et al., 2021; Chen et al., 2023b; Zaman et al., 2021).

2.1.2 Green innovation and capital market misvaluation

In efficient capital market theory, asset prices fully and immediately incorporate all available information, thereby eliminating long-term misvaluation (Wang et al., 2024; Zhang & Yang, 2023; Yang et al., 2024). Firm misvaluation occurs when market prices diverge from intrinsic firm value (Benlemlih et al., 2021; Cho et al., 2021; Khan et al., 2024; Lin et al., 2023). In practice, however, markets frequently deviate from this ideal because of information asymmetry, investor irrationality, cognitive biases (Lin et al., 2023; Wu et al., 2024), and challenges associated with interpreting complex technical information (Yin & Xin, 2024).

Existing literature presents contradictory findings regarding whether ESG or green initiatives lead to overvaluation or undervaluation. Some studies argue that markets undervalue green investments because they are long-term and intangible (Guo et al., 2023). Others find that sustainability visibility—such as inclusion in CSR indices—attracts analyst coverage and long-term investors, potentially increasing valuations (Durand et al., 2019). These mixed results suggest that variations in investor perceptions and ESG visibility may result in either undervaluation or overvaluation.

The intangible, uncertain, and technically complex nature of innovation makes it particularly susceptible to misvaluation (Bedford et al., 2021; Sirin, 2025). Investors often face difficulties in assessing the risks and rewards associated with long-term innovation investments (Fiorillo et al., 2022; Yin & Xin, 2024). ESG greenwashing—defined as selective or misleading environmental disclosures—further complicates valuation by weakening the information environment and making firm value more difficult for investors to assess (Khan et al., 2024; Lin et al., 2023; Yin & Xin, 2024). These distortions may result in substantial valuation errors (Cho et al., 2021; Sirin, 2025; Zhang & Yang, 2023). Although this study discusses greenwashing as a theoretical concern, it does not incorporate empirical measures such as greenwashing scores or disclosure - action gaps, thereby leaving an avenue for future research.

Studies linking ESG performance to misvaluation suggest that sustainability characteristics can significantly influence firm value (Lin et al., 2023; Wang et al., 2024; Zhang & Yang, 2023; Kim and Yoon, 2024). Depending on investor attitudes and information quality, strong ESG performance may increase overvaluation or help correct undervaluation

(Khan et al., 2024). ESG-related misvaluation is often attributed to market frictions, including investor biases, information asymmetry, and difficulties in interpreting detailed disclosures (Yang et al., 2024; Yin & Xin, 2024). Greenwashing may further exacerbate these issues (Lin et al., 2023; Xiao et al., 2025).

Despite these insights, most existing research examines ESG performance broadly rather than isolating the effects of green innovation. Many studies focus on related outcomes such as stock price crash risk (Zaman et al., 2021) or stock liquidity (Chen et al., 2023b). Given the strategic importance of ESIs and their heightened public and regulatory scrutiny, a substantial gap remains in understanding how green innovation contributes to misvaluation (Garcia et al., 2017; Naeem et al., 2022). In this regard, distinguishing ESG disclosure-based valuation effects from innovation-based effects tied to concrete green R&D and product development is critical. This study focuses on the latter.

Although prior studies provide valuable insights, existing research has not fully examined how market inefficiencies interact with key characteristics of green innovation—including intangibility, uncertainty, technical complexity, dual externalities, and stakeholder salience—to generate misvaluation (Bauweraerts et al., 2022; Chen et al., 2023a; Guo et al., 2023; Khan et al., 2024; Lin et al., 2023). Moreover, limited research examines how firm-specific characteristics, such as business models (e.g., B2B vs. B2C), moderate these effects. By examining the relationship between green innovation and firm misvaluation in ESIs and identifying conditions under which this relationship varies, this study addresses these gaps and responds to calls for more nuanced analyses of ESG components across specific industrial and informational contexts (Bauweraerts et al., 2022; Fiorillo et al., 2022).

2.1.3 Market inefficiency

Market inefficiency theory suggests that stock prices diverge from fundamental values when asset prices fail to fully reflect available information (Khan et al., 2024; Lin et al., 2023; Zhang & Yang, 2023). This discrepancy, commonly referred to as equity misvaluation, arises when market prices diverge from a company's intrinsic value (Cho et al., 2021). Common sources of misvaluation include information asymmetry (He et al., 2023; Khan et al., 2024), investor irrationality, cognitive biases (Sirin, 2025; Yin & Xin, 2024), and challenges associated with interpreting complex or technical disclosures (Bedford et al., 2021).

Innovation's intrinsic intangibility, uncertainty, and technological complexity make it particularly susceptible to mispricing (Wang, 2025). These inefficiencies are amplified in the context of green innovation. Its long-term, high-risk nature and uncertain outcomes

(Fiorillo et al., 2022) make it challenging for investors to assess future risks and returns (Sirin, 2025; Wang, 2025). The complexity of environmental R&D, combined with limited disclosure—especially regarding innovation quality—further impairs valuation accuracy and increases the likelihood of investor underreaction or misjudgment (Bedford et al., 2021; Yin & Xin, 2024). These constraints exacerbate information asymmetry between managers and investors (Chen et al., 2023b; Zaman et al., 2021).

The possibility of ESG greenwashing adds noise to the information environment through selective or manipulated environmental disclosures (Lin et al., 2023; Xiao et al., 2025). Such practices impair investors' ability to accurately assess firm value (Yin & Xin, 2024). As a result, imperfect capital markets may fail to fully incorporate the value of green innovation into stock prices, thereby increasing the likelihood of substantial mispricing (Lin et al., 2023; Sirin, 2025; Zhang & Yang, 2023).

2.1.4 Signaling theory

According to signaling theory, firms can reduce information asymmetry by credibly communicating with external stakeholders through disclosures and observable actions (Lin et al., 2023; Sirin, 2025). Investments in eco-friendly technologies and sustainability initiatives can signal competitive advantage (Chen et al., 2023b; Liu et al., 2024), innovation capability (Guo et al., 2023), and long-term sustainability (Xiao et al., 2025).

For signals to remain effective, they must be costly or difficult to imitate (Xiao et al., 2025). Because green innovation typically requires high-risk (Fiorillo et al., 2022) and substantial long-term investment (Quan et al., 2025), it can serve as a credible signal of commitment to sustainable development and environmental stewardship (Xiao et al., 2025). Investors may therefore view green innovation as a signal of stronger managerial quality, greater operational efficiency, lower regulatory risk, and enhanced corporate reputation (Chen et al., 2023b; Guo et al., 2023; Sirin, 2025).

However, signal strength and reliability vary. Disclosure clarity, reporting transparency, and the risk of greenwashing (Lin et al., 2023) can complicate investor interpretation, potentially resulting in either favorable valuation effects or mispricing (Xiao et al., 2025). Thus, signaling theory helps explain how green innovation shapes firm valuation through the information it conveys while also highlighting factors that may distort or undermine this signaling mechanism (Sirin, 2025; Yin & Xin, 2024).

2.1.5 Stakeholder theory

Stakeholder theory emphasizes that firms must effectively manage the interests of multiple stakeholder groups—including customers, employees, regulators, communities, suppliers, and investors—to achieve long-term success (Garcia et al., 2017; Xiao et al.,

2025; Aastvedt et al., 2021; Bofinger et al., 2022; Khan et al., 2024). The theory argues that long-term wealth creation depends on effectively managing relationships with diverse stakeholders rather than focusing exclusively on shareholder value maximization (Naeem et al., 2022; Khan et al., 2024).

Stakeholder pressures strongly influence corporate environmental strategies, particularly in highly polluting industries (Guo et al., 2023; Chen et al., 2023a). Rising expectations regarding environmental responsibility frequently motivate green innovation (Fiorillo et al., 2022; Xiao et al., 2025). Firms adopt green innovation to satisfy stakeholder demands and gain environmental legitimacy (Huang et al., 2023). Doing so can enhance legitimacy and reputation (Xiao et al., 2025), strengthen relationships with key stakeholders (Chen et al., 2023a), and reduce external pressures (Aastvedt et al., 2021). Stakeholder theory, therefore, explains why firms pursue green innovation to meet broader stakeholder expectations as well as regulatory requirements (Fiorillo et al., 2022).

Importantly, the influence of stakeholders varies across firm characteristics (Bauweraert et al., 2022; Rahman et al., 2020; Wang, 2025). In particular, customer pressure directly influences product market performance (Huang et al., 2023), affecting how markets respond to and value green initiatives (Zaman et al., 2021; Khan et al., 2024). Stakeholder theory emphasizes how specific stakeholder groups, particularly customers, influence firm strategy and perceived value (Fiorillo et al., 2022; Sirin, 2025), whereas institutional theory focuses more broadly on pressures to conform to regulatory and normative standards (Guo et al., 2023; Quan et al., 2025). This perspective is particularly relevant for understanding how business-level attributes, including firm innovation and customer awareness, shape the valuation effects of green innovation (Rahman et al., 2020).

2.2 Hypothesis development

Because green innovation is inherently complex, uncertain, and long-term, investors may struggle to evaluate it accurately, particularly in markets characterized by information asymmetry and behavioral biases (Quan et al., 2025; Yin & Xin, 2024). According to signaling theory, green innovation may signal long-term firm value and lower risk, although these signals can be distorted by technical complexity, greenwashing, and uncertainty surrounding project outcomes (Bedford et al., 2021; Sirin, 2025; Xiao et al., 2025).

Existing research suggests that complex innovation activities, particularly R&D, are frequently mispriced because investors face limited transparency and constraints in processing related information (Bedford et al., 2021; Fiorillo et al., 2022). Comparable challenges apply to green innovation in ESIs, where disclosure practices and regulatory frameworks vary across contexts (Chen et al., 2023b; Guo et al., 2023; Lv et al., 2023).

Although market efficiency theory suggests that prices should reflect all available information, markets frequently deviate from this ideal because of interpretive complexity, noisy trading, and behavioral biases (Wang et al., 2024; Zhang & Yang, 2023). The intangible nature of green innovation and uncertainty surrounding its future returns further complicate valuation, particularly when ESG disclosures are selective or ambiguous (Khan et al., 2024; Lin et al., 2023; Xiao et al., 2025).

As a result, green innovation disclosures intended to signal firm quality and future potential may be misunderstood or discounted, widening the gap between market price and intrinsic value and contributing to misvaluation (Cho et al., 2021; Sirin, 2025). Accordingly, we expect a positive empirical association between green innovation and firm misvaluation in environmentally sensitive industries.

We next examine whether green innovation is associated with undervaluation, overvaluation, or both valuation states. Prior studies suggest that markets may undervalue innovation, particularly long-term and intangible investments, because they struggle to assess future returns and face information constraints (Yin & Xin, 2024; Fiorillo et al., 2022).

Conversely, green innovation may contribute to overvaluation by improving investor sentiment and signaling compliance with sustainability objectives, especially in highly scrutinized ESIs (Guo et al., 2023). From a stakeholder perspective, meeting regulatory and societal expectations can increase perceived firm value, whereas exaggerated or selective disclosures may inflate prices beyond fundamentals (Dong et al., 2021; Lin et al., 2023; Liu et al., 2024).

Accordingly, green innovation may be associated with both undervaluation and overvaluation through different channels, including persistent information gaps and optimistic market interpretations. In both cases, green innovation may be associated with overall mispricing.

We therefore expect the positive association between green innovation and misvaluation to be observable among both undervalued and overvalued firms.

The strength of this relationship may vary according to firms' market orientation. In B2C firms, customers represent key stakeholders and are often responsive to environmental messaging (Garcia et al., 2017). In these firms, green innovation serves as a visible signal of environmental commitment and may shape brand image, media exposure, and consumer behavior, particularly in ESIs (Bauweraerts et al., 2022; Chen et al., 2023a; Naeem et al., 2022).

Because green initiatives in B2C firms are more transparent and accessible, they are more likely to attract sentiment-driven attention from retail and ESG-oriented investors,

thereby increasing the risk of valuation bias associated with optimism or emotional appeal (Yin & Xin, 2024; Fiorillo et al., 2022).

By contrast, B2B firms often undertake less visible forms of green innovation – such as process improvements and supply chain sustainability – that are evaluated by a narrower group of stakeholders and receive less public attention (Tang et al., 2018; Liu, L. et al., 2024; Wu et al., 2024). While both B2B and B2C firms may benefit internally from green innovation, B2C firms are more likely to generate observable market-facing outcomes that attract investor attention, thereby increasing the likelihood of valuation distortions.

Based on this reasoning, we expect the association between green innovation and misvaluation to vary across business models and to be more visible in B2C firms because of greater transparency and stakeholder attention. These expectations are intended to guide the empirical analysis by outlining potential patterns in the data rather than testing causal relationships.

3. Methodology

3.1 Data and sample

We construct a panel dataset spanning 2003 – 2021 from multiple established databases. The data collection process involves identifying 1,422 publicly traded companies operating in environmentally sensitive industries (ESIs) worldwide (Meles et al., 2023). We obtain environmental innovation scores for these firms from the Thomson Reuters Eikon ESG database, which provides firm-level measures of the volume and quality of green innovation activities.

We combine the ESG data with financial information from Worldscope and analyst earnings forecasts from the Institutional Brokers' Estimate System (IBES). Worldscope provides key accounting variables, whereas IBES supplies analyst earnings projections used to estimate the firm misvaluation (MSV) measure.

We apply several screening criteria to construct the final sample. First, we retain firms for which environmental innovation scores are available from Eikon. Second, we retain only firms with complete financial statement data from Worldscope. Third, we retain only firms with available IBES analyst forecasts required to estimate misvaluation. Fourth, we exclude firms with missing observations for any regression variable. In addition, the use of lagged variables and firm fixed effects requires sufficiently long and continuous time series, which further restricts the sample.

We restrict the sample to European firms to enhance comparability across institutional,

regulatory, and reporting environments. European markets provide a relatively homogeneous institutional setting with respect to ESG disclosure requirements, environmental regulation, and investor protection. This restriction aims to reduce cross-country heterogeneity that might otherwise confound the relationship between green innovation and firm misvaluation. A detailed description of the sample selection process appears in the sample construction table.

After applying these criteria, the final sample comprises 22 firms and 319 firm-year observations from 13 countries: Austria, Belgium, Denmark, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, Spain, Switzerland, and the United Kingdom. To mitigate the effects of outliers, continuous variables are winsorized at the 1st and 99th percentiles. Appendix Table A0 presents a detailed description of the sample construction procedure, including the reduction of the initial global dataset to the final sample.

Following Haddock-Fraser and Tourelle (2010), we classify firms as business-to-consumer (B2C) or business-to-business (B2B) based on reviews of company websites, annual reports, and product descriptions. Firms that primarily serve final consumers are classified as B2C, whereas the remaining firms are classified as B2B. The final sample consists of 7 B2B firms (100 observations) and 15 B2C firms (219 observations).

The relatively small sample size reflects the stringent data requirements associated with simultaneously obtaining measures of green innovation, analyst forecast inputs for misvaluation, and complete financial information. Accordingly, the findings should be interpreted with caution.

3.2 Variables

Following Dong et al. (2006) and Cho et al. (2021), we proxy firm misvaluation as the ratio of the current stock price (P_{it}) to the fundamental value (V_{it}), expressed as follows:

$$MSV_{it} = \frac{P_{it}}{V_{it}} \quad (1)$$

We estimate the fundamental value of equity (V_{it}) using a three-period forecast horizon model:

$$V_{it} = B_{it} + \frac{FROE_{i,t+1} - re_i}{1 + re_i} + \frac{(FROE_{i,t+2} - re_i)B_{it} + 1}{(1 + re_i)^2} + \frac{(FROE_{i,t+3} - re_i)B_{it}}{(1 + re_i)^2 re_i} \quad (2)$$

where $FROE_{it}$ represents the forecasted return on equity in year t , re_i is the estimated equity cost of capital, and B_{it} denotes the estimated book value of equity at the end of year t . Specifically, $FROE_{it}$ is estimated as $FROE_{it} = FEPS_{it+1}/[(B_{it} + B_{it+1})/2]$, where $FEPS_{it+1}$ is the forecasted earnings per share in period $t+1$. The future book value of equity is estimated as $B_{t+1} = [1 + (1 - k)Roe_{t+1}]B_t$, where k is the dividend payout ratio ($k = D_t/EPSt$). We estimate the cost of equity capital (re_i) using Dong et al. (2006) and the CAPM, winsorizing values outside the 0.03 - 0.3 range (Bofinger et al., 2022; Dong et al., 2006). We classify observations as overvalued when MSV exceeds 1 and undervalued when MSV is less than 1.

Because MSV relies on a three-year ROE projection horizon, it may capture both short-term mispricing and changes in anticipated fundamentals, including future cash flows and strategic value related to green innovation. Accordingly, we interpret MSV as reflecting deviations from model-implied values rather than a precise distinction between mispricing and intrinsic value.

We measure green innovation (*GreenInv*) using environmental innovation scores widely employed in prior research (Fiorillo et al., 2022; Meles et al., 2023). Following Bofinger et al. (2022), Li (2020), and Sakaki et al. (2021), we control for firm size, leverage, growth opportunities, profitability, capital expenditure, and dividend policy to account for additional determinants of misvaluation. These controls serve specification purposes and are not the primary focus of the analysis.

3.3 Model specification

We estimate panel regressions with firm and year fixed effects to account for unobserved time-invariant heterogeneity. Year fixed effects absorb common shocks, such as changes in ESG regulations and macroeconomic conditions, whereas firm fixed effects control for time-invariant firm characteristics. The Hausman test supports the use of fixed effects rather than random effects. Our baseline specification is:

$$MSV_{it} = \beta_0 + \beta_1 MSV_{it-1} + \beta_2 GreenInv_{it-1} + \beta_3 Size_{it} + \beta_4 Lev_{it} + \beta_5 Growth_{it} + \beta_6 ROA_{it} + \beta_7 CapEx_{it} + \beta_8 Div_{it} + \varepsilon_{it} \quad (3)$$

As a robustness check, we also estimate models with country-by-year fixed effects to control for cross-country heterogeneity in macroeconomic and regulatory conditions (Appendix Tables A1 - A2).

We include the lagged dependent variable (MSV_{it-1}) to capture persistence in mispricing. We cluster standard errors at the firm level to address autocorrelation and

heteroskedasticity. Given the limited number of clusters, we also use wild-cluster bootstrap inference to address potential small-cluster concerns (Appendix Table A3). The bootstrap p-values show that statistical significance weakens substantially under this approach, suggesting that conventional clustered standard errors may overstate significance in small-sample settings. This bootstrap evidence reinforces that the main results should be interpreted as suggestive associations rather than statistically robust findings.

We examine whether the relationship between green innovation and misvaluation varies between the overvalued ($ESI_{Over} - MSV > 1$) and undervalued ($ESI_{Under} - MSV < 1$) subsamples. The sample includes 114 ESI_{Over} observations and 205 ESI_{Under} observations. Increasing sustainable investment flows toward firms with high green innovation ratings may raise misvaluation ratios even when such firms are already overvalued. Accordingly, we expect *GreenInv* to have a positive effect on *MSV* in both subsamples.

Given the limited sample size and data constraints, we do not make causal claims. We design the empirical analysis to document conditional associations using panel fixed-effects specifications and multiple sensitivity checks.

4. Empirical results

4.1 Summary statistics

Table 1 presents descriptive statistics for all variables in the ESI_{Full} , ESI_{Over} , and ESI_{Under} panels. The mean *MSV* in the ESI_{Full} panel is 1.322. In contrast, the median *MSV* is 1.749 in the ESI_{Over} panel and 0.878 in the ESI_{Under} panel, indicating substantial valuation differences across groups. The mean *GreenInv* score is also higher in the ESI_{Over} group (57.910) than in the ESI_{Under} group (49.973), suggesting that environmentally proactive firms exhibit stronger green innovation performance. These firms also exhibit higher mean *ROA* (13.481) and growth rates (0.069), indicating stronger performance and market prospects, whereas firms in the ESI_{Under} group tend to be more leveraged (*Lev* = 0.535) and slightly larger (*Size* = 9.835). ESI_{Under} firms also show marginally higher capital expenditure ratios, suggesting greater investment intensity in physical assets relative to innovation-based investments.

Table 2 presents the correlation matrix (Panel A) and variance inflation factors (VIF; Panel B) for the primary variables in ESI_{Full} . Panel A reports a statistically significant positive correlation between *GreenInv* and *MSV* (0.346, $p < 0.01$), supporting the view that green innovation enhances stock price informativeness. All pairwise correlations remain below 0.3 in absolute value, suggesting that multicollinearity is unlikely to bias

〈Table 1〉 Descriptive Statistics

	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	J.B.	Prob	Obs
Panel A ESI_{Full}										
<i>MSV</i>	1.322	1.097	7.131	0.267	0.833	2.758	16.800	2936	0.000	319
<i>GreenInv</i>	52.809	50.000	99.770	14.290	24.651	0.236	1.762	23	8.588	319
<i>Size</i>	9.250	9.631	11.527	5.762	1.367	-0.752	2.914	30	2.786	319
<i>Lev</i>	0.522	0.538	0.887	0.140	0.146	-0.447	3.391	13	1.789	319
<i>Growth</i>	0.068	0.049	0.664	-0.318	0.170	1.105	5.912	178	2.769	319
<i>ROA</i>	8.777	7.350	73.680	-12.680	8.568	2.296	17.428	3047	0.000	319
<i>CapEx</i>	0.055	0.048	0.198	0.000	0.028	1.229	5.428	159	3.631	319
<i>Div</i>	0.944	1.000	1.000	0.000	0.231	-3.845	15.782	2958	0.000	319
Part B ESI_{Over}										
<i>MSV</i>	1.917	1.749	7.053	0.619	0.807	2.766	16.610	1025	2.400	114
<i>GreenInv</i>	57.910	61.840	99.770	14.290	25.247	-0.083	1.802	7	3.107	114
<i>Size</i>	8.197	8.169	11.527	5.762	1.464	0.740	3.340	11	4.209	114
<i>Lev</i>	0.498	0.509	0.887	0.140	0.206	-0.127	2.074	4	1.117	114
<i>Growth</i>	0.069	0.059	0.664	-0.317	0.158	1.637	8.525	196	2.884	114
<i>ROA</i>	13.481	14.210	73.680	-12.680	9.906	1.444	14.030	617	8.244	114
<i>CapEx</i>	0.055	0.047	0.198	0.010	0.032	1.625	6.675	144	1.464	114
<i>Div</i>	0.904	1.000	1.000	0.000	0.297	-2.733	8.470	284	2.050	114
Part C ESI_{Under}										
<i>MSV</i>	0.991	0.878	7.131	0.267	0.643	5.148	44.020	15278	0.000	205
<i>GreenInv</i>	49.973	45.450	99.300	15.130	23.907	0.414	1.860	17	2.092	205
<i>Size</i>	9.835	10.006	11.343	5.908	0.873	-2.124	10.063	580	9.614	205
<i>Lev</i>	0.535	0.544	0.763	0.302	0.096	-0.272	2.563	4	1.252	205
<i>Growth</i>	0.067	0.046	0.664	-0.319	0.178	0.895	4.916	59	1.744	205
<i>ROA</i>	6.161	6.030	62.610	-11.420	6.390	3.790	35.146	9317	0.000	205
<i>CapEx</i>	0.055	0.049	0.131	0.000	0.026	0.766	3.249	21	3.359	205
<i>Div</i>	0.966	1.000	1.000	0.000	0.182	-5.130	27.210	5952	0.000	205

Note: This table reports descriptive statistics for the ESI_{Full} , ESI_{Over} , and ESI_{Under} samples in Parts A, B, and C, respectively.

the regression estimates. Panel B confirms this conclusion: all VIF values fall well below the conventional threshold of 10, ranging from 1.037 to 1.480, suggesting that multicollinearity is not a concern.

〈Table 2〉 Correlation Matrix and Multicollinearity Diagnostics for Main Variables (ESIFull Sample)

Part A – Correlation matrix								
Variables	<i>MSV</i>	<i>GreenInv</i>	<i>Size</i>	<i>Lev</i>	<i>Growth</i>	<i>ROA</i>	<i>CapEx</i>	<i>Div</i>
<i>MSV</i>	1.000***							
<i>GreenInv</i>	0.346***	1.000***						
<i>Size</i>	-0.325***	-0.008	1.000***					
<i>Lev</i>	-0.021	0.155**	0.282***	1.000***				
<i>Growth</i>	-0.102*	-0.027	-0.081	0.083	1.000***			
<i>ROA</i>	0.171***	-0.009	-0.297***	-0.405***	0.198***	1.000***		
<i>CapEx</i>	-0.080	-0.081	0.050	-0.147***	-0.128*	-0.097*	1.000***	
<i>Div</i>	-0.058	-0.040	0.240***	-0.269***	-0.038	0.177***	0.015	1.000
Part B – Variance inflation factors of variables (VIF)								
	<i>GreenInv</i>	<i>Size</i>	<i>Lev</i>	<i>Growth</i>	<i>ROA</i>	<i>CapEx</i>	<i>Div</i>	
VIF	1.037	1.320	1.480	1.090	1.396	1.078	1.268	

Note: This table presents the correlation matrix (Part A) and variance inflation factors (VIFs; Part B) for all variables in the full sample.

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

4.2 Empirical results

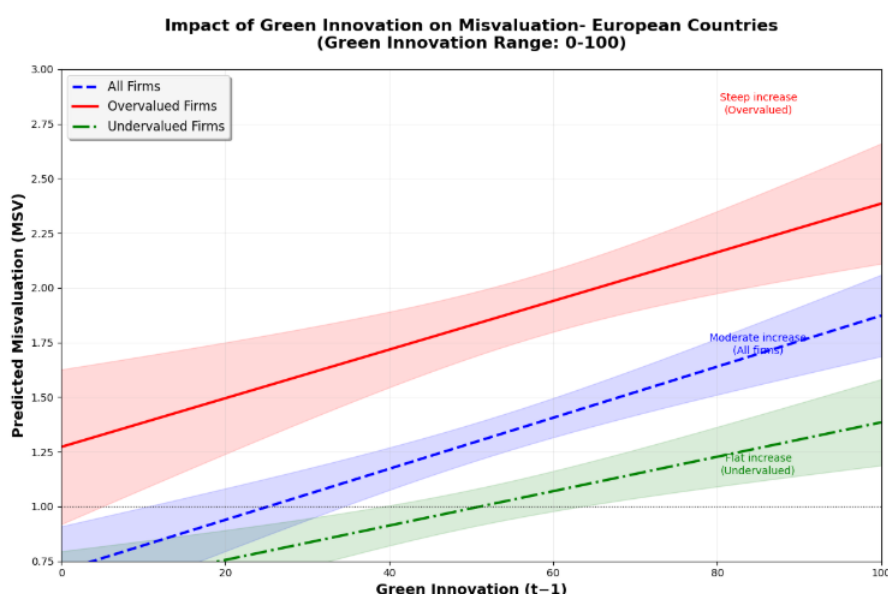
Table 3, Column (1), reports the results for the full sample (ESI_{Full}). The coefficient for $GreenInv_{t-1}$ is 0.005 ($t = 1.927$), positive and statistically significant at the 10% level. This suggests that firms with higher levels of green innovation in the previous year tend to exhibit higher misvaluation in the following year, consistent with the expected positive association. Columns 2 and 3 examine the same relationship for the ESI_{Over} and ESI_{Under} subsamples, respectively. The coefficient for $GreenInv_{t-1}$ is 0.008 ($t = 2.667$) for overvalued firms, positive and statistically significant at the 1% level. The coefficient for $GreenInv_{t-1}$ is 0.005 ($t = 1.583$) for undervalued firms, indicating a positive but statistically insignificant association. These results are broadly consistent with the expectation of a positive association between green innovation and misvaluation for both undervalued and overvalued firms; however, the relationship is statistically stronger in the overvalued subsample. This suggests that the association between green innovation and misvaluation is more pronounced among overvalued firms, while it appears weaker and statistically insignificant among undervalued firms.

A Chow test ($\chi^2 = 6.017$, $p = 0.000$) indicates structural heterogeneity between ESI_{Over} and ESI_{Under} firms. Although the Chow test does not isolate coefficient-specific differences, the subgroup estimates suggest that the association between green innovation and

misvaluation is economically stronger among overvalued firms (0.008) than among undervalued firms (0.005). To address concerns regarding country-level heterogeneity and common regulatory shocks, we re-estimate the baseline specification with country-by-year fixed effects. Taken together, the sensitivity of the results to alternative specifications (Appendix Tables A1 and A2) and the weaker statistical significance under wild-cluster bootstrap inference (Appendix Table A3) suggest that the findings should be interpreted as indicative rather than definitive. Coefficient magnitudes and statistical significance vary across model specifications, further supporting a cautious interpretation. These variations suggest that the estimated association is sensitive to model specification and should be interpreted cautiously rather than as robust evidence.

Green innovation may be associated with higher levels of misvaluation among already overvalued firms. Complex or unclear innovation-related information may hinder accurate valuation, whereas optimistic interpretation by sustainability-focused investors may push prices further above intrinsic values. These dynamics may create a feedback loop in which investor sentiment and limited transparency reinforce misvaluation.

Green innovation may also affect how undervalued firms are reassessed by the market. It may reflect managerial capability, long-term strategic planning, improved productivity, or a commitment to sustainability that investors previously overlooked. Environmentally-oriented investors may respond favorably, thereby reducing undervaluation and moving MSV closer to or above unity.



⟨Figure 1⟩ The Impact of Green Innovation on Firm Misvaluation.

〈Table 3〉 Effects of Green Innovation on Firm Misvaluation for Overall Misvaluation (ESI_{Full}), Overvalued Firms (ESI_{Over}), and Undervalued Firms (ESI_{Under})

Variables	(1) ESI_{Full} MSV	(2) ESI_{Over} MSV	(3) ESI_{Under} MSV
$GreenInv_{t-1}$	0.005* (1.927)	0.008*** (2.667)	0.005 (1.583)
MSV_{t-1}	0.073 (0.472)	0.423* (2.076)	0.037 (0.191)
$Size$	0.134** (1.988)	-0.499 (-0.892)	0.139* (1.932)
Lev	0.991 (1.405)	2.086* (1.726)	0.243 (0.272)
$Growth$	-0.377 (-1.504)	-0.397 (-0.787)	-0.484 (-1.525)
ROA	-0.012 (-0.996)	-0.055** (-2.597)	0.001 (0.065)
$CapEx$	1.019 (0.493)	2.922 (0.910)	0.864 (0.247)
Div	0.287 (0.690)	1.447 (1.400)	-0.090 (-1.007)
$Constant$	-0.9717 (-1.055)	3.020 (0.583)	-0.726 (-0.919)
Obs	319	114	205
Adj. R2	0.085	0.362	0.060
F-statistic	3.161***	5.755***	1.324
Durbin Watson	2.001	1.999	1.966
Hausman	0.000(FE)	0.000(FE)	0.000(FE)
Chow Test (p-value)			6.017 (0.000)
Firm Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Standard Errors	Clustered by firm	Clustered by firm	Clustered by firm

Note: t-values are based on firm-level clustered robust standard errors and are reported in parentheses. The p-value row reports the Chow test for the equality of regression coefficients across subsamples. All variables are defined in Appendix 1. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. All regressions include firm and year fixed effects. Results from alternative specifications that include country-by-year fixed effects are reported in Appendix Tables A1 and A2.

Figure 1 illustrates these effects across the full sample and subsamples. Overvalued firms exhibit the steepest upward slope, suggesting that higher levels of green innovation correspond to larger misvaluation gaps. In contrast, the flatter slope for undervalued firms suggests convergence of MSV toward 1.0, implying that green innovation may reduce undervaluation. The trend in the full sample reflects the average net effect of these two dynamics.

The lagged misvaluation variable (MSV_{t-1}) is positive across all models: 0.073 for the full sample, 0.423 for overvalued firms (significant at the 10% level), and 0.037 for undervalued firms. These results indicate strong persistence in misvaluation, particularly for overvalued firms. The estimated persistence of misvaluation is roughly 11.4 times greater in overvalued firms than in undervalued firms, suggesting inertia in investor sentiment or momentum in mispricing.

Control variables generally exhibit the expected signs but are mostly statistically insignificant. Their primary role is to ensure proper model specification. *Growth* and *ROA* are negatively associated with misvaluation across all samples, consistent with prior research (Bofinger et al., 2022; Li, 2020). Firms with strong growth and profitability tend to have higher intrinsic values, narrowing the gap between market and intrinsic valuations. *Size* and *Leverage* are positively associated with MSV, suggesting that larger and more leveraged firms may attract speculative attention or present greater valuation complexity, increasing the likelihood of overpricing (Sakaki et al., 2021). Capital expenditures (*CapEx*) are positively associated with misvaluation across all samples, while dividends (*Div*) are positively associated with misvaluation in the full and overvalued samples. Although dividends often signal firm value, they may amplify optimistic investor sentiment in already overvalued firms. Overall, control variables behave as expected and are not discussed further.

Table 4 presents the estimated associations between green innovation and misvaluation for B2B firms (Columns 1 - 3) and B2C firms (Columns 4 - 6). The coefficient on $GreenInv_{t-1}$ is positive in most specifications, suggesting that green innovation is positively associated with misvaluation in the subsequent period. However, the magnitude and significance vary by business model.

For B2B firms, the relationship is asymmetric: green innovation has no significant association with misvaluation in the full sample (Column 1), but the coefficient for $GreenInv_{t-1}$ among overvalued firms (Column 2) is 0.007, positive, and significant at the 5% level. The relationship appears weaker or negative among undervalued firms (Column 3). This pattern suggests that the association between green innovation and misvaluation differs across valuation states within B2B firms, with opposing associations

canceling out at the aggregate level.

In contrast, the B2C sample reports uniformly insignificant coefficients across the full, overvalued, and undervalued subsamples (Columns 4 - 6), suggesting no significant association between green innovation and misvaluation dynamics for B2C firms in this context. These differences may reflect limited sample size, data composition, or lower statistical power in the B2C subsamples. Overall, the results indicate economically meaningful associations primarily among B2B firms, with weaker evidence for B2C firms.

One possible explanation is that professional stakeholders—business clients, regulators, and institutional investors—scrutinize green innovation in B2B firms more closely and may interpret such information with greater precision. In contrast, the estimated market response among B2C firms appears weaker and statistically insignificant in this sample. These interpretations remain tentative and should be viewed as suggestive rather than causal. The B2C results remain insignificant when we include country-by-year fixed effects (Appendix Table A2).

To assess the sensitivity of the baseline results, we estimate alternative specifications using different fixed-effects structures, as reported in Appendix Tables A1 and A2. The results suggest that coefficient magnitudes and statistical significance vary across model specifications. In some specifications, the estimated association weakens or becomes statistically insignificant, indicating sensitivity of the baseline findings to model specification. Overall, these findings should be interpreted as evidence of empirical associations rather than causal relationships.

4.2.1 Robustness Checks

Sensitivity checks offer additional insight into how the estimated associations vary across alternative specifications. A leave-one-firm-out sensitivity analysis indicates that the sign of the estimated association between green innovation and misvaluation remains stable across firm exclusions (Appendix Table A4). In addition, the estimated associations remain directionally consistent, although statistical significance and coefficient magnitudes vary across specifications (Appendix Table A5). However, as shown in Appendix Tables A1 and A2, variations in coefficient magnitude and statistical significance across model specifications suggest that the findings should be interpreted cautiously. Overall, these sensitivity analyses suggest that the findings are sensitive to model specification and inference methods and should therefore be interpreted as indicative rather than conclusive.

⟨Table 4⟩ Effects of Green Innovation on Firm Misvaluation for B2B and B2C Firms in
 ESI_{Full} , ESI_{Over} , and ESI_{Under} .

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	B2B			B2C		
	ESI_{Full} <i>MSV</i>	ESI_{Over} <i>MSV</i>	ESI_{Under} <i>MSV</i>	ESI_{Full} <i>MSV</i>	ESI_{Over} <i>MSV</i>	ESI_{Under} <i>MSV</i>
<i>GreenInv</i> _{t-1}	0.003 (0.842)	0.007** (2.110)	-0.003** (-2.490)	0.004 (1.269)	-0.004 (-0.815)	0.006 (1.451)
<i>MSV</i> _{t-1}	0.646*** (5.416)	0.542*** (4.519)	0.726*** (9.501)	-0.102 (-1.605)	0.008 (0.040)	-0.106 (-1.155)
<i>Size</i>	0.108** (2.255)	-0.193*** (-6.785)	0.183*** (14.365)	-0.287 (-1.373)	3.306*** (6.999)	-0.279 (-1.537)
<i>Lev</i>	0.425 (1.102)	1.878** (2.681)	-0.513 (-1.563)	2.113*** (3.241)	4.315*** (4.448)	1.093** (2.332)
<i>Growth</i>	-0.371 (-1.462)	0.188 (0.668)	-1.084*** (-4.696)	-0.251 (-0.986)	0.605 (0.794)	-0.361* (-1.782)
<i>ROA</i>	-0.004 (-0.145)	-0.018 (-0.883)	0.011** (2.147)	-0.011 (-1.007)	-0.048*** (-3.867)	-0.003 (-0.259)
<i>CapEx</i>	-0.964 (-0.457)	-1.105 (-0.645)	-5.765 (-1.520)	1.779 (0.748)	3.151 (0.577)	0.430 (0.132)
<i>Div</i>	0.084 (0.341)	0.273 (0.822)	-0.509* (-0.886)	0.541 (1.183)	3.761*** (13.018)	0.028 (0.308)
<i>Constant</i>	-0.573 (-1.442)	16.385*** (7.648)	4.300** (2.013)	2.236 (1.215)	-32.228*** (-7.626)	2.935* (1.718)
Observations	100	56	44	219	58	161
AdjR2	0.427	0.577	0.825	0.143	0.664	0.057
F-statistic	6.240***	4.772***	10.804***	3.704***	7.169***	0.933
Durbin Watson	2.104	2.079	1.944	2.017	1.750	2.005
Hausman	0.000(FE)	0.000(FE)	0.000(FE)	0.000(FE)	0.000(FE)	0.000(FE)
Chow-test (<i>B2B</i> and <i>B2C</i>)				4.174** (0.016)	1.692 (0.105)	5.260*** (0.000)
Chow-test (ESI_{Over} and ESI_{Under})		0.888 (0.541)			6.386 (0.000)	
Firm Fixed Effects		Yes		Yes		Yes
Year Fixed Effects		Yes		Yes		Yes
Standard Errors	Clustered by firm		Clustered by firm		Clustered by firm	

Note: t-values are based on robust standard errors clustered at the firm level and are reported in parentheses. The p-value row reports the Chow test for equality of regression coefficients across subsamples. All variables are defined in Appendix 1. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. All regressions include firm and year fixed effects.

5. Discussion and Conclusion

This study examines the relationship between green innovation and firm misvaluation, particularly among B2B and B2C firms in environmentally sensitive industries. Our findings indicate that green innovation is positively associated with misvaluation, particularly among overvalued firms. Observed differences between B2B and B2C firms remain exploratory because of sample size and statistical limitations. These findings offer preliminary insights into how environmental innovation relates to valuation dynamics.

First, investor psychology and behavioral finance provide a possible explanation for why the association between green innovation and misvaluation differs between overvalued and undervalued firms. Overvalued firms are often associated with heightened investor optimism, confirmation bias, and overconfidence. Salient triggers such as green innovation signals amplify these biases because rising environmental concerns increase their emotional significance. Investors may place disproportionate weight on positive green signals, causing prices to rise above fundamental levels. This pattern may reflect a feedback loop in which rising prices stimulate speculative trading and further reinforce misvaluation. In contrast, undervalued firms—often viewed more skeptically—benefit from green innovation because it serves as a corrective signal that attracts value-oriented investors. Although green innovation appears to reduce undervaluation, it does not appear to induce overpricing. This behavioral asymmetry may help explain why green innovation is more strongly associated with overvaluation than with correcting undervaluation.

Second, the B2B findings align with differences in how investors process and interpret information. In B2B firms, green innovation is often more technical and less transparent to general investors, making it more difficult to evaluate and more susceptible to misinterpretation. This lower transparency may increase uncertainty and lead to greater deviations of prices from fundamental values. In contrast, green innovation in B2C firms is typically more visible and easier to understand because it is embedded in consumer-facing products and marketing. This greater visibility may facilitate more accurate investor interpretation, potentially resulting in more muted valuation responses. However, these differences should be interpreted cautiously because the empirical evidence is sensitive to model specification and constrained by the small sample size.

These findings offer preliminary implications for investors, regulators, and managers. The stronger misvaluation effect in B2B firms suggests that clearer and more standardized reporting of green innovation activities may be beneficial. Regulators should encourage reliable and consistent disclosure standards to reduce investor uncertainty and mitigate potential mispricing. Investors—particularly in B2B contexts—should recognize that less

transparent green innovation activities are more difficult to evaluate and can contribute to pricing inefficiencies. More rigorous fundamental analysis may help investors avoid misinterpreting the valuation implications of such investments.

Additional sensitivity analyses suggest that the results vary across model specifications. In particular, the statistical significance of the key coefficients declines under more demanding specifications and alternative inference methods, including wild-cluster bootstrap procedures. These findings indicate that the documented relationship should be interpreted cautiously.

Managers should also avoid overemphasizing the short-term market benefits of green innovation. Although green innovation is essential for long-term competitiveness and environmental stewardship, firms may need to balance public visibility with substantive progress so that sustainability initiatives contribute to genuine long-term value creation rather than symbolic signaling.

This study uses the Thomson Reuters Eikon ESG green innovation score as a proxy for firms' environmental innovation activities. Although this metric is widely used in prior research, it is available for only a limited number of firms and may not fully capture the scope or authenticity of innovation efforts. Future research should consider more objective and granular indicators of green innovation, including green patent filings, patent citations, and environmental R&D expenditures. These alternative measures may help distinguish substantive innovation from symbolic innovation.

This study focuses on European firms to maintain comparability across regulatory and reporting environments. Although this improves internal consistency, the findings may not generalize fully to regions with different institutional settings. Future research could examine a broader international sample to determine whether the observed patterns persist across diverse regulatory environments. In addition, the small sample size and the sensitivity of the findings to model specification suggest that the results should be viewed as preliminary rather than conclusive.

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Appendix

〈Appendix 1〉 Definition of Variables

Variables	Measure
Misvaluation variables - MSVVariables	
MSV	The P/V ratio, where P is the price value or market capitalization. V reflects the firm's imputed intrinsic value, which is presented in part 3.2
Business sustainability variables	
GreenInv	The Environmental Innovation category score
Control variables	
Size	The natural logarithm of the total number of employees
Lev	Total liabilities over total assets
Growth	Percentage of total sales
ROA	Net income over total assets
CapEx	Capital expenditure scaled by total assets
Div	Dummy variable: takes 1 if the firm pays dividends and 0 otherwise

〈Appendix 2〉 List of ESI Firms in the Sample

Firm (B2B)	Year	Firm (B2C)	Year
Lonza _{SW} U	2010–2021	Solvay _{BG} U	2003–2021
Sika _{SW} U	2009–2021	Grifols, S.A. _{ES} U	2010–2021
Johnson Matthey _{UK} U	2003–2021	Repsol, S.A. _{ES} U	2008–2021
Chr. Hansen _{DK} O	2011–2021	MOL Magyar Olaj _{HN} U	2009–2021
Ems-Chemie _{SW} O	2011–2021	Eni _{IT} U	2009–2021
Victrex _{UK} O	2005–2021	Koninklijke _{NL} U	2003–2021
Croda _{UK} O	2005–2021	Akzo Nobel _{NL} U	2003–2021
		Equinor _{NW} U	2008–2021
		Yara _{NW} U	2008–2021
		Mayr-Melnhof Karton AG _{OE} U	2009–2021
		Polski Koncern Naftowy _{PO} U	2011–2021
		Novozymes _{DK} O	2004–2021
		Pharma Mar _{ES} O	2009–2021
		Galp Energia _{PT} O	2008–2021
		Roche _{SW} O	2009–2021

Note: Austria_{OE}, Belgium_{BG}, Denmark_{DK}, Hungary_{HN}, Italy_{IT}, Netherlands_{NL}, Norway_{NW}, Poland_{PO}, Portugal_{PT}, Spain_{ES}, Switzerland_{SW}, United Kingdom_{UK}. The final letter (O/U) mentions the overvaluation/undervaluation of firms.

〈Appendix Table A0〉 Sample construction

Panel A: Source Dataset	
Step	Number of firms
Initial global ESI firms with green innovation coverage	1,422
Firms with matched ESG (Eikon), financial (Worldscope), and analyst forecast (IBES; source dataset)	152
Panel B: This Study Sample Selection	
Step	Number of firms
Source dataset (Panel A)	152
Restrict to European firms	48
Require complete variables for MSV estimation (Eikon, Worldscope, IBES)	30
Require non-missing control variables	26
Require sufficient time series for lagged variables and fixed effects	22

Appendix Table A0 summarizes the sample construction process in detail. Importantly, the reduction in sample size reflects cumulative data integration and availability constraints rather than a single filtering step. The initial sample includes 1,422 firms drawn from a global universe of environmentally sensitive companies potentially engaged in green innovation activities.

After integrating multiple data sources, the final matched sample consists of 152 firms across 35 countries. This reduction primarily reflects the need to merge three specialized databases: Thomson Reuters Eikon (environmental innovation scores), Worldscope (financial statement data), and IBES (analyst forecasts used to construct misvaluation measures). Differences in coverage, reporting standards, and firm inclusion criteria across these databases prevent a substantial number of firms from being matched across all three sources. In particular, the limited availability of IBES analyst forecasts represents a major constraint in the matching process.

The study then applies additional restrictions based on research design considerations and data requirements. First, the study limits the sample to European firms to improve comparability across regulatory frameworks, institutional environments, and ESG disclosure practices. As a result of this geographic restriction, the sample decreases from 152 to 48 firms.

Second, estimating firm misvaluation within a panel framework requires the concurrent availability of all relevant variables. These variables include environmental innovation scores, financial statement variables, analyst forecasts, and a comprehensive set of control variables. Requiring consistent firm-year coverage across all variables further reduces the sample from 48 to 22 firms. In many cases, firms are excluded at this stage because incomplete IBES coverage or insufficient time-series observations prevent the construction of misvaluation measures and the estimation of firm fixed-effects models. The final sample consists of 22 firms and 319 firm-year observations. Overall, the reduction in sample size reflects the combined effects of integrating multiple data sources and satisfying the stringent data requirements of the empirical design rather than discretionary exclusion. Such constraints are common in studies combining ESG-related measures with analyst-based valuation metrics. Accordingly, the findings should be interpreted cautiously, given the limited sample size.

〈Appendix Table A1〉 Robustness Results with Firm and Year Fixed Effects

This table reports robustness regressions corresponding to Table 3 using firm and year fixed effects.

Variables	(1)	(2)	(3)
	ESI_{Full} MSV	ESI_{Over} MSV	ESI_{Under} MSV
$GreenInv_{t-1}$	0.002 (0.352)	0.002 (0.234)	0.004 (0.757)
MSV_{t-1}	0.283 (1.212)	0.788 (7.196)	0.147 (1.105)
$Size$	0.098 (1.207)	-1.823 (-2.484)	-0.131 (-0.899)
Lev	1.187 (1.201)	2.334 (1.006)	0.585 (1.738)
$Growth$	-0.500 (-1.353)	-0.078 (-0.160)	-0.742 (-0.928)
ROA	-0.022 (-1.224)	-0.019 (-0.482)	-0.002 (-0.214)
$CapEx$	-0.702 (-0.223)	0.703 (0.468)	-3.797 (-0.542)
Div	0.683 (1.022)	-0.402 (-6.499)	0.212 (0.665)
Obs	319	114	205
Adj. R2	0.191	0.460	0.224
F-statistic	2.483	-1.098	3.858
Durbin Watson	2.023	2.390	1.825
Hausman	0.000(FE)	0.000(FE)	0.000(FE)
Firm Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Standard Errors	Clustered by firm	Clustered by firm	Clustered by firm

Notes: t-values and F-statistics are based on firm-level clustered robust standard errors and are reported in parentheses. All regressions include firm and year fixed effects. All variables are defined in Appendix 1. Results from specifications that include country-by-year fixed effects are reported in Appendix Table A2.

〈Appendix Table A2〉 Robustness Results with Firm and Country-by-Year Fixed Effects

This table reports robustness checks for the baseline specifications that include firm fixed effects and country-by-year fixed effects.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	B2B			B2C		
	<i>ESI</i> _{Full} <i>MSV</i>	<i>ESI</i> _{Over} <i>MSV</i>	<i>ESI</i> _{Under} <i>MSV</i>	<i>ESI</i> _{Full} <i>MSV</i>	<i>ESI</i> _{Over} <i>MSV</i>	<i>ESI</i> _{Under} <i>MSV</i>
<i>GreenInv</i> _{t-1}	0.007 (1.154)	0.017 (1.676)	0.004 (5.000)	-1.623 (-0.001)	- (-)	0.005 (1.184)
<i>MSV</i> _{t-1}	0.247 (1.823)	-0.210 (-1.474)	-0.088 (-2.629)	-0.106 (-0.377)	0.805 (6.106)	0.021 (0.239)
<i>Size</i>	0.070 (2.233)	-0.469 (-3.298)	-2.128 (-1.888)	-0.215 (-0.951)	- (-)	0.031 (0.204)
<i>Lev</i>	-0.275 (-0.639)	-2.414 (-1.198)	0.573 (9.114)	3.030 (1.174)	- (-)	1.190 (4.602)
<i>Growth</i>	-0.127 (-0.348)	0.595 (3.367)	-0.019 (-2.714)	-0.284 (-0.311)	- (-)	-0.777 (-0.849)
<i>ROA</i>	-0.019 (-1.100)	-0.071 (-2.237)	-0.005 (-9.806)	-0.012 (-0.580)	- (-)	-0.003 (-0.222)
<i>CapEx</i>	-1.851 (-1.133)	-2.166 (-1.292)	-0.304 (-4.074)	-4.093 (-0.400)	- (-)	-10.863 (-1.418)
<i>Div</i>	- (-)	- (-)	20.121 (1.882)	0.934 (0.976)	- (-)	0.159 (0.650)
<i>Constant</i>	0.773 (1.948)	7.006 (7.192)	- (-)	1.241 (0.732)	0.413 (-)	0.252 (0.200)
Observations	100	56	44	219	58	161
AdjR2	0.294	0.652	0.836	0.299	0.000	0.284
F-statistic	5.172	-7.167	4.071	3.766	3.728	-4.598
Hausman	0.000(FE)	0.000(FE)	0.000(FE)	0.000(FE)	0.000(FE)	0.000(FE)
Firm Fixed Effects	Yes		Yes	Yes		
Year Fixed Effects	Yes		Yes	Yes		
Standard Errors	Clustered by firm		Clustered by firm		Clustered by firm	

Notes: t-values and F-statistics are based on firm-level clustered robust standard errors and are reported in parentheses. All regressions include firm fixed effects and country-by-year fixed effects. In some subsamples, firm fixed effects cannot be jointly estimated with country-by-year fixed effects because of nesting or perfect collinearity; in these cases, the specification is adjusted accordingly, and variables fully absorbed by the fixed effects are omitted and reported as “-”. All variables are defined in Appendix 1.

〈Appendix Table A3〉 Wild Cluster Bootstrap Inference

This table reports wild cluster bootstrap inference for the coefficient on lagged green innovation ($GreenInv_{t-1}$) in the baseline regression specifications. All models include firm and year fixed effects. Wild cluster bootstrap p-values are computed using 999 replications with clustering at the firm (ISIN) level.

Sample	Coefficient ($GreenInv_{t-1}$)	Clustered t-statistic	Wild bootstrap p-value	Observations
ESL_Full	0.0046	1.886	0.513	319
ESL_Over	0.0082	2.506	0.630	114
ESL_Under	0.0051	1.529	0.530	205

Notes: The table reports coefficient estimates and corresponding inference based on wild cluster bootstrap procedures. Bootstrap p-values are computed using 999 replications with clustering at the firm (ISIN) level. All specifications include firm and year fixed effects.

〈Appendix Table A4〉 Leave-one-firm-out Sensitivity Analysis

Statistic	$GreenInv(t-1)$
Baseline coefficient	0.0046
Minimum LOFO coefficient	0.0027
Maximum LOFO coefficient	0.0054
Share with the same sign as baseline	100%
Number of LOFO regressions	22

Notes: This table reports the sensitivity of the estimated coefficient on lagged green innovation to the exclusion of individual firms. Each leave-one-firm-out regression excludes one firm at a time from the baseline specification.

〈Appendix Table A5〉 Winsorization Sensitivity

Specification	Winsorization	Coef. ($GreenInv_{t-1}$)	t-stat	p-value	N
Baseline	None	0.005	1.927	0.055	319
Robust	1%	0.004	2.534	0.012	319
Robust	5%	0.004	2.500	0.013	319

Notes: This table reports estimates from the baseline specification using alternative winsorization thresholds for firm misvaluation. Continuous variables are winsorized at the 1st and 99th percentiles (1%) and the 5th and 95th percentiles (5%). Standard errors are clustered at the firm level.

