

# **Monetary Policy and ESG Dilemma: How Higher Real Interest Rates Hamper Corporate ESG Performance**

## **Abstract**

This study examines the impact of real interest rates on ESG performance and risk using a global sample of 30,069 firm-year observations from 2010 to 2023. We find that higher real interest rates are linked to poorer ESG performance and greater ESG risk. Our results are robust to endogeneity tests, including propensity score matching, entropy balancing, and two-stage least squares. The Paris Agreement serves as an exogenous shock to establish causality through a difference-in-difference analysis. The negative impact is more pronounced during high economic policy uncertainty, in jurisdictions with weaker investor protection, and in polluted industries. Notably, the negative impact diminishes for firms that adopt the GRI framework and becomes positive in firms with strong governance. Our findings highlight the need for monetary policies that balance economic stability with sustainability goals.

**Keywords:** Monetary policy, real interest rates, ESG

**JEL Classification:** E52, E43, Q01

## 1. Introduction

*“Monetary policy has to support such fiscal policy initiatives, rather than obstruct governments by raising interest rates and choking off the multiplier effects of public spending and financing the climate transition...Our thinking about monetary policy has to change. Instead of treating central bankers as powerful, benevolent, technocratic guardians of price and macro stability, it is time to downgrade their role to that of servants of fiscal and industrial policies. If central bankers are unwilling to learn to play second fiddle, they’ll end up fiddling while our world burns.”*

(Ferguson & Storm, 2023, The Guardian)

Environmental, Social, and Governance (ESG) has emerged as a central focus for governments, shareholders, and civil society, driven by growing stakeholder expectations for enhanced corporate responsibility, ethical conduct, and long-term value creation (Ambec & Lanoie, 2008; Krueger et al., 2024). Global sustainability and climate change initiatives, such as those endorsed by international institutions including the United Nations (UN), highlight the growing importance of aligning corporate strategies with sustainable development goals (Bose et al., 2024). In parallel, monetary policy – through mechanisms such as interest rates, liquidity provisions, and central bank interventions – affects firms' financial conditions, influencing their ability to allocate resources toward ESG initiatives, igniting global debates on the role of monetary policy in influencing green transformation (Isiksal et al., 2019; Ferguson & Storm, 2023; Abakah et al., 2024; Aguila & Wullweber, 2024). Building on this context, our study seeks to examine the pivotal role of monetary policy in shaping firms' ESG performance and risk. Specifically, we explore whether, and to what extent, real interest rates as influenced by monetary policy decisions, impact firms' ESG outcomes.<sup>1</sup>

As raised by Anastasiou et al. (2024), the global economy has navigated two contrasting monetary policy phases over the past two decades. Following the Global Financial Crisis, many industrialized economies adopted negative interest rates as an unconventional

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<sup>1</sup> According to Guérin (2023), firm-level data offer key advantages for analyzing the effects of monetary policy on ESG performance. First, they help address endogeneity concerns, as monetary policy decisions are unlikely to be driven by individual firm-level developments. Second, firm-level data enable the inclusion of detailed fixed effects - such as country, firm, industry, and time effects - enhancing the precision of identifying how monetary policy shocks influence ESG performance.

monetary policy tool to revive economic growth and counter recessionary pressures (Onofri et al., 2023). In contrast, after the Covid-19 pandemic, central banks implemented unprecedented short-term interest rate hikes to counter inflationary pressures, driven by pandemic-induced supply chain disruptions, geopolitical tensions from the Ukraine conflict, and rising energy costs (International Monetary Fund, 2023; Bouri et al., 2023; Ferguson & Storm, 2023). This abrupt shift from monetary easing to tightening highlights the diverse and asymmetric effects of monetary policy across sectors (Auer et al., 2021; Durante et al., 2022). The significant surge in global inflation since 2021, coupled with widespread monetary policy tightening, has sparked interest in understanding how monetary policy impacts the economy. In particular, rising interest rates in many economies have raised concerns about the potential long-term effects of unexpectedly tighter-than-expected monetary policy on economic performance and corporate activities (Gu erin, 2023).

Monetary policy decisions, such as adjustments in interest rates, can either enable or constrain firms' abilities to invest in ESG initiatives. Lower real interest rates, under monetary easing, can create more favorable financial conditions for firms to pursue ESG goals including investments in sustainable technologies, workforce well-being, and governance improvements. Conversely, higher real interest rates, driven by monetary tightening, increase borrowing costs and financial distress risks, limiting firms' access to external financing and reducing their ability to invest in ESG initiatives (Kawai et al., 1996; Egli et al., 2018; Isiksal et al., 2019; Anastasiou et al., 2024). The financial accelerator theory (Bernanke et al., 1996) explains how worsening credit conditions magnify economic shocks, while real options theory (Trigeorgis & Reuer, 2017) highlights firms' tendency to delay or abandon long-term ESG investments under uncertainty. Together, these theories suggest that during periods of high real interest rates, firms are inclined to prioritize short-term financial survival over discretionary ESG activities, scaling back ESG initiatives (Harrison & Berman, 2016; Mahmoudian et al., 2023; Abakah et

al., 2024). Consequently, tightening monetary policy can perpetuate short-termism, compromise ESG performance, and increase ESG risk exposure. This leads us to hypothesize a negative relationship between real interest rates and ESG performance.

Utilizing an international sample of 30,069 firm-year observations spanning 2010-2023, we find that a higher real interest rate is associated with poorer ESG performance and greater ESG risk. The results withstand endogeneity tests, including propensity score matching and entropy balancing, which account for potential estimation bias stemming from differences in observable variables (Shipman et al., 2017). Additionally, our results are robust to firm-fixed effects and two-stage least squares addressing concerns of unobserved omitted variables (Larcker & Rusticus, 2010). We also utilize the Paris 2015 agreement as an exogenous shock (Anastasiou et al., 2024) to establish the causality of the impact of monetary policy on ESG performance and risk in a difference-in-difference analysis (Callaway & Sant'Anna, 2021).

Furthermore, we find that the relationship between higher real interest rate and poorer ESG performance is more pronounced in the presence of economic policy uncertainty, in jurisdictions with poorer investor protection, and for firms operating in polluted industries. This relationship is diminished in firms that adopt GRI reporting and becomes significantly positive in those with strong governance. Our results hold upon quantile regression and splitting observations into several regions, and are robust to the exclusion of the top three country observations (i.e., U.S.A, China, India) individually or in combination.

Our study contributes to the ESG and monetary policy literature, by offering global evidence on how high real interest rates compromise firm ESG performance. Research on how monetary policy, particularly interest rates, influences ESG outcomes is still emerging. While previous studies, such as Isiksal et al. (2019) and Anastasiou et al. (2024), focus on the effects of real interest rates on carbon emissions, our study broadens the scope by examining ESG performance holistically. This approach emphasizes the importance of addressing broader

sustainability impacts and achieving balanced progress across ESG dimensions. Moreover, Abakah et al. (2024) use the Shadow Short Rate, as a proxy for monetary policy uncertainty, in examining ESG performance in the energy sector. In contrast, our study adds further insights by investigating real interest rates' impact on global ESG performance holistically across sectors. We investigate the monetary policy implications using real interest rates which offer transparency, relevance across cycles, and clearer links to economic output, investment, and productivity (Smithin, 2007; Burr & Willems, 2024; Lunsford, 2017). Notably, shadow short rates can be less intuitive for policymakers and highly dependent on model assumptions, although it holds significance during extraordinary periods of monetary easing, particularly when nominal interest rates near zero (Christensen & Rudebusch, 2015).

Moreover, our study employs an ESG score adjusted for ESG controversies, following Beckmann and Rogmann (2024). This approach enhances the accuracy of ESG performance measurement by integrating a critical dimension – firm-level controversies – which traditional ESG scores often overlook. While standard ESG scores provide a broad assessment of environmental, social, and governance efforts, they may fail to account for incidents that directly contradict sustainable practices, such as environmental violations or governance scandals. This adjustment helps address the potential overestimation of ESG performance in firms that engage in greenwashing or have significant yet unaddressed ESG risks. In addition, the introduction of the ESG risk dummy variable offers a straightforward measure of firms that are at a higher risk of poor ESG performance. Together, these adjustments provide more balanced and reliable measures ESG performance, contributing to improved empirical rigor in research examining the relationship between financial factors, such as real interest rates, and corporate sustainability outcomes.

Our study also provides practical contribution. It underscores the critical role of monetary policy in influencing financial conditions which underpin corporate strategies around

ESG initiatives. Implementing tightening monetary policy can inadvertently hinder firm ESG performance by increasing financing costs and reducing ESG investment incentives. Crafting effective monetary policies, therefore, demands a nuanced approach that balances economic stability with sustainability (Abakah et al., 2024). This requires central banks to acknowledge the complex relationship between financial measures, social and environmental impacts, and governance rigor to ensure enduring sustainable growth. This reiterates the current macroeconomic environment calls for a 'greener and cost-effective' monetary policy strategy aimed at tackling both the environmental and climate crisis while effectively addressing inflationary pressures (Panetta, 2022; Aguila & Wullweber, 2024).

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature and develops the hypothesis. Section 3 describes data sample and the research design. Section 4 discusses main results and robustness tests. Section 5 reports additional analyses. Section 6 concludes the study.

## **2. Literature review and hypothesis development**

### **2.1. ESG performance**

The literature on ESG performance is extensive, dynamic, and rapidly evolving, encompassing diverse perspectives and methodologies. Numerous studies, including Garcia et al. (2017), Broadstock et al. (2021), Zhou et al. (2022), Khaw et al. (2024), Li et al. (2024), Martiny et al. (2024), and Postiglione et al. (2024), underscore the increasing academic and practical interest in ESG performance. These studies emphasize the far-reaching implications of ESG for a wide range of stakeholders, highlighting both the complexity and significance of ESG considerations in contemporary research and practice.

Firms pursue ESG performance for a variety of reasons, driven by both internal and external pressures. Several theories offer explanations for firms' ESG initiatives. Stakeholder

theory suggests that firms engage in ESG activities to meet the expectations and balance the demands of their stakeholders, including investors, employees, customers, and communities (Friedman & Miles, 2002; Brower & Mahajan, 2013). Institutional theory posits that firms adopt ESG practices to conform to regulations, peer pressures and societal norms, enhancing their legitimacy and acceptance (DiMaggio & Powell, 1983; Galbreath, 2013). Agency theory argues that strong ESG performance aligns the managerial interest with those of shareholders, ensuring long-term value creation and reducing agency costs (Jensen & Meckling, 1976; Chen et al., 2023). The resource-based view suggests that firms develop ESG capabilities as strategic assets that can lead to competitive advantages and superior performance (Bansal & Roth, 2002; Chiu & Sharfman, 2011).

Strong ESG performance is associated with numerous benefits for firms, including enhancing a firm's brand reputation, attracting customers who value sustainability, and attracting and retaining talent who are drawn to purpose-driven organizations (Boufounou et al., 2023; Li et al., 2024; Monrel, 2024; Xu et al., 2024). These can translate into improved firm value, as measured by metrics such as profitability and market valuation (Zhou et al., 2022; Sandberg et al., 2023). Firms with strong ESG profiles are also perceived as less risky by investors, leading to lower costs of debt and equity (Ng & Rezaee, 2015; Giese et al., 2019; Pástor et al., 2022).

The determinants of strong ESG performance are multifaceted, encompassing firm-level factors, industry characteristics, and country-level institutions. Firm-level determinants include firm size, profitability, board quality, CEO characteristics, and strategic orientation (Short et al., 2016; Khaled et al., 2021; Abdullah et al., 2024; Martiny et al., 2024). Industry factors, such as the environmental impact of the industry and the level of stakeholder scrutiny, can also influence ESG performance (Short et al., 2016; Khaw et al., 2024). Country-level institutions, including regulatory frameworks, cultural norms, and legal systems, play a

significant role in shaping firms' ESG practices (Ahlström & Monciardini, 2022; Umar et al., 2020; Martiny et al., 2024).

Research on how monetary policy holistically influences ESG performance remains limited, with Abakah et al. (2024) being a notable exception (discussed and differentiated in the following subsection). Aligning with the ongoing debates on how monetary policy can impede green transformation (Isiksal et al., 2019; Ferguson & Storm, 2023; Aguila & Wullweber, 2024), our study aims to address this gap by examining the intricate interplay between monetary policy and ESG outcomes.

## **2.2. Interest rate channel of monetary policy**

Central banks primarily design monetary policies to manage a nation's money supply (Chen et al., 2021). Economic theory identifies multiple pathways through which monetary policy influences the real economy (Choi et al., 2024). Mishkin (1995) categorizes these pathways into four primary transmission channels: the interest rate channel, the exchange rate channel, the asset price channel, and the credit channel. Each channel represents a distinct mechanism through which changes in monetary policy impact economic activity and financial conditions. Our study focuses on the interest rate channel, which considers how a monetary contraction – typically through a rise in short-term interest rates – affects longer-term rates via the expectations hypothesis of the term structure. With sticky prices, higher nominal rates translate into higher real interest rates, increasing the cost of capital (Choi et al., 2024). Changes in interest rates, a key monetary policy tool, have far-reaching effects on economic dynamics, influencing factors such as investment, consumption, and overall financial stability (Chan et al., 2023; Wu et al., 2023). In response to tightening financial conditions, firms reduce investment spending (Guérin, 2023), with further implications on productivity and outputs.

For instance, Gertler and Gilchrist (1993) find that bank loans to smaller firms decrease relative to those to larger firms following monetary tightening. Johri et al. (2022) observe that an increase in global interest rates reduces debt issuance, spotlighting the sensitivity of corporate financing decisions to changes in borrowing costs. Uribe and Yue (2006) reveal that interest rates exert a significant influence on key economic fundamentals in emerging markets, influencing their stability and growth prospects. Istrefi and Mouabbi (2018) document that heightened uncertainty around interest rate movements disrupt industrial production and contribute to higher unemployment rates, adversely impacting economic performance. Luo et al. (2022) demonstrate that monetary policy uncertainty dissuades risk-taking, as firms become more prudent in allocating capital amid unpredictable financial conditions. Likewise, Ma and Zimmermann (2023) find that tighter monetary policy significantly impacts innovation, leading to lower research and development (R&D) spending, reduced venture capital investment, and a decline in patent activity. Jordà et al. (2024) examine the long-term impacts of monetary policy using over a century of aggregate data. Their findings reveal that a one percentage point rise in interest rates leads to a 3% decline in total factor productivity after 12 years.

Research on how monetary policy, particularly interest rates, influences ESG related outcomes is still at its infancy. For instance, Isiksal et al. (2019) find that real interest rates have a negative effect on Turkey's carbon emissions, reinforced through energy consumption, income levels, and FDI channels. Whereas, Anastasiou et al.'s (2024) international study reveals a positive association between real interest rates and carbon emissions. Using the global energy sector as the empirical setting and Shadow Short Rate as a measure of monetary policy uncertainty, Abakah et al. (2024) document a negative relationship between Shadow Short Rate and ESG performance. We extend this line of literature by examining how real interest rates influence ESG performance across all sectors globally.

Our study is distinct from Isiksal et al. (2019) and Anastasiou et al. (2024) because we holistically investigate the impact of real interest rates on ESG performance, while theirs focus is on carbon emissions. Our study is also different from Abakah et al. (2024). While shadow short rate, as employed in Abakah et al. (2024), is relevant during exceptional periods of monetary easing when nominal rates approach zero, this theoretical measure is less intuitive for policymakers and it is highly sensitive to model assumptions (Christensen & Rudebusch, 2015). In contrast, real interest rates, estimated as the nominal interest rates minus expected inflation, reflect the true cost of borrowing. Real interest rates provide enhanced transparency, maintain relevance across economic cycles, and serve as a crucial indicator for evaluating the stance of monetary policy (Smithin, 2007; Burr & Willems, 2024). They demonstrate clearer relationships with economic output, investment, and productivity (Lundsford, 2017).

### **2.3. Hypothesis development**

Imperfect capital markets characterized by costly contract enforcement and macroeconomic disruptions – such as monetary tightening – can exacerbate agency conflicts between borrowers and lenders (Anastasiou et al., 2024). These disruptions often restrict access to external financing or increase the costs of capital, thereby hindering firms' ability to invest and sustain production activities (Isiksal et al., 2019). Bernanke et al. (1996) introduced the concept of the "financial accelerator" to explain how deteriorating credit market conditions can magnify the impact of adverse economic shocks. They exemplify that during economic downturns or monetary tightening, lenders become more risk-averse, triggering a "flight to quality" where credit shifts from high-risk borrowers with greater agency costs to safer, more reliable investments. When economic shocks increase borrowing rates and reduce borrowers' net worth, their ability to invest and produce decreases further, magnifying the initial shock's impact on the economy. Therefore, while a higher real interest rate increases the cost of

borrowing and the risk of financial distress (Kawai et al., 1996), it incentivises cost reductions and exacerbates credit rationing. This impairs firm capacity to allocate resources towards ESG initiatives.

During periods of tight monetary policy, firms are often compelled to prioritize short-term financial survival and maximize shareholder wealth over pursuing long-term ESG goals (Palmer et al., 1995; Harrison & Berman, 2016). Facing the squeeze from higher real interest rates, firms may resort to cutting costly and discretionary ESG activities such as green and renewable technology innovation, employee welfare programs, social welfare initiatives, and robust internal governance (Edmans, 2012; Harrison & Berman, 2016; Mahmoudian et al., 2023; Abakah et al., 2024). This is particularly true when these capital-intensive initiatives heavily rely on external debt financing, which becomes significantly more expensive under rising interest rates (Schmidt et al., 2019; Martin et al., 2024; Reuters, 2024). If such initiatives are perceived as non-essential costs rather than integral business functions, they are vulnerable to budget cuts during financial strain. This deprioritization of ESG goals is especially pronounced in economies with constrained liquidity and solvency, as well as in developing countries where financial markets are less developed and credit availability remains limited (Song & Wilson, 2024).

The real options theory, as outlined by Trigeorgis and Reuer (2017), extends the principles of financial options to real assets and strategic investment decisions. It further provides a framework for assessing and valuing opportunities where uncertainty surrounds monetary policy (Anastasiou et al., 2024) can influence firm ESG performance. A real option offers firms the right – but not the obligation – to delay, abandon, or adjust a project as market conditions evolve (Trigeorgis & Reuer, 2017). This flexibility allows firms to make more informed investment decisions and adapt to dynamic environments under resource constraints, allowing firms to minimise losses and benefit from favourable developments (Bowman &

Hurry, 1993; McGrath, 1997). Rising interest rates reduce the present value of future cash flows from ESG investments, making ESG investments such as those in renewable energy infrastructure less financially attractive in the short term (Egli et al., 2018). This can potentially discourage firms from committing to such significant upfront capital outlays. Consequently, firms may delay or scale back ESG-related investments, thereby perpetuating short-termism and reducing their sustainability outcomes. The deprioritization of ESG goals during high real interest rates periods can also result in compounding risks, in view of heightened regulatory requirements, shifting consumer preferences, and elevated environmental challenges, which leads to greater overall ESG risk exposure. Conversely, during monetary easing, firms are likely to have considerable “slack resources” and demonstrate less need to make trade-offs for advancing multiple ESG objectives (Waddock & Grave, 1997; Perez-Batres et al., 2012; Xiao et al., 2018). As the decline of real interest rates gives rise to a more favourable condition for financing, it enables firms to restore their ESG vigilance and revisit previously shelved ESG projects, resulting in stronger (lower) ESG performance (risk).

The preceding discussions lead to the formulation of the following hypothesis<sup>2</sup>:

*H1: Real interest rates and ESG performance are negatively related.*

### **3. Sample and methodology**

#### **3.1. Data and sample**

We collect data for this study from a wide variety of sources. We use the LSEG (formerly known as REFINITIV) to collect ESG and firm-level data. We collect real interest

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<sup>2</sup> Like Anastasiou et al. (2024), an opposite view suggests an opposite directional hypothesis between real interest rates and ESG performance. Stakeholder theory (Friedman & Miles, 2002) acknowledges firm commitment to address and balance diverse stakeholder needs. Particularly, resource-based view suggests that firms may still sustain and even prioritise ESG commitments to strategically signal commitments, enhance reputation and stakeholder trust during periods of uncertainty (Bansal & Roth, 2002; Yuan et al., 2022). Such commitment is expected to yield competitive advantage and improve market valuations, outweighing short-term financial pressures. This suggests that firms might sustain and increase ESG initiatives during high real interest rates periods, leading to stronger ESG performance. However, our findings refute this alternate hypothesis.

rate and country-level data from the World Bank database. Our data covers 14 years between 2010 to 2023. There are several rationales for choosing the time frame between 2010 to 2023. First, the time frame allows us to examine the impact of the Paris Accord on the extent of ESG performance and risk. Second, the chosen timeframe allows us to explore the impact of monetary policy on ESG performance and risk after the economic shock resulting from the 2008 global financial crisis. There have been several sustainability policy advancements during this time: (1) the UN Sustainable Development Goals, (2) the Copenhagen Accord and (3) the Cancun Agreements.

We apply several criteria to ensure the robustness of our study sample. First, we drop firms with insufficient information on ESG performance and risk. Second, we removed financial firms from the study sample as these firms are subject to different accounting rules. The final sample consists of 2,645 firms from 45 countries, resulting in an unbalanced panel of 30,069 firm-year observations.

Table 1 reports the number of firms and their evolution over time with the average ESG performance and average real interest rates in Panel A, as well as the distribution across industries in Panel B. Al Amosh and Khatib (2023) suggest that the COVID-19 pandemic may divert firms' attention from non-financial ESG performance because it may not directly enhance financial performance. This is evident from a drop in the observation in 2021 and 2022 as we find less firm-level ESG data available in the LSEG database compared to the pre-pandemic level. Panel B reveals that the Industrials industry makes the highest percentage contribution to the total sample (27.1 per cent), followed by Basic Materials (14.75 percent) and Real Estate (12.0 percent). The contributions of industries, such as Telecommunications, Consumer Discretionary and Consumer Staples, remain below 5 per cent.

**[Insert Table 1 about here]**

### 3.2. Analytical models

The primary objective of this study is to examine the effect of monetary policy on firms' ESG performance. We develop Equation (1) and use OLS regression to test such associations. Both year and country fixed effects are used in our baseline OLS to control for the year and country influences.

$$ESG_{i,t} = \beta_0 + \beta_1 REALINT_{it} + \beta_2 SIZE_{i,t} + \beta_3 AGE_{i,t} + \beta_4 CASH_{i,t} + \beta_5 ROA_{i,t} + \beta_6 MTB_{i,t} + \beta_7 CAPEX_{i,t} + \beta_8 SALES_{i,t} + \beta_9 PPE_{i,t} + \beta_{10} COD_{i,t} + \beta_{11} SOE_{i,t} + \beta_{12} GDPG_{i,t} + \beta_{13} RULE_{i,t} + \beta_{14} INFL_{i,t} + \beta_{15} UNEM_{i,t} + \text{Year FE} + \text{Country FE} + \epsilon_{i,t} \quad (1)$$

*ESG* is the dependent variable in Equation (1). For the main analysis, it is measured by ESG performance (*ESGP*), which is the ESG controversy-adjusted ESG performance data available in the LSEG database. Secondly, in the robustness analysis, we measure *ESG* with ESG risk (*ESGR*), an indicator variable that takes the value of one if a firm's ESG score falls below 25 per cent, and zero otherwise. We follow the ESG risk definition prescribed by LSEG (2022). LSEG developed four groups (A, B, C and D) based on the ESG index score; firms in the A group (divided into A-, A and A+) are the ESG leaders with ESG scores above 75 per cent. ESG laggards, on the other hand, are those firms with ESG scores below 25 per cent (classified as group D). While there have been studies exploring firms' aggregate ESG performance, recent studies have begun examining ESG leaders and laggards (Naffa & Fain, 2022; Chen & Lin, 2022; Lewellyn & Muller-Kahle, 2024). Therefore, we introduce this measure of ESG risk to ensure the robustness of our findings.

The primary variable of interest in the equation is *REALINT*. We use three different proxies for *REALINT*: (1) Real interest rate (*REALI*); (2) Variation of real interest rate ( $\Delta REALI$ ); and (3) High real interest rate (*BINREALI*). While the real interest rate (*REALI*) itself gives a snapshot of borrowing costs relative to inflation, its variation ( $\Delta REALI$ ) reveals how those costs are changing over time. For example, a significant positive variation indicates

tightening monetary conditions, whereas a negative variation suggests easing conditions. Moreover, scaling the difference by the previous year's rate normalises the change, making it easier to compare across periods with different base levels of interest rates (Garcia & Perron, 1996). This is particularly useful in periods of low or high absolute rates, where absolute changes may appear misleadingly small or large. Interest rates have implications for the state of demand and supply of money in the economy which has direct implications on firm performance. The indicator variable (*BINREALI*) takes the value of one if real interest rate is above its sample median, and zero otherwise. It is constructed to filter out minor variations created by small fluctuations in continuous real interest rates. We expect these three proxies for *REALINT* to be significantly and negatively related to *ESGP*, but significantly and positively related to *ESGR*.

We control for both firm and country-level variables. Our firm-level control variables include *SIZE*, *AGE*, *CASH*, *ROA*, *MTB*, *CAPEX*, *SALES*, *PPE*, *COD* and *SOE*. We measure firm size (*SIZE*) by taking the natural logarithm of total assets. Drempetic et al. (2020) find a positive relationship between firm size and corporate ESG performance, confirming firms with superior resources have better ESG performance. Firm age (*AGE*) is the total number of years a firm has been in operation since incorporation. Yang and Baasandorj (2017) conclude that younger firms are less inclined to focus on sustainability-related initiatives as they concentrate on financial performance. The cash-to-asset ratio (*CASH*) is the ratio of cash and cash equivalent to current liabilities. Liu et al. (2024) find a positive impact of *CASH* on ESG performance, indicating that cash-rich firms have more resources to engage in sustainability initiatives. Return on asset ratio (*ROA*) is the ratio of net income over total assets. Profitable firms are more capable of investing in sustainable practices (Anastasiou et al., 2024). The market-to-book ratio (*MTB*) is the firm's market value scaled by the firm's book value. *MTB* can capture the market's perceptions of the sustainability practices adopted by firms

(Anastasiou et al., 2024).

Capital expenditure (*CAPEX*) is the ratio of net investment expenditures to total assets. A firm's capital expenditures are closely associated with more value-relevant activities, resulting in a higher level of carbon footprint in the environment (Karim et al., 2021). Sales growth (*SALES*) is the difference between sales for the current scale by the sales of the previous year. Rauf et al. (2024) report a moderating impact of sales growth between sustainable finance and ESG performance. The firm's long-term assets (*PPE*) are the property, plant and equipment scaled by total assets. Following Wei et al. (2022), we introduce *PPE* as a control variable in this study as it demonstrates the firm's long-term commitment toward sustainable practices. The firm's cost of debt (*COD*) is the interest expense scaled by total debt. Apergis et al. (2022) report a negative association between ESG performance and cost of debt; concluding that firms with a higher ESG rating are associated with lower cost of unsecured debt. State-owned enterprise (*SOE*) is an indicator variable, it takes the value of one if the firm is a state-owned enterprise, and zero otherwise. State-owned enterprises with better ESG performance have easy access to equity financing via stock markets (Zahid et al, 2023).

Our country-level controls include: *GDPG*, *RULE*, *INFL* and *UNEM*. GDP growth (*GDPG*) is the annual percentage of GDP change. GDP growth has a positive influence on firms ESG Performance (Leogrande & Costantiello, 2023). We also control for the inflation rate (*INFL*) in our study. Baek and Song (2024) find that low ESG-rated firms are more susceptible to inflation and GDP growth. Unemployment (*UNEM*) is the annual percentage of unemployment rate change. Angelo et al. (2023) conclude that unemployment has a positive influence on GHG gas emissions. Rule-based governance (*RULE*) evaluates the degree to which a rule-based administrative structure and judicial system assists the private economic activity within a society. Firms operating in a rule-based environment are more likely to adopt sustainability practices.

## 4. Analyses and results

### 4.1. Descriptive statistics, correlation and univariate analyses

Table 2 presents the descriptive statistics of the included variables. ESG risk measures and firm-level variables are winsorized at the 1<sup>st</sup> and 99<sup>th</sup> percentile to limit the influence of outliers. As reported in Panel A of Table 2, for firms in the full sample, the mean of *ESGP* indicates that the ESG performance adjusted by controversies score is 29.7% on average. By construction, the mean value of *ESGR* reveals that 44% of firms have ESG performance score adjusted by the ESG controversies below 25 per cent. The mean and median difference in two-sample *t*-tests show the mean difference of *ESGP* and *ESGR* for high and low real interest rates is -11.96 and 7.60, respectively ( $p$ -value<0.00). These suggest that ESG performance is poorer and ESG risk is higher in the high real interest rate period compared to the low real interest rate period.

The mean value of the real interest rate (*REALI*), as shown in Panel B, in our sample is 3.028%. Variation of real interest rate ( $\Delta$ *REALI*) shows a mean difference between the real interest rate for the current and previous years scaled by the real interest rate of the previous year of 0.507. The mean value of high real interest rate (*BINREALI*) reveals that 23% of observations are during the high real interest rate period when the rate is above the sample median. These measures are substantially and statistically different between the high and low-interest rate sub-samples. This deviation reflects the diverse environments across the examined period, from those exhibiting high financial costs to those with low financial costs that firms encountered.

Turning to our firm-level control variables delineated in Panel C, firms in our sample have on average total assets (*SIZE*) of 9.76 millions which translated into a natural logarithm value of 21.812. The average firm age (*AGE*) is 29 years, suggesting our sample firms are

relatively well-established. The ratio of cash and cash equivalent to current liability (*CASH*) has a mean of 0.481, suggesting that cash and cash equivalent are about half of current liability. Return on assets (*ROA*) has a mean of 0.041, indicating sample firms are profitable on average. Market-to-book (*MTB*) signals a 1.333 times higher market value than the book value of the firm's equity. Net investment expenditures (*CAPEX*) are scaled by total assets and hence reveal that, on average, 21.2 percent of total assets lie in *CAPEX*. Furthermore, the average firm in the sample has a sales growth (*SALES*) of 11.2%, their property, plant and equipment assets (*PPE*) occupy 31.8 percent of total assets while interest expenditures equate 21.5 percent of total debt. There are 8.9 percent of the firms are state-owned enterprise (*SOE*).

In terms of country-level variables in Panel D, the average yearly economic growth (*GDPG*) is 3.114% over the 2010-2023 period, the average annual inflation rate (*INFL*) stands at 2.493%, while annual percentage of unemployment rate change (*UNEM*) is 5.333%. Rule-based governance (*RULE*) has a mean value of 1.541, ranging from 0 to 3.5, indicating a broad spectrum of the degree to which a rule-based administrative structure and judicial system assists the private economic activity within a country.

Considering the statistically significant test-of-difference values, we find that during high real interest rate periods, as compared to low real interest rate periods, firms: (a) are relatively smaller; (b) hold less cash; (c) are less profitable; (d) display reduced market value; (e) invest less in capital expenditure; (f) slowdown in sales growth; (g) have higher long-term assets; and (h) experience higher costs of debt. At the macro level, during the high real interest rate period, GDP growth is higher, the inflation rate is marginally lower, and the unemployment rate is substantially lower compared to the low real interest rate period. These results confirm the need to control for these variables in our regression models and to conduct propensity score and entropy balanced matching tests to address endogeneity concerns.

**[Insert Table 2 about here]**

Table 3 reports Pearson correlation values among variables. *BINREALI* has a negative and significant correlation with *ESGP*, and a positive and significant correlation with *ESGR*. Whereas *REALI* has a positive and significant correlation with *ESGR*. These provide preliminary evidence supporting our hypothesis that during high real interest rate periods, firms ESG performance is poorer or ESG risk is higher. Most of our control variables are strongly related to the main dependent variable. This confirms our intuition and justifies their use in the regression model. The correlation matrix further indicates that all correlation coefficients are less than 0.6, ruling out the multicollinearity concerns as they are lower than the commonly accepted threshold (Gujarati & Porter, 2009).

**[Insert Table 3 about here]**

#### **4.2. Real interest rates and ESG risk**

Table 4 shows the main regression results of our hypothesis (H1) that real interest rates is negatively associated with ESG performance. Specifically, in Column (1) we present the ordinary-least-squares (OLS) regression results for the relationship between real interest rate (*REALI*) and ESG performance (*ESGP*) after controlling for firm-level determinants of ESG risk, country-level variables, year fixed effects and country fixed effects. The coefficient of *REALI* is negative and statistically significant at the 1% level (coefficient = -0.002, *p*-value = 0.001), which is consistent with hypothesis H1 that when real interest rate is low, firms experience poorer ESG performance, as the worsening credit conditions compel firms to focus on short-term financial stability, often at the expense of discretionary ESG initiatives. Our result is also economically significant. For example, a standard deviation increase in the level of real interest rate corresponds to a decrease in ESG performance by 0.009 [ $4.530 \times (-0.002)$ ], where -0.002 is the coefficient of *REALI* reported in Column (1)]. This indicates a decrease in ESG performance of 0.003 ( $0.009 \times 0.297$ ) for the average firm in our sample. Moreover, this

is associated with an increase of 0.010 (0.003/0.297) in the mean ESG performance given that the mean ESG performance in our sample is 0.297.

Column (2) reports coefficient estimates where we use an indicator variable capturing high real interest rate (*BINREALI*) as the independent variable to reduce noises created by insignificant variations caused by minor fluctuations in continuous real interest rates. In Column (3), we use  $\Delta REALI$  to measure the variation of real interest rate to capture the momentum and trend dynamics of the monetary condition. In all these models, the coefficients of the alternative real interest rates measures are negative and statistically significant, with coefficients of -0.021 and -0.001 in Models (2) and (3), respectively, all significant at the 1% level.

The strong and negative coefficients of real interest rate measures across all models support the hypothesis that higher real interest rates lead to poorer ESG performance. This aligns with the financial accelerator theory (Bernanke et al., 1996) on the consequences of deteriorating credit conditions and real options theory (Trigeorgis & Reuer, 2017) on firms' inclination to postpone or forgo long-term ESG investments when facing uncertainty. Our findings suggest that during periods of elevated real interest rates, firms tend to focus on immediate financial stability at the expense of non-essential ESG initiatives, leading to a reduction in ESG. Consequently, restrictive monetary policies can drive short-term thinking, weaken ESG performance, and heighten firms' exposure to ESG risks, posing challenges to sustainable business practices (Harrison & Berman, 2016; Mahmoudian et al., 2023; Abakah et al., 2024).

**[Insert Table 4 about here]**

### **4.3. Endogeneity correction**

#### **4.3.1. Propensity score and entropy balancing matched approaches**

One might contend that firms demonstrating high ESG performance differ fundamentally from those that do not. This raises the concern that our regression analysis may not adequately control for these differences. Furthermore, the observed relationship might be influenced by the linear functional form of our OLS estimates. Therefore, we use two matched samples, namely propensity score matched and entropy-balanced samples, to assuage potential selection bias related to firm-specific characteristics and mitigate bias from functional misspecification (Rosenbaum and Rubin, 1983; Armstrong et al., 2010; Hainmueller, 2012; Shipman et al., 2017).

For PSM analysis, we begin by dividing the sample into two groups based on the median ESG performance. Firm-year observations with ESG performance above the median are classified as the high ESG performance group (treatment group), while those below the median are assigned to the low ESG performance group (control group). Using a logit model, we calculate the propensity score – the probability of belonging to the treatment group – for observations in both groups. The logit model includes all control variables specified in Equation (1). Next, each observation from the treatment group is matched with one observation from the control group, ensuring that the absolute difference in propensity scores is less than 0.001 (caliper of 0.001). Matching is performed without replacement, meaning each control group observation can only be matched to one treatment group observation and cannot be reused. The resulting matched sample, consisting of 19,994 observations, is then used for further analysis.

We report the PSM results in Panel A of Table 5. In Columns (1) to (3), the key variables of interest, *REALI*, *BINREALI* and  $\Delta REALI$  carry significant negative coefficients of -0.002, -0.007 and -0.002 respectively ( $p$ -value = 0.00). This result is consistent with the idea that firms experience lower level of ESG performance during high real interest rate period.

Nonetheless, the PSM methodology has faced criticism for two main reasons. First, it requires researchers to specify a model to determine the best match between the treatment and control groups. Second, the technique often leads to a loss of observations, reducing the statistical power of tests. To address these limitations, entropy balancing, introduced by Hainmueller (2012), has gained popularity in social science research. Unlike PSM, entropy balancing does not require specifying a matching model or criteria. Instead, this method uses a multivariate matching approach to calculate weights for control group observations, ensuring the selected characteristics are balanced (Hainmueller, 2012; Hainmueller and Xu, 2013). Therefore, we employ entropy balancing procedure to supplement the PSM findings.

We assign weights to low ESG performance firms and create balanced distributions for the covariates between the treatment and control groups based on the first moment (mean) controlling for variables from Equation (1). We then re-estimate Equation (1) using the entropy-balanced sample. The findings, presented in Panel B of Table 5, show that the coefficients for real interest rate proxies remain consistently negative and significant across Columns (4) to (6). These results confirm the robustness of our baseline findings after addressing selection bias.

**[Insert Table 5 about here]**

#### **4.3.2. Instrumental variable 2SLS regression**

To address the inherent unobserved omitted variables concerns, we further conduct instrumental variable (IV) 2SLS regression on the entropy balanced sample. We follow Larcker and Rusticus (2010) to identify and validate a suitable IV that satisfies the three key criteria of relevance, exclusion restriction, and exogeneity. The relevance criterion requires that the IV be correlated with the endogenous regressors (*REALI*, *BINREALI* and  $\Delta REALI$ ). Empirical (Arnone & Romelli, 2013) and practical (Bank of England, 2024) evidence suggests

central banks increase interest rates as a monetary measure impacting the real cost of borrowings, contributing to lowering the inflation rate. Berger and Kießmer (2013) show the nexus between degree of central bank independence (CBI) and monetary policy. If central banks are completely insulated from political pressure, they refrain from implementing preemptive monetary tightening to maintain financial stability. Hence, we use the Central Bank Independence – Extended Index (CBIE) (Romelli, 2024) which is an extension of the original index introduced by Romelli (2022). This extended index provides information on 42 criteria of central bank institutional design across six dimensions: 1) Governor and central bank board, 2) Monetary policy and conflict resolution, 3) Objectives, 4) Limitations on lending to the government, 5) Financial independence and 6) Reporting and disclosure. The score ranges between 0 (no independence) to 1 (full independence). We perform post-estimation tests to confirm the validity of this instrument for explaining the variation in real interest rates that affects ESG performance and risk.

The exclusion restriction criterion necessitates that the IV does not directly affect ESG performance in subsequent years. The Central Bank of a country may influence ESG performance indirectly through promoting financial stability. Therefore, the primary channel through which an independent (free from political pressure) central bank of a country could affect ESG performance is via its influence on real interest rates, rather than having a direct or separate effect on firms' ESG behaviors. Thus, our IV satisfies the exclusion restriction by ensuring that its impact on the dependent variable, ESG performance, occurs only through real interest rates.

The exogeneity criterion requires that the IV be uncorrelated with the error term in the model, ensuring no bias from unobserved factors. Interest rates are generally independent of firm-specific decisions regarding ESG performance. While central banks have specific characteristics such as regulatory preferences and sustainability mandates, these are not

correlated with the unobserved factors affecting the firm's ESG behavior in a direct manner., Therefore, the IV influences ESG outcomes only through real interest rates and not through any direct correlation with unobserved factors.

The results of this analysis are presented in Table 6. All regressions include industry and year-fixed effects, and we report *t*-statistics with robust standard errors clustered at the firm level. The first stage regression reports a negative impact of CBI on real interest rates. Such evidence indicates that central bank independence leads to quantitative easing to stimulate economic growth (Neely & Fawley, 2013). In the second stage, we report that the instrumented values of IVs have negative and statistically significant coefficients at the 1% level across all columns. These findings are consistent with our baseline results, further supporting the prediction that real interest rates negatively affect ESG performance.

We performed several diagnostic tests to ensure the validity of our instrument. First, we perform “Tests of endogeneity” to examine whether real interest rate treated as an endogenous variable in the OLS model could instead be treated as exogenous. The null hypothesis Wu–Hausman tests is that the variable under consideration can be treated as exogenous. However, the p-value is significant for all models (Model 4 – 6), indicating that all three proxies of real interest rates should be treated as endogenous and instrumental variable analysis is appropriate. Next, we proceed with examining the validity of the instrument. For an excluded exogenous variable to be a valid instrument, it must be sufficiently correlated with the included endogenous regressors but uncorrelated with the error term. We apply “estat firststage” procedure available in STATA and report the F-statistic in Table 6. In our model, if we are willing to tolerate a 10% relative bias, then we can conclude that our instruments are not weak because the F-statistic exceeds the critical value for each of the second-stage models (Model 4 – 6) (Stock & Yogo, 2005).

**[Insert Table 6 about here]**

### 4.3.3. Firm fixed effect regression

To further addressing the endogeneity issue, we run the same regression reported in Table 4 in which we include all control variables and firm and year fixed effects. Firm fixed effects can attenuate the concerns associated with time-invariant unobserved firm characteristics that may affect ESG performance. Our results remain consistently unchanged across all the models. More specifically, the coefficient estimates on real interest rate (*REALI*), variation of real interest rate ( $\Delta REALI$ ) and high real interest rate (*BINREALI*) are negative and statistically significant at the 1% level under this specification.

[Insert Table 7 about here]

### 4.4. Likelihood of ESG risk due to real interest rate

Next, we examine the likelihood of ESG risk due to real interest rate whereby we regress ESG risk on real interest rate proxies and control variables. More precisely, we estimate a logit model where *ESGR* is an indicator variable equals to one, if the firm's ESG performance is below 25 per cent, and zero otherwise. The results are presented in Table 8. In Column (1) and Column (2), the coefficient estimates on real interest rate (*REALI*) and high real interest rate (*BINREALI*) are 0.065 and 0.173, respectively, both significant at the 1% level, suggesting a positive association between real interest rates and the propensity of having a high ESG risk.

In Columns (3) and (4), we use Probit models as an alternative specification to address the concern of a "left-censored at zero" situation where some observations fall between zero and positive values (Wooldridge, 2010). The coefficients for real interest rate proxies in these models are also positive (0.037 and 0.108) and statistically significant at the 1% level, reinforcing the findings from the logit model.

These findings suggest that ESG risk tends to rise during periods of high real interest rates compared to low-rate periods. This may be attributed to the increased cost of capital associated with higher real interest rates, which can strain a firm's financial resources. Such financial pressure may compel firms to deprioritize long-term ESG investments in favour of immediate financial obligations, thereby elevating ESG risk. Additionally, higher borrowing costs might discourage sustainable projects that require substantial upfront investment, further amplifying the firm's exposure to ESG risks (Harrison & Berman, 2016; Mahmoudian et al., 2023; Abakah et al., 2024).

[Insert Table 8 about here]

## 4.5. Additional analysis

### 4.5.1. Paris Agreement

The DID regression analysis is applied to examine how the Paris Agreement influenced the relationship between real interest rates and ESG risk. We identify the Paris Agreement as an exogenous policy intervention since it signalled a global commitment to addressing sustainability issues, potentially altering the strategic priorities of firms (Anastasiou et al., 2024). We define *PARIS2015* as an indicator variable that assigns a value of one to firm-years prior to 2015, and zero otherwise. The interested variable is the interaction term between *REALI* and *PARIS2015*. We run the OLS regression with *ESGP* as dependent variable and the logit model with *ESGR* as dependent variable to evaluate firm ESG performance and risk, respectively, in response to changes in real interest rates post-2015. The coefficient of the interaction term  $REALI \times PARIS2015$  indicates whether the effect of real interest rates on ESG risk has significantly changed after the Paris Agreement.

The results in Table 9 reveal a negative and statistically significant coefficient for the interaction term  $REALI \times PARIS2015$  in Column (1), where ESG performance is the dependent

variable. This finding suggests that the Paris Agreement mitigates the adverse impact of real interest rates on firms' ESG performance. Specifically, the negative coefficient implies that post-2015, firms have shown relatively better ESG outcomes, even in high-interest-rate environments. While rising real interest rates generally discourage discretionary spending, the post-Paris period reflects a shift in firms' commitment to maintain or enhance their ESG investments, recognizing the long-term reputational and operational benefits of adhering to global sustainability goals (Falkner, 2016).

In contrast, the coefficient of the interaction term is positive and statistically significant on ESG risk in Column (2), highlighting that the Paris Agreement reshapes the influence of real interest rates on ESG risk. The analysis suggests that firms are either under increased regulatory pressure and heightened investor scrutiny in a high-interest-rate environment post-2015, where firms may face increased costs or reputational risks linked to the “green mandate” of the Paris Agreement (Anastasiou et al., 2024).

**[Insert Table 9 about here]**

#### **4.5.2. The moderating influence of economic policy uncertainty, investor protection, polluted industry, GRI adoption and corporate governance**

In this section, we explore how economic policy uncertainty, investor protection and polluted industry, GRI adoption and corporate governance moderate the adverse impact of real interest rates on ESG performance. First, we assess whether a country's economic policy uncertainty affects the relationship between real interest rates and ESG performance. The results, presented in Panel A of Table 10, show a negative and statistically significant coefficient for real interest rates in the high economic policy uncertainty group. This finding indicates that firms in countries with high levels of economic policy uncertainty are more likely to exhibit lower ESG performance in response to higher real interest rates. This outcome can be

attributed to the challenges posed by an uncertain economic policy environment, where firms may face difficulty in long-term planning and resource allocation (Lin et al., 2021; Phan et al., 2021). High real interest rates further exacerbate these challenges by increasing the cost of capital, leading firms to prioritize immediate financial concerns over sustainability initiatives. The combination of economic uncertainty and financial pressure may force firms to scale back investments in ESG-related projects, resulting in poorer ESG performance.

Second, we investigate whether the investor protection index influences the relationship between real interest rates and ESG performance. Previous research emphasizes the role of investor protection in fostering improved ESG performance, as robust investor protection mechanisms encourage long-term investments, including those in sustainability initiatives (Breuer et al., 2018; Wang et al., 2021). Given that ESG activities often yield benefits in the long term, investors who are better protected are more likely to support and benefit from enhanced ESG performance. To test our prediction, we partition our sample based on the investor protection index and present the results in Panel B of Table 10. The findings reveal a negative and statistically significant coefficient for real interest rates in the group operating in a weakly protected investor environment. This suggests that firms in jurisdictions with weaker investor protection are more likely to exhibit lower ESG performance when real interest rates are high. This result can be explained by the short-term focus that may prevail in environments with weak investor protection. In such settings, firms may prioritize immediate financial outcomes over long-term sustainability objectives, particularly during periods of high real interest rates that increase borrowing costs and financial constraints.

Panel C presents the findings on how industry setting influences the relationship between real interest rates and ESG performance. The results indicate that the adverse impact of real interest rates on ESG performance is more pronounced within polluted industries (Gull et al., 2024). This suggests that firms operating in environmentally sensitive sectors are

particularly vulnerable to the pressures of high real interest rates, likely due to the increased cost of implementing sustainability measures in industries with higher environmental liabilities.

Panel D focuses on the influence of GRI adoption. The results reveal a contrasting pattern: in firms adopting the Global Reporting Initiative (GRI) framework, the coefficient for real interest rates is positive, while remaining negative and significant in non-GRI adopters. This suggests that firms following GRI standards, which promote transparency and accountability in sustainability reporting (Luo & Tang, 2023), are better equipped to manage ESG risks and enhance ESG performance even during periods of high real interest rates. In contrast, non-GRI adopters may face increasing ESG risks under similar conditions, possibly due to a lack of structured sustainability practices and reporting frameworks.

Next, we analyse the impact of a firm's corporate governance on the monetary policy and ESG performance relationship in Panel E. We argue that strong governance mechanisms can mitigate the adverse effects of tightening monetary policy on ESG initiatives because well-governed firms are more likely to prioritize long-term value creation over short-term financial pressures (Rowley et al., 2017). Moreover, these firms often have better credit ratings, stronger investor confidence and more diversified funding sources (Klapper & Love, 2004). This financial stability allows them to continue ESG initiatives even during periods of high borrowing costs. The results in Panel E indicate that the coefficient of REALI is positive and significant for firms with strong governance, suggesting that higher real interest rates do not necessarily deteriorate ESG performance in these firms. This finding aligns with the argument that strong governance acts as a buffer against the negative pressures of monetary tightening.

**[Insert Table 10 about here]**

#### **4.5.2. Impacts on the global region**

The results presented in Panel A of Table 11 demonstrate that the negative relationship between real interest rates and ESG performance persists across different global regions, confirming the robustness of our findings. Specifically, the coefficient estimates for *REALI* are negative and statistically significant across all regions, though the magnitude of the effect varies. Africa (Column 1) has the most negative coefficient of -0.027, significant at the 1% level, suggesting a relatively stronger negative impact of real interest rates on ESG performance compared to other regions. This may reflect heightened sensitivity to financing costs in African firms, where access to affordable capital is typically more constrained (Appiah-Konadu et al., 2022), thereby limiting their ability to maintain ESG investments during periods of high real interest rates. In the Americas (Column 2), while the coefficient is smaller and least negative (-0.002) but still significant at the 1% level, this may indicate a less pronounced but consistent adverse effect. Firms in this region might have greater access to capital markets and more developed financial infrastructures, which could partially mitigate the negative impact of rising real interest rates. For Asia (Column 3), Europe (Column 4), Oceania (Column 5), the coefficients range from -0.009 to -0.007, also significant at the 1% or 5% levels, confirming that the negative impact of real interest rates on ESG performance is a consistent global phenomenon.

**[Insert Table 11 about here]**

#### **4.5.3 Alternative samples**

Panel B of Table 11 presents the robustness checks where we exclude the top three countries in terms of sample size - U.S.A., China, and India - individually and in combination, to test whether our primary findings are driven by firms in these major economies. Across all specifications (Columns 10 to 14), the coefficients on *REALI* remain negative, statistically significant at the 1% level, and relatively stable in magnitude, indicating that the adverse effect of real interest rates on ESG performance persists even after removing these dominant

observations. These robustness checks demonstrate that our results are not driven by any single country or a combination of large countries but rather reflect a consistent global relationship between real interest rates and ESG performance.

#### **4.5.4 Quantile regression**

Panel C of Table 11 reports the results from quantile regression, which allows us to assess whether the impact of real interest rates on ESG performance varies across different levels of ESG performance (Koenker & Hallock, 2001). Across all quantiles - 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, and 90<sup>th</sup> - the coefficient on *REALI* remains consistently negative and statistically significant at the 1% level, with an estimated value of -0.003. This uniformity in the coefficient across quantiles suggests that the adverse effect of real interest rates on ESG performance is not confined to firms at a particular level of ESG performance but is broadly consistent across the distribution.

### **5. Conclusion**

Our study examines the extent to which real interest rates determine the level of firm's ESG performance and risk. Utilizing an international sample of 30,069 firm-year observations, we demonstrate a negative association between real interest rates and ESG performance. We also find evidence that tightening monetary policy increases the likelihood of ESG risk. The findings support financial accelerator theory (Bernanke et al., 1996) and real options theory (Trigeorgis & Reuer, 2017) that worsening credit conditions and financial pressures constrain firms' ability to prioritize sustainability during periods of elevated borrowing costs.

The moderating analyses reveal that firms in countries with high economic policy uncertainty and weak investor protection are particularly vulnerable to declines in ESG performance during high-interest-rate periods. The findings bear implications on the importance of stable policy environments and robust investor protection in supporting

corporate sustainability efforts. Similarly, we show that the negative impact of real interest rates on ESG performance is more pronounced in polluted industries where regulatory and stakeholder expectations are higher. The contrasting effects of GRI adoption and corporate governance further emphasize the critical role of structured sustainability frameworks in mitigating ESG risks under financial constraints.

Our findings demonstrate consistent robustness across various analytical tests. Specifically, when the sample is divided by region, the adverse effect of real interest rates on ESG outcomes is significant across all regions, though more (less) pronounced in Africa (Americas). Furthermore, the results remain stable even after excluding the top three contributing countries – U.S.A, China, and India – individually and in various combinations, indicating that our conclusions are not driven by any single dominant economy. Additionally, the relationship between real interest rates and ESG performance holds under quantile regression, revealing that the negative impact of high real interest rates persists across different levels of ESG performance distribution. These insights collectively strengthen the validity of our findings and highlight the global applicability of the observed relationship between monetary policy and ESG outcomes.

Our study contributes to the ESG and monetary policy literature by providing global evidence on how high real interest rates negatively affect firm ESG performance. While prior research, such as Isiksal et al. (2019) and Anastasiou et al. (2024), focuses on real interest rates' effects on carbon emissions, our work broadens the scope to examine ESG performance holistically across sectors. Unlike Abakah et al. (2024), which uses the Shadow Short Rate to study ESG performance in the energy sector, we emphasize the broader implications of real interest rates, given their transparency, relevance across economic cycles, and clear links to investment and productivity (Smithin, 2007; Burr & Willems, 2024).

Practically, our findings highlight the significant role of monetary policy in shaping financial conditions that influence corporate ESG strategies. In today's macroeconomic context, a "greener and cost-effective" monetary policy is crucial to addressing environmental challenges alongside inflationary pressures (Panetta, 2022; Aguila & Wullweber, 2024). Tightening monetary policy, by raising financing costs, can inadvertently deter ESG investments. Our study highlights that global policymakers must adopt a balanced approach that supports both economic stability and sustainability.

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**Table 1: Sample Distribution**

This table presents sample distribution across years (Panel A) and industries (Panel B): 2010-2023. The industry classification is as per the Industry Classification Benchmark (ICB).

**Panel A: Year-by-year distribution****Panel B: Industry-by-industry distribution**

<b>Year</b>	<b>N</b>	<b>%</b>	<b>Average ESG performance</b>	<b>Average Real Interest Rates</b>	<b>Industry category</b>	<b>N</b>	<b>Percent</b>
2010	2,259	7.513	0.215	1.682	Industrials	8,146	0.271
2011	2,401	7.985	0.222	2.746	Basic Materials	4,398	0.146
2012	2,516	8.367	0.229	2.886	Real Estate	3,598	0.120
2013	2,630	8.747	0.223	2.922	Energy	2,909	0.097
2014	2,520	8.381	0.227	3.975	Technology	2,897	0.096
2015	2,590	8.614	0.261	3.753	Health Care	2,720	0.090
2016	2,645	8.796	0.286	2.559	Telecommunications	1,320	0.044
2017	2,312	7.689	0.295	3.329	Consumer Discretionary	1,131	0.038
2018	2,470	8.214	0.314	4.739	Consumer Staples	1,79	0.006
2019	2,397	7.972	0.352	3.932			
2020	2,464	8.194	0.427	-0.048			
2021	1,612	5.361	0.487	1.962			
2022	1,253	4.167	0.496	5.856			
2023	2,259	7.513	0.215	1.682			
<b>Total</b>	<b>30,069</b>	<b>100</b>			<b>Total</b>	<b>30,069</b>	<b>100</b>

**Table 2: Descriptive statistics**

Variables	Full Sample		High Real Interest Rate		Low Real Interest Rate		Mean test of difference	Median test of Difference
	Mean	Median	Mean	Median	Mean	Median	<i>t</i> -stat and <i>p</i> -vales	( $\chi^2$ -stat and <i>p</i> -value)
<b>Panel A: ESG Risk</b>								
<i>ESGP</i>	0.297	0.303	0.223	0.000	0.254	0.208	-11.96 (0.00)	13.039 (0.00)
<i>ESGR</i>	0.440	0.000	0.567	1.000	0.530	1.000	7.60 (0.00)	-7.592 (0.00)
<b>Panel B: Real Interest Rates</b>								
<i>REALI</i>	3.028	2.469	5.186	3.755	0.459	1.162	125.21 (0.00)	-177.379 (0.00)
<i>BINREALI</i>	0.507	1.000	0.959	1.000	0.000	0.000	697.38 (0.00)	-196.538 (0.00)
$\Delta$ <i>REALI</i>	0.230	0.098	0.289	0.128	0.092	-0.026	11.37 (0.00)	-45.667 (0.00)
<b>Pane C: Firm-level controls</b>								
<i>SIZE</i>	21.812	21.858	21.469	21.538	21.591	21.686	-6.45 (0.00)	7.019 (0.00)
<i>AGE</i>	29.031	21.000	26.059	20.000	25.506	17.000	2.18 (0.00)	-13.485 (0.00)
<i>CASH</i>	0.481	0.267	0.496	0.232	0.582	0.258	-9.46 (0.00)	6.923 (0.00)
<i>ROA</i>	0.041	0.040	0.040	0.041	0.041	0.042	-0.28 (0.78)	1.628 (0.10)
<i>MTB</i>	1.333	0.691	1.421	0.681	1.460	0.764	-1.63 (0.10)	8.767 (0.00)
<i>CAPEX</i>	0.212	0.191	0.168	0.134	0.175	0.143	-4.49 (0.00)	2.460 (0.00)
<i>SALES</i>	0.112	0.059	0.092	0.044	0.152	0.083	-16.14 (0.00)	22.243 (0.00)
<i>PPE</i>	0.318	0.263	0.310	0.258	0.307	0.234	1.30 (0.19)	-2.924 (0.00)
<i>COD</i>	0.215	0.055	0.243	0.062	0.196	0.051	5.28 (0.00)	-24.706 (0.00)
<i>SOE</i>	0.089	0.000	0.109	0.000	0.060	0.000	18.07 (0.00)	-17.995 (0.00)
<b>Panel D: Country-level controls</b>								
<i>GDPG</i>	3.114	2.762	3.432	2.989	3.427	2.523	0.20 (0.84)	-16.915 (0.00)
<i>RULE</i>	1.541	2.500	1.411	0.000	1.593	2.5	-12.57 (0.00)	6.687 (0.00)
<i>INFL</i>	2.493	2.041	2.553	2.09	2.572	2.069	-0.78 (0.43)	2.243 (0.02)
<i>UNEM</i>	5.333	5.150	4.937	5.15	6.196	5.29	-32.46 (0.00)	20.893 (0.00)

This table presents mean and median values of the variables used in the study the statistics of the test of differences. *P*-values are reported in parentheses. All variables are defined in Appendix A.

**Table 3: Correlation matrix**

		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]
<i>ESGP</i>	[1]	1.000																		
<i>ESGR</i>	[2]	-0.861*	1.000																	
<i>REALI</i>	[3]	-0.028	0.012*	1.000																
<i>BINREALI</i>	[4]	-0.093*	0.070*	0.511*	1.000															
<i>ΔREALI</i>	[5]	0.036*	-0.038*	0.013*	0.061*	1.000														
<i>SIZE</i>	[6]	0.571*	-0.499*	-0.002*	-0.070*	0.053*	1.000													
<i>AGE</i>	[7]	0.171*	-0.154*	0.011*	-0.030*	0.030*	0.102*	1.000												
<i>CASH</i>	[8]	0.004*	-0.014*	-0.027*	-0.049*	-0.010*	-0.085*	-0.053*	1.000											
<i>ROA</i>	[9]	0.028*	-0.023*	-0.007*	0.007*	0.002*	-0.029*	0.051*	0.020*	1.000										
<i>MTB</i>	[10]	-0.030*	0.018*	-0.045*	-0.009	0.017*	-0.213*	0.005	0.166*	0.240*	1.000									
<i>CAPEX</i>	[11]	0.118*	-0.100*	0.056*	-0.070*	-0.058*	0.263*	-0.124*	-0.054*	-0.226*	-0.192*	1.000								
<i>SALES</i>	[12]	-0.103*	0.106*	-0.077*	-0.082*	-0.013*	-0.071*	-0.127*	0.053*	0.104*	0.104*	-0.013*	1.000							
<i>PPE</i>	[13]	-0.008*	0.013*	0.010*	0.012*	-0.028*	0.074*	0.031*	-0.090*	-0.084*	-0.104*	0.166*	-0.036*	1.000						
<i>COD</i>	[14]	-0.103*	0.090*	0.005	0.046*	0.021*	-0.159*	-0.003	0.001	0.006*	0.054*	-0.246*	-0.006*	-0.046*	1.000					
<i>SOE</i>	[15]	-0.001	0.006	0.073*	0.113*	0.064*	0.170*	-0.044*	-0.023*	0.011*	-0.047*	-0.080*	-0.006	0.093*	0.025*	1.000				
<i>GDPG</i>	[16]	-0.160*	0.166*	-0.105*	-0.004	0.050*	-0.086*	-0.078*	-0.052*	0.101*	0.067*	-0.138*	0.171*	0.018*	0.074*	0.186*	1.000			
<i>RULE</i>	[17]	0.103*	-0.117*	-0.180*	-0.061*	0.061*	0.206*	-0.127*	0.101*	-0.019	0.023*	0.145*	0.049*	-0.022*	-0.046*	0.128*	-0.005*	1.000		
<i>INFL</i>	[18]	-0.055*	0.053*	0.202*	0.074*	0.042*	-0.144*	0.039*	-0.097*	0.108*	0.043*	-0.030*	0.041*	0.059*	0.047*	0.046*	0.220*	-0.045*	1.000	
<i>UNEM</i>	[19]	0.066*	-0.066*	0.000*	-0.121*	-0.141*	0.044*	-0.100*	0.042	-0.041*	-0.113*	0.118*	-0.002*	-0.022*	-0.048*	-0.107*	-0.258*	0.059*	-0.231	1.000

**Table 4: Regression to test the association between real interest rates and ESG performance**

This table reports regression estimates for Equation (1) when the dependent variable is ESG performance (*ESGP*). Model (1) uses the Real Interest Rate as the main explanatory variable (*REALI*), model (2) uses an indicator variable (*BINREALI*) that takes the value of one if the real interest rate is higher than the median and zero otherwise as the main explanatory variable and model (3) uses changes in real interest rates ( $\Delta REALI$ ) as explanatory variable. The robust standard errors are reported in parentheses, while superscript \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% levels, respectively. Variable definitions are given in Appendix A.

	Dependent Variable = <i>ESGP</i>		
	Model (1)	Model (2)	Model (3)
<i>REALI</i>	-0.002*** (0.001)		
<i>BINREALI</i>		-0.021*** (0.003)	
$\Delta REALI$			-0.001** (0.001)
<i>SIZE</i>	0.091*** (0.001)	0.097*** (0.001)	0.091*** (0.001)
<i>AGE</i>	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)
<i>CASH</i>	0.009*** (0.002)	0.015*** (0.002)	0.009*** (0.002)
<i>ROA</i>	0.111*** (0.015)	0.079*** (0.016)	0.111*** (0.015)
<i>MTB</i>	0.009*** (0.001)	0.012*** (0.001)	0.009*** (0.001)
<i>CAPEX</i>	-0.070*** (0.008)	-0.080*** (0.009)	-0.070*** (0.008)
<i>SALES</i>	-0.054*** (0.003)	-0.047*** (0.004)	-0.054*** (0.003)
<i>PPE</i>	-0.014*** (0.005)	-0.025*** (0.005)	-0.015*** (0.005)
<i>COD</i>	-0.002 (0.001)	-0.003** (0.001)	-0.002 (0.001)
<i>SOE</i>	-0.020*** (0.005)	-0.026*** (0.005)	-0.020*** (0.005)
<i>GDPG</i>	0.003*** (0.001)	-0.002*** (0.000)	0.003*** (0.001)
<i>RULE</i>	0.009*** (0.003)	0.048*** (0.003)	0.009*** (0.003)
<i>INFL</i>	0.005*** (0.001)	0.010*** (0.001)	0.005*** (0.001)
<i>UNEM</i>	0.001 (0.001)	-0.023*** (0.001)	0.001 (0.001)
Constant	-1.819*** (0.026)	-1.563*** (0.031)	-1.810*** (0.026)
Year and Country FE	Yes	Yes	Yes
<i>N</i>	30,069	30,069	30,069
<i>R-squared</i>	0.521	0.435	0.521

**Table 5: Propensity score matching and entropy balancing**

This table presents the regression results with matched samples for the association between real interest rate and ESG performance. We apply propensity matched scores (Panel A) and entropy balanced techniques (Panel B). Coefficient values (robust standard errors) are shown with standard errors clustered at the firm level. Superscript \*\*\*, \*\* and \* represent statistical significance at the 1%, 5% and 10% levels, respectively. All definitions of variables are provided in Appendix A.

	Dependent Variable = <i>ESGP</i>					
	Panel A: Propensity Score Matched			Panel B: Entropy Balanced		
	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
<i>REALI</i>	-0.002*** (0.001)			-0.002*** (0.001)		
<i>BINREALI</i>		-0.007* (0.004)			-0.020*** (0.003)	
$\Delta$ <i>REALI</i>			-0.002* (0.001)			-0.002** (0.001)
<i>SIZE</i>	0.092*** (0.001)	0.096*** (0.001)	0.092*** (0.001)	0.090*** (0.001)	0.096*** (0.001)	0.090*** (0.001)
<i>AGE</i>	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)
<i>CASH</i>	0.009*** (0.002)	0.013*** (0.002)	0.009*** (0.002)	0.009*** (0.002)	0.015*** (0.002)	0.009*** (0.002)
<i>ROA</i>	0.123*** (0.018)	0.112*** (0.019)	0.123*** (0.018)	0.116*** (0.017)	0.081*** (0.019)	0.116*** (0.017)
<i>MTB</i>	0.009*** (0.001)	0.010*** (0.001)	0.009*** (0.001)	0.009*** (0.001)	0.013*** (0.001)	0.009*** (0.001)
<i>CAPEX</i>	-0.058*** (0.010)	-0.073*** (0.011)	-0.059*** (0.010)	-0.057*** (0.010)	-0.072*** (0.011)	-0.058*** (0.010)
<i>SALES</i>	-0.046*** (0.004)	-0.040*** (0.005)	-0.046*** (0.004)	-0.053*** (0.004)	-0.049*** (0.004)	-0.054*** (0.004)
<i>PPE</i>	-0.005 (0.006)	-0.016** (0.006)	-0.005 (0.006)	-0.009* (0.005)	-0.022*** (0.006)	-0.009* (0.005)
<i>COD</i>	-0.001 (0.002)	-0.002 (0.002)	-0.001 (0.002)	-0.001 (0.002)	-0.002 (0.002)	-0.001 (0.002)
<i>SOE</i>	-0.014*** (0.005)	-0.021*** (0.005)	-0.014*** (0.005)	-0.017*** (0.005)	-0.024*** (0.006)	-0.017*** (0.005)
<i>GDPG</i>	0.001* (0.001)	-0.005*** (0.001)	0.001* (0.001)	0.002*** (0.001)	-0.003*** (0.001)	0.002*** (0.001)
<i>RULE</i>	0.018*** (0.004)	0.053*** (0.004)	0.019*** (0.004)	0.006** (0.003)	0.039*** (0.004)	0.006** (0.003)
<i>INFL</i>	0.004*** (0.001)	0.005*** (0.001)	0.005*** (0.001)	0.004*** (0.001)	0.011*** (0.001)	0.004*** (0.001)
<i>UNEM</i>	0.000 (0.001)	-0.023*** (0.001)	-0.000 (0.001)	0.002** (0.001)	-0.022*** (0.001)	0.002* (0.001)
Constant	-1.823*** (0.037)	-1.555*** (0.038)	-1.819*** (0.037)	-1.768*** (0.035)	-1.485*** (0.043)	-1.754*** (0.036)
Year and Country FE	Yes	Yes	Yes	Yes	Yes	Yes
<i>N</i>	19,994	19,994	19,994	30,069	30,069	30,069
<i>R</i> -squared	0.530	0.458	0.530	0.524	0.429	0.524

**Table 6: 2SLS testing the association between real interest rates and ESG performance**

This table presents the 2SLS regression results for the association between real interest rate and ESG performance. We use central bank independence as an instrument for all regression models. Coefficient values (robust standard errors) are shown with standard errors clustered at the firm level. Superscript \*\*\*, \*\* and \* represent statistical significance at the 1%, 5% and 10% levels, respectively. All definitions of variables are provided in Appendix A.

	1 <sup>st</sup> Stage			2 <sup>nd</sup> Stage		
	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
	REALI	BINREALI	REAL	Dependent variable = ESGP		
CBI	-1.284*** (0.126)	-0.510*** (0.075)	-0.750*** (0.048)			
REALI				-0.034*** (0.006)		
BINREALI					-0.462*** (0.088)	
ΔREALI						-0.059*** (0.009)
SIZE	0.068*** (0.017)	-0.094*** (0.010)	0.058*** (0.006)	0.097*** (0.001)	0.087*** (0.002)	0.099*** (0.001)
AGE	-0.003*** (0.001)	-0.003*** (0.001)	0.000 (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)
CASH	0.172*** (0.036)	-0.087*** (0.021)	-0.027** (0.014)	0.010*** (0.002)	-0.002 (0.003)	0.003 (0.002)
ROA	0.336 (0.327)	0.265 (0.193)	-0.552*** (0.124)	0.115*** (0.019)	0.124*** (0.022)	0.071*** (0.018)
MTB	0.013 (0.012)	0.010 (0.008)	0.006 (0.005)	0.007*** (0.001)	0.007*** (0.001)	0.007*** (0.001)
CAPEX	1.717*** (0.184)	-0.764*** (0.109)	-0.455*** (0.070)	0.074*** (0.014)	-0.048*** (0.018)	-0.012 (0.010)
SALES	-0.231*** (0.075)	-0.232*** (0.045)	-0.037 (0.029)	-0.060*** (0.004)	-0.071*** (0.006)	-0.054*** (0.004)
PPE	-2.316*** (0.142)	-0.078 (0.084)	0.077 (0.054)	-0.074*** (0.015)	0.001 (0.009)	0.010 (0.007)
COD	0.044 (0.030)	0.031* (0.018)	0.012 (0.011)	-0.000 (0.002)	0.000 (0.002)	-0.001 (0.002)
SOE	1.420*** (0.092)	0.860*** (0.057)	0.230*** (0.035)	-0.014 (0.009)	0.004 (0.014)	-0.050*** (0.005)
GDPG	-0.102*** (0.012)	0.060*** (0.007)	-0.026*** (0.004)	-0.015*** (0.001)	-0.006*** (0.001)	-0.013*** (0.001)
RULE	-0.583*** (0.018)	-0.067*** (0.010)	0.098*** (0.007)	-0.030*** (0.004)	-0.015*** (0.002)	-0.004*** (0.001)
INFL	0.665*** (0.012)	0.149*** (0.007)	0.004 (0.005)	0.027*** (0.004)	0.018*** (0.003)	0.004*** (0.001)
UNEM	0.087*** (0.008)	-0.023*** (0.004)	-0.054*** (0.003)	0.010*** (0.001)	0.005*** (0.001)	0.004*** (0.001)
Constant	-1.559*** (0.489)	0.259 (0.293)	-0.415** (0.185)	-1.399*** (0.031)	-1.017*** (0.094)	-1.579*** (0.028)
Year and industry FE	Yes	Yes	Yes	Yes	Yes	Yes
N	30,069	30,069	30,069	30,069	30,069	30,069
R-squared/Pseudo R2	0.253	0.2406	0.194	0.264	0.017	0.414
<u>2SLS post-estimation tests</u>						
<i>Test of endogeneity</i>						
Wu-Hausman F-statistic				50.751***	51.687***	45.720***
<i>Weak instrument test</i>						
F-statistic (First-stage regression)				103.411***	52.1738***	244.976***
Critical values >F-statistic				No	No	No

**Table 7: Firm fixed effect regression to test the association between real interest rates and ESG performance**

This table presents the firm fixed effect regression results for the association between real interest rate and ESG performance. Column (1), (2) and (3) shows the regression results for the association between three different proxies of real interest rate. Coefficient values (robust standard errors) are shown with standard errors clustered at the firm level. Superscript \*\*\*, \*\* and \* represent statistical significance at the 1%, 5% and 10% levels, respectively. All definitions of variables are provided in Appendix A.

	Dependent Variable = <i>ESGP</i>		
	Model (1)	Model (2)	Model (3)
<i>REALI</i>	-0.003*** (0.000)		
<i>BINREALI</i>		-0.010*** (0.002)	
$\Delta$ <i>REALI</i>			-0.001*** (0.000)
<i>SIZE</i>	0.082*** (0.002)	0.083*** (0.002)	0.083*** (0.002)
<i>AGE</i>	0.028*** (0.000)	0.028*** (0.000)	0.028*** (0.000)
<i>CASH</i>	0.003* (0.002)	0.003* (0.002)	0.003* (0.002)
<i>ROA</i>	-0.017 (0.015)	-0.017 (0.015)	-0.017 (0.015)
<i>MTB</i>	-0.001* (0.001)	-0.001* (0.001)	-0.001 (0.001)
<i>CAPEX</i>	-0.020* (0.011)	-0.021* (0.011)	-0.023** (0.011)
<i>SALES</i>	-0.030*** (0.003)	-0.029*** (0.003)	-0.029*** (0.003)
<i>PPE</i>	0.028** (0.013)	0.026** (0.013)	0.024* (0.013)
<i>COD</i>	-0.002 (0.001)	-0.002 (0.001)	-0.002 (0.001)
<i>GDPG</i>	0.002*** (0.000)	0.003*** (0.000)	0.003*** (0.000)
<i>RULE</i>	0.009*** (0.002)	0.009*** (0.002)	0.008*** (0.002)
<i>INFL</i>	0.014*** (0.001)	0.015*** (0.001)	0.016*** (0.001)
<i>UNEM</i>	-0.000 (0.001)	0.000 (0.001)	-0.000 (0.001)
Constant	-2.347*** (0.044)	-2.367*** (0.044)	-2.381*** (0.044)
Year and Firm FE	Yes	Yes	Yes
<i>N</i>	30,069	30,069	30,069
<i>R-squared</i>	0.419	0.418	0.418

**Table 8: Likelihood of ESG risk due to real interest rate**

This table reports regression estimates for Equation (1) when the dependent variable is ESG risk (ESGR) which is an indicator variable that takes the value of one if a company's ESG performance is below 25 per cent, and zero otherwise. Model (1) uses *REALI* as the main explanatory variable, while Model (2) uses *BINREALI* as the main explanatory variable. The robust standard errors are reported in parentheses, while superscript \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% levels, respectively. Variable definitions are given in Appendix A.

	Dependent Variable = <i>ESGR</i>			
	Logit		Probit	
	Model (1)	Model (2)	Model (3)	Model (4)
<i>REALI</i>	0.065*** (0.008)		0.037*** (0.004)	
<i>BINREALI</i>		0.173*** (0.036)		0.108*** (0.021)
<i>SIZE</i>	-1.026*** (0.015)	-1.025*** (0.015)	-0.586*** (0.008)	-0.586*** (0.008)
<i>AGE</i>	-0.011*** (0.001)	-0.011*** (0.001)	-0.007*** (0.000)	-0.007*** (0.000)
<i>CASH</i>	-0.161*** (0.022)	-0.162*** (0.022)	-0.097*** (0.013)	-0.098*** (0.013)
<i>ROA</i>	-0.908*** (0.231)	-0.906*** (0.231)	-0.517*** (0.131)	-0.511*** (0.131)
<i>MTB</i>	-0.152*** (0.009)	-0.153*** (0.009)	-0.086*** (0.005)	-0.086*** (0.005)
<i>CAPEX</i>	1.226*** (0.115)	1.238*** (0.115)	0.668*** (0.067)	0.675*** (0.067)
<i>SALES</i>	0.675*** (0.052)	0.651*** (0.052)	0.385*** (0.030)	0.372*** (0.030)
<i>PPE</i>	0.226*** (0.063)	0.230*** (0.063)	0.135*** (0.037)	0.137*** (0.036)
<i>COD</i>	0.036* (0.020)	0.036* (0.020)	0.020* (0.011)	0.020* (0.011)
<i>SOE</i>	0.270*** (0.062)	0.273*** (0.062)	0.156*** (0.036)	0.156*** (0.036)
<i>GDPG</i>	0.059*** (0.006)	0.052*** (0.006)	0.034*** (0.004)	0.030*** (0.004)
<i>RULE</i>	-0.591*** (0.042)	-0.603*** (0.042)	-0.327*** (0.023)	-0.335*** (0.023)
<i>INFL</i>	-0.095*** (0.011)	-0.115*** (0.011)	-0.056*** (0.006)	-0.067*** (0.006)
<i>UNEM</i>	0.334*** (0.014)	0.327*** (0.014)	0.192*** (0.008)	0.188*** (0.008)
Constant	18.538*** (0.440)	18.449*** (0.431)	10.640*** (0.243)	10.595*** (0.240)
Year and Country FE	Yes	Yes	Yes	Yes
<i>N</i>	30,069	30,069	30,069	30,069
Pseudo <i>R</i> -squared	0.323	0.321	0.321	0.319

**Table 9: Difference-in-difference analysis using the Paris Agreement as the exogenous shock**

This table presents the difference-in-difference (DID) regression results to test the impact of the Paris Agreement on the association between real interest rate and ESG performance and risk. We introduce the interaction  $REALI*PARIS2015$  to perform the DID analysis. Column (1) and (2) shows the OLS and Logit regression results, respectively. Coefficient values (robust standard errors) are shown with standard errors clustered at the firm level. Superscript \*\*\*, \*\* and \* represent statistical significance at the 1%, 5% and 10% levels, respectively. All definitions of variables are provided in Appendix A.

	ESGP	ESGR
	(1)	(2)
<i>REALI</i>	0.001 (0.001)	-0.036*** (0.010)
<i>PARIS 2015</i>	0.309*** (0.008)	-6.083*** (0.234)
<i>REALI * PARIS 2015</i>	-0.003*** (0.001)	0.023*** (0.008)
<i>SIZE</i>	0.091*** (0.001)	-1.179*** (0.018)
<i>AGE</i>	0.001*** (0.000)	-0.010*** (0.001)
<i>CASH</i>	0.009*** (0.002)	-0.125*** (0.026)
<i>ROA</i>	0.112*** (0.015)	-1.881*** (0.273)
<i>MTB</i>	0.009*** (0.001)	-0.144*** (0.010)
<i>CAPEX</i>	-0.069*** (0.008)	1.197*** (0.128)
<i>SALES</i>	-0.053*** (0.003)	0.914*** (0.066)
<i>PPE</i>	-0.014*** (0.005)	0.212*** (0.070)
<i>COD</i>	-0.002 (0.001)	0.029 (0.023)
<i>SOE</i>	-0.020*** (0.004)	0.148** (0.071)
<i>GDPG</i>	0.002*** (0.001)	0.000 (0.011)
<i>RULE</i>	0.009*** (0.003)	-0.115*** (0.045)
<i>INFL</i>	0.004*** (0.001)	-0.083*** (0.015)
<i>UNEM</i>	0.001 (0.001)	0.018 (0.017)
Constant	-1.813*** (0.026)	26.675*** (0.510)
Year and Country FE	Yes	Yes
<i>N</i>	30,069	30,069
<i>R-squared/ Pseudo R2</i>	0.521	0.443

**Table 10: Cross-sectional analyses**

This table presents the OLS regression results of the cross-sectional analyses based on economic policy uncertainty (Panel A), investor protection (Panel B), polluted industry (Panel C), GRI adoption (Panel D), and corporate governance (Panel E) on the association between real interest rates and ESG performance. Coefficient values (robust standard errors) are shown with standard errors clustered at the firm level. Superscript \*\*\*, \*\* and \* represent statistical significance at the 1%, 5% and 10% levels, respectively. All definitions of variables are provided in Appendix A.

Dependent Variable = <i>ESGP</i>		
<b>Panel A: Economic Policy Uncertainty (<i>EPU</i>)</b>		
	High	Low
	Model (1)	Model (2)
<i>ΔREALI</i>	-0.002*** (0.001)	-0.002* (0.001)
Constant	-1.652*** (0.029)	-2.026*** (0.034)
Controls	Yes	Yes
Year and Country FE	Yes	Yes
<i>N</i>	17,326	12,855
<i>R</i> -squared	0.538	0.506
<b>Panel B: Investor Protection (<i>IP</i>)</b>		
	High	Low
	Model (1)	Model (2)
<i>ΔREALI</i>	-0.003** (0.001)	-0.001 (0.001)
Constant	-1.693*** (0.025)	-1.771*** (0.031)
Controls	Yes	Yes
Year and Country FE	Yes	Yes
<i>N</i>	15,613	14,568
<i>R</i> -squared	0.470	0.558
<b>Panel C: Polluted Industry (<i>PI</i>)</b>		
	Yes	No
	Model (1)	Model (2)
<i>ΔREALI</i>	-0.003*** (0.001)	0.001 (0.001)
Constant	-1.875*** (0.033)	-1.663*** (0.038)
Controls	Yes	Yes
Year and Country FE	Yes	Yes
<i>N</i>	22,035	8,146
<i>R</i> -squared	0.529	0.518

Panel D: <i>GRI</i> adoption		
	Yes	No
	Model (1)	Model (2)
$\Delta REALI$	0.0011 (0.0011)	-0.0014* (0.0008)
Constant	0.518*** (0.038)	0.001*** (0.016)
Controls	Yes	Yes
Year and Country FE	Yes	Yes
<i>N</i>	10,056	20,577
<i>R</i> -squared	0.162	0.328
Panel E: Corporate Governance ( <i>CG</i> )		
	High	Low
	Model (1)	Model (2)
$\Delta REALI$	0.002** (0.001)	-0.0004 (0.0005)
Constant	0.363*** (0.020)	-0.038*** (0.005)
Controls	Yes	Yes
Year and Country FE	Yes	Yes
<i>N</i>	18,468	11,713
<i>R</i> -squared	0.123	0.217

**Table 11: Regional analysis, alternate sampling, and quantile regression**

This table presents the regression results for the association between real interest rate and ESG performance across different regions (Panel A), excluding the top three countries including USA, China and India individually or collectively (Panel B). Panel C presents quantile regression results: 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup> and 90<sup>th</sup>. Coefficient values (robust standard errors) are shown with standard errors clustered at the firm level. Superscript \*\*\*, \*\* and \* represent statistical significance at the 1%, 5% and 10% levels, respectively. All definitions of variables are provided in Appendix A.

Dependent Variable = <i>ESGP</i>					
<b>Panel A: Sample divided across regions</b>					
	Africa	Americas	Asia	Europe	Oceania
	(1)	(2)	(3)	(4)	(5)
<i>REALI</i>	-0.027***	-0.002***	-0.008***	-0.009***	-0.007**
	(0.004)	(0.000)	(0.001)	(0.001)	(0.003)
Constant	-2.228***	-1.748***	-1.682***	-1.861***	-1.743***
	(0.183)	(0.031)	(0.026)	(0.039)	(0.090)
Controls	Yes	Yes	Yes	Yes	Yes
<i>N</i>	701	10,179	14,622	3,728	998
<i>R</i> -squared	0.388	0.369	0.386	0.429	0.496
<b>Panel B: Sample excluding Top 1, 2 and 3 country observations</b>					
	USA (Top 1)	China (Top 2)	India (Top 3)	Top 1 and 2	Top 1, 2 & 3
	(10)	(11)	(12)	(13)	(14)
<i>REALI</i>	-0.003***	-0.002***	-0.004***	-0.004***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-1.783***	-1.820***	-1.706***	-1.759***	-1.840***
	(0.018)	(0.016)	(0.017)	(0.018)	(0.021)
Controls	Yes	Yes	Yes	Yes	Yes
<i>N</i>	22,546	26,170	26,999	22,941	15,259
<i>R</i> -squared	0.372	0.391	0.365	0.381	0.387
<b>Panel C: Quantile regression</b>					
	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	
	(15)	(16)	(17)	(18)	
<i>REALI</i>	-0.003***	-0.003***	-0.003***	-0.003***	
	(0.000)	(0.000)	(0.000)	(0.000)	
Constant	-1.681***	-1.968***	-1.848***	-1.403***	
	(0.025)	(0.027)	(0.027)	(0.028)	
Controls	Yes	Yes	Yes	Yes	
Year and country FE	Yes	Yes	Yes	Yes	
<i>N</i>	30,069	30,069	30,069	30,069	
<i>R</i> -squared	0.11	0.268	0.219	0.172	

## Appendix A: Variable definition

Notations	Variable Name	Description	Reference
Panel A: Dependent Variables			
<i>ESGP</i>	ESG Performance	ESG score adjusted by the ESG controversies score, available in the LSEG database.	Aydođmuş et al. (2022)
<i>ESGR</i>	ESG Risk	Indicator variable equals to 1 if the firm's ESG performance is below 25 per cent, and 0 otherwise.	LSEG (2023) Naffa & Fain (2022)
Panel B: Independent Variables			
<i>REALI</i>	Real interest rate	The lending interest rate adjusted for inflation as measured by the GDP deflator.	Anastasiou wt al. (2024)
$\Delta REALI$	Variation of real interest rate	The difference between real interest rate for the current and previous years scaled by the real interest rate of the previous year	Anastasiou wt al. (2024)
<i>BINREALI</i>	High real interest rate	Indicator variable equals to 1 if real interest rate is above its sample median, and 0 otherwise.	Anastasiou wt al. (2024)
Panel C: Control Variables			
<i>SIZE</i>	Firm size	The natural logarithm of total assets.	Anastasiou wt al. (2024)
<i>AGE</i>	Firm age	Number of years in operation since incorporation.	Giacomini et al. (2023)
<i>CASH</i>	Cash to asset ratio	The ratio of cash and cash equivalent to current liability.	Liu et al. (2024)
<i>ROA</i>	Return on assets ratio	The ratio of net income over total assets.	Anastasiou wt al. (2024)
<i>MTB</i>	Market-to-book ratio	The firm's market value scaled by firm's book value.	Anastasiou wt al. (2024)
<i>CAPEX</i>	Capital Expenditure	The ratio of net investment expenditures to total assets.	Anastasiou wt al. (2024)
<i>SALES</i>	Sales growth	The difference between sales for the current and previous years scaled by the sales of the previous year.	Anastasiou wt al. (2024)
<i>PPE</i>	Firm long-term assets	The property, plant and equipment assets scaled by total assets.	Anastasiou wt al. (2024)
<i>COD</i>	Firm cost of debt	The interest expenditures scaled by total debt.	Anastasiou wt al. (2024)
<i>SOE</i>	State owned enterprise	Indicator variable equals to 1 if the firm is a state owned enterprise, and 0 otherwise.	Zahid et al. (2023)
<i>GDPG</i>	GDP Growth	Growth of GDP or economic growth (annual %).	Işık et al. (2024)
<i>INFL</i>	Inflation	Inflation rate.	Abakah et al. (2024)
<i>UNEM</i>	Unemployment	Annual percentage of unemployment rate change.	Angelidis et al. (2024)
<i>RULE</i>	Rule-based governance	This variable evaluates the degree to which a rule-based administrative structure and judicial system assists the private economic activity within a country	Megersa & Cassimon, (2015)
<i>DC</i>	Developed Country	An indicator variable equals to 1 signalling if the country belongs to the list of high-income countries following the World Bank definition, and 0 otherwise	Hernandez (2017)
<i>EPU</i>	Economic Policy Uncertainty	The degree of uncertainty about the host country's economic policy.	Baker et al. (2016)
<i>IP</i>	Investor Protection	The investor protection measured by 15 different metrics adopted from La Porta et al. (1998) and The Global Competitiveness Report 2015–2016 by World Economic Forum.	Persakis and Iatridis (2017)
<i>PI</i>	Polluted Industry	Indicator variable equals to 1 if the firm operates in an industry with high emissions of carbon monoxide, nitrogen dioxide, vocs, sulfur dioxide and particulates, and 0 otherwise.	Kahn (2003)
<i>CG</i>	Corporate Governance	Governance pillar score available in LSEG database.	Sahin et al. (2022)
<i>CBI</i>	Central Bank Independence	An extended index based on the original central bank independence index developed by Romelli, D. (2022). The score ranges between between 0 (no independence) to 1 (full independence).	Romelli, D. (2024).