

Riding the wave of climate risk: how firms' attention to climate change-related opportunities responds to economic and climate policy uncertainty

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Abstract

Purpose – Drawing on theoretically grounded hypotheses, this paper aims to compares the linear and asymmetric impact of Economic Policy Uncertainty (EPU) and Climate Policy Uncertainty (CPU) on firms' attention to climate change-related opportunities.

Design/methodology/approach – The authors focus on a sample of German-listed firms observed from the first quarter of 2010 to the second quarter of 2022. The system GMM is used with standard error estimates robust to heteroskedasticity and autocorrelation within panels. The authors run robustness tests to explore issues that have been insufficiently addressed by the literature.

Findings – The linear estimation reveals that policy uncertainty exerts a positive effect on firms' attention to climate opportunities, with CPU exerting stronger impact than EPU. The asymmetric estimators show that firms tend to increase their attention to climate-related opportunities when EPU rises, and are more likely to reduce this attention when CPU decreases. The attention of firms, operating in the manufacturing industry, to climate change-related opportunities is found to be more sensitive to uncertainty than that of firms in other sectors. The positive impacts of EPU and CPU are endogenous to physical and transitional climate risk.

Research limitations/implications – The results imply that market pressure should remain a key driver of corporate innovation in green technologies and act as a substitute during periods of lower economic policy uncertainty, to sustain firms' attention to climate issues. Stronger safeguards should be implemented during times of decreased uncertainty, particularly those linked to pro-environmental regulations, legislation and the energy transition.

Originality/value – This paper explores explicitly the impact of uncertainty on firms' engagement with low-carbon strategies rather on broader environmental metrics. It introduces a dual-uncertainty framework by using both Economic Policy Uncertainty (EPU) and Climate Policy Uncertainty (CPU) indices. It investigates the asymmetric effects of uncertainty which have not yet been explored in the context of firms' commitment to climate change.

Keywords Climate change exposure, Policy uncertainty, Asymmetric relationship, System GMM, Germany

Paper type Research paper



1. Introduction

The present study explores the extent to which policy uncertainty shapes firms' engagement with business opportunities arising from climate change exposure. In particular, we investigate whether economic policy uncertainty and climate policy uncertainty exert distinct effects, and whether these effects manifest linearly or vary in magnitude according to periods of rising vs falling uncertainty. To address this research question, the present study formulates and tests three hypotheses. The first two posit a linear relationship between policy uncertainty and firms' attention to climate-related opportunities. The third hypothesis posits an asymmetric effect, predicting that periods of heightened uncertainty exert a more pronounced influence than intervals of relative stability.

Our inquiry is driven by the conviction that firms' capacity to adapt to climate-related risks, by leveraging opportunities in innovation and competitive positioning, is pivotal to maintaining investor confidence. Indeed, firms are increasingly expected to include climate risk in their strategies and business models. In addition to the physical risks linked to climate change, firms are exposed to long-term uncertainty associated with climate transition and mitigation policies. The threat is so significant that it is beginning to produce effects on a global scale, impacting the productivity and economic growth around the world. In recent years, sustainable investments adhering to ESG criteria have increased, and institutional investors' interest in these criteria has considerably strengthened ([Lopez-de-Silanes et al., 2024](#)). For instance, [Secinaro et al. \(2020\)](#) demonstrate that, for European listed companies, the adoption of environmental practices mitigates operational risks, reduces production costs and enhances profitability. Over time, firms have recognized that strong environmental performance and proactive attention to climate change instill confidence among investors ([Konar and Cohen, 2001](#); [Beatty and Shimshack, 2010](#)). [Ai and Gao \(2023\)](#) find that exposure to climate disasters significantly increases firms' systematic and idiosyncratic volatility, a risk amplified by geographic dispersion and investor awareness yet alleviated by strong environmental performance. [Yu et al. \(2023\)](#) show that, for Chinese renewable energy firms, climate shocks, specifically CO₂ emissions and extreme weather events, improve investment efficiency. This effect is supported by policies for wind and solar power but attenuated by extreme temperature fluctuations. However, this attention to climate change can be endogenous to factors influencing firms' policies and growth strategies. In light of recent major events, like the COVID-19 pandemic and the Russia-Ukraine war, that destabilized supply chains, international commodity prices and global growth, policy uncertainty emerges as a key factor likely to influence corporate attention to climate change.

The proposition of linear and asymmetric relationships between policy uncertainty and firms' attention to climate-related opportunities builds upon three distinct theoretical frameworks. First, the real-options theory predicts a negative effect, on the grounds that heightened uncertainty elevates the option value of postponing irreversible investments and thus dampens managerial engagement. Second, the signaling theory anticipates a positive association, since firms may react to growing uncertainty by amplifying their focus on climate opportunities to signal resilience to capital-market participants. The institutional theory likewise forecasts a positive impact, emphasizing that regulatory pressures is expected to push firms to comply more closely to new climate-related standards under uncertain policy environment. The third hypothesis, built on the attention-based view (ABV), posits an asymmetric effect of policy uncertainty on the attention of firms toward climate-related opportunities. According to this perspective, senior executives allocate their finite cognitive and temporal resources to the most salient issues, like preserving their reputation and investors' trust. Alternatively, when policy uncertainty intensifies, negative signals may disproportionately capture managerial focus, thereby amplifying the firm's

(positive or negative) responsiveness to climate opportunities compared with periods of declining uncertainty.

A firm-level algorithm-driven score on climate change exposure is gathered along with balance-sheet and income statement data for a sample of listed German firms. On the empirical side, the sample period (2010Q1–2022Q2) encompasses two major global and regional disruptions that significantly shaped German firms' strategic attention to climate-related opportunities. The pandemic (2020–2021) caused severe supply-chain disruptions, liquidity constraints and heightened short-term survival priorities, leading many firms to deprioritize long-term environmental initiatives in favor of operational continuity and financial stability. The Russia–Ukraine conflict intensified Germany's energy security and transition debate due to the country's historic dependence on Russian gas. Using dynamic panel data, we estimate a baseline specification with the system generalized method of moments (system GMM) where the score of firms' attention to climate opportunities is the dependent variable and policy uncertainty is the main explanatory variable. Then, we split policy uncertainty into partial positive and negative sums to test whether firms' attention to climate change follows a linear or asymmetric pattern.

As for the linear relationship, the findings confirm the hypothesis based on the signaling theory and the institutional theory, as they reveal a positive impact of policy uncertainty on firms' attention to climate opportunities. The results also reveal that climate policy uncertainty (CPU) exerts a stronger impact than economic policy uncertainty (EPU). In addition, the estimations prove the existence of a non-linear impact of policy uncertainty. The asymmetric analysis indicates, indeed, that the hypothesis based on the ABV is verified for EPU and rejected for CPU. More precisely, growing EPU prompts a positive impact on firms' attention to climate opportunities stronger, in absolute terms, than the negative impact of diminishing EPU. Whereas, the reaction of firms' attention to climate opportunities to diminishing CPU is found to be stronger than their reaction when CPU is heightening.

This research contributes the literature in many respects. First, it explores explicitly the impact of uncertainty on firms' engagement with low-carbon strategies rather on broader environmental metrics. Indeed, the bulk of the empirical literature linking uncertainty to firms' environmental policies relied on traditional indicators such as ESG scores, climate disclosures, green innovation or GHG emissions (cf. Section 2). These indicators can be subject to measurement error biases born by opportunistic and pro-environmental behavior like greenwashing or window-dressing. In contrast to traditional indicators of corporate environmental performance, we use a score that captures both ex-ante efforts (screening and identification) and ex-post actions (monitoring and development) that firms undertake to engage in green business opportunities and initiatives related to climate change. This approach allows capturing the aptitude of firms in facing strategic challenges and opportunities associated with global warming. In addition, this focus enables a deeper understanding of how different levels of climate policy uncertainty (CPU) influence the way firms shift their strategic orientation between compliance-driven risk management and opportunity-driven engagement, thereby offering fresh insights into the evolving literature on corporate responses to climate change. Second, our approach introduces a dual-uncertainty framework by using both Economic Policy Uncertainty (EPU) and Climate Policy Uncertainty (CPU) indices. EPU reflects ambiguity arising from unexpected endogenous or exogenous economic shocks, such as fiscal retrenchments or sudden monetary tightening. While CPU isolates regulatory uncertainty specifically tied to climate-preservation policies, including carbon pricing mechanisms and emissions-reduction mandates. By distinguishing these two dimensions of uncertainty, the study is able to disentangle their separate and interactive effects on firms' attention to climate-related

strategic opportunities. Through this step, we aim at offering novel insights into how firms allocate scarce managerial resources under differing regimes of policy uncertainty. Additionally, the impact of policy uncertainty on firms' commitment to climate change remains insufficiently examined. To the best of our knowledge, the extant researches have not yet investigated the asymmetric impact of policy uncertainty on firms' commitment to climate change. Scholars adopting similar approach to the present one concentrated their analyses on the asymmetric impact of uncertainty on firms' realized investment in low-carbon technologies, pollutant emissions and voluntary environmental disclosures (Aghion *et al.*, 2014; Kim and Lyon, 2011). Building on this literature, we argue that the effect of rising uncertainty on firms' attention to climate change could also differ significantly from the impact of diminishing uncertainty.

The symmetric (linear) results align with previous empirical research, indicating that firms' engagement with climate and environmental issues is sensitive to uncertainty. However, the results contribute to the literature by demonstrating that the degree of firms' sensitivity varies according to the specific nature of policy uncertainty. In particular, firms' attention to climate-related issues is found to display a more pronounced response to climate policy uncertainty than to economic policy uncertainty. Additionally, the results from the asymmetric analysis contradict the main body of literature which asserts that the negative effect of increasing uncertainty on firms' commitment to green innovation and climate action is stronger than the positive impact of reduced uncertainty. Indeed, our results reveal that increases in economic policy uncertainty exert a stronger (positive) influence on firms' engagement with climate-related opportunities compared to equivalent increases in climate policy uncertainty. Importantly, this study extends the current understanding by emphasizing the need for differentiated mechanisms to monitor and guide firms' strategic responses dealing with climate change exposures. Specifically, it underscores the significance of accounting for the source of policy uncertainty, whether it is related to economic or climate policies, in the design of governance frameworks aimed at promoting corporate climate consciousness and adaptability. The results potentially suggest that firms are more concerned about climate opportunities in response to economic uncertainty, which is expected to have a more salient impact on investor and market confidence than climate policy uncertainty. By directly affecting investors' trust, heightened economic policy uncertainty may prompt firms to signal their ability to adapt to unexpected shocks, particularly those related to climate change. However, the results also indicate that periods of reduced climate policy uncertainty significantly diminish firms' attention to climate opportunities. This result suggests that stronger safeguards should be implemented during times of decreased climate policy uncertainty, particularly those linked to pro-environmental regulations, legislation and the energy transition. These findings help investors, small shareholders and regulators to better understand and anticipate corporate decisions related their climate change exposure, particularly in a context where multi-dimensional uncertainty shapes the choices of economic agents.

Moreover, the robustness tests explore issues that have been insufficiently addressed by the literature. This includes controlling for the influence of business confidence since we expect that business optimism or pessimism can, at various levels, impact the willingness of firms to engage in costly innovative projects aiming at reducing their exposure to climate change risks. The results show that the impact of uncertainty remains unchanged after including the Ifo Business climate index, but an increase in business confidence enhances firms' attention to climate change opportunities in the manufacturing sector, while it has the opposite effect in the service sector. We also investigate the sectoral heterogeneity in firms' sensitivity to climate change-related opportunities. The attention of firms in the

manufacturing industry to climate change-related opportunities is found to be more sensitive to uncertainty than that of firms in other sectors. In addition, we try to control the endogeneity of policy uncertainty to perceived physical and transitional climate risks. The findings reveal that the positive predicted impact of economic policy uncertainty is primarily explained by physical risk shocks, whereas the positive effect of climate policy uncertainty is prompted by both physical and transitional climate risk predictions.

The remainder of this paper is organized into five sections. The following section is dedicated to the literature review and the development of the hypotheses to be tested. Section 3 outlines the empirical methodology, detailing the primary hypotheses to be tested, the model specification, data and the estimation method. Section 4 is devoted to interpreting the estimation results and conducting robustness tests. The fifth and final section concludes the paper, offering a brief discussion of the policy implications, the paper's limitations and suggestions for future research.

2. Literature review and hypotheses development

Firms' efforts to manage risks related to climate change is being subject to a rich academic debate. Recent studies explore the different factors affecting this effort, such as management, market pressure or uncertainty. For example, some studies show that eco-friendly innovation, company size and good governance can all help improve firms' commitment. Other researchers point out that strong management and clear environmental communication can influence the attitude of firms toward climate change. Uncertain times can also lead businesses to become more socially responsible or invest in green innovation. On the other hand, indebtedness and poor management are identified as obstacles to firms' climate consciousness. The relationship between uncertainty and the attitude of firms toward environmental and climate issues can also be subject to non-linearity. The following subsections offer a brief literature review around these topics before developing our hypotheses.

2.1 *Uncertainty and firms' commitment to climate change*

Empirical evidence shows the existence of different sources influencing firms' commitment to climate change (Aggarwal and Dow, 2012; Littlewood *et al.*, 2018; Albitar *et al.*, 2023). Concerning the impact of uncertainty on firms' commitment to climate change, however, studies are scarce but recent empirical results highlights the ambiguous impact of different dimensions of uncertainty on corporate environmental and climate engagement. For instance, Assaf *et al.* (2024) investigate the impact of economic policy uncertainty (EPU) on firms' climate-related information publications. Results show a positive relationship between uncertainty and the publication of climate-related information, with this effect being negative for highly polluting industries like extractive industries. The authors argue that in times of uncertainty, firms are encouraged to disclose information on their exposure to climate change to build stakeholder trust and improve their ethical image. In addition, firms with larger size and higher tangibility are more likely found to publish climate-related information, while leverage has a negative effect. Ou and Yan (2024) use the provincial EPU index in China between 2010 and 2016 to estimate the impact of uncertainty on firms' CSR commitment. They found a positive relationship between uncertainty and CSR commitment especially for large firms and state-owned firms. Results also show that size and profitability reinforce CSR commitment while age and leverage exert a negative impact. Zhang *et al.* (2023) show that firms engaged in CSR are more likely to send positive signals to stakeholders of Chinese firms during times of uncertainty. They suggest that EPU has a positive effect on green commitment, particularly in non-state, manufacturing and non-heavily polluting firms. On a

macroeconomic scale, [Feng and Zheng \(2022\)](#) show that EPU positively impacts renewable energy innovation, especially in OECD countries. While the results of [Sohag et al. \(2022\)](#) indicate a positive impact of geopolitical uncertainty on green equity and green bonds values, especially in the clean energy sector. These results suggest that clean energy growth is more robust during periods of uncertainty.

On the other hand, [Abdullah et al. \(2024\)](#) found that geopolitical uncertainty reduces ESG performance. The authors use a news-based geopolitical risk index covering 41 countries and a comprehensive data set spanning the period 2002–2021, comprising 65,354 firm-year observations. They base their hypotheses on the stakeholder theory and the institutional theory. Their analysis reveals a significant negative correlation between overall geopolitical risk and ESG performance, indicating that rising geopolitical tensions tend to undermine firms' ESG initiatives. However, the study also finds that in countries characterized by lower geopolitical risk and higher levels of peace, overall geopolitical conditions may exert a positive influence on ESG performance. [Zhang et al. \(2023\)](#) conclude that heightened climate policy uncertainty (CPU) compels firms to prioritize short-term financial stability over long-term ESG objectives, thereby compromising sustainable development strategies. Their analysis, based on data from 4,490 publicly listed Chinese firms over the period 2011–2022, uses regression analysis and a range of econometric techniques to assess the relationship between CPU and corporate sustainability performance. The results demonstrate that CPU has a significantly negative impact on firms' environmental performance, corporate governance and social responsibility. [Guo et al. \(2024\)](#) use fixed-effects regression models and robustness checks to validate their findings, ultimately suggesting that policy and market stability are essential for sustaining long-term ESG engagement. Their analysis focuses on the ESG performance of Chinese A-share listed companies between 2009 and 2021, revealing that environmental uncertainty significantly undermines ESG outcomes. The authors argue that such uncertainty leads to increased financing constraints, which limit firms' capacity to undertake ESG-related initiatives.

2.2 The asymmetric impact of uncertainty

Concerning the asymmetric response of firm environmental policies to uncertainty, studies reveal a wide consensus based on the real-option theory which predict a stronger reaction from firms to increasing uncertainty than to decreasing uncertainty. For instance, [Aghion et al. \(2014\)](#) develop a formal model that integrates path-dependent innovation dynamics with real-options reasoning to assess how policy uncertainty influences firms' investment in low-carbon technologies. They calibrate the model to reflect the cost and return parameters of clean-technology R&D, and demonstrate that an increase in policy ambiguity raises the option value of delay, leading to substantial postponement of green innovation projects. Conversely, when credible policy signals reduce uncertainty, the model predicts only gradual acceleration of investment, owing to built-in irreversibility and adjustment costs. Their findings underscore that early, stable and transparent policy frameworks generate disproportionately large long-term gains in emissions reduction and private R&D effort, by mitigating the asymmetric negative effect of uncertainty. [Assamoi and Wang \(2022\)](#) use a nonlinear ARDL framework to examine the asymmetric impacts of EPU and environmental policy stringency (EPS) on carbon emissions in China and the USA. The findings reveal that increases in EPU significantly exacerbate environmental degradation, whereas decreases do not yield significant improvements. Similarly, more stringent environmental policies lead to substantial reductions in emissions, while policy relaxation has comparatively weaker adverse effects. These asymmetries underscore the heightened sensitivity of environmental outcomes to rising uncertainty and policy tightening. [Li et al. \(2018\)](#) adopt a real-options

framework to simulate investment renewable energy projects under varying degrees of carbon market uncertainty. They demonstrate that the option value of waiting escalates with uncertainty and leads firms to postpone or curtail projects far more sharply during periods of elevated uncertainty than they advance them during relative stability. The study of [Lian et al. \(2024\)](#) investigates the asymmetric effects of trade policy uncertainty on green innovation in the USA and China, using a Nonlinear Autoregressive Distributed Lag (NARDL) model over the period from the first quarter of 2000 to the fourth quarter of 2021. It reveals that positive shocks (increases) in trade policy uncertainty exert a more substantial negative impact on green innovation than the positive effects resulting from negative shocks (decreases) in uncertainty. On the other hand, [Kim and Lyon \(2011\)](#) implemented an event-study design centered on U.S. federal elections between 2000 and 2012. They examine voluntary environmental disclosures submitted to the Carbon Disclosure Project (CDP) in the six months preceding and following each electoral event. Controlling for firm size, industry affiliation and prior financial performance, the authors found that periods of elevated political uncertainty trigger a significant improvement in voluntary reporting as firms seek to signal stability and reassure stakeholders. In contrast, once electoral outcomes clarify the policy landscape, disclosure rates decline only gradually, evidencing an attentional asymmetry in corporate communication strategy.

2.3 Hypotheses development

The impact of climate policy uncertainty (CPU) on firms' attention to climate change opportunities is theoretically ambiguous, which motivates testing competing hypotheses. On one hand, real-option theory predicts a negative effect, as firms may delay attention or strategic engagement to preserve flexibility under uncertain policy conditions. On the other hand, institutional and signaling theories suggest a positive effect, as firms may proactively increase attention to demonstrate legitimacy, align with stakeholder expectations or position themselves advantageously for anticipated regulations. In the German context, fluctuations in climate and energy policies—such as periodic reforms to the Renewable Energy Sources Act or changing carbon pricing schemes—create ambiguity that can reduce managerial attention to climate opportunities, as firms may adopt a “wait-and-see” approach to avoid irreversible commitments. On the other hand, regulatory compliance and stakeholder scrutiny are high in Germany, and firms may proactively highlight engagement with green initiatives even when policies are unpredictable, using such actions to strengthen reputation and secure future advantages.

The first hypothesis posits a negative and linear impact of policy uncertainty. Attention to climate change opportunities reflects the commitment to environmental sustainability and the role of green innovation in strategic objectives. According to the real option theory, uncertainty can lead firms to reduce their attention to climate challenges, as environmental performance often requires irreversible investment decisions ([Yuan et al., 2022](#)). Indeed, uncertainty shocks are likely to increase the volatility of cash flows from such investments, with the associated redeployment costs. Given the limited predictability of the net present value (NPV) of these projects, firms may opt to delay their green investment decisions. Our expectation of a negative relationship between uncertainty and CCO is also supported by two additional arguments. First, in times of uncertainty, households may reduce or postpone their demand for renewable energy technologies, leading to a subsequent reduction in supply ([Zenghelis, 2012](#); [Campiglio, 2016](#)). On the other hand, during periods of low uncertainty, governments are better positioned to commit to policies that enhance energy efficiency and promote investments in renewable energy through mechanisms such as subsidies, tax incentives, cap-and-trade programs or new regulatory standards, thereby strengthening

firms' ability to engage in pro-environmental activities (Pindyck, 2007). Hence, drawing on the above-mentioned arguments, and building on the empirical results of Zhang *et al.* (2023) and Guo *et al.* (2024), the following hypothesis will be tested:

H1. Policy uncertainty negatively impacts firms' attention to climate change-related opportunities.

The second hypothesis stipulates a positive and linear impact of policy uncertainty. According to the signaling theory, by providing more attention to business and investment opportunities linked to climate change, firms are sending signals to build trust and preserve reputation. Trying to cushion the negative effect of uncertainty on stakeholders' and market's expectations, firms can be encouraged, or constrained, to enforce climate change-oriented actions. Truong *et al.* (2021), for instance, empirically show that a substantial commitment by firms to environmental actions improves their reputation among competitors. It is also a way to reduce information asymmetry between insiders, outsider shareholders and the firm's main creditors (Yuan *et al.*, 2022). In addition, based on the institutional theory, we argue that the outcome of climate change is sensitive to legislative and regulatory uncertainty. This would lead firms to increase their vigilance in the face of news related to the revision of environmental standards and the opportunities that these standards can offer (Hyatt and Berente, 2017). Building on this theoretical background and the empirical findings of Assaf *et al.* (2024), Zhang *et al.* (2023) and Bai *et al.* (2023), we propose to test the following hypothesis:

H2. Policy uncertainty positively impacts firms' attention to climate change-related opportunities.

Guided by the attention-based view (ABV) developed by Ocasio (1997), we formulate our third hypothesis to account for the asymmetric influence of policy uncertainty on firms' attention to climate-related opportunities. According to the ABV:

Limited attentional capacity for nonroutine activities by organizational decision-makers implies that alternative issues will compete for [managers] selective attention, energy, and effort. This limited capacity for controlled attentional processing underlies the importance of strategic focus (Ocasio, 1997, page 203).

Alternatively, the ABV posits that executive managers allocate their limited cognitive and temporal resources to issues perceived as most consequential, whether they represent acute threats or promising prospects. Hence, we argue that during periods of heightened policy uncertainty, any erosion of confidence among investors or other stakeholders is likely to be perceived as a critical risk, thereby triggering managerial and executive intervention. In such circumstances, firms are more expected to intensify their investor-relations to gain trust and safeguard their reputation and position in capital markets. In stable times, managerial attention is reallocated toward alternative strategic imperatives, such as operational optimization, resulting in a diminished emphasis on monitoring investor sentiment. This suggests that firms are expected to react asymmetrically to uncertainty by attributing more weight to investors' trust during pronounced threats than during periods of relative stability. Whether we model managerial decision-making through the lens of real options theory, signaling theory or institutional theory, the underlying assumption is that executive managers respond asymmetrically according to what they consider as an optimal reaction to uncertainty. We can then expect a negative (positive) linear impact of policy uncertainty on firms' attention to climate opportunities, consistent with real options theory (or signaling theory/institutional theory). However, the present hypothesis posits that this impact will be

stronger during periods of increasing uncertainty than during periods of diminishing uncertainty. In other words, from the perspective of the ABV, strategic decisions (such as those informed by attention to climate-related opportunities) are expected to be more responsive during periods of heightened uncertainty than in times of calm and stability. Building on these arguments, we test the following hypothesis:

- H3. The impact of increasing policy uncertainty on firms' attention to climate opportunities is more important (in absolute value) than the impact of diminishing policy uncertainty.

3. Methodology

3.1 Model, variables and hypotheses

3.1.1 *The model.* We model firms' climate-related opportunities based on the empirical contributions presented in the previous section. Attention to opportunities linked to climate change (*CCO*) is explained by its lagged value as well as by the uncertainty variables (*EPU* and *CPU*) and other control variables:

$$CCO_{i,t} = \gamma + \alpha_1 CCO_{i,t-1} + \alpha_2 Uncertainty_t + \sum_k \alpha_k Controls_{k,i,t} + \sum_f \alpha_f Sector_f + \varepsilon_{i,t} \quad (1)$$

where the indices *i* and *t* refer, respectively, to the firm and the observed quarter. The dummy *Sector* indicates the sector *f* to which the firm *i* belongs. The error term ε is assumed to be white noise. The model also takes into consideration the asymmetric reaction of *CCO* to uncertainty. Uncertainty indicators are split into partial sums, a positive sum $Uncertainty_{i,t}^+$ which captures the cumulative increase in uncertainty and a negative sum $Uncertainty_{i,t}^-$ which calculates the cumulative decline in uncertainty throughout the observation period:

$$CCO_{i,t} = \partial + \beta_1 CCO_{i,t-1} + \beta_2^+ Uncertainty_t^+ + \beta_2^- Uncertainty_t^- + \sum_k \beta_k Controls_{k,i,t} + \sum_f \beta_f Sector_f + \varepsilon_{i,t} \quad (2)$$

With:

$$Uncertainty_t^+ = \sum_q^t \Delta Uncertainty_{i,q}^+ = \sum_q^t \max(\Delta Uncertainty_{i,q}^+, 0),$$

and

$$Uncertainty_t^- = \sum_q^t \Delta Uncertainty_{i,q}^- = \sum_q^t \max(\Delta Uncertainty_{i,q}^-, 0)$$

3.1.2 *Dependent variable.* The measure of firms' attention to opportunities linked to climate change, noted *CCO*, is constructed using the method of [Sautner et al. \(2023\)](#) which identifies the attention paid to exposure to climate change as perceived by participants in earnings calls. Attention to opportunity shocks linked to climate change is captured by machine learning keyword discovery algorithm and transformed into a score. Migrating toward cleaner production technologies, exploring new markets, including zero emission objectives

and renewable energies in the business model, are some examples of the opportunities linked to climate change. The database is large and includes a significant number of firms established in 34 countries. The use of this kind of score also helps minimize measurement error bias and eliminates much of the unnecessary, and at times opportunistic, pro-environmental behavior exhibited by firms. Indeed, *CCO* reflects the outcome of discussions, critiques, ideas and strategies debated in a professional setting under the control of financial analysts, shareholders and stakeholders. Therefore, we believe that our results are less likely to be biased by greenwashing or window-dressing, issues that may affect other environmental performance indicators. Furthermore, measuring firms' environmental commitment by their attention to climate opportunities is more relevant than relying on standard indicators like ESG scores, environmental disclosures or carbon intensity. This approach focuses on a firm's ability to anticipate the physical and regulatory impacts of climate change and identify innovative solutions and investments that can help mitigate potential losses. From an economic standpoint, such anticipatory and rational microeconomic behavior could lead to more effective actions, supporting a safer and faster global transition toward reducing greenhouse gas emissions.

3.1.3 Independent variables. **3.1.3.1 Policy uncertainty.** We use the EPU and CPU indices to measure policy uncertainty. These indicators were developed by [Baker et al. \(2016\)](#) and [Gavriilidis \(2021\)](#), respectively, and are available from the website www.policyuncertainty.com.

3.1.3.2 Control variables. The selection of control variables was based on a review of empirical studies outlined in the introductory section. We carried out several *a priori* regressions to choose the most statistically significant control variables. The final choice fell on the most relevant variables and for which observations are most available: age of the firm, size, leverage, market-to-book ratio and bid-ask spread. [Table A1](#) in the [Appendix](#) presents the definition and sources of all variables used in the model.

3.2 Sample and estimation method

The observation period spans from the first quarter of 2010 to the second quarter of 2022, covering a total of 172 firms listed on the Frankfurt Stock Exchange and resulting in 5,869 firm-quarter observations. Our study focuses on a final sample representing the maximum coverage of firms with available *CCO* scores during the observation period. The sample includes several large German corporate groups and covers the majority of business sectors, capturing the most relevant firms for climate-related strategic engagement. Listed firms are also more concerned with governance and reporting practices. In addition, the gradual reduction in the number of listed firms in Germany during the last two decades has enhanced the representativeness of the sample [\[1\]](#) over the observation period. Moreover, robustness tests controlling for sector heterogeneity or excluding the most polluting sectors yield consistent results, confirming that the findings are not materially affected by sample composition.

This study focuses on German firms which have been significantly impacted by successive periods of policy uncertainties, including events such as Brexit, the COVID-19 pandemic and especially the Russia-Ukraine war ([Zhang and Hamori, 2021](#); [Azqueta-Gavaldón et al., 2023](#); [Grebe et al., 2024](#)). The sample period (2010Q1–2022Q2) encompasses two major global and regional disruptions that significantly shaped German firms' strategic attention to climate-related opportunities: the COVID-19 pandemic and the Russia-Ukraine war. The pandemic (2020–2021) caused severe supply-chain disruptions, liquidity constraints and heightened short-term survival priorities, leading many firms to deprioritize long-term environmental initiatives in favor of operational continuity and financial stability. The German economy experienced substantial contraction during this period, reflecting the deep economic and structural impact of the pandemic on firms'

investment and innovation. Conversely, the Russia–Ukraine conflict, which began in early 2022, sharply intensified Germany’s energy security and transition debate due to the country’s historic dependence on Russian gas. This geopolitical shock prompted a series of national responses, such as the Energy Security Progress Reports issued by the Federal Ministry for Economic Affairs and Climate Action ([Federal Ministry for Economic Affairs and Climate Action \(BMWK\), 2022a, 2022b](#)), which highlighted efforts to diversify energy sources, accelerate investment in renewables and support broader industrial decarbonization initiatives. Additionally, the German Government has been highly proactive in addressing climate change. The goal of climate neutrality, aiming for greenhouse gas neutrality by 2045, along with the 2030 climate action program promoting the transition to renewable energies, is expected to create attractive business opportunities across various sectors ([Wiese et al., 2022](#); [Göhler et al., 2024](#)). The model is estimated using the system GMM method, with standard error estimates robust to heteroskedasticity and autocorrelation within panels. This estimation technique accounts for the dynamic nature of the dependent variable. We assume that the decision-making process of firms regarding their green investment and innovation intentions is complex and involves various internal and external stakeholders, including management, insider shareholders and other influential parties. This process is dynamic, as the knowledge gained from today’s decisions informs future ideas and strategies, requiring a relatively long time for implementation and refinement. As such, we assume that firms’ attention to climate change-related opportunities evolves over time, shaped by accumulated experiences and the firm’s past actions. Accordingly, we use the system GMM since it is suitable for dynamic panel models as it effectively addresses endogeneity arising from the inclusion of lagged dependent variables. By using internal instruments constructed from lagged levels and first differences of the variables, the estimator improves efficiency compared to Difference GMM, especially when variables exhibit high persistence. This dual-equation system enhances instrument relevance and reduces finite-sample bias, providing more consistent and efficient estimates. The optimal number of firm-specific endogenous variables and lags of instruments is selected to minimize overidentification and serial autocorrelation of residuals.

4. Empirical results

4.1 Descriptive statistics

[Table 1](#) below presents the statistical properties of the variables in the baseline specification. The *CCO* variable reaches an average of 0.038 with a standard deviation of 0.117 and a

Table 1. Statistical properties of variables

Variable	Mean	SD	Min.	Max.
<i>CCO</i>	0.038	0.117	0	2.202
<i>EPU</i>	0.021	0.011	0.008	0.071
<i>CPU</i>	0.014	0.007	0.005	0.034
<i>Qage</i>	2.615	1.152	1	4
<i>Size</i>	15.972	2.641	9.661	19.516
<i>Leverage</i>	0.233	0.563	0	44.2
<i>Mtb</i>	0.004	1.628	−144.346	7.289
<i>Bid_ask_spread</i>	0.001	0.001	0	0.024

Note(s): This table presents main statistical properties of the variables included in the baseline specification. Std.Dev: Standard deviation. Min (Max): Minimal and maximal observed value. Observation period extends from 2010:Q1 to 2022:Q2

Source(s): Authors’ own work

maximum value observed for EnBW (EnBW Energie Baden-Württemberg) during the second quarter of 2018. The average age (*Qage*) of the selected firms is close to the median age while the average sample size is 317,108m euros. A maximum size is observed during the third quarter of 2019 for Dailmer AG. The statistics also show a relatively high variability of Market-to-book ratio (*Mtb*) which records a minimum value of -144.34 observed for Heidelberg Pharma AG.

EPU varies between 0.008 and a maximum of 0.071 observed during the second quarter of 2022. The CPU index shows less volatility than EPU, with a maximum value observed during the third quarter of 2019.

Pairwise correlations presented in Table 2 show a positive and significant correlation of *CCO* with *EPU* and *CPU*. *CCO* is also positively correlated with the *Size*, *Qage* and *Leverage* of firms and negatively correlated with the *bid-ask spread*.

Figure 1 below presents the co-evolution of the cumulative growth of *EPU*, *CPU* and *CCO*. Starting from 2016 (i.e. after Paris COP 21 agreement of 2015), firms' attention to opportunities related to climate change began to grow significantly in parallel with a notable growth in the two uncertainty indices. The graph shows a clear common trend among the three variables starting in 2016, as indicated by the vertical dashed line. This pattern may suggest a positive relationship between the series, although it remains a purely descriptive observation. The subsequent econometric analysis will provide further evidence on the impact of both policy uncertainty indicators on firms' attention to climate change-related opportunities.

The box plots shown in Figure 2 reveal that, on average, the automotive and electricity sectors are more engaged with climate opportunities compared to other sectors. Additionally, the machinery and metal and mining sectors also exhibit relatively higher *CCO* values. Overall, the graph highlights that accounting for sample heterogeneity and sector-specific sensitivity to uncertainty is essential for understanding how German firms integrate climate challenges into their strategies.

4.2 Baseline estimation

Table 3 presents estimated coefficients of the baseline model (columns (1) and (2)) and the model capturing the asymmetric impact of the *EPU* and *CPU* indices (columns (3) and (4)). The Hansen and Arellano and Bond tests reject the existence of over-identification and second-order autocorrelation problems. Justifying the estimation of a dynamic panel model, the lagged value of *CCO* standing between 0.43/0.44 and significantly correlated with the

Table 2. Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) <i>CCO</i>	1.000							
(2) <i>Qage</i>	0.039*	1.000						
(3) <i>Size</i>	0.327*	0.276*	1.000					
(4) <i>Leverage</i>	0.040*	0.017	-0.036*	1.000				
(5) <i>Mtb</i>	0.003	0.005	0.011	-0.017	1.000			
(6) <i>Bid_ask_spread</i>	-0.044*	-0.102*	-0.112*	0.025*	0.029*	1.000		
(7) <i>Epu</i>	0.100*	0.032*	0.073*	0.021*	-0.005	0.067*	1.000	
(8) <i>Cpu</i>	0.129*	0.032*	0.073*	0.018	-0.005	0.027*	0.482*	1.000

Note(s): * Indicates 99% significance level

Source(s): Authors' own work

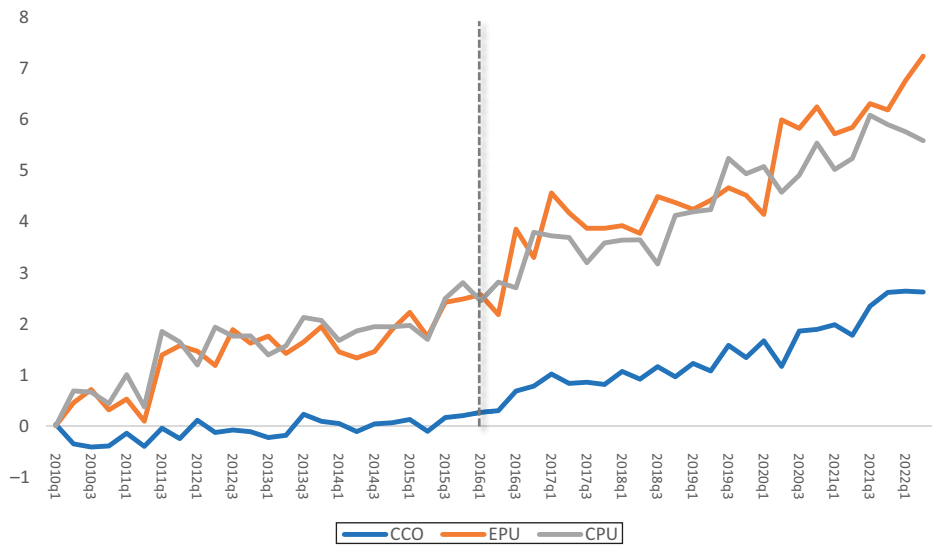


Figure 1. Co-evolution of cumulative growth of CCO, EPU and CPU
Source: Authors' own work

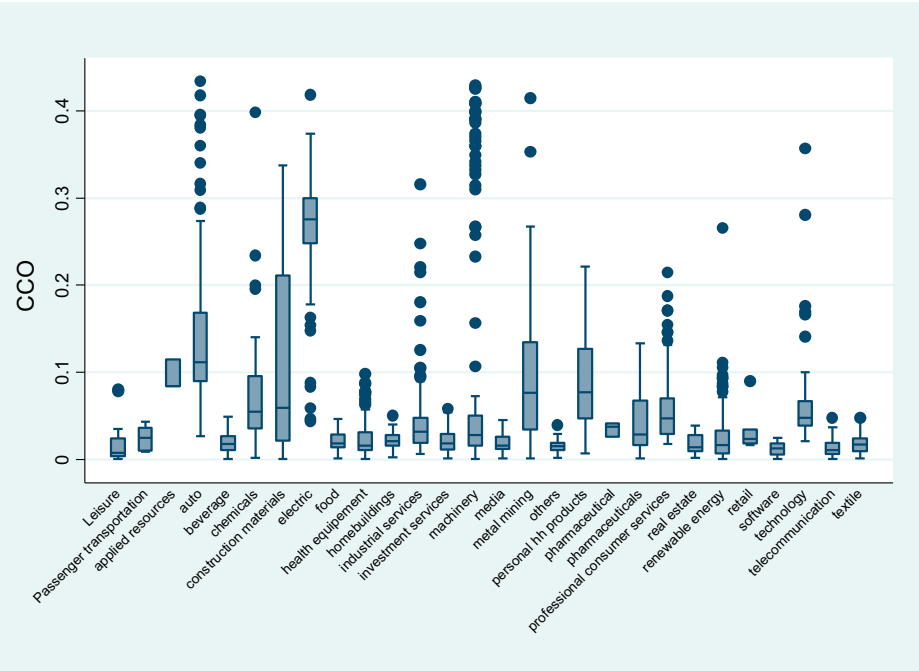


Figure 2. Distribution of CCO by business sector
Source: Authors' own work

Table 3. Symmetric and asymmetric impact of uncertainty

Variables	Linear impact of EPU	Linear impact of CPU	Asymmetric impact of EPU	Asymmetric impact of CPU
<i>CCOt-1</i>	0.4469*** (0.000)	0.4430*** (0.000)	0.4411** (0.000)	0.4365** (0.000)
<i>Qage</i>	0.0334** (0.036)	0.0332** (0.034)	0.0331** (0.039)	0.0326** (0.039)
<i>Size</i>	0.0236*** (0.000)	0.0228*** (0.000)	0.0196*** (0.001)	0.0178*** (0.004)
<i>Leverage</i>	0.0148 (0.467)	0.0158 (0.401)	0.0228 (0.214)	0.0231 (0.203)
<i>Mtb</i>	0.1145* (0.051)	0.1013* (0.065)	0.1164** (0.047)	0.1079* (0.056)
<i>Bid_ask_spread</i>	-13.9145** (0.034)	-11.0963 (0.061)	-13.8088** (0.035)	-12.6296** (0.045)
<i>EPU</i>	0.4494** (0.036)			
<i>CPU</i>		0.8680*** (0.000)		
<i>EPU</i> ⁺			0.0153** (0.019)	
<i>EPU</i> ⁻			-0.0100** (0.019)	
<i>CPU</i> ⁺				0.0093*** (0.000)
<i>CPU</i> ⁻				-0.0163*** (0.000)
<i>Constant</i>	-0.3695*** (0.000)	-0.3612*** (0.000)	-0.2692** (0.014)	-0.2368** (0.036)
Observations	5,869	5,869	5,869	5,869
Hansen <i>p</i> -value	0.499	0.567	0.500	0.510
AR2 <i>p</i> -value	0.171	0.170	0.178	0.176

Note(s): Estimation of the baseline model (equation (1)) using system GMM with robust standard errors. The dependent variable is CCO. All specifications include business sector dummies. The dummies are not reported to save space. Hansen stat: overidentification test; AR2: Second order autocorrelation test. *, ** and ***: 90, 95 and 99% significance levels, respectively

Source(s): Authors' own work

dependent variable. Attention to climate opportunities appears to be positively influenced by firm age and size, confirming the results obtained by [Zhang et al. \(2023\)](#) and [Assaf et al. \(2024\)](#) and contradicting those of [Ou and Yan \(2024\)](#) and [Gasbarro et al. \(2017\)](#). Market value of firms also has a positive and significant impact on CCO which is aligned with the findings of [Aggarwal and Dow \(2012\)](#), but in opposition with those of [Albitar et al. \(2023\)](#).

The negative and significant relationship at 95% between bid-ask spread and CCO shows the importance of information asymmetry in corporate environmental policy. A low level of information asymmetry between shareholders and the firm is associated with a more obvious attention to climate issues capable of increasing the confidence of all stakeholders. Consistent with the findings of [Lemma et al. \(2021\)](#), this result suggests that firms' attention to climate opportunities is part of the importance that these firms give to the transparency of their relationship with shareholders and investors.

The results also show a positive and significant impact at 95% of economic policy uncertainty (EPU) on CCO (column (1)). This positive impact of EPU and CPU on CCO confirms the H2 and rejects the H1. [Bai et al. \(2023\)](#), [Feng and Zheng \(2022\)](#) and [Zhang et al. \(2023\)](#) found similar results by using other indicators of environmental performance or corporate engagement in the fight against climate change. Our results show that climate policy uncertainty (CPU) exerts a greater impact on CCO (column (2)) compared to the impact exerted by EPU. This suggests that firms appear to be less attentive to climate change opportunities when uncertainty, especially uncertainty related to climate policy, is lower.

Concerning the asymmetric impact of uncertainty on firms' climate attention, the results prove the existence of such a non-linear effect. Indeed, an increase in uncertainty leads to a rise in CCO, albeit with a different magnitude than the reduction in CCO observed when uncertainty decreases. These asymmetric findings are in line with the predictions of [Assamoi](#)

and Wang (2022) and Lian *et al.* (2024). In addition, as shown by column (3), EPU^+ exerts a positive impact on CCO greater than the impact exerted by EPU^- . These results, similar to those found by Kim and Lyon (2011), prove that firms' attention to climate change opportunities is more sensitive to increasing uncertainty related to economic policy than decreasing uncertainty.

On the other hand, as noted from column (4), a decrease in CPU has a much greater impact on CCO than an increase in CPU . In contradiction with the conclusions of Aghion *et al.* (2014) and Li *et al.* (2018), among others, this finding suggests that lower climate policy uncertainty induce stronger reaction from firms' commitment to climate change. The apparent contradiction between our findings and those reported by Aghion *et al.* (2014) and Li *et al.* (2018) reflects both the use of fundamentally different methodological approaches and the focus on distinct dimensions of sustainability. Methodologically, our study explicitly models firms' attention to climate change opportunities (CCO) as the dependent variable. In contrast, Aghion *et al.* (2014) present a conceptual study, and Li *et al.* (2018) use an augmented real-options model combined with a case study to assess its effectiveness. Both prior studies align with real-option investment theory, which posits that increasing uncertainty raises the option value of waiting and thus tends to suppress irreversible capital or R&D expenditures. This prediction applies to ex-post commitments, such as R&D, green innovation or green investments. By contrast, our study uses an ex-ante indicator of climate engagement, consistent with the attention-based view (Ocasio, 1997). The CCO variable captures managers' focus and priorities in response to policy-related signals but does not measure actual managerial or investment actions undertaken in reaction to economic or climate policies. Consequently, while our results show that firms pay greater attention to climate opportunities when policy uncertainty increases, this heightened attention does not necessarily translate into immediate managerial or investment decisions, unlike the results observed by Aghion *et al.* (2014) and Li *et al.* (2018).

In addition, contradictions between the present paper's results and those of Aghion *et al.* (2014) can also be related to the specific German policy and industrial context. Aghion *et al.* (2014) emphasize the effectiveness of credible, predictable long-run policy to direct R&D toward clean technologies. These predictions can be more relevant for emergent or fragile climate policy regimes, where more predictability induces more marginal decrease of downside risk of R&D projects and boosts green investment, than more predictability in mature climate policy regimes. In Germany, the energy and climate policy frameworks are relatively mature and well established (International Energy Agency, 2025). As a result, policy signals are often viewed more as mandatory compliance requirements and less expected to induce important marginal increase of new business opportunities. In this context, firms' attention to climate opportunities during periods of increasing uncertainty may be lower than during decreasing uncertainty, as managers perceive the environment to be stable, reducing their active search for new opportunities. Hence, we are able to confirm that the $H3$ is verified regarding the impact of EPU and rejected concerning the impact of CPU on firms' attention to climate opportunities.

Globally, firms' attention to climate change-related opportunities is mainly influenced by age and size of firms in addition to their market value and information asymmetry with investors. Uncertainty driven by climate policy exerts a stronger positive linear impact on firms' attention than uncertainty resulting from economic policy. Moreover, the asymmetric analysis shows that firms' attention to climate change is more stimulated by growing uncertainty driven by economic policies than by increasing uncertainty related to climate policies.

4.3 Robustness tests

4.3.1 Introducing business confidence as a control variable. To assess the robustness of the results, we conduct several tests. The first test involves including the Ifo Institute's Business Climate Index among the explanatory variables.

This index, based on surveys, gauges entrepreneurs' perceptions of the business climate. We hypothesize that business confidence in the economic situation could be a crucial factor influencing attention to climate opportunities. The level of optimism or pessimism within firms can, at various levels, impact their willingness to engage in innovative projects or business strategies in response to the challenges posed by climate change. We use the "Business Expectations" sub-indices, which measure sentiment for the next six months across different business sectors. These sectors include manufacturing, services, trade (encompassing both retail and wholesale) and construction, denoted as *Ifo_manufacturing*, *Ifo_services*, *Ifo_trade* and *Ifo_construction*, respectively. Each Ifo sub-index takes the value of the "Business Expectations" index if firm *i* belongs to the corresponding sector group and zero otherwise.

The results presented in Table 4 show that the positive linear effects of *EPU* and *CPU* on *CCO* remained significant and are slightly strengthened after including the confidence index. The linear impact corroborates again the *H2*. Moreover, the asymmetric effects of both uncertainty indices remain largely stable. These findings, again, confirms the *H3* only concerning the impact of *EPU*. The positive and significant relationship at the 95% level between *Ifo_manufacturing* and *CCO* suggests that periods of optimism regarding the

Table 4. Business climate index as explanatory variable

Variables	Linear impact of EPU	Linear impact of CPU	Asymmetric impact of EPU	Asymmetric impact of CPU
<i>CCOt-1</i>	0.4379*** (0.000)	0.4352*** (0.000)	0.4318*** (0.000)	0.4282*** (0.000)
<i>Qage</i>	0.0281* (0.081)	0.0283* (0.073)	0.0288* (0.074)	0.0280* (0.081)
<i>Size</i>	0.0242*** (0.000)	0.0239*** (0.000)	0.0198*** (0.001)	0.0187*** (0.002)
<i>Leverage</i>	0.0153 (0.453)	0.0176 (0.335)	0.0224 (0.231)	0.0242 (0.191)
<i>Mtb</i>	0.1088* (0.051)	0.0949* (0.070)	0.1109* (0.050)	0.1010* (0.062)
<i>Bid_ask_spread</i>	-13.8557** (0.024)	-10.0309 (0.061)	-14.3406** (0.023)	-11.9123** (0.040)
<i>Ifo_manufacturing</i>	0.0006** (0.044)	0.0007** (0.033)	0.0006** (0.045)	0.0007** (0.024)
<i>Ifo_services</i>	-0.0018** (0.033)	-0.0012* (0.080)	-0.0019** (0.029)	-0.0013* (0.063)
<i>Ifo_trade</i>	0.0013 (0.575)	-0.0001 (0.947)	0.0010 (0.652)	-0.0001 (0.957)
<i>Ifo_construction</i>	0.0124 (0.278)	0.0110 (0.269)	0.0110 (0.284)	0.0107 (0.277)
<i>EPU</i>	0.5506** (0.037)			
<i>CPU</i>		0.8909*** (0.000)		
<i>EPU</i> ⁺			0.0189** (0.014)	
<i>EPU</i> ⁻			-0.0124** (0.014)	
<i>CPU</i> ⁺				0.0099*** (0.000)
<i>CPU</i> ⁻				-0.0172*** (0.000)
<i>Constant</i>	-0.3665*** (0.000)	-0.3666*** (0.000)	-0.2556** (0.018)	-0.2407*** (0.027)
Observations	5,869	5,869	5,869	5,869
Hansen <i>p</i> -value	0.508	0.475	0.473	0.460
AR2 <i>p</i> -value	0.175	0.185	0.169	0.175

Note(s): Robustness test including the Ifo Business Climate Index and using system GMM with robust standard errors. The dependent variable is *CCO*. All specifications include business sector dummies. The dummies are not reported to save space. Hansen stat: overidentification test; AR2: Second order autocorrelation test. *, ** and ***: 90, 95 and 99% significance levels, respectively

Source(s): Authors' own work

business situation increase the attention of firms in the manufacturing sector to opportunities related to climate change. Conversely, in the services sector, as indicated by the negative and significant coefficient associated with *Ifo_services*, the optimism of entrepreneurs does not translate into a stronger commitment to climate issues. The relationship between *CCO* and the control variables remains unchanged; the variables *Qage*, *Size*, *Mtb* and *Bid_ask_spread* continue to exert the same impact with the same degree of significance.

4.3.2 Changing the definition of the dependent variable. In the second step, we transform the score constructed by Sautner et al. (2023) into a dummy variable. To achieve this, we retrieve another score developed by the same authors, which is designed to capture whether a firm expresses a positive or negative sentiment regarding the opportunities created by climate change. We equate these two scores in such a way that only *CCO* scores associated with a positive sentiment score greater than zero are retained. Specifically, our new variable, *Dum_CCO*, is equal to 1 if, during quarter *t*, for firm *i*, a positive *CCO* score is paired with a strictly positive sentiment score. By using this variable, we exclude all cases where the identification of climate-related opportunities is accompanied by negative sentiment and retain only those firms that are optimistic about the opportunities presented by climate change. The new model retains the same explanatory variables and will be estimated using the logit method.

Firstly, it is noted from Table 5 that, based on the Hausman specification test, the fixed-effect estimator is preferred over the random-effect estimator for the model specifications presented in columns (9), (11) and (12). The random-effect estimator, however, is deemed more efficient for the model specification reported in column (10). An additional firm has been included in the observations, bringing the total number of firms to 173 and the total

Table 5. Changing the definition of the dependent variable

Variables	Linear impact of EPU	Linear impact of CPU	Asymmetric impact of EPU	Asymmetric impact of CPU
<i>Qage</i>	1.4099*** (0.000)	1.21*** (0.000)	1.6365*** (0.000)	1.2818*** (0.000)
<i>Size</i>	0.7995*** (0.000)	0.554*** (0.000)	1.0952*** (0.000)	0.4895*** (0.000)
<i>Leverage</i>	0.5307*** (0.000)	0.441*** (0.003)	0.6746*** (0.000)	0.4777*** (0.001)
<i>Mtb</i>	0.6695** (0.036)	0.49 (0.152)	0.9257** (0.011)	0.5753* (0.066)
<i>Bid_ask_spread</i>	7.7038 (0.828)	37.476 (0.318)	31.3124 (0.366)	23.7132 (0.524)
<i>EPU</i>	82.6071*** (0.000)			
<i>CPU</i>		185.88*** (0.000)		
<i>EPU</i> ⁺			1.6265*** (0.000)	
<i>EPU</i> ⁻			-1.0646*** (0.000)	
<i>CPU</i> ⁺				2.0520*** (0.000)
<i>CPU</i> ⁻				-3.5786*** (0.000)
<i>Constant</i>	-12.8122*** (0.000)	-13.119*** (0.000)	-17.0916*** (0.000)	-9.2524*** (0.000)
Observations	5,916	5,916	5,916	5,916
LR χ^2 /Wald χ^2	614.79***	603.59***	1104.05***	1233.27***
Hausman test FE/RE	28.66***	10.62	385.40***	644.48***

Note(s): Robustness test using logit model. The dependent variable is *Dum_CCO*. All specifications include business sector dummies. Fixed effect estimators are used in columns (1), (3) and (4). Random effect estimators are used in column (2). The null hypotheses of LR χ^2 and Wald χ^2 statistics check for the overall non-significance of the fixed effect model and random effect model respectively. The dummies are not reported to save space. Hansen stat: overidentification test; AR2: Second order autocorrelation test. *, ** and ***: 90, 95 and 99% significance levels, respectively

Source(s): Authors own work

number of firm-quarter observations to 5,916. This adjustment reflects the estimation of a static panel model rather than a dynamic panel model. Overall, the models are statistically significant and continue to show a positive linear relationship between uncertainty and (optimistic) attention to climate opportunities. The asymmetric effect of EPU^+ remains consistently greater than that of EPU^- .

The results further reveal that firms are more sensitive to a decrease in CPU than to an increase, which is clearly distinguishable from the results in column (12). Accordingly, the confirmation of the present study's hypotheses remains unchanged. The control variables maintain their coefficients and signs, with the exceptions of Bid-ask spread and Leverage.

The Bid-ask spread variable becomes non-significant, a result that can be attributed to the conversion of the dependent variable from continuous to binary. In this case, the measure captures the occurrence rather than the magnitude of attention to climate opportunities, reducing sensitivity to liquidity-related variation.

Leverage exhibits a positive and significant relationship with CCO, confirming the results of [Abdullah et al. \(2024\)](#) and contradicting those of [Zhang et al. \(2023\)](#). From a traditional agency perspective, high leverage can increase risk aversion, discouraging long-term or uncertain investments such as climate-related innovation. Conversely, leverage can also serve as a disciplinary mechanism, pushing managers to identify profitable opportunities and signal strategic focus to investors, which may increase attention to climate opportunities. These opposing effects help explain the non-significance of leverage in the baseline estimation, particularly in a heterogeneous sample across sectors. The measurement of attention as a dummy variable captures threshold effects, highlighting situations where leveraged firms signal climate engagement to investors. In conclusion, the previous findings remain robust despite changes in the definition of the dependent variable.

4.3.3 Excluding most polluting business sectors. The following robustness test involves excluding the business sectors in Germany that emit the highest levels of CO₂. It is assumed that firms within these sectors are most affected by climate change and face significant market and regulatory pressure to reduce their GHG emissions. Including these sectors may introduce endogeneity issues due to selection bias. To address this, the Climate Watch Historical Emissions data is used to identify the German business sectors that, on average, emitted the greatest quantities of carbon dioxide equivalents between 2010 and 2020 [2].

The six most polluting business sectors, i.e. heat and electricity, transport, buildings, manufacturing and construction, agriculture and industry, were subsequently excluded.

According to the results presented in [Table 6](#), 37 firms from the most polluting sectors were excluded, reducing the number of observations to 4,535 firm-quarters. It is important to note that leverage and size continue to have a positive and significant effect. However, the variables *Qage*, *Mtb* and *Bid_ask_spread* lose their significance after excluding firms from the most polluting sectors. This highlights the importance of these variables in influencing the attention of firms most exposed to stakeholder pressures concerning climate change issues. The loss of significance for the market-to-book ratio after excluding the most polluting sectors, can be explained by sample heterogeneity and the sector-specific nature of climate policy impacts. The market-to-book ratio primarily captures growth opportunities and firm valuation, but its explanatory power for managerial attention to climate change opportunities may be diluted when sectoral differences are explicitly accounted for. Excluding the most polluting sectors reduces the cross-sectional variation in environmental exposure and strategic relevance of climate opportunities, further diminishing the marginal explanatory role of market-to-book ratios. Excluding the most polluting sectors also limits cross-sectional differences in information asymmetry and trading activity, which are the primary channels through which bid-ask spreads influence managerial attention. [Table 6](#)

Table 6. Estimation after excluding most polluting business sectors

Variables	Linear impact of EPU	Linear impact of CPU	Asymmetric impact of EPU	Asymmetric impact of CPU
<i>CCOt-1</i>	0.5497*** (0.000)	0.5475*** (0.000)	0.5458*** (0.000)	0.5443*** (0.000)
<i>Qage</i>	−0.0064 (0.750)	−0.0059 (0.767)	−0.0054 (0.790)	−0.0051 (0.800)
<i>Size</i>	0.0250*** (0.004)	0.0246*** (0.004)	0.0218** (0.023)	0.0210** (0.025)
<i>Leverage</i>	0.0200 (0.122)	0.0222* (0.059)	0.0214* (0.068)	0.0221** (0.046)
<i>Mtb</i>	0.0934 (0.122)	0.0859 (0.133)	0.0886 (0.132)	0.0837 (0.140)
<i>Bid_ask_spread</i>	−10.1383 (0.181)	−8.1296 (0.234)	−9.7444 (0.180)	−8.8199 (0.203)
<i>EPU</i>	0.4728* (0.060)			
<i>CPU</i>		0.6049*** (0.000)		
<i>EPU</i> ⁺			0.0163** (0.039)	
<i>EPU</i> [−]			−0.0107** (0.039)	
<i>CPU</i> ⁺				0.0063*** (0.001)
<i>CPU</i> [−]				−0.0110*** (0.001)
<i>Constant</i>	−0.3135*** (0.000)	−0.3104*** (0.000)	−0.2411** (0.017)	−0.2322** (0.020)
Observations	4,535	4,535	4,535	4,535
Hansen <i>p</i> -value	0.995	0.996	0.992	0.993
AR2 <i>p</i> -value	0.468	0.469	0.473	0.469

Note(s): Robustness test using system GMM with robustness standard errors after excluding most polluting business sectors. The dependent variable is *CCO*. All specifications include business sector dummies. The dummies are not reported to save space. Hansen stat: overidentification test; AR(2): Second order autocorrelation test. *, ** and ***: 90, 95 and 99% significance levels, respectively

Source(s): Authors' own work

further shows that the positive linear effect of uncertainty on *CCO* remains robust despite the change in the sample. The impact of *CPU* remains consistently greater than that of *EPU*. The asymmetric results remain unchanged, suggesting that an increase in economic policy uncertainty enhances firms' commitment to climate change more than an increase in climate policy uncertainty does.

Additionally, we observe that the linear and asymmetric responses of *CCO* to both uncertainty indicators are weaker when the most polluting sectors are excluded. This suggests that firms in these sectors may be more sensitive to climate change-related opportunities than firms in other sectors.

4.3.4 Using two stages instrumental variable regression. The efficiency of the system GMM estimators can be sensitive to the small size of the individual dimension of the sample and the limited number of observed cross-sections. To test the robustness of system GMM estimation while controlling for endogeneity, we use a two-stage instrumental variable model with standard errors robust to arbitrary heteroskedasticity. The first step in the estimation process involves creating instruments for all firm-specific variables using their one- and two-period lagged values, as well as the 'industry' dummies. The second step involves regressing *CCO* on the predicted values of the endogenous variables. Kernel-based autocorrelation-consistent standard errors are used, ensuring robustness to arbitrary intra-group autocorrelation issues. The statistical application of Hansen's J-test allows for the detection of potential over-identification problems with the instruments.

The Hansen test in Table 7 rejects the existence of an over-identification problem, thereby validating the instruments used. The results once again show a positive and significant relationship between uncertainty and firms' attention to opportunities related to climate change. The analysis of the asymmetry impact confirms the previous findings, specifically that *CCO* is more sensitive to a decrease in *CPU* than to an increase in *CPU*. In contrast, the

Table 7. Two stage instrumental variable regression

Variables	Linear impact of EPU	Linear impact of CPU	Asymmetric impact of EPU	Asymmetric impact of CPU
<i>CCOt-1</i>	0.8232*** (0.000)	0.8216*** (0.000)	0.8236*** (0.000)	0.8220*** (0.000)
<i>Qage</i>	−0.0005 (0.506)	−0.0006 (0.479)	−0.0005 (0.554)	−0.0005 (0.511)
<i>Size</i>	0.0037** (0.016)	0.0036** (0.022)	0.0039** (0.019)	0.0037** (0.024)
<i>Leverage</i>	0.0033*** (0.000)	0.0032*** (0.001)	0.0033*** (0.000)	0.0032*** (0.000)
<i>Mtb</i>	0.0113** (0.025)	0.0116** (0.016)	0.0120** (0.022)	0.0122** (0.013)
<i>Bid_ask_spread</i>	0.6304 (0.702)	0.5584 (0.741)	0.8550 (0.609)	0.7365 (0.663)
<i>EPU</i>	0.3104** (0.013)			
<i>CPU</i>		0.5639*** (0.000)		
<i>EPU</i> ⁺			0.0098** (0.025)	
<i>EPU</i> [−]			−0.0064** (0.025)	
<i>CPU</i> ⁺				0.0059*** (0.000)
<i>CPU</i> [−]				−0.0103*** (0.000)
<i>Constant</i>	−0.0436*** (0.001)	−0.0437*** (0.001)	−0.0393*** (0.001)	−0.0408*** (0.001)
Observations	5,331	5,331	5,331	5,331
R-squared	0.699	0.700	0.699	0.700
Hansen <i>p</i> -value	0.7285	0.6705	0.6008	0.5502

Note(s): Robustness test using Two Two-stage panel instrumental variable models with robust standard errors. The dependent variable is *CCO*. All specifications include business sector dummies. The dummies are not reported to save space. Hansen stat: overidentification test; AR2: Second order autocorrelation test. *, ** and ***: 90, 95 and 99% significance levels, respectively

Source(s): Authors' own work

impact of *EPU* is nearly symmetrical, with a slight superiority of the coefficient associated with *EPU*⁺ relative to that of *EPU*[−]. Thus, we do not find any noticeable change in the verification of this study's hypotheses. The impact of the control variables remains consistent with the baseline regression, except for *Bid_ask_spread* and *Qage*, which become non-significant. Even if the two-stage instrumental variable approach is less sensitive to small sample size bias, when using it instead of system GMM, the estimator relies on a smaller selected set of instruments and does not exploit the full dynamic panel structure. As a result, the efficiency and weight of endogenous variation captured by bid-ask spread can be reduced, diminishing its statistical significance.

4.3.5 Controlling for business sectors heterogeneity. In this robustness test, we use interaction variables to assess whether the impact of uncertainty varies depending on the business sector to which a firm belongs. The advantage of the interaction terms is that they allow for the estimation of the effect of the covariates within each sub-sample (representing a specific sector), helping to mitigate biases arising from causal heterogeneity. Dummies are created for firms in sectors such as manufacturing (including electrical, automotive, textile, etc.), transport, food and beverage, construction and building and renewables. These dummies are then interacted with *EPU* and *CPU*. The coefficient related to each interaction term reveals whether the impact of uncertainty on a firm's attention in a particular sector significantly differs from the average impact across the entire sample.

From Tables 8 and 9, we observe that the coefficients associated with the interaction terms of the dummy variable *MNF_IND* with the two uncertainty indices are significant and relatively large, while the other interaction terms are non-significant. This suggests that the attention of firms in the manufacturing industry to climate change-related opportunities is more sensitive to uncertainty than that of firms in other sectors. The average impact of *EPU*

Table 8. Interaction between EPU and business sectors dummies

Variables	Interaction with manufacturing	Interaction with transport	Interaction with food and beverage	Interaction with construction	Interaction with renewables
<i>CCOI-1</i>	0.4383*** (0.000)	0.4628*** (0.000)	0.4637*** (0.000)	0.4649*** (0.000)	0.4635*** (0.000)
<i>Qage</i>	0.0307** (0.042)	0.0306** (0.039)	0.0294* (0.052)	0.0307*** (0.044)	0.0288* (0.053)
<i>Size</i>	0.0232*** (0.001)	0.0229*** (0.001)	0.0242*** (0.001)	0.0255*** (0.001)	0.0236*** (0.001)
<i>Leverage</i>	-0.0024 (0.939)	0.0201 (0.261)	0.0220 (0.227)	0.0220 (0.244)	0.0189 (0.295)
<i>MTB</i>	0.0587 (0.277)	0.0785 (0.158)	0.0826 (0.146)	0.0867 (0.134)	0.0784 (0.184)
<i>Bid_ask</i>	-13.4890* (0.050)	-15.1742** (0.040)	-14.6182** (0.037)	-15.2141** (0.039)	-14.2824** (0.038)
<i>EPU</i>	-0.5385* (0.063)	0.6188* (0.077)	0.4382** (0.035)	0.2682 (0.168)	0.3970** (0.046)
<i>MNF_IND × EPU</i>	4.5036** (0.023)				
<i>TRANS × EPU</i>		-12.8558 (0.359)			
<i>FOOD_BEV × EPU</i>			0.2044 (0.969)		
<i>CONST × EPU</i>				5.4254 (0.193)	
<i>RENEW × EPU</i>					0.6813 (0.769)
<i>Constant</i>	-0.4085*** (0.000)	-0.3760*** (0.002)	-0.3914*** (0.003)	-0.4156*** (0.002)	-0.3751*** (0.001)
<i>Observations</i>	5,869	5,869	5,869	5,869	5,869
<i>AR2 p-value</i>	0.128	0.135	0.164	0.162	0.162
<i>Hansen p-value</i>	0.630	0.595	0.454	0.564	0.505

Note(s): The robustness test uses system GMM with robustness standard errors after including interaction terms between EPU and business sector dummies. The dependent variable is CCO. All specifications include business sector dummies. The dummies are not reported to save space. Hansen stat: overidentification test; AR2: Second order autocorrelation test. *, ** and ***: .90, 95 and 99% significance levels, respectively

Source(s): Authors' own work

Table 9. Interaction between CPU and business sectors dummies

Variables	Interaction with manufacturing	Interaction with transport	Interaction with food and beverage	Interaction with construction	Interaction with renewables
<i>CCO-I</i>	0.3955*** (0.000)	0.4558*** (0.000)	0.4604*** (0.000)	0.4597*** (0.000)	0.4603*** (0.000)
<i>Qage</i>	0.0271** (0.049)	0.0307** (0.031)	0.0291** (0.049)	0.0294** (0.047)	0.0288* (0.059)
<i>Size</i>	0.0237*** (0.000)	0.0208*** (0.001)	0.0230*** (0.002)	0.0246*** (0.001)	0.0224*** (0.001)
<i>Leverage</i>	-0.0033 (0.908)	0.0176 (0.267)	0.0220 (0.194)	0.0219 (0.204)	0.0200 (0.217)
<i>Mtb</i>	0.0413 (0.409)	0.0616 (0.236)	0.0668 (0.206)	0.0743 (0.175)	0.0639 (0.238)
<i>Bid_ask_spread</i>	-8.2001 (0.109)	-12.2690* (0.062)	-11.9801* (0.063)	-12.6162* (0.062)	-11.7621* (0.056)
<i>CPU</i>	-0.7147 (0.200)	1.1428*** (0.001)	0.8477*** (0.000)	0.6285*** (0.002)	0.8089*** (0.002)
<i>MNF_IND × CPU</i>	7.1974** (0.011)				
<i>TRANS × CPU</i>		-26.1747 (0.263)			
<i>FOOD_BEV × CPU</i>			-0.3927 (0.963)		
<i>CONST × CPU</i>				5.8289 (0.225)	
<i>RENEW × CPU</i>					0.6175 (0.865)
<i>Constant</i>	-0.4156*** (0.000)	-0.3425*** (0.002)	-0.3733*** (0.003)	-0.3997*** (0.003)	-0.3598*** (0.002)
Observations	5,869	5,869	5,869	5,869	5,869
AR2 <i>p</i> -value	0.141	0.167	0.164	0.170	0.163
Hansen <i>p</i> -value	0.534	0.503	0.629	0.621	0.504

Note(s): Robustness test using system GMM with robustness standard errors after including interaction terms between *CPU* and business sector dummies. The dependent variable is *CCO*. All specifications include business sector dummies. The dummies are not reported to save space. Hansen stat: overidentification test; AR2: Second order autocorrelation test. *, ** and ***: 90, 95 and 99% significance levels, respectively

Source(s): Authors' own work

remains positive and significant in all specifications, except when $CONST_IND \times EPU$ is included. Similarly, the impact of CPU remains positive, significant and stronger than that of EPU , except when $MNF_IND \times CPU$ is added to the specification. These results indicate that the positive linear relationship between uncertainty and attention to climate change opportunities is generally robust, even when accounting for causal heterogeneity.

4.3.6 Controlling for endogeneity of uncertainty to transition and physical climate risk. The influence of uncertainty on firms' interest in climate-related issues can be channeled through an important factor which is the firms' perception of physical and transitional risks associated with climate change. We argue that the degree of sensitivity and awareness concerning the complex issues surrounding climate change can be a decisive factor in shaping the forward-looking attention and importance that firms attribute to these matters. Accordingly, both physical and transitional perceived risks associated with climate change are expected to amplify the influence of uncertainty on firms' attention to climate-related opportunities. We use the indices developed by [Bua et al. \(2024\)](#) to measure (unexpected changes in) physical risk shocks (such as rising sea levels, heatwaves, floods, etc.) and transitional risks (including new regulations, technological advances, etc.) related to climate change. The authors use a text-analysis approach, leveraging news articles focused on the European region. Our focus is not only on the endogeneity of uncertainty but also on how unexpected changes in physical and transitional climate risks influence CCO through EPU and CPU .

To this end, the first step involves determining the extent to which the predicted values of uncertainty (EPU and CPU) are explained by physical and transitional climate risks, by running the following regressions:

$$Uncertainty_t = \partial_0 + \sum_{z=1}^2 \partial_z uncertainty_{t-z} + \sum_{h=1}^2 \sum_{l=3}^4 \partial_l PRI_{t-h} + \vartheta_t$$

$$Uncertainty_t = \varphi_0 + \sum_{p=1}^2 \varphi_p uncertainty_{t-p} + \sum_{v=1}^2 \sum_{u=3}^4 \varphi_u TRI_{t-v} + \pi_t$$

We then recover the values of the two uncertainty indices predicted by the coefficients $\sum_{l=3}^4 \partial_l$ and $\sum_{u=3}^4 \varphi_u$. Finally, we include the predicted values (PR_PRI_EPU , PR_TRI_EPU , PR_PRI_CPU , PR_TRI_CPU) in the baseline regression to have an estimate of the impact of variations in uncertainty predicted by unexpected changes in climate risk on CCO . [Table 10](#) shows that the positive predicted impact of EPU is more strongly explained by the prediction of physical risks than by transitional risks, whereas the impact of CPU is similarly predicted by both climate risk indices. In other words, it is only physical climate risk that drives the sensitivity of firms' environmental commitment to EPU , which may explain why the impact of CPU is more pronounced. The positive impact of CPU could capture the reaction of firms to new climate-related policies and regulations aimed at protecting against physical climate risks and accelerating firm adaptation to the climate transition.

5. Conclusion

We examined the relationship between uncertainty and firms' attention to climate change-related opportunities. Our goal was to contribute to the literature focusing on corporate commitment to sustainability by using a score that captures firms' ability to leverage climate change-related business opportunities. Additionally, we empirically tested whether firms'

Table 10. Controlling for climate physical and transitional risksStudies in
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Variables	EPU and climate risk	CPU and climate risk
<i>CCOt-1</i>	0.4921*** (0.000)	0.4749*** (0.001)
<i>Qage</i>	0.0243 (0.192)	0.0264 (0.176)
<i>Size</i>	0.0248*** (0.000)	0.0247*** (0.000)
<i>Leverage</i>	0.0395* (0.069)	0.0272 (0.210)
<i>MTB</i>	0.0930 (0.113)	0.1102* (0.051)
<i>Bid_ask</i>	-13.4184** (0.042)	-11.5831 (0.111)
<i>PR_PRI_EPU</i>	0.0045* (0.082)	
<i>PR_TRI_EPU</i>	-0.0006 (0.946)	
<i>PR_PRI_CPU</i>		0.0076* (0.080)
<i>PR_TRI_CPU</i>		0.0045* (0.074)
Constant	-0.3903** (0.000)	-0.3760** (0.000)
Observations	5,601	5,601
AR2 <i>p</i> -value	0.162	0.168
Hansen <i>p</i> -value	0.414	0.313

Note(s): Robustness test using system GMM with robustness standard errors with predicted uncertainty using unexpected changes in climate risk. The dependent variable is *CCO*. All specifications include business sector dummies. The dummies are not reported to save space. Hansen stat: overidentification test; AR2: Second order autocorrelation test. *, ** and ***: 90, 95 and 99% significance levels, respectively

Source(s): Authors' own work

attention to climate change responds symmetrically or asymmetrically to uncertainty. The firm-level score for climate change-related opportunities was analyzed alongside two widely recognized indicators of uncertainty: Economic Policy Uncertainty and Climate Policy Uncertainty. The sample spans from Q1 2010 to Q2 2022, encompassing 5,869 firm-quarter observations of publicly listed German firms. To estimate a dynamic panel model, we used the system GMM method, with standard error estimates robust to heteroskedasticity and autocorrelation within panels. We conducted several sensitivity and robustness checks, including altering the definition of the dependent variable, excluding the most polluting sectors, using two-stage instrumental variables and accounting for the endogeneity of uncertainty in relation to physical and transitional climate risks. The key findings are as follows:

- The linear estimation indicates that Economic Policy Uncertainty (*EPU*) and Climate Policy Uncertainty (*CPU*) are positively correlated with firms' attention to climate change-related opportunities (*CCO*), with *CPU* having a more substantial impact on *CCO*. The linear relationship indicates that German firms' focus on climate issues is influenced by the level of uncertainty and the concerns they have about the unpredictability of economic and climate policy and regulatory decisions. Specifically, firms seem to be responding to climate-related opportunities not out of conviction, but as a reaction to the surrounding uncertainty. This confirms the study's hypotheses based on the signaling theory and the institutional theory.
- Contradicting a large body of the literature, the asymmetric results indicate that an increase in economic policy uncertainty enhances firms' attention to climate opportunities more than a decrease does. This result confirms the hypothesis based on the attention-based view. This suggests that firms are more responsive to investor confidence, which is primarily influenced by news related to economic policies. This behavior, in some respects, threatens the long-term sustainability of the fight against climate change.

- In addition, a decrease in *CPU* has a much greater impact on *CCO* than an increase in *CPU*, contradicting the findings of [Aghion et al. \(2014\)](#) and [Li et al. \(2018\)](#). This contradiction likely stems from methodological differences as well as from the specific characteristics of the German climate policy landscape. Firms are more likely to reduce their attention to opportunities arising from climate change when climate policy uncertainty decreases. This result reinforces the argument that German firms tend to adopt a passive approach to addressing climate change, scaling back their focus when the unpredictability of climate policy recedes.
- Taking into account the endogeneity of uncertainty in relation to physical and transitional climate risks, the results suggest that the positive predicted impact of *EPU* on *CCO* is primarily explained by physical risk forecasts, whereas the effect of *CPU* on *CCO* is influenced by both physical and transitional climate risk predictions.

Other results, concerning the control variables, emerge from the sensitivity and robustness tests. Firms' attention to climate change-related opportunities remains strongly influenced by their size and maturity (age). However, the impacts of leverage, information asymmetry, gauged by bid-ask spread and market value are sensitive to the definition of the dependent variable, business sector heterogeneity and estimation method. Moreover, when introducing business confidence indexes among control variables, the results show that an increase in confidence regarding the business situation enhances firms' attention to climate change opportunities in the manufacturing sector, while it has the opposite effect in the service sector.

These findings highlight the importance of the relationship between policy uncertainty and firms' sensitivity to climate issues, which stakeholders should take into account in their evaluation and decision-making processes. To mitigate the "passive" behavior of firms during decreasing climate policy uncertainty, policy design in Germany should maintain a persistent incentive structure to improve the scope of climate-related business and investment opportunities even when uncertainty diminishes. German authorities could expand and complement the EU's Carbon Border Adjustment Mechanism and Emissions Trading System with sector-specific efficiency standards and decarbonization trajectories that reflect the heterogeneous characteristics of firms. Even though we study firms' attention to climate-related opportunities, such decisions are expected to be efficient, as empirical results show that they can sustain R&D and green investment momentum over time ([Dechezleprêtre et al., 2014](#); [Aghion et al., 2016](#)). In addition, fiscal instruments can be structured to encourage sustained attention to climate opportunities. For example, conditional tax credits or accelerated depreciation schemes linked to verified low-carbon investments can motivate firms to remain actively engaged, even in a stable regulatory environment ([Dressler and Warwick, 2025](#)). Likewise, expanding green public procurement and sovereign green bond programs can offer a consistent demand signal for firms' climate-focused initiatives ([Flammer, 2021](#)). Moreover, enhanced mandatory disclosure frameworks, such as the EU Corporate Sustainability Reporting Directive (CSRD) and taxonomy-aligned reporting standards targeting environmental objectives can help maintain managerial focus by embedding climate considerations into firms' governance and decision-making processes ([Krueger et al., 2020](#)). Similarly, research indicates that consistent reporting obligations and ESG performance benchmarking encourage firms to engage more proactively with environmental issues, in absence of growing uncertainty ([Tripopsakul, 2025](#)).

Stakeholders must heighten their awareness of how uncertainty impacts corporate behavior to maintain effective market discipline and ensure the continuity of pro-climate projects. Our arguments align with those of [Feng and Zheng \(2022\)](#), who assert that market

pressure should remain a key driver of innovation in green technologies and act as a substitute during periods of lower economic policy uncertainty, to sustain firms' attention to climate issues. However, the results also indicate that periods of lower climate policy uncertainty significantly diminish firms' attention to opportunities related to climate change. Consequently, alongside stakeholder pressure, stronger safeguards should be implemented during times of decreased uncertainty, particularly those linked to pro-environmental regulations, legislation and energy transition. Authorities should also assess the effectiveness of coercive measures aimed at penalizing the most polluting firms, especially those in the industrial sector, during periods of heightened uncertainty, as such measures may lead to unintended consequences.

Like other studies, the results of this paper were constrained by certain limitations, such as the unavailability of the CCO score for several German-listed firms. While the sample of 172 German-listed firms represents the largest group for which CCO scores are available, its relatively limited size may reduce the statistical power to detect small effects and restrict the broader applicability of the findings to smaller or unlisted firms. In addition, the observation period ends in 2022Q2, which allows capturing uncertainty dynamics generated only by the first months of the Russia-Ukraine. Moreover, while country-specific case studies help address issues related to institutional and jurisdictional heterogeneity, expanding the sample to include other countries could prove valuable in identifying key common trends at a regional or international level. Future research could focus on examining how other climate change exposure scores react to uncertainty. The uncertainty indicators could also incorporate additional dimensions, such as geopolitical risk, to provide a more comprehensive understanding of the factors influencing corporate commitment to climate change. Moreover, future studies should explore the interaction between uncertainty and firm-specific determinants of attention (or exposure) to climate change.

Notes

- [1.] Source: the World Bank - <https://data.worldbank.org/indicator/CM.MKT.LDOM.NO?locations=DE>
- [2.] www.climatewatchdata.org/data-explorer

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Further reading

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Table A1. Variable measures and sources

Variable	Definition/Measure	Source
<i>CCO</i>	Firms' attention to opportunities linked to climate change (score)	Sautner et al. (2023)
<i>Qage</i>	Equals 1 if age belongs to the first quartile (Q1), 2 if it belongs to Q2, 3 if it belongs to Q3 and 4 if it belongs to Q4 of the statistical distribution of firm age	Firm's websites, stock market and other open-source data
<i>Size</i>	Natural logarithm of total assets	Thomson Reuters eikon database
<i>Leverage</i>	Total debts on total assets	
<i>Mtb</i>	Market value of equity on book value of equity	
<i>Bid_ask_spread</i>	Daily difference between the ask price and the bid price of issued shares	Ifo institut
<i>Ifo_manufacturing</i>	Business expectations Sub-indices	
<i>Ifo_services</i>		
<i>Ifo_trade</i>		
<i>Ifo_construction</i>		
<i>EPU</i>	Economic policy uncertainty	www.policyuncertainty.com
<i>CPU</i>	Climate policy uncertainty	Bua et al. (2024) Climate risk index available on www.policyuncertainty.com
<i>PRI</i>	Physical climate risk shocks	
<i>TRI</i>	Transitional climate risk shocks	

Source(s): Authors' own work

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