Unsustainable Sustainability? ESG Resilience under Macro-Financial Uncertainty

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Acknowledgements and Disclosure Statement: The authors received no external financial support for this research. The authors declare that they have no financial relationships or other potential conflicts of interest relevant to this paper.

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Abstract

Can firms sustain their environmental, social and governance (ESG) performance when macro-financial uncertainty intensifies? This study examines how financial stress, climate policy uncertainty and oil price uncertainty relate to both the level and stability of corporate ESG performance. The results show that all three sources of uncertainty are negatively associated with ESG performance and positively associated with ESG volatility, suggesting that uncertainty is associated not only with weaker sustainability outcomes but also with greater instability in firms' ESG trajectories. Quantile regressions further reveal that these relationships vary across the conditional distributions of ESG performance and volatility, with weaker ESG performers particularly vulnerable to adverse uncertainty shocks and firms with more volatile ESG outcomes experiencing greater instability. Additional analyses indicate that financial flexibility and board gender diversity provide some protection against ESG instability, although their moderating effects vary across uncertainty types and outcomes. Cash holdings offer partial evidence of a financial transmission channel, particularly for ESG performance under climate policy and oil price uncertainty only but not for ESG volatility. Overall, the findings highlight the importance of distinguishing the level of corporate sustainability from its temporal consistency and suggest that firms' capacity to sustain ESG outcomes depends partly on their exposure to external macro-financial uncertainty and their financial and governance characteristics.

Keywords: ESG performance; ESG volatility; financial stress; climate risk; oil price uncertainty; financial flexibility; board gender diversity

1. Introduction

The growing focus on environmental, social, and governance (ESG) considerations has reshaped corporate decision-making and positioned sustainability as a central pillar of long-

term value creation (Henisz et al., 2019). Firms are increasingly expected to integrate ESG principles into their strategic and operational frameworks, not only to meet stakeholder expectations (Cornel & Shapiro, 2021) but also to generate sustainable economic and social value (Serafeim, 2020), even amid an evolving macro-financial risk landscape. For example, despite growing political opposition and economic uncertainty, companies continue to integrate ESG considerations into long-term corporate strategy by expanding climate disclosures and strengthening sustainability governance[1]. However, this shift towards sustainability is unfolding in an era characterised by increased macro-financial uncertainty, driven by financial market stress, geopolitical tensions, climate policy ambiguity, inflationary pressures, and energy price volatility[2]. These conditions create a challenging environment in which firms must reconcile long-term sustainability commitments with short-term economic and financial constraints. Despite ESG attracting substantial attention from policymakers, investors, and corporate leaders, relatively little is known about how macro-financial uncertainty affects firms' ability to maintain consistent ESG performance. This growing importance of ESG in both academia and industry therefore warrants further investigation into the dynamic relationship between macro-financial uncertainty and corporate sustainability outcomes.

Macro-financial policy uncertainties and their influence on ESG practices have emerged as a focal point of scholarly inquiry in recent years (e.g., Ongan et al., 2026; Wang et al., 2025; Shi et al., 2025). While these studies provide valuable insights into the relationship between different forms of uncertainty and corporate ESG performance, limited attention has been paid to the distinct implications of financial stress, oil price uncertainty, and climate policy uncertainty for ESG outcomes. Organisations face mounting pressures to integrate sustainable and responsible business practices (European Commission, 2023; FSB, 2022; NGFS, 2024). At the same time, rising uncertainties, i.e., economic conditions, climate change, energy security, and environmental risks, are exerting pressure not only on firms' financial performance but also on their ESG-driven sustainability strategies (Alnafrah 2024; Jiang et al. 2024; Naseer, Guo, Bagh, et al. 2024; Su et al. 2025). For example, when confronted with uncertainties such as climate change and resource scarcity, firms may struggle to develop effective countermeasures, thereby affecting their ESG performance (Wan et al., 2024).

[1] See article entitled, "ESG might be more resilient than critics expect", in the Financial Times (published October 4, 2025). https://giftarticle.ft.com/giftarticle/actions/redeem/848c8b0c-1838-41f9-876a-bdf0c219344f.
[2] See Global Risk Report (2026) by World Economic Forum. https://reports.weforum.org/docs/WEF_Global_Risks_Report_2026.pdf.

Likewise, increased macro-financial uncertainty may discourage long-term sustainability investments, as firms reallocate financial resources towards core business operations, potentially resulting in delayed ESG initiatives or less consistent ESG performance. Recent global events, including the COVID-19 pandemic and the energy crisis following the Russia-Ukraine conflict and the Middle East conflict, have further demonstrated how external shocks can divert managerial attention and financial resources from long-term sustainability objectives[3]. These developments raise an important yet underexplored question: *to what extent can firms sustain consistent ESG performance amid pervasive uncertainty?*

To motivate this question empirically in our study, Figure 1 presents the standardized trends in ESG performance, ESG volatility, and key uncertainty measures, including financial stress, climate risk, and oil price uncertainty, over the last two decades for our sample of European-listed firms. Two important patterns emerge. First, while ESG performance exhibits a gradual upward trajectory, ESG volatility remains pronounced, suggesting that firms' sustainability engagement is not uniformly stable even as performance improves. Second, fluctuations in uncertainty measures appear to coincide with shifts in both ESG performance and its variability, indicating that ESG outcomes may be closely linked to broader macro-financial conditions. Together, these stylised facts suggest that ESG is not evolving in isolation, but within an environment characterised by episodic and persistent uncertainty shocks (Wang et al., 2025; Ongan et al., 2026; Shi et al., 2025).

[INSERT FIGURE NO 1 HERE]

Despite these suggestive patterns, the existing literature has largely overlooked the role of macro-financial uncertainty in shaping ESG dynamics, particularly regarding their stability. Prior studies predominantly treat ESG performance as a relatively persistent firm characteristic, focusing on its implications for firm value, risk, and financial performance (Rahat & Nguyen, 2024; Wang et al.,2026; Zheng et al., 2025). Yet, macro-financial uncertainty may weaken firms' ability to sustain consistent ESG performance by increasing financial and operational pressures, including financing constraints, regulatory ambiguity, and volatile operating conditions. In response to these pressures, firms may reallocate resources towards core business operations and liquidity preservation, potentially crowding out long-term and discretionary

[3] See article entitled, "For Energy, ESG Now Means Economics, Security and Geopolitics", in the Bloomberg (published March 6, 2026). https://www.bloomberg.com/opinion/articles/2026-03-06/iran-war-economics-security-and-geopolitics-are-the-new-esg.

investments such as ESG initiatives. Firms are also likely to respond heterogeneously to these shocks. While some continue to prioritise sustainability despite adverse conditions, others may reduce or postpone ESG-related activities to alleviate short-term financial pressures. This heterogeneous response points to two distinct forms of ESG engagement. On the one hand, ESG-embedded firms are likely to maintain relatively stable sustainability performance despite adverse macro-financial conditions, indicating that ESG is integrated into their long-term strategic orientation. On the other hand, ESG-opportunistic firms may be more likely to pursue symbolic ESG strategies, with sustainability initiatives becoming contingent on favourable economic conditions, thereby leading to greater fluctuations in ESG performance over time.

This study hence advances the literature by reconceptualising ESG outcomes along two critical dimensions: performance and volatility. Focusing solely on the level of ESG performance provides an incomplete understanding of corporate sustainability behaviour. Instead, ESG volatility, which captures fluctuations in ESG performance over time, represents an equally important yet largely overlooked dimension of sustainability risk. From a theoretical perspective, this distinction is grounded in real options theory and precautionary behaviour under uncertainty (Dixit & Pindyck, 1994; Bloom, 2009). As uncertainty increases, we argue that firms tend to delay irreversible investments and accumulate liquidity buffers (Bates et al., 2009), leading to underinvestment in long-term projects such as ESG initiatives. At the same time, shifting economic conditions and strategic adjustments can generate variability in ESG engagement, resulting in heightened ESG volatility.

Building on this framework, we examine how macro-financial uncertainty, proxied by global financial stress, climate policy uncertainty (CPU), and oil price uncertainty (OPU), affects both ESG performance and ESG volatility. These measures represent complementary sources of uncertainty associated with financial instability, regulatory ambiguity, and commodity market fluctuations. By integrating these sources of uncertainty, this study advances understanding of how system-wide shocks influence corporate sustainability behaviour, not only by affecting firms' ESG outcomes but also by altering the consistency and resilience of their sustainability commitments. Our analysis focuses on STOXX 600 firms from 2002 to 2024, providing an appropriate setting where firms are at the forefront of sustainability adoption, highly exposed to global financial, energy, and policy shocks, and subject to evolving European sustainability regulations and climate objectives (Agoraki et al., 2023; & Pinto-Barga et al., 2026). Empirically, we employ a multi-method approach that combines panel regression, quantile

regression, and two-stage least squares (2SLS) estimation using an interaction-based instrument. This approach allows us to address endogeneity concerns while uncovering distributional heterogeneity in the effects of uncertainty. Our findings reveal that macro-financial uncertainty negatively affects ESG performance while increasing ESG volatility. Our findings suggest that uncertainty not only weakens firms' sustainability engagement but also undermines the stability of their ESG trajectories.

Moreover, the quantile regression analysis uncovers substantial heterogeneity across firms. The adverse impact of uncertainty on ESG performance is more pronounced among firms in the lower and middle segments of the ESG distribution, indicating that weaker ESG performers are particularly vulnerable to uncertainty shocks. In contrast, firms with stronger ESG profiles exhibit relatively greater resilience, although the negative effect persists across all quantiles. For ESG volatility, the results show a convex, increasing pattern across the distribution, implying that uncertainty disproportionately amplifies instability among firms already characterised by higher ESG volatility. This divergence highlights structural asymmetries in how firms respond to uncertainty, reinforcing the need to move beyond average effects.

To further explore the underlying mechanisms, we conduct channel and moderation analyses. The results identify cash holdings as a key transmission channel through which uncertainty affects ESG outcomes. Consistent with precautionary motives, firms facing higher uncertainty increase liquidity buffers, which in turn constrains ESG investment and contributes to greater volatility. Additionally, we examine the moderating roles of financial flexibility and governance quality. While financial flexibility, proxied by the interest coverage ratio (ICR), and governance attributes such as gender diversity exhibit modest stabilising effects, their influence remains limited, suggesting that firm-level characteristics can only partially offset the broader impact of macro-financial uncertainty.

This study makes several important contributions to the growing literature on uncertainty and corporate sustainability. First, it extends the ESG literature by examining not only uncertainty's effect on ESG performance but also on ESG volatility, offering a broader view of how macro-financial uncertainty shapes both the level and stability of sustainability outcomes. While prior studies have largely focused on average ESG performance (e.g.; Chen et al., 2024; Wang et al., 2025), this study highlights that uncertainty also affects the consistency of firms' sustainability commitments, which is equally important for long-term stakeholder confidence and regulatory compliance.

Second, the study identifies the mechanisms and moderators shaping this relationship by examining how firm-level financial capacity and governance quality mitigate ESG instability. Specifically, it demonstrates that financial resilience, proxied by the interest coverage ratio, serves as a critical buffer, enabling firms to sustain ESG commitments during periods of uncertainty by reducing pressure to divert resources toward short-term survival. Furthermore, the study highlights the role of governance mechanisms, demonstrating that gender-diverse boards can improve their stability. However, it also reveals that this governance effect is context-dependent, particularly under severe financial constraints.

Third, the study advances understanding of the mechanisms underlying the relationship between uncertainty and corporate sustainability by examining the mediating role of cash holdings (Alnahedh et al., 2019). The findings provide partial evidence that cash holdings help explain the relationship between uncertainty and ESG performance, particularly under climate policy uncertainty and oil price uncertainty. However, this channel is not consistently supported across all uncertainty measures or ESG outcomes, suggesting that the financial transmission of uncertainty is context dependent. These results highlight the potential importance of firms' liquidity management in sustaining ESG performance under uncertain conditions, while indicating that cash holdings alone cannot fully explain the relationship between macro-financial uncertainty and corporate sustainability.

Finally, the study contributes to the literature on differential firm responses by demonstrating that the effects of uncertainty vary across firms. Rather than affecting all firms uniformly, uncertainty reinforces existing disparities: firms with weaker ESG performance experience greater deterioration, whereas firms with stronger ESG profiles remain relatively resilient. Similarly, firms with historically unstable ESG practices exhibit greater volatility, while firms with more stable ESG performance maintain greater consistency in their sustainability outcomes.

The rest of the study is structured as follows: Section 2 adds the literature review and hypothesis development, while Section 3 highlights the data and methodology; Section 4 focuses on findings analysis followed by a discussion, and Section 5 concludes the study with policy implications and future research directions.

2. Literature review and hypothesis development

ESG outcomes do not change independently of the macro-financial environment in which a firm operates. ESG performance is relatively persistent corporate policy driven by stakeholder and managerial orientation to sustainability (Sheng et al., 2026); however, maintaining and improving such performance still requires allocating financial, managerial and organisational resources over time. Environmental investment, employee and community initiatives, sustainability-related innovation, governance improvement and ESG disclosure can vary to a greater extent with changes in corporate resources (Heubeck and Ahrens, 2025) and macro factors, such as monetary policy uncertainty (Abakah et al., 2024), environmental law (He et al., 2023), and social trust (Zhu and Wang, 2024). Shocks that affect firms' financing conditions, expected cash flows, investment opportunities or perception of future economic conditions can potentially weaken both firms' capacity and incentives for ESG commitments and engagement. This is particularly important under heightened uncertainty. Although uncertainty does not always constitute a homogeneous shock, different sources of uncertainty influence corporate decisions through partially distinct but interconnected transmission mechanisms. Adverse macro-financial conditions can increase external financing costs, increase liquidity issues, and increase operational vulnerability, which can potentially affect firms prioritise activities associated with more immediate financial payoffs. In addition, uncertainty can affect ESG-related decision-making through changes in stakeholder expectations, pressure, managerial expectations and investor risk perception. Therefore, it seems that corporate sustainability decisions need to be viewed as contingent on broader financial, regulatory, and energy and environmental conditions rather than as a side or isolated corporate choice.

These transmission mechanisms influence the level of ESG performance as well as its stability over time. Here, the distinction between ESG performance and ESG volatility is important as ESG performance captures the extent to which firms achieve ESG-related outcomes, whereas ESG volatility captures the degree to which such outcomes fluctuate in response to changing economic conditions. Moreover, ESG scores capture the level of sustainability performance; they may conceal temporal instability driven by external uncertainties, strategic adjustments and disclosure incentives (Berg et al., 2022; Christensen et al., 2022; Delmas & Burbano, 2011). Hence, our argument relies on the basis that a firm could maintain a relatively high level of ESG performance but may exhibit fluctuations when exposed to external shocks. Next, ESG

embedded firms are likely to show stable ESG outcomes during the period of heightened uncertainty compared to firms with an ESG opportunistic attitude, as firms might also consider ESG as peripheral (Aguinis & Glavas, 2013). Therefore, examining both ESG performance and ESG volatility will provide a more comprehensive assessment of whether external uncertainty affects both the level and stability of corporate sustainability outcomes. Considering the framework, we use financial stress, climate policy uncertainty and oil price uncertainty, which represent three economically distinct sources of instability covering financial, environmental and energy-related issues. Financial stress is expected to influence ESG outcomes through tighter financing conditions, deteriorating liquidity, greater risk aversion and resource constraints. While climate policy uncertainty related to ambiguity regarding the timing, direction and stringency of future climate regulation is expected to change firms' expectations regarding transition costs and returns to low-carbon emissions, in consequence, this can encourage postponement or reassessment of sustainability-related expenditures. Next, oil price uncertainty is likely to affect production costs, expected cash flow, investment incentives and the relative attractiveness of conventional and low-carbon technologies. Although they arise from different sources, these uncertainties can shape firms' ESG decisions by altering financial conditions, investment incentives, and expectations about future risks. They may therefore affect not only ESG performance, but also the stability of ESG outcomes over time.

2.1 Financial stress and ESG

Prior studies have largely focused on the effect of economic policy uncertainty on ESG performance (Jia and Li, 2020; Ilyas et al., 2022; Abakah et al., 2024). Less attention has been paid to broader episodes of financial stress, even though financial disruptions can directly constrain firms' liquidity, financing capacity, and resource allocation decisions. Examining how firms adjust ESG activities during periods of financial stress therefore provides a useful test of whether sustainability is treated as a strategically embedded capability or as a discretionary investment that is scaled back when financial constraints intensify. From a trade-off perspective, firms' financial flexibility enables managers to allocate limited resources across competing priorities under uncertainty (Dreyer & Grønhaug, 2004). As firms face greater pressure to preserve liquidity and maintain financial stability, they may reduce investments, including green innovation and other ESG initiatives.

Alternatively, firms make decisions by balancing costs and benefits when facing financial constraints. When resources become limited, managers are more likely to cut expenditures that are perceived as less essential or provide delayed financial returns. Firms typically reduce spending on environmental activities, such as reducing carbon emissions, improving energy efficiency, and adopting renewable energy technologies. They also reduce investment in social and governance activities by cutting expenditures on employee training and development, workplace health and safety programmes, diversity and inclusion initiatives, and cybersecurity infrastructure, as these activities often generate long-term rather than immediate financial benefits (Cohn & Wardlaw, 2016; Sun & Gunia, 2018).

Moreover, in light of short-termism, managers face increasing pressure from investors and market-related external factors, such as analyst coverage and stock price volatility, to focus on near-term financial metrics (Sampson & Shi, 2023). Therefore, managers focus on short-term financial performance, reducing investments in environmental compliance upgrades, social welfare activities, and governance reform initiatives (Flammer & Bansal, 2017; Fan et al., 2024). Hence, this is likely to yield an overall reduction in ESG performance due to rising financial stress. We further argue that financial stress influences not only ESG performance but also the volatility of ESG engagement. For example, firms under financial stress not only downgrade their ESG performance but also exhibit fluctuations in ESG engagement during periods of high financial stress. In contrast, lower levels of financial uncertainty provide firms with greater flexibility to sustain ESG commitments, resulting in more stable patterns of ESG engagement. We, therefore, propose our first hypothesis as;

> H_1: *Financial stress is negatively associated with ESG performance and positively associated with ESG volatility*.

2.2 Climate policy uncertainty and ESG

Climate change is considered one of the major systemic risks for global society in the twenty-first century (Hambira et al., 2020; Li et al., 2021). Existing literature shows mixed effects, demonstrating that climate policy uncertainty affects ESG performance both positively (Persakis, 2024; Ge & Zhang, 2025) and negatively (Jia & Li, 2020). This could be due to contrasting views, such as expectations of stricter future climate regulations may encourage firms to accelerate investments in cleaner technologies and strengthen their ESG strategies. Conversely, uncertainty surrounding the timing, scope, or stringency of climate policies may discourage long-term sustainability investment commitment or divert resources toward short-

term operational priorities. Climate policy uncertainty is therefore more than a compliance challenge; it shapes firms' long-term capacity for sustainable development (Farooq et al., 2025). Consequently, it can represent either a risk or an opportunity, depending on how firms perceive and respond to it.

From the perspective of trade-off theory, firms are likely to reassess their ESG investments when climate policy is uncertain, weighing the potential benefits of sustainability initiatives against the risks associated with an unclear regulatory environment. This is because firms might not be sure which of their ESG initiatives could be more/less aligned with climate policy. In light of the short-termism concept, managers facing earnings pressure may have limited willingness to commit resources to ESG investments when the future direction of climate policy is ambiguous. This may be because misjudging the future direction of climate regulation can have immediate and significant financial consequences, reinforcing incentives to defer long-term ESG investments. Consistent with this view, empirical evidence suggests that firms tend to reduce ESG engagement during periods of elevated climate policy uncertainty (Ge & Zhang, 2025). Beyond its impact on ESG performance, climate policy uncertainty may also affect the stability of ESG outcomes by creating unpredictable and divergent firm responses over time. As firms adjust their sustainability strategies in response to evolving policy signals, ESG trajectories may become less consistent, increasing volatility even among firms with moderate ESG performance. Therefore, climate policy uncertainty not only influences the level of ESG performance but also destabilises ESG outcomes by generating irregular and less predictable sustainability trajectories.

> H_2: *Climate policy uncertainty is negatively associated with ESG performance and positively associated with ESG volatility.*

2.3 Oil price uncertainty and ESG

Prior studies suggest that ESG engagement increases during periods of oil market volatility, not just for ethical reasons (Zhang et al., 2024; Benlemlih et al., 2024), but also as a strategic risk management reason (Li et al., 2023). This relationship is particularly important because energy markets are closely linked to the environmental dimension of ESG. Since oil is a major production input and a primary source of emissions, fluctuations in oil prices directly affect firms' operations and sustainability strategies. Oil price uncertainty is also a macroeconomic risk because of its pervasiveness across industries. For example, a firm might be affected

through input cost volatility, demand-side contraction, supply-side disruption as well as shifts in investment sentiment due to oil price uncertainty (Kilian & Park, 2009; Kang et al., 2017).

In light of trade-off theory, firms are likely to revise capital allocations where returns are uncertain due to oil price swings, which makes revenue and cost streams unpredictable. Therefore, higher oil price uncertainty is expected to reduce the level of ESG engagement while increasing its volatility, as firms adjust sustainability investments in response to changing financial conditions. In contrast, when oil price uncertainty is lower, firms are more likely to sustain ESG investments, resulting in higher and more stable ESG engagement. From a short term perspective, oil price uncertainty is likely to shift managerial attention towards immediate financial performance. As volatile oil prices increase uncertainty over future revenues and costs, firms face stronger pressure to preserve liquidity and maintain financial resilience. In addition, oil price uncertainty is unlikely to affect all firms equally over time. Energy-intensive firms may increase ESG engagement during periods of high uncertainty to signal resilience, while lower uncertainty may enable firms to expand ESG initiatives due to improved financial flexibility and lower energy costs (Yoon & Ratti, 2011). Hence, we argue that the ups and downs of oil price uncertainty may not uniformly affect ESG performance but it creates dynamic response, captured by ESG uncertainty.

> H_3: *Oil price uncertainty is negatively associated with ESG performance and positively associated with ESG volatility.*

3. Data and methodology

Our sample of firms consists of the STOXX Europe 600 index, spanning 17 countries and 10 industries over 23 years from 2002 to 2024. There are several reasons behind choosing STOXX 600 index to study how corporate sustainability responds to macro-financial and policy-related uncertainty. First, European firms, in particular the STOXX 600, are global leaders in ESG adoption, which makes it an ideal setting for examining how firms with already established sustainability orientation respond to different sources of uncertainty, allowing us to isolate variation in the maintenance and stability of ESG engagement once a baseline sustainability commitment is in place. We use the STOXX Europe 600 because it covers established, listed European firms, and European companies have some of the most mature ESG and

sustainability reporting practices. This makes them a relevant context for studying corporate sustainability[4].

Second, the STOXX 600 firms are highly internationalised with cross-border revenue, supply chain and financing exposures, making them exposed to Oil price shocks, Financial market stress and Climate policy changes. Third, European firms are under strict regulations like the EU taxonomy regulation and Corporate Sustainability Reporting Directive (CSRD), which are likely to shape how firms manage ESG compared to firms in jurisdictions with relatively less voluntary disclosure regimes. Finally, the European Green Deal's objective of climate neutrality by 2050 sets European firms under sustained pressure to align with an economy-wide decarbonisation trajectory. Considering all these features, STOXX 600 firms provide an ideal setting for examining the effects of financial stress, climate policy and energy-related uncertainty on ESG performance and ESG volatility.

Our study relies on two dependent variables, ESG performance and ESG uncertainty, to capture the level and risk dimension of corporate sustainability outcomes. ESG performance score is retrieved from LSEG Workspace, a widely used data source in ESG studies that scores firms on environmental, social and governance pillars derived from company disclosures. ESG uncertainty is the 3-year rolling standard deviation of the ESG score, following the standard academic practice of measuring volatility. We conjecture that a firm can sustain a high average ESG score while still exhibiting considerable year-to-year instability, and this instability is conceptually distinct from the level of ESG itself.

We consider three measures of uncertainty to capture uncertainty across finance, commodity, and environment, considering the financial stress index, which reflects disruptions in the functioning of financial institutions, asset markets, and credit conditions, oil price uncertainty index, which represent the level of uncertainty about future oil prices and climate policy uncertainty which is a PCA based four standardized indicators such as; transition concern, transition risk, physical concern, and physical risk respectively. All of these uncertainty variables are extracted from economic policy uncertainty index website[5]. This reflects the view

[4] To read that European companies have relatively established sustainability-reporting practices and are increasingly adopting formal sustainability targets and reporting frameworks, Available here; https://kpmg.com/dk/en/esg/survey-of-sustainability-reporting-2024.html.

[5] See: https://www.policyuncertainty.com/.

that uncertainty is not a single homogeneous shock but arises from different sources that can transmit to firms through different channels. Financial stress refers to the degree of strain in financial markets, reflecting disruptions in the functioning of financial institutions, asset markets, and credit conditions. Oil Price Uncertainty (OPU) measures the level of uncertainty about future oil prices, typically derived from time-varying or stochastic-volatility-based models of oil price dynamics rather than the price level itself, since it is the *unpredictability* of future prices, not price direction, that is likely to affect firms' investment and cash-flow decisions. Finally, climate risk uncertainty is a composite index constructed based on the Principal Component Analysis (PCA) of four standardised indicators: transition concern, transition risk, physical concern, and physical risk. It measures the degree of uncertainty surrounding government policies related to climate change, including regulations, carbon pricing, environmental laws, and energy transition policies, and is preferred over a single indicator because transition- and physical-risk perceptions can move independently and even in opposite directions depending on the nature of the underlying climate news, so collapsing them via PCA avoids conflating two conceptually distinct sources of climate-related uncertainty into one variable.

Finally, the analysis controls for both firm- and country-specific characteristics likely to affect ESG performance and ESG uncertainty independently of the uncertainty channels of interest. At the firm level, the study includes profitability (ROA), size, liquidity, leverage, growth opportunities (Tobin's Q), firm age, sales growth, market power (the Lerner index) and board size, reflecting the established finding that firms with greater profitability and financial slack are better positioned to sustain ESG-related expenditure, while larger, more mature firms typically face greater stakeholder visibility and disclosure pressure, and firms with greater market power may have more discretionary resources to allocate toward sustainability initiatives without compromising short-term competitiveness. At the country level, economic growth and inflation are included to account for the broader macroeconomic environment in which firms operate, since national economic conditions can shape both the resources available for ESG investment and the regulatory and stakeholder pressures firms face, independently of firm-specific circumstances. The definitions, constructions and sources of the variables are illustrated in the Appendix A1.

3.1 Empirical model

Consistent with prior studies in the uncertainty and ESG literature (Wang et al., 2025; Shi et al., 2025; & Tan et al., 2025), our study uses the following baseline equation to examine the effect of financial stress, oil price uncertainty and climate policy uncertainty on ESG performance and ESG uncertainty.

$$ESG\ Score_{it} = \alpha + \beta Uncertainty_{it} + \sum_{i=1}^{N} \Upsilon Controls_{it} + e_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$ESG\ Uncertainty_{it} = \alpha + \beta Uncertainty_{it} + \sum_{i=1}^{N} \Upsilon Controls_{it} + e_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where $_i$ and $_t$ are firms and years, respectively. The dependent variable in Equation 1 is ESG performance and the independent variables of interest include financial stress, oil price uncertainty, and climate policy uncertainty. The control variables include both firm- and country-specific variables supported by earlier studies and presented in Appendix 1. Equation 2 considers the three-year rolling standard deviation of ESG as the ESG risk/ uncertainty, keeping all other variables the same on the right-hand side of the equation as in Equation 1. All the continuous variables are winsorised.

A concern with estimating Equations 1 and 2 by ordinary least squares (OLS) is that the relationship between uncertainty and ESG outcomes is unlikely to be strictly exogenous. Reverse causality is a plausible threat here because firms with weaker ESG performance may themselves become more exposed to financial stress, rather than financial stress simply driving down ESG scores. Measurement error in our uncertainty proxies, together with potential multicollinearity among the control variables, could further bias OLS estimates and inflate the standard errors attached to them. To address these concerns, we employ a two-stage least squares instrumental variable (2SLS-IV) approach, following the broader corporate finance literature on handling endogeneity in panel settings (Roberts & Whited, 2013; Wooldridge, 2010). This strategy allows us to isolate the variation in uncertainty that is plausibly exogenous to firm-level ESG outcomes, thereby providing more credible estimates of the causal effect of uncertainty on both ESG performance and ESG volatility

While the panel and 2SLS-IV estimates identify the average effect of uncertainty across the sample, they implicitly assume that this effect is constant across the entire ESG distribution an assumption that may not hold if firms at different points in that distribution respond to

uncertainty in systematically different ways. Since our interest lies specifically in whether uncertainty affects strong and weak ESG performers differently, rather than only in the average firm, we complement the mean-based estimates with quantile regression, following the methodology originally developed by Koenker and Bassett (1978). Quantile regression allows the coefficient on uncertainty to vary across selected points of the conditional distribution of the dependent variable, rather than restricting it to a single average effect. We estimate this model at the 25th, 50th, 75th, and 95th percentiles of both ESG performance and ESG uncertainty, specified as follows:

$$Q_{0.25}(ESG/ESG\ uncertainty) = \alpha_{0.25} + \beta_{0.25,1}Uncertainty + \delta_{0.25,2}Controls + \varepsilon_{0.25it} \quad \textit{(3)}$$

$$Q_{0.95}(ESG/\ ESG\ uncertainty) = \alpha_{0.95} + \beta_{0.95,1}Uncertainty + \delta_{0.95,2}Controls + \varepsilon_{0.95it} \quad \textit{(4)}$$

4. Result analysis

4.1 Descriptive statistics

Table 1 reports summary statistics for the variables used in the analysis, based on 6,684 firm-year observations in the baseline model examining the relationship between climate policy uncertainty and ESG performance[6]. The dependent variables, ESG performance and ESG uncertainty, have means of 61.49 and 4.54 respectively, with ESG performance showing a fairly wide spread (SD = 19.16, ranging from 13.30 to 90.12) that points to meaningful cross-sectional variation in sustainability outcomes, while ESG uncertainty is right-skewed (median of 3.498 against a mean of 4.54, maximum of 16.38), suggesting that most firms show modest fluctuation in ESG scores but a subset experience considerably more erratic performance, consistent with the divergence documented later in the quantile results. Among the focal uncertainty variables, financial stress is available for a smaller sample reflecting limited data availability across our period and country coverage rather than selective sampling, which we account for in our robustness checks. Climate risk uncertainty, constructed via principal component analysis, has a mean close to zero (-0.132) by construction with values ranging from -3.10 to 4.06, consistent with its nature as a standardized composite index; and oil price uncertainty has a considerably higher mean (117.39) and standard deviation (40.07) given its construction from raw price-based volatility measures, with its range (70.74 to 228.72) pointing to substantial variation in oil market conditions over the sample period. The control variables further support the suitability of the sample: firm size (mean = 23.21) and age (mean = 47.83 years) indicate a set of relatively large, established firms consistent with the STOXX 600 sampling frame, leverage (mean = 0.25) and liquidity (mean = 0.23) fall within ranges typical of large European listed firms, Tobin's Q (mean = 1.48, up to 9.47) suggests reasonable variation in market valuation, board size averages 11 members in line with governance norms for large-cap European firms, and GDP growth and inflation show sufficient dispersion (SD = 2.71 and 1.92, respectively) to capture meaningful macroeconomic heterogeneity across the panel, together indicating adequate cross-sectional and time-series variation for the panel, quantile, and instrumental variable analyses that follow. Table 2 shows the correlation matrix

[6] Summary statistics are based on the baseline climate policy uncertainty model; the financial stress and oil price uncertainty models use different estimation samples due to differences in data availability for the respective independent variables and control variables.

among the study variables with lower value indicates non-existence of multicollinearity problem. Appendix A2 shows sample observations distribution by countries and industries.

[INSERT TABLE NO 1 & 2 HERE]

4.2 Main results

Our results in Table 3 show the effect of uncertainty on ESG performance and ESG uncertainty correspondingly. Models 1 to 3 in Table 3 show that financial stress, climate policy uncertainty and oil price uncertainty affect ESG performance negatively, demonstrating that the rise of uncertainty, including financial, energy and environmental decrease the ESG performance of the firms. This indicates that firms experiencing greater uncertainty tend to focus on short-term gains, ignoring long term sustainability targets, focusing and diverting resources from ESG initiatives to other areas that strengthen financial stability. This is because, in such scenarios, businesses experience increasing pressure in response to the resources available to them, requiring them to spend more and divert more resources from sustainability activities to survival. ESG strategies therefore tend to become inconsistent and fragmented, reducing their effectiveness and undermining the overall commitment to sustainable business practices. Our result of a negative effect of uncertainty on ESG performance is consistent with prior studies of Qureshi et al. (2024), who find that non-financial firms restrict environmental and governance-related activity and prioritise short-term survival during periods of elevated economic policy uncertainty. Similar findings are also documented by the study of Ge & Zhang (2025), who find the climate specific uncertainty affects operational risk and resource constraints, echoing the findings above. The negative climate policy uncertainty result is further corroborated by Niu et al. (2025), who show that climate policy uncertainty deteriorates ESG performance in energy firms by intensifying operational risk, customer concentration and financing constraints, a resource-access channel consistent with the mechanism proposed here. For oil price uncertainty, our finding aligns with Hassen & Hamdi (2022), who document that oil price uncertainty negatively affects corporate social responsibility among US firms, with the effect exacerbated for more indebted firms, reinforcing the financing-constraint channel through which commodity-market uncertainty erodes non-financial performance.

However, the existing studies also provide contradicting findings as well. Literatures demonstrate positive relationship between uncertainty and ESG performance, suggesting that

firms use ESG performance strategically to signal resilience as well as to hedge against regulatory risk (Zheng & Chen, 2023; Peng & Gao, 2026). This variation could be due to institutional variations, as we see that the existing studies demonstrate that the positive effect is mostly found in the Chinese context, in which firms operate under strong government backing and, in an environment, where ESG compliance is incentivised (Zheng & Chen, 2023). For oil price uncertainty specifically, the results align with Phan et al. (2021), who report that oil price uncertainty depresses operating performance and, by extension, discretionary spending categories such as ESG investment, particularly outside the energy sector. This contrasts with more recent evidence from Saif-Alyousfi (2026), who finds that strong ESG performance can *buffer* firms against energy-market uncertainty rather than being eroded by it, thereby examining the reverse causal direction, in which ESG protects firms against uncertainty, and offering evidence that is complementary rather than contradictory to the present results.

Models 4, 5 and 6 in the same table show that uncertainty is positively associated with ESG uncertainty. This means that the rise of uncertainty increases the ESG uncertainty of the firms. Alternatively, financial stress, climate policy uncertainty and oil price uncertainty increase volatility in ESG performance, demonstrating that the variability from the mean ESG becomes high. Under uncertain conditions, firms may repeatedly reassess their investment priorities, postpone or scale back sustainability projects, or selectively maintain ESG activities considered strategically important, producing greater instability in ESG outcomes over time. This interpretation is consistent with Ongan et al. (2026), who show that climate, economic-policy, and oil-price uncertainties can increase sustainability uncertainty, and Qin et al. (2025), who document a dynamic relationship between oil-market conditions and ESG-related uncertainty. Importantly, this result may also help reconcile the mixed evidence in the literature: while some firms respond to uncertainty by strengthening ESG as a signalling or risk-management strategy, others reduce ESG investment because of financial and resource constraints. Such responses increase the variability of ESG outcomes. Overall, the results therefore suggest that uncertainty has a dual effect on corporate sustainability, reducing the level of ESG performance while increasing its instability**,** thereby weakening both the strength and consistency of firms' sustainability commitments.

[INSERT TABLE NO 3 HERE]

4.3 Moderating effect of financial flexibility

Understanding the channel through which uncertainty is transmitted to firms' sustainability outcomes is central to this analysis. A growing body of work emphasises that macro-financial uncertainty affects long-term sustainability initiatives primarily through a financial channel, destabilising operational continuity and asset valuations. Consistent with this view, the European Central Bank and the Network for Greening the Financial System (NGFS) have both underscored that a firm's capacity to absorb and respond to such uncertainty depends on its financial resilience. Guided by this reasoning, we employ the interest coverage ratio (ICR) as a proxy for financial strength, on the premise that it serves as a critical buffer against financial, climate-related, and oil price uncertainty. A firm with a higher interest coverage ratio is better positioned to meet its debt obligations, which affords it greater flexibility to sustain ESG-related investment even during periods of heightened uncertainty. This financial cushion is expected to stabilise ESG commitments by lowering the likelihood of abrupt retrenchment in sustainability initiatives, thereby allowing firms to maintain consistent ESG practices while adapting to shifting regulatory and market pressures.

The results in Table 4 offer partial support for this reasoning. Among the ESG performance models, the interest coverage ratio weakly moderates the relationship between oil price uncertainty and ESG performance, attenuating its negative effect at the 10% significance level; the interaction terms for financial stress and climate risk uncertainty, however, are not statistically significant. This suggests that financial slack cushions ESG performance mainly, and only marginally, against uncertainty originating in commodity markets, rather than against broader financial-stress or climate-related channels. The picture is more consistent for ESG uncertainty: the interest coverage ratio significantly and negatively moderates the relationship between all three uncertainty measures financial stress, climate risk uncertainty, and oil price uncertainty and ESG uncertainty. This indicates that financially resilient firms consistently mitigate the volatility-inducing effect of uncertainty on their ESG disclosures, across financial, climate, and commodity-related sources alike. Taken together, these findings suggest that financial strength functions less as a uniform shield against uncertainty's effect on the *level* of ESG performance, and more as a robust stabiliser of ESG *consistency*, dampening the extent to which uncertainty translates into erratic or unpredictable ESG outcomes.

The stabilising role of financial slack identified here, proxied by the interest coverage ratio, is broadly consistent with the wider financial-flexibility literature on ESG persistence. Duque-

Grisales and Aguilera-Caracuel (2021) similarly find that slack resources allow firms to sustain ESG-related investment through adverse shocks, treating this capacity as a precondition for stakeholder-oriented strategy rather than a simple by-product of profitability. The relationship, however, is unlikely to be strictly linear. Drawing on Nasdaq-100 data, Heubeck and Ahrens (2024) identify an inverted-U pattern in which slack resources support ESG investment only up to a threshold, beyond which excess slack is associated with weaker ESG discipline. While the present specification does not formally test for such non-linearity, this possibility merits acknowledgement, as it implies that a larger financial cushion is not an unconditional prescription for ESG stability but may instead yield diminishing or even reversing returns beyond a certain point.

[INSERT TABLE NO 4 HERE]

4.3 Moderating effect of governance quality

Board composition is another lever through which firms may translate financial and governance strength into ESG resilience, and gender diversity is a natural candidate to examine. Board gender diversity may serve as a stabilising governance mechanism by fostering more inclusive decision-making and strengthening firms' responsiveness to sustainability concerns, thereby helping them maintain their ESG commitments in periods of heightened uncertainty. This argument is consistent with prior research linking board gender diversity to corporate sustainability engagement, carbon disclosure, and environmental innovation (Ben-Amar et al., 2017; Bazel-Shoham et al., 2024; Apel & Velte, 2026). Table 5 tests this proposition directly. The results partly bear it out. On the ESG performance side, gender diversity significantly and positively moderates the oil price uncertainty relationship, but its interactions with financial stress and climate risk uncertainty are statistically insignificant. In other words, diverse boards do not systematically buffer ESG performance against financial-stress or climate-driven uncertainty and only against uncertainty stemming from oil price movements. On the ESG uncertainty side, however, the pattern is stronger and more consistent, with gender diversity significantly and negatively moderating the effects of climate policy uncertainty and oil price uncertainty, in the theoretically expected direction. These findings suggest that gender diversity dampens the extent to which these forms of uncertainty destabilises ESG disclosure. Taken together, this asymmetry suggests that gender diversity's stabilising influence operates less on the level of ESG performance and more on the consistency of ESG reporting, a distinction that qualifies, rather than negates, the conventional expectation that diverse boards are

unconditionally beneficial for sustainability outcomes. However, the interaction between gender diversity and financial stress is positive and significant, suggesting that gender diversity does not uniformly mitigate ESG uncertainty. One possible explanation is that financial stress creates immediate resource and survival pressures that constrain boards' ability to maintain consistent ESG performance, even in firms with more gender-diverse boards.

Prior study of Yasin (2025) finds that board gender diversity raises ESG performance on average, but that this positive effect weakens under high earnings volatility, as resource-constrained boards redirect attention toward short-term financial stability rather than longer-term ESG goals. Our finding that gender diversity fails to significantly moderate the financial-stress and climate-uncertainty channels for ESG performance extends this same logic: under acute strain, board diversity's stabilizing capacity appears to give way to more pressing financial concerns. This is also consistent with Grau-Grau et al. (2025), who argue that the ESG benefits of board gender diversity are conditional on the surrounding institutional and financial context rather than universal. Our results support this contingency view over the unconditional-benefit framing that dominates earlier governance research, including Marie et al. (2025), which tends to treat gender diversity as a uniformly positive governance attribute regardless of the firm's external environment. The evidence here suggests a more nuanced reading. Gender-diverse boards contribute meaningfully to ESG stability, but their capacity to protect ESG performance levels specifically is uncertainty-type dependent and should not be assumed to hold uniformly across all sources of macro-financial and climate-related strain.

[INSERT TABLE NO 5 HERE]

4.4 Channel analysis

Having established that financial resilience and board composition each shape how uncertainty feeds through to ESG outcomes, a natural question remains, through what concrete financial mechanism does this transmission actually occur? Identifying such a channel matters because it moves the analysis beyond documenting a statistical association toward explaining why uncertainty disrupts sustainability commitments in the first place. One plausible candidate is cash holdings. When firms face heightened uncertainty, a common corporate response might be to build up cash reserves against future financial shocks (Goodell et al., 2021; Fernandes & Papadimitriou, 2025), consistent with the precautionary motive hypothesis for corporate cash

holding. This precautionary build-up, while rational from a risk-management standpoint, can come at the expense of long-horizon, discretionary spending and ESG initiatives, which are often viewed internally as postponable relative to core operations, are a plausible casualty of this reallocation. If this logic holds, cash holdings should function as a channel that helps explain how uncertainty translates into weaker or more volatile ESG outcomes, rather than the two simply moving together for unrelated reasons.

The results in Table 6 show support to this reasoning. Cash holdings respond significantly and negatively to uncertainty measures in Models 1–2, confirming that firms do indeed draw down or build up reserves precautionarily in response to financial stress and climate risk uncertainty alike but not for oil price uncertainty. But when cash holdings are entered as a mediating variable in the ESG performance and ESG uncertainty equations, its role is far from uniform. The cash-holding coefficient is significant only for climate-risk and oil-price specifications (Models 5 and 6) for ESG performance and insignificant for all specifications under ESG uncertainty. This selective, rather than blanket, pattern suggests that cash reserves matter more for ESG performance only as a transmission mechanism for climate and commodity uncertainty than for financial stress, for which other channels are likely to play a greater role.

This pattern is broadly consistent with precautionary-motive literature. Bin-Feng et al. (2024) show that environmental uncertainty raises firms' precautionary cash reserves, and that this build-up buffers rather than fully explains the resulting decline in ESG performance, which fits with cash holdings acting as a partial mediator here rather than the dominant one. Farooq et al. (2025) similarly report a mediating role for ESG-specific uncertainty in a BRICS sample, where uncertainty raises cash holdings and elevated reserves subsequently constrain investment, including ESG-related capital allocation.

[INSERT TABLE NO 6 HERE]

4.5 Additional analyses and robustness tests

This section provides additional analyses and a battery of robustness tests to support our main findings.

Ordinary least square model captures only the average relationship between uncertainty and ESG outcomes, which can mask important differences in how firms at different points of the ESG distribution actually respond. Quantile regression addresses this by estimating the effect of uncertainty separately across low, median, and high ESG quantiles, making it possible to

detect whether uncertainty affects strong and weak performers differently rather than assuming a single uniform effect for all firms. The results in Graph 2 show that uncertainty's impact is not evenly distributed, and instead widens the gap that already exists between strong and weak ESG performers. Firms at the lower quantiles of ESG performance decline more steeply as uncertainty rises, consistent with these firms having weak institutional capacity and fewer resources to protect sustainability commitments under stress. Firms at the upper quantiles absorb the same shocks with comparatively little erosion, pointing to greater resilience. A similar pattern holds for ESG uncertainty. Firms with historically stable disclosures largely retain that stability, while firms already prone to erratic reporting become even more volatile. Together, these patterns suggest that uncertainty interacts with each firm's pre-existing position rather than acting as a uniform shock, although, because quantile regression describes shifts in the conditional distribution rather than within-firm causal pathways, this divergence is best read as being consistent with an amplification story rather than as direct proof of it.

[INSERT FIGURE NO 2 HERE]

This pattern fits the cumulative-advantage literature applied to ESG contexts, where initial resource endowments, rather than the shock itself, determine firms' capacity to absorb adverse conditions (Merton, 1968; extended to sustainability by Qureshi et al., 2024). It also aligns with Ge and Zhang (2025), who find that weaker pre-existing ESG stability is associated with disproportionately larger increases in volatility under climate policy uncertainty, providing convergent evidence across a different sample and estimator that strengthens the case that this amplification is a general regularity rather than an artifact of this dataset, although the precise underlying mechanism likely warrants more targeted testing in future work.

To address potential endogeneity concerns and strengthen causal inference, we construct an interaction-based instrumental variable by combining the global economic policy uncertainty index with firms' lagged leverage. This instrument is designed to capture firm-specific exposure to exogenous global uncertainty shocks, reflecting how financially leveraged firms are differentially affected by shifts in the broader uncertainty environment. The instrumental variable results are consistent with and reinforce the earlier findings, confirming that heightened uncertainty adversely affects ESG performance and increases instability in sustainability outcomes. This consistency strengthens the robustness of the main analysis and provides further evidence that the observed relationship is not merely driven by reverse

causality or omitted variable bias, but reflects a meaningful and economically significant channel through which uncertainty shapes firms' sustainability behaviour.

In Table 8, we use propensity score matching (PSM) to mitigate potential selection bias arising from differences in firm characteristics. The results remain consistent with our baseline findings. In Table 9, we examine the robustness of our findings to the choice of ESG data provider by replacing the LSEG ESG scores used in the baseline analysis with ESG scores obtained from Bloomberg. This approach accounts for potential differences in ESG assessment methodologies and rating criteria across providers, which may lead to variations in firms' ESG scores. The results remain consistent with our baseline findings, suggesting that our conclusions are not driven by the choice of ESG data provider.

[INSERT TABLE NO 7 HERE]

[INSERT TABLE NO 8 HERE]

[INSERT TABLE NO 9 HERE]

4.6 Further discussion

There is also an important discussion about whether ESG is a long-term strategic investment or a discretionary expense that companies cut back on in times of uncertainty. From a traditional stakeholder and resource perspective, ESG adds resilience, boosts reputation and improves long-term value (Wang et al., 2024; & Chen et al., 2024). However, research indicates that in times of high uncertainty, many companies often regard ESG as a variable cost and focus on cash flow management and short-term survival. This sets up a conflict between the norm of sustainability and the reality of 'crisis decision-making'.

A second debate relates to the role of financial capacity in sustaining ESG commitments. Much of the existing work has already been focused on whether or not firms with strong ESG tend to stay the course following temporary shocks. Our findings, however, suggest that the assumption is incorrect because financial resiliency plays a significant role in determining stability in ESG, especially interest coverage. An important question that arises is whether or not there is a genuine value-oriented approach to ESG or simply a dependence on financial leeway. The findings indicate that financial capability could be considered a key determinant for sustainability consistency, not just an enabler.

A third debate is about the effectiveness of governance, including the importance of gender diversity. In the best of the governance literature, gender-diverse boards are consistently found to have a more ethical orientation and meet stakeholder sensitivities, which are believed to drive up ESG performance. But the results show a more complex picture. Gender diverse boards might be more conservative in times of financial doubt and reconsider ESG priorities more often, meaning that diversity does not equate to stability. This contradicts the universalist perspective on diversity of boards and reinforces the governance perspective of context dependence.

Another key issue is whether uncertainty is a levelling-up or levelling-down external shock or a multiplier mechanism of the existing inequalities. One approach to the economics of uncertainty assumes that it is a standard shock faced by all firms. The results on heterogeneity, on the other hand, indicate that uncertainty has a negative influence on divergence, with those companies performing worse on ESG criteria becoming even worse under uncertain conditions and those performing even better. This is consistent with the cumulative advantage perspective, which suggests that existing differences in firm resources and capabilities can reinforce outcome inequalities over time (DiPrete & Eirich, 2006). Last, there is a regulatory debate over whether enough is enough when one gets to the issue of improving corporate sustainability through the help of ESG regulation. Frequently, regulatory frameworks are built on the premise that increased ESG requirements will result in improved compliance and consistency. However, findings suggest that regulatory environments, uncertainty and firm-specific capacities strongly influence ESG outcomes (Chourou et al., 2023; Jia and Li, 2020; Ma et al., 2025). This is because it means that the regulation process would lead to irregular sustainability results between firms if not supported by financial and institutional means. To incorporate these debates into the context of the discussion enhances the theoretical contribution of this study because it allows our findings to be grounded in existing tensions within the literature. It also highlights the fact that ESG under uncertainty is not just an operating problem but one of overall strategic, financial and governance considerations.

5. Conclusion

The pressure on firms to deliver consistent ESG performance has intensified at precisely the moment when the macro-financial environment has become harder to predict. Financial stress, climate policy uncertainty, and oil price uncertainty are no longer peripheral concerns for

corporate sustainability strategy as they sit at the centre of it. Our study set out to understand exactly how macro-financial uncertainty constrains firms' ESG performance while also making that performance harder to sustain consistently over time. We examine this question using on a sample of STOXX 600 firms spanning 23 years. Our findings demonstrate that financial stress, climate policy uncertainty, and oil price uncertainty each weaken ESG performance while simultaneously increasing its volatility, and this pattern holds consistently across our different estimation methods. Quantile regression shows that firms with weaker ESG performance suffer more under climate risk uncertainty than their higher-performing counterparts, even though the direction of the effect remains negative for all. A similar divergence appears on the volatility side, where firms already prone to unstable ESG outcomes experience further instability under uncertainty, while firms with a track record of stability largely hold their consistency. Overall, these results suggest that uncertainty does not hit firms uniformly; it rather tends to widen the distance between those already well-positioned to absorb shocks and those that are not.

We also examined what helps firms withstand this pressure. Financial flexibility and gender diversity both emerge as stabilising forces, though their influence is best described as moderate rather than transformative. They marginally improve ESG performance and marginally reduce volatility, rather than fully insulating firms from uncertainty's effects. Digging further into the mechanism, we find that cash holdings act as one meaningful channel through which uncertainty transmits into ESG performance. These results carry a clear message for firms and policymakers that sustainability commitments are financially contingent. A firm's ability to sustain its ESG trajectory through turbulent periods depends heavily on the liquidity buffers and governance structures it has built beforehand. For corporate decision-makers, this points toward strengthening cash reserves and reinforcing governance mechanisms, including gender-diverse boards should be considered as practical safeguards against the erosion of ESG commitments during periods of macro-financial stress. For regulators and policymakers, our findings suggest that expecting uniform ESG consistency from all firms, regardless of their financial resilience, may be unrealistic. Policymakers therefore need to consider firms' financial capacity when setting ESG expectations or disclosure requirements.

Our study has limitations as our sample is restricted to STOXX 600 firms, and the extent to which these dynamics generalise to smaller firms, private firms, or firms outside the European context remains an open question. Our moderation analysis does not exhaust the possible

channels through which uncertainty could affect ESG outcomes; factors such as investor pressure, supply chain disruption, or managerial risk appetite may operate alongside cash holdings. Similarly, while our quantile results document heterogeneity in outcomes, they stop short of identifying the precise firm-level characteristics that drive it. Future research would do well to unpack these underlying mechanisms in more depth, and to test whether the patterns identified here hold in non-European or emerging market settings, where financial constraints and institutional context differ considerably from those observed in our sample.

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Table 1: Descriptive statistics

Variables	Obs	Mean	SD	Min	p50	Max
ESG Performance	6,684	61.491	19.155	13.302	64.916	90.117
ESG Uncertainty	6,471	4.536	3.543	.471	3.498	16.379
Financial Stress	3,486	100.816	0.718	100.084	100.706	102.461
Climate Risk uncertainty	6,684	-0.132	1.649	-3.102	-0.172	4.063
Oil price uncertainty	6,684	117.393	40.066	70.739	107.184	228.724
Gender diversity	6,626	25.517	15.028	0	26.666	54.545
Interest coverage ratio	6,133	2.507	1.221	0.249	2.268	6.169
ROA	6,684	6.229	6.022	-8.270	5.355	24.432
Size	6,684	23.210	1.541	19.215	23.113	27.581
Liquidity	6,684	0.232	0.296	0.002	0.136	1.615
Leverage	6,684	0.2511	0.148	0	0.244	0.633
Tobin's Q	6,684	1.479	1.804	0.025	0.850	9.467
Firm's age	6,684	47.828	33.114	4.000	36	131
ΔGrowth	6,684	0.089	0.6341	-2.239	0.069	2.826
Learner index	6,684	-8.050	10.271	-47.278	-5.167	12.669
Board size	6,684	11.103	3.700	5.000	11	21
GDP	6,684	1.458	2.710	-7.440	1.718	6.882
Inflation	6,684	2.148	1.922	-0.494	1.850	7.922

Table 2: Correlation matrix of the variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(1)ESG performance	1.000																	
(2)ESG volatility	-0.153*	1.000																
(3)Financial Stress	-0.166*	0.293*	1.000															
(4) Climate Risk uncertainty	-0.168*	0.205*	0.628*	1.000														
(5) Oil price uncertainty	-0.123*	0.207*	0.158*	0.395*	1.000													
(6) Gender diversity	0.424*	-0.242*	-0.355*	-0.301*	-0.187*	1.000												
(7) Interest coverage ratio	-0.055*	-0.059*	-0.160*	-0.099*	-0.040*	0.105*	1.000											
(8) ROA	-0.144*	0.031*	-0.056*	0.060*	0.032*	-0.039*	0.610*	1.000										
(9) Size	0.391*	-0.108*	-0.078*	-0.064*	-0.035*	0.196*	-0.335*	-0.346*	1.000									
(10) Liquidity	-0.146*	0.008	-0.016	-0.026*	-0.015	-0.030*	0.478*	0.254*	-0.287*	1.000								
(11) Leverage	0.093*	-0.021*	0.041*	-0.006	0.005	0.050*	-0.411*	-0.178*	-0.004	-0.448*	1.000							
(12) Tobin's Q	-0.114*	-0.002	-0.100*	-0.051*	-0.041*	0.046*	0.529*	0.530*	-0.409*	0.397*	-0.186*	1.000						
(13) Firm's age	0.047*	-0.044*	0.000	0.000	0.000	-0.027*	-0.007	0.032*	0.123*	-0.065*	-0.022*	-0.048*	1.000					
(14) Growth change	-0.037*	0.026*	-0.022	0.065*	0.033*	-0.003	0.112*	0.154*	-0.052*	0.037*	-0.007	0.064*	-0.008	1.000				
(15) Learner index	-0.045*	-0.012	0.009	0.013	0.011	0.040*	0.177*	0.143*	0.020*	0.114*	0.066*	0.124*	-0.063*	0.082*	1.000			
(16) Board size	0.226*	-0.022*	0.030*	0.039*	0.023*	-0.002	-0.241*	-0.258*	0.453*	-0.137*	0.001	-0.281*	0.057*	-0.031*	-.050*	1.000		
(17) GDP	-0.051*	0.003	-0.267*	0.201*	0.143*	0.008	0.061*	0.119*	-0.006	0.014	-0.053*	0.040*	0.003	0.118*	0.018	-.057*	1.000	
(18) Inflation	0.116*	-0.073*	0.390*	0.343*	0.295*	0.226*	-0.014	-0.006	0.071*	-0.047*	0.022*	-0.028*	-0.014	0.047*	0.048*	-0.018	0.170*	1.000

. ***, **, and * denote significance at the less than 1%, 5%, and 10% levels, respectively.

Table 3: Baseline results for the effect of Uncertainty on ESG performance and ESG uncertainty

	(1)	(2)	(3)	(4)	(5)	(6)
	ESG performance			ESG uncertainty		
Financial stress	-4.392**			1.954***		
	[-2.607]			[7.249]		
Climate risk uncertainty		-2.696***			0.663***	
		[-5.062]			[6.638]	
Oil price uncertainty			-0.087***			0.024***
			[-2.982]			[4.712]
ROA	-0.118	-0.115	-0.141	0.006	-0.004	0.003
	[-0.990]	[-1.348]	[-1.651]	[0.308]	[-0.294]	[0.190]
Size	7.910***	6.968***	7.332***	-0.181*	-.357***	-.379***
	[13.437]	[10.506]	[12.398]	[-2.129]	[-5.220]	[-5.149]
Liquidity	-1.936	-1.508	-0.837	-0.536	-0.128	-0.228
	[-0.625]	[-0.569]	[-0.316]	[-1.239]	[-0.364]	[-0.666]
leverage	-3.472	2.504	3.009	0.378	0.169	0.012
	[-0.730]	[0.648]	[0.757]	[0.711]	[0.396]	[0.029]
Tobin's Q	1.956**	1.781***	2.014***	-0.022	-0.051	-0.072
	[2.809]	[3.733]	[4.560]	[-0.276]	[-0.765]	[-1.302]
Age	-0.003	-0.005	-0.011	-0.005**	-0.004**	-0.004*
	[-0.149]	[-0.311]	[-0.683]	[-2.278]	[-2.610]	[-1.985]
ΔGrowth	-0.983**	-0.428	-0.469	0.208**	0.193**	0.195***
	[-2.342]	[-1.054]	[-1.257]	[2.480]	[2.764]	[2.994]
Learner index	-0.061	-0.079*	-0.067	-0.008	-0.009	-0.008
	[-1.297]	[-2.003]	[-1.666]	[-1.722]	[-1.705]	[-1.456]
Board_Size	-0.009	0.148	0.006	-0.029	-0.022	-0.008
	[-0.040]	[0.723]	[0.027]	[-1.171]	[-0.892]	[-0.389]
GDP	-1.145**	-0.034	-0.244	0.253**	-0.050	-0.007
	[-2.852]	[-0.118]	[-0.499]	[2.769]	[-1.061]	[-0.108]
Inflation	-0.197	1.960***	1.759***	-0.060	-.395***	-.353***
	[-0.243]	[4.560]	[2.900]	[-0.421]	[-4.445]	[-2.989]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3810	6684	7008	3495	6471	6612
R-squared	0.425	0.417	0.392	0.131	0.117	0.106

Note: This baseline regression model tests the effect of uncertainty on ESG performance and ESG volatility. The dependent variables are ESG performance and ESG volatility while focused independent variables are financial stress, climate policy uncertainty and oil price uncertainty across the models. The definitions and measurement of all variables are available in Appendix Table A1. Values in parenthesis are robust t-statistics with two-way cluster-robust standard errors at the firm and year levels to account for serial correlation and cross-sectional dependence. ***, **, and * denote significance at the less than 1%, 5%, and 10% levels, respectively.

Table 4: Moderation effect of interest coverage ratio

	(1)	(2)	(3)	(4)	(5)	(6)
	ESG performance			ESG uncertainty		
Financial stress	-4.220*			2.315***		
	[-2.063]			[7.224]		
Interest coverage ratio	-15.684	0.984	1.114	17.722***	-0.286**	0.021
	[-0.452]	[1.567]	[0.929]	[3.354]	[-2.694]	[0.114]
*Financial stress * interest coverage ratio*	0.165			-0.179***		
	[0.483]			[-3.420]		
Climate risk uncertainty		-2.851***			0.860***	
		[-4.789]			[7.030]	
*Climate risk uncertainty * Interest coverage ratio*		0.138			-0.095***	
		[1.040]			[-3.697]	
Oil price uncertainty			-0.098**			0.031***
			[-2.813]			[5.825]
*Oil price uncertainty * Interest coverage ratio*			0.008*			-0.004***
			[1.955]			[-3.757]
Controls	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Country FE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Industry FE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	3367	6133	6380	3120	5957	6066
R-squared	0.425	0.407	0.391	0.144	0.126	0.115

Note: The models test the moderation effect of financial strength on the relationship between uncertainty and ESG performance, and ESG volatility. Financial strength here is measured by interest coverage ratio. The definitions and measurement of all variables are available in Appendix Table A1. Values in parenthesis are robust *t-statistics* with clustered standard error at the firm level. ***, **, and * denote significance at the less than 1%, 5%, and 10% levels, respectively.

Table 5: The moderating effect of gender diversity

	(1)	(2)	(3)	(4)	(5)	(6)
	ESG performance			ESG uncertainty		
Financial stress	-1.636			1.398***		
	[-1.045]			[4.562]		
Gender Diversity	3.389	0.377***	0.361***	-3.142*	-0.030***	-0.013
	[0.781]	[9.906]	[3.582]	[-2.092]	[-3.033]	[-0.505]
Financial stress * Gender Diversity	-0.030			0.031*		
	[-0.698]			[2.082]		
Climate risk Uncertainty		-1.136***			0.687***	
		[-3.200]			[7.341]	
Climate risk uncertainty * Gender Diversity		0.009			-0.008*	
		[0.878]			[-2.013]	
Oil price uncertainty			-0.040			0.024***
			[-1.427]			[5.554]
Oil price uncertainty * Gender Diversity			0.001			-0.001**
			[0.847]			-2.55
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3722	6626	6920	3432	6419	6549
R-squared	0.472	0.476	0.480	0.139	0.130	0.127

Note: The models test the moderation effect of gender diversity on the relationship between uncertainty and ESG performance, and ESG volatility. Gender diversity here is measured by the percentage of female board members in the board. The definitions and measurement of all variables are available in Appendix Table A1. Values in parenthesis are robust *t-statistics* with clustered standard error at the firm level. ***, **, and * denote significance at the less than 1%, 5%, and 10% levels, respectively.

Table 6: Channel analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Cash holding			ESG performance			ESG uncertainty		
Financial stress	-0.079**			-4.360**			1.960***		
	[-2.591]			[-2.561]			[7.231]		
Climate index uncertainty		-0.040***			-2.625***			0.662***	
		[-3.228]			[-4.971]			[6.620]	
Oil price uncertainty			-0.001			-0.086***			0.024***
			[-2.31]			[-2.938]			[4.690]
Cash holding				0.417	1.726**	1.913***	0.040	-0.023	-0.042
				[0.714]	[2.675]	[2.947]	[0.603]	[-0.339]	[-0.655]
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3782	6675	6992	3770	6650	6966	3459	6437	6574
R-squared	0.781	0.768	0.766	0.426	0.421	0.398	0.131	0.117	0.106

Note: The models test the mediation effect of cash holding on the relationship between uncertainty and ESG performance, and ESG volatility. The definitions and measurement of all variables are available in Appendix Table A1. Values in parenthesis are robust *t-statistics* with clustered standard error at the firm level. ***, **, and * denote significance at the less than 1%, 5%, and 10% levels respectively.

Table 7: 2SLS regression

Panel A: 2SLS regression (Frist stage regression)						
	(1)	(2)	(3)	(4)	(5)	(6)
	ESG performance			ESG uncertainty		
Financial stress	0.512***					
	[61.417]					
Climate risk uncertainty		0.267***				
		[30.548]				
Oil price uncertainty			0.065***			
			[10.291]			
Z_GEPU_InitLev				-0.003***	-0.005***	-0.096***
				[-4.576]	[-7.419]	[-6.280]
Z_GEPU_LagLev	-0.014***	-0.020***	-0.418***	-0.009***	-0.028***	-0.485***
	[-5.982]	[-15.142]	[-12.671]	[-5.189]	[-19.013]	[-13.529]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country & Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3666	6446	7008	3298	5650	5791
Panel B: 2nd Stage regression						
	(1)	(2)	(3)	(4)	(5)	(6)
	ESG performance			ESG uncertainty		
Financial stress	-8.866***			5.378***		
	[-11.594]			[8.623]		
Climate risk uncertainty		-6.529***			1.120***	
		[-15.205]			[11.750]	
Oil price uncertainty			-0.466***			0.066***
			[-15.635]			[11.829]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country & Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3810	6446	7008	3298	5650	5791
R-squared	0.300	0.202	-0.288	-0.112	0.095	-0.077
KP F-statistic	3674.849	1874.888	387.040	124.601	258.163	188.747
Hansen J p-value	0.000	0.102	0.052	0.483	0.602	0.519

Note: This table shows results of 2SLS regression. The definitions and measurement of all variables are available in Appendix Table A1. Values in parenthesis are robust *t-statistics* with clustered standard error at the firm level ***, **, and * denote significance at the less than 1%, 5%, and 10%levels respectively.

Table 8: Propensity score matching model

	(1)	(2)	(3)	(4)	(5)	(6)
	ESG performance			ESG uncertainty		
Financial stress	-4.454**			1.952***		
	(1.662)			(0.273)		
Climate risk uncertainty		-1.702***			0.650***	
		(0.156)			(0.097)	
Oil price uncertainty			-0.039***			0.023***
			(0.005)			(0.006)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country & Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3713	3393	3713	3404	3266	3404

Note: This table shows results of propensity score matching (PSM) samples. The definitions and measurement of all variables are available in Appendix Table A1. Values in parenthesis are clustered standard error at the firm level ***, **, and * denote significance at the less than 1%, 5%, and 10%levels respectively.

Table 9: Robustness check using ESG variable from Bloomberg

	(1)	(2)	(3)	(4)	(5)	(6)
	Bloomberg_ESG performance			Bloomberg_ESG uncertainty		
Financial stress	-3.994***			0.197*		
	[-3.586]			1.89		
Climate risk uncertainty		-3.116***			0.158***	
		[-6.070]			[3.783]	
Oil price uncertainty			-0.083***			0.007***
			[-2.907]			[4.671]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country & Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3128	6188	6188	2850	6025	6025
R-squared	0.459	0.457	0.397	0.086	0.079	0.082

Note: This table shows the results of the effect of uncertainty on ESG performance and ESG volatility, using Bloomberg ESG variable. The definitions and measurement of all variables are available in Appendix Table A1. Values in parenthesis are robust *t-statistics* with clustered standard error at the firm level ***, **, and * denote significance at the less than 1%, 5%, and 10%levels respectively.

Figure 1. Trends of uncertainty and ESG over the time.

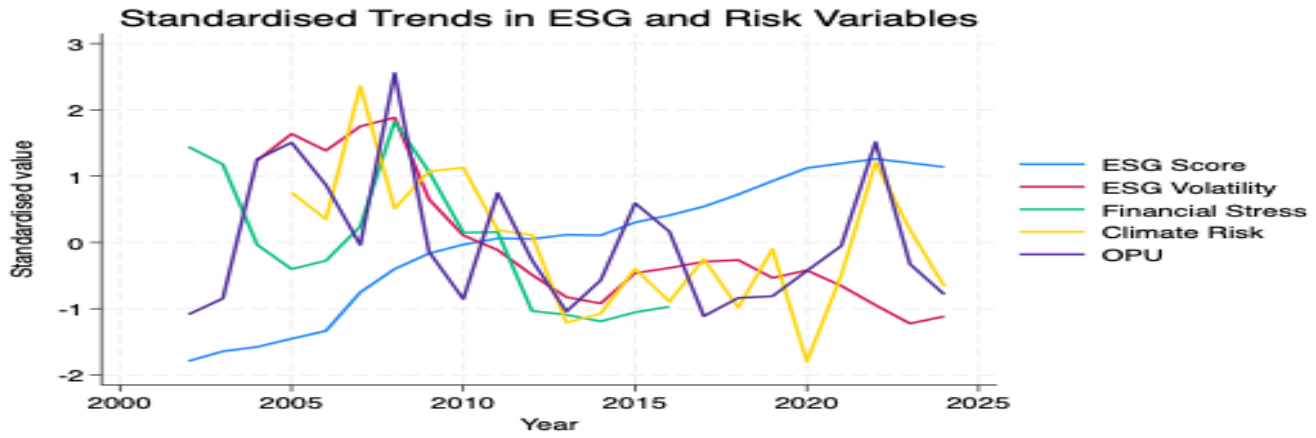
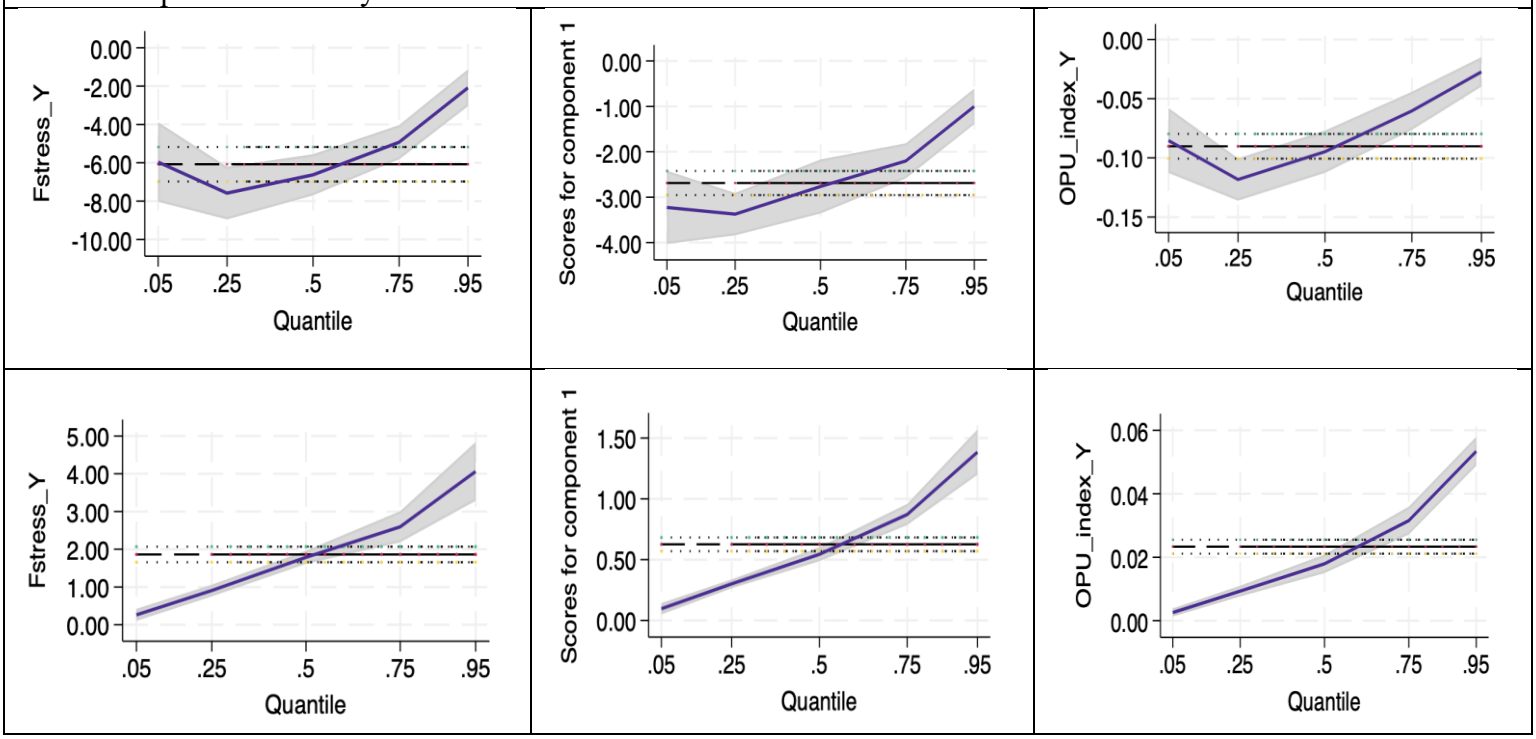


Figure 2. The effect of uncertainty on ESG performance and ESG uncertainty across the quantiles. The first part shows financial stress, second part shows climate policy uncertainty and last part shows oil price uncertainty.



Appendix A1: Variable descriptions		
Variables	***Definition***	***Source***
ESG score	LSEG provides scores from 0 to 100% for individual firms from company disclosure, capturing information on environmental (resource use, emissions, innovation etc.), social (workforce, human rights, community, product responsibility etc.) and governance (management, shareholders strategy etc.) based on a comprehensive subset of metrics.	LSEG
ESG uncertainty	ESG uncertainty is the 3-year rolling standard deviation of ESG score from LSEG.	Self-constructed from LSEG data
Financial stress	Financial stress refers to the degree of strain in financial markets, reflecting disruptions in the functioning of financial institutions, asset markets, and credit conditions.	https://www.policyuncertainty.com/
Climate risk uncertainty	Climate risk uncertainty is a composite index constructed based on the Principal Component Analysis (PCA) of four standardized indicators: transition concern, transition risk, physical concern, and physical risk. It measures the degree of uncertainty surrounding government policies related to climate change, including regulations, carbon pricing, environmental laws, and energy transition policies.	https://www.policyuncertainty.com/
Oil price uncertainty	Oil Price Uncertainty (OPU) measures the level of uncertainty about future oil prices.	https://www.policyuncertainty.com/
ROA	Net income over total assets.	LSEG
Size	Natural logarithm of total asset of a firm.	LSEG
Liquidity	Liquidity is measured as the ratio of total cash to total liabilities.	LSEG
Leverage	Leverage is defined as the ratio of a firm's total debt to its total assets.	LSEG
Tobin's Q	Tobin's Q is defined as the ratio of a firm's market capitalization to its total assets.	Authors' calculation based on data available in LSEG
Age	Firm age is measured as the number of years since a company's incorporation up to the observation year.	LSEG
ΔGrowth	Growth Change measures the year-on-year growth in operating profit before non-recurring income and expenses, calculated as the difference between the current and previous period values divided by the previous period value.	Authors' calculation based on data available in LSEG
Learner index	Lerner index is the ratio of operating profit minus operating expenses to operating profit before non-recurring items.	Authors' calculation based on data available in LSEG
Board_Size	Board size is the total number of directors serving on a company's board in a given year.	LSEG
GDP growth	GDP growth is the annual percentage growth rate of Gross Domestic Product (GDP) at market prices based on constant local currency.	World Bank
Inflation	Inflation is the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services, measured by the Consumer Price Index (CPI).	World Bank
Interest Coverage Ratio	Interest Coverage Ratio (ICR) is the natural logarithm of one plus the interest coverage ratio, after excluding non-positive values.	Authors' calculation based on data available in LSEG

Gender diversity	Gender diversity is the proportion of female directors on a company's board, calculated as the number of female board members divided by the total number of board members.	LSEG
Cash holding	Cash holding is defined as the natural logarithm of a firm's total cash and cash equivalents.	LSEG
IV_GEPU Instrument variable	iv_gepu is an interaction-based instrumental variable constructed as the product of the current global economic policy uncertainty index and the lagged leverage of the firm.	Authors' calculation

Appendix A2: Sample distribution by countries and industries

Country	Observations
Austria	99
Belgium	169
Denmark	239
Finland	266
France	1018
Germany	816
Ireland	113
Italy	103
Luxembourg	39
Netherlands	316
Norway	145
Poland	68
Portugal	39
Spain	299
Sweden	539
Switzerland	651
United Kingdom	1765
Total	6684

Industry	Observations
Basic Materials	768
Consumer Cyclicals	995
Consumer Non-Cyclicals	616
Energy	348
Financials	361
Healthcare	560
Industrials	1509
Real Estate	374
Technology	729
Utilities	424
Total	6684