Firm-level Climate Change Exposure and Zombification Risk: The Role of Managerial Issue Interpretation

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Abstract

This study investigates the relationship between firm-level climate change exposure (FCCE) and the risk of zombification, providing evidence of a positive association. However, this effect is not uniform across different types of climate exposure. While physical and opportunity-related exposures significantly increase zombification risk, regulatory exposure does not exhibit a clear impact. Most importantly, this relationship is mainly driven by managerial perception. When managers perceive climate change as a threat, the positive impact of FCCE on zombification risk is mitigated. In contrast, when climate change is viewed as an opportunity, the relationship is amplified, further heightening the risk of zombification. This effect is particularly pronounced in firms that are highly visible, having strong environmental capabilities, and operating in countries with stringent climate governance frameworks. These findings highlight the pivotal role of managerial issue interpretation and firm-specific and institutional factors in shaping how climate change exposure affects firm viability. By shedding light on these dynamics, our study underscores the importance of managerial decision-making and external conditions in addressing the financial risks associated with climate change.

Keywords: Climate change, Climate governance, Managerial perception, Visibility, Zombies.

1 Introduction

Climate change has become a contentious yet unresolved topic of debate among economists, policymakers, and scholars over the past decades. Its impacts are far-reaching, affecting nearly every sector of the economy and all facets of financial systems. The climate crisis is forcing market participants to reassess and adapt their financial practices and priorities in response to growing risks and uncertainties (Gasparini and Tufano, 2023). Evidence highlights that extreme weather events and climate-related disasters have already caused trillions of dollars in economic losses globally, with significant implications for businesses, infrastructure, and livelihoods.

The Intergovernmental Panel on Climate Change (IPCC) highlights the potential impacts of climate change, including global warming, rising sea levels, and extreme weather events, which can have both direct and indirect severe consequences for firms. These include effects on profitability (Addoum et al., 2020; Pankratz et al., 2023), cost of capital (Huynh et al., 2020; Javadi et al., 2021; Zhou et al., 2018), and financial market performance (Griffin et al., 2017). Moreover, an extensive body of literature underscores the multifaceted effects of climate change on corporate financial and business outcomes. These include impacts on capital structure (Nguyen et al., 2020; Jung et al., 2018), financial performance (Nguyen et al., 2018; Huang et al., 2017; Addoum et al., 2020), earnings (Huang et al., 2017), and CEO equity incentives (Hossain et al., 2022). Together, these findings emphasize the critical role of climate change in reshaping corporate strategies and financial stability.

Building on existing evidence, this study investigates the impact of firm-level climate change exposure (FCCE) on the risk of zombification. Zombie firms, distinct from distressed companies, are characterized by their prolonged survival in the market despite financial difficulties. Unlike distressed firms, which face both cash-flow and balance-sheet insolvency, zombie firms remain operational largely due to external financial support. They rely on mechanisms such as subsidized loans and evergreen loans provided by undercapitalized banks seeking to avoid recognizing losses (McGowan et al., 2017; Acharya et al., 2021). These practices are often influenced by national insolvency regimes and weak regulatory frameworks, which enable such firms to persist despite their inefficiencies. By examining FCCE, this study sheds light on how climate-related risks intersect with financial vulnerabilities to exacerbate zombification trends.

Although the relationship between FCCE and financial performance has garnered increasing attention from scholars and investors (Capasso et al.,2020 ; Bell et al.,2022 ; Oguntuase O.J,2020), its impact on specific forms of financial distress remains relatively underexplored. In this study, we focus on zombie firms as previously defined. To measure FCCE, we follow Sautner et al. (2023) which leverages textual analysis of earnings conference call transcripts to capture firm-level climate-related discussions. Unlike

traditional measures such as carbon emissions, the Palmer Drought Severity Index, or abnormal temperature (Hong et al., 2019; Javadi and Masum, 2021; Hsu et al., 2023), this method provides a dynamic and nuanced assessment of climate change exposure by focusing on management-analyst interactions and their emphasis on climate-related risks and opportunities.
This innovative proxy is developed using earnings conference call transcripts and identifies the attention, perception, and judgments of participants regarding FCCE. It leverages a machine learning keyword discovery algorithm to capture exposure related to opportunities, as well as physical and regulatory shocks associated with climate change. Specifically, the index is calculated as the relative frequency of climate change-related bigrams divided by the total number of bigrams in the transcript, providing a normalized measure of attention. To the best of our knowledge, this dataset is one of the most comprehensive sources on FCCE, covering over 10,000 unique firms from 34 countries. By integrating machine learning techniques with textual analysis, it offers a dynamic and granular view of how firms and their stakeholders engage with climate-related risks and opportunities.

Using a sample of 192,927 firm-year observations from 9187 unique firms across 34 OECD countries during the 2002-2022 period, we first find that the relationship between FCCE and zombification risk is positive and significant. To further investigate this relationship, we control for the role of managerial interpretation of FCCE as developed by Sautner et al. (2023). The authors propose two proxies to capture positive vs negative managerial perception of FCCE. Our results reveal that the direct effect of FCCE on zombification risk disappears after controlling for the managerial perception. In particular, we observe that the interaction term between FCCE and positive interpretation is positive and significant, whereas the interaction term between FCCE and negative interpretation is negative and significant. These findings suggest that the impact of FCCE on zombification risk mainly depends on how managers interpret and monitor climate change — whether this issue is perceived as an opportunity or a threat -.

Further analyses explore the underlying mechanisms driving this relationship. Our results indicate that the effect is more pronounced for firms that are highly visible, having better environmental capabilities, and operating in countries with more stringent climate governance. Managers who perceive climate change as an opportunity often feel compelled to pursue ambitious environmental goals to meet stakeholder expectations and sustain their public image as industry leaders. However, for firms with these characteristics, such overcommitment can exacerbate financial inefficiencies and heighten zombification risk. Conversely, managers with a more skeptical perspective tend to adopt a conservative approach, prioritizing financial stability over expansive environmental initiatives. These findings highlight the importance of managerial perception and external conditions in

shaping the consequences of FCCE on firm viability.
Further analyses delve into the underlying mechanisms driving this relationship. Our results reveal that the effect of FCCE on zombification risk is more pronounced for firms that are highly visible, having strong environmental capabilities, and operating in countries with stringent climate governance. Managers who perceive climate change as an opportunity often feel compelled to pursue ambitious environmental goals to meet stakeholder expectations and maintain their public image as industry leaders. However, for firms with these characteristics, such overcommitment can lead to resource misallocation, exacerbate financial inefficiencies, and ultimately increase the risk of zombification. In contrast, managers with a more skeptical perspective tend to adopt a conservative approach, prioritizing financial stability over sustained environmental initiatives. This cautious strategy helps mitigate the financial risks associated with overextending resources toward environmental goals.

These findings underscore the critical role of managerial perception and firm-specific and institutional factors in shaping how FCCE impacts firm viability. They highlight the delicate balance between addressing climate-related challenges and maintaining financial health, particularly for firms under heightened scrutiny from stakeholders and regulators. Overall, our study contributes to both academic and policymaking discussions on the potential financial implications of climate change. Our findings also align with managerial issue interpretation theory (Dutton and Jackson, 1987), emphasizing that a manager's framing of climate change — whether as an opportunity or a threat — significantly shapes the focus and nature of corporate actions. This, in turn, influences the financial stability outcomes associated with FCCE.
This research makes several significant contributions to the extant literature. First, the study is among the first to explore how climate change exposure directly impacts zombification risk at the firm level. It expands our understanding of the determinants of financial distress, particulary the drivers of zombification, and introduces climate change as a critical factor shaping firm viability. Second, another important contribution of this research is to incorporate a behavioral lens to the relationship between climate change exposure and zombification risk. Specifically, the study draws on strategic issue interpretation theory, providing empirical evidence that managerial perceptions and responses to climate-related risks play a pivotal role in shaping firm outcomes. This contribution bridges the gap between environmental challenges and managerial decision-making in the context of financial distress. Moreover, this study examines the underlying mechanisms that can explain this relationship using insights from the institutional theory , visibility theory and legitimacy theory. Finally, this research offers interdisciplinary contributions by employing the sentiment analysis to quantify managerial responses, introducing a novel methodological approach to the financial distress literature. By combining insights

from climate exposure, behavioral finance, and governance, this study not only refines theoretical frameworks but also offers practical implications for policymakers and corporate leaders aiming to mitigate zombification risk in the face of growing environmental hazards.

The reminder of the paper is organized as follows. Section 2 presents prior literature and hypotheses development. Section decribes the sample, data and variables. Section 4 reports empirical results while Section 5 concludes the paper.

2 Literature review and hypotheses development

2.1 FCCE and zombification risk

According to the "physical-transitioning-regulatory risk paradigm," climate change can expose firms to significant potential challenges such as physical, transitioning, and regulatory risks, inducing several negative outcomes.

For instance, climate change can incur physical damage to the firm's fixed assets, resulting in their depreciation, which can hinder the entire supply chain and significantly harm firm profits and production capacity. This can increase the credit risk of banks and induce financial losses for the insurance sector (Battiston et al.,2021). It may also indirectly affect a firm's costs due to governmental sanctions and regulations such as the emission trading scheme or impose transition burdens.

In addition, the transition to a low-carbon economy could lead to unanticipated and sudden adjustments of asset prices (both positive and negative) and changes in defaults for entire asset classes, resulting in financial shocks for asset managers, institutional investors, and banks' portfolios (Battiston et al.,2021).Furthermore, firms facing greater climate change exposure are likely to suffer from reputational risk, diminished competitive advantage, and reduced ability to sustain consistent dividend payments, which may further translate into a loss of income and market share (Dewaelheyns et al.,2023). Climate change can also affect businesses by increasing costs and causing operational disruptions (Burke et al.,2015 ; Dietz et al.,2016). Barrot and Sauvagnat (2016) and Pankratz et al.(2023) also indicate that extreme temperatures and natural disasters have had an adverse impact on corporate earnings and sales growth and are associated with declining revenues and operating income.

These impacts can heighten firms' cash-flow volatility and elevate their default risk in adverse scenarios. Other research has examined the impact of climate change exposure on firm performance. Several studies have shown that climate risk can contribute to reduced firm performance (Krueger P, 2015 ; Huang et al.,2017 ;Ding et al.,2021) and can contribute to the volatility of firm profits (khabir et al.,2021 ;Lemma et al.,2019).

In terms of financial constraints, climate change has significantly increased the cost of

external financing for both debt and equity capital. It is well documented in the literature that lenders who continue providing funding support to these firms require a higher cost of debt capital and/or include stricter credit terms that are unfavorable to borrowers (Chava,2014 ;Javadi et al.,2021), which elevates operational costs and constrains the flexibility of business operations. In fact, to safeguard their interests against the higher default risks of borrowers exposed to significant climate change, creditors may respond by implementing more stringent debt terms. These terms might include shorter debt maturities, higher interest rates, and more restrictive debt covenants.

Similar findings are also reported for equity capital. Hong et al.(2019) show that drought conditions increase the cost of equity for a sample of international firms due to disruptions caused by the physical risk of drought. Similarly, Huynh et al.(2020) document an increase in forward-looking cost of equity due to drought conditions for a large sample of U.S. firms. Additionally, firms facing heightened climate risk may experience downgrades in their credit ratings, leading to higher debt costs for these entities as indicated by Li et al.(2014), and Graham et al.(2001).

Prior studies have explored the impact of climate change on default risk by using carbon emissions as a proxy for climate risk (khabir et al.,2021 ; Capasso et al.,2020). However, this measure only reflects self-reported past performance and past corporate strategic settings, which may lead to biased conclusions (Sautner, 2020). Two recent studies conducted by Nguyen et al.(2023) and Feng et al.(2023) have investigated the repercussions of climate change exposure on financial risks at the firm level. Nguyen et al.(2023) find a positive impact of firm-level exposure to climate change risks on default risk, and this effect is particularly pronounced within firms facing greater financial constraints and distress. Feng et al.(2023) delve into the relationship between firm-level climate change exposure and bankruptcy risk, and their results confirm that a firm's bankruptcy risk increases with its climate change exposure. Both studies used a firm-level climate risk exposure measure initially developed by Sautner et al.(2023)

Based on the aforementioned arguments, the first hypothesis is framed as follows:

Hypothesis 1: FCCE is positively associated with zombification risk.

2.2 On the role of managerial issue interpretation

Managerial interpretation is a crucial managerial capability that underlines organizations' strategic choices. It is a central process highlighting the dynamic managerial capability of sensing and can have important implications for strategic change and innovation (Helfat and Peteraf, 2014). In fact, the ability of managers to identify and make sense of challenges in the external environment is one of the microfoundations of dynamic capabilities (Teece, D.J, 2007).

Based on the strategic issue interpretation theory, we know that managers tend to apply

categories to new issues, and these categories can in turn shape cognition, motivation, and actions of senior decision-makers, which affect the process and the focus of organizational actions (Dutton and Jackson, 1987). One of the most common categorizations of strategic issues is threat/opportunity (Daft and Weick, 1984 ; Dutton and Jackson, 1987; Sharma, 2000).

This paper examines climate change as a complex issue, emphasizing how managers' perceptions shape their responses. Framing climate change as either a threat or an opportunity directly influences the strategies they adopt, driving decisions that either address risks or leverage potential advantages. Indeed, managerial perceptions of exposure to climate risks determine whether organizations decide to intervene to eliminate, reduce, or shift risks or, alternatively, delay possible organizational responses (Berkhout, Hertin and Gann, 2006)

For instance, Haney (2017) found that the threat interpretation of climate change stimulates innovative and proactive approaches to climate action, as a result of an enlarged understanding of a firm's environmental and social responsibility and a long-term thinking perspective on environmental problems. According to the author, perceiving climate change as a threat entails a better understanding of the implications of climate issues on society beyond the boundaries of the firm and thus favors a more detailed identification of climate risks. However, Sharma (2000) suggests that focusing on opportunities leads to entrepreneurial and open approaches to innovation. The author argues that categorizing issues as opportunities, rather than threats, helps managers reduce ambiguity and fosters the transmission of shared interpretations within organizations through social processes and formal interactions.

This approach encourages open problem-solving and predictable actions by emphasizing opportunity-focused thinking into organizational systems, resulting in more effective strategic responses. For instance, if managers frame climate change as an opportunity rather than a threat, they are more likely to see it as a chance to innovate, adopt sustainable practices, and develop new business models. At the same time, a focus purely on environmental issues as opportunities may encourage firms to commit fewer resources and to be less risk-seeking. This is in part because individuals have a tendency to respond in more risk-seeking ways to potential losses rather than potential gains (Kahneman and Tversky,1979). A focus on opportunities alone may then lead managers to focus on short-term and incremental improvements rather than considering long-term changes and entry into new markets.

In this context, the interplay between managerial interpretation of climate change and organizational strategies is crucial. Climate change, as a major issue, might produce events that cannot be precisely predicted, analyzed, or prepared for with traditional risk analysis techniques. How managers frame climate change—as a threat or an opportunity—affects their decisions, which can either exacerbate or mitigate zombification risk.

Building on the strategic issue interpretation theory that underlines the critical role of managerial perceptions in shaping organizational responses (Dutton and Jackson, 1987 ; Weick, 1995) , we propose the following hypothesis:
Hypothesis 2: The impact of FCCE on zombification risk is shaped by the Managerial Interpretation of FCCE.

2.3 Exploring the nexus between managerial interpretation of FCCE and zombification risk

The role of environmental capabilities

Firms operate in an environment where stakeholder's awareness and expectations significantly shape strategic decision-making. Based on legitimacy theory, companies tend to build and maintain public perceptions that they operate legitimately and by social norms and values (Deegan, 2019) .
On one hand, ESG engagement can be considered a critical source of legitimacy (Chiu and Sharfman, 2018) and a long-term investment that serves to meet stakeholders' demands (Chen, Zhou, and Zhu, 2019; Peloza, 2009). Although a vast body of literature supports the positive association between ESG performance and investment efficiency (Samet and Jarboui, 2017 ; Benlemlih and Bitar, 2018 ; Shahzad et al., 2018 ; Cook et al.,2019 ; Khediri, 2021 ; Liu et al.,2022 ; Phan et al., 2022), other studies found that greater ESG engagement causes over-investment (Zamir et al.,2022; Lin et al.,2021) and reduces merger and acquisition activity (Krishnamurti et al.,2021). In fact, firms may overinvest in ESG activities in order to signal their status and credibility, improve company's reptutation and gain a competitive advantage .However, this overambitious pursuit of ESG may cause firms to divert limited resources from programs that have a significant impact on firm profitability and adversely affect firm performance (Brammer et al., 2006). Indeed, when resources are abundant, executives tend to adopt proactive ESG strategies to meet stakeholder expectations without excessive concern about short-term financial pressures (Voss et al., 2008).
As a result, the positive relationship between excessive ESG engagement and firm value could be due to the CEO's incentive to gain more support from stakeholders. Moreover, although stakeholder theory can shape the decision- making process within the company it can also generate managerial conflict with regard to deciding how to best exploit the scarce capital resources of the firm (Bird, Hall, Momentè and Reggiani, 2007; Mishra and Modi, 2013). In fact, while a high ESG expenditure may confer benefits upon a firm's managers, the other shareholders may not approve of a high ESG expenditure if it reduces firm value create a conflict between different shareholders.

On the other hand, the managerial opportunism hypothesis provides another lens to understand excessive ESG engagement. In fact, according to agency theory, managers may overinvest in ESG activities to obtain self-serving benefits, such as building their reputations and social networks with stakeholders, besides increasing shareholder wealth (Benabou and Tirole, 2010; Jensen and Meckling, 1976; Krüger, 2015; Masulis and Reza, 2015). Borghesi, Houston, and Naranjo (2014) observed that CEOs with greater media coverage are likely to engage in ESG activities to fulfill their personal needs, such as reputation building and career development, and Bu et al. (2021) argued that CEOs engage in excessive ESG investments to enhance their reputations at the expense of stockholders' interests. Moreover, Masulis and Reza (2015) showed that managers tend to engage in corporate generosity to extract private benefits beyond generating shareholder wealth, which decreases firm value.

The trade-off hypothesis also states that ESG investments reduce company resources, bringing a competitive disadvantage and decreasing firm value and investment efficiency (Preston and O'bannon, 1997).

In summary, while environmental capabilities can enhance a firm's legitimacy and stakeholder relationships, excessive environmental expenditures may deplete resources, leading to financial inefficiencies and conflicts among shareholders. These factors can adversely affect firm performance and elevate the likelihood of zombification, which brings us to the following hypothesis:

Hypothesis 3: : The relationship between FCCE and zombification risk is stronger for firms with better environmental capabilities.

The role of firm visibility

Visibility theory posits that stakeholders will develop expectations of a firm's ESG strengths and concerns based on whether the firm is more or less visible (Bowen, 2000). In fact, highly visible organizations are more likely to be vulnerable to attention from interested parties (Bansal, 1996), and are therefore more exposed to institutional pressure in the social system (Oliver, 1991 ; Goodstein, 1994). This increased visibility often ensures that firms receive recognition for their sustainability efforts but simultaneously subjects them to heightened expectations and pressures (Belkaoui and Karpik, 1989 ; Brammer and Pavelin, 2006 ; Holthausen and Leftwich, 1983). This dual nature of visibility makes it a critical factor in managerial decision-making, thus shaping how managerial interpretation of climate change exposure influence zombification risk.

Prior research suggests that visibility is often associated with greater scrutiny and better performance expectations from a wide range of stakeholders (Pan et al., 2020 ; Zavyalova et al., 2016 ; Zhang et al., 2020). Higher visibility reduces information asymmetry, and thereby gives shareholders a clearer picture of the firm's actions, which may in turn

increase their future expectations. In addition, highly visible firms place significant emphasis on reputation, which is an important source of competitive advantage and therefore economic rents (Rindova et al., 2005). Carter (2006) notes that firms facing amplified visibility among different stakeholder groups will increase corporate reputation management actions directed to those groups and decrease activities towards other groups. Despite its benefits, visibility is a double-edged sword. In fact, a firm's inconsistent ESG actions toward stakeholders only matter when stakeholders become aware of such inconsistencies. Once stakeholders recognize these unreliable practices, they may respond in various ways, such as boycotting or posting negative reviews, which can significantly damage the firm's reputation (Harrison et al., 2018). Stakeholders reward or penalize firms based on the nature of their actions (Chiu and Sharfman, 2011 ; Matten and Moon, 2008). Firms with higher visibility are subject to stronger stakeholder activism and external pressures (Eesley and Lenox, 2006 ; Gomez-Carrasco and Michelon, 2017). All these stakeholder scrutiny and expectations may motivate managers to invest in more ESG activities in order to address the pressures from institutional actors and other important stakeholders. Moreover, a firm's high visibility often signals its capacity to allocate resources toward sustainability initiatives. In fact, high visibility signals to stakeholders that the firm has greater resources to devote to ESG expenditures (Chiu and Sharfman, 2011; Dowling and Pfeffer, 1975). Easley and O'hara (2004) find that firms with lower costs of capital, and thereby probably greater slack resources, generally engage in more corporate disclosures.In fact, as discretionary resource spending levels increase, organizations are expected to fulfill their obligations to society by allocating greater resources to ESG activities, because stakeholders and society expect firms with higher resources to develop ESG strengths, which in turn enhance firm visibility (Easley and O'hara,2004).
However, economic, social, and cultural conditions, as well as the lack of strong control mechanisms, make investors and lenders distrust ESG information, and consequently, companies with more disclosure go on the path of more financial difficulties.In addition,while these investments can enhance a firm's reputation, they also increase the risk of inefficiency, particularly when managerial interpretations of CCE prioritize visible compliance over strategic resilience, thereby heightening the firm's zombification risk. On the basis of the above arguments, stakeholder awareness of an organization's actions significantly influences their decisions and behaviors toward the firm (Rindova et al., 2005). All this leads us to the following hypothesis:
Hypothesis 4: :The relationship between managerial interpretation of climate change and zombification risk is stronger for highly visible firms.

The role of the institutional context

Country-level climate governance plays a crucial role in mitigating climate change by implementing policies and regulations tailored to national circumstances, thus fostering accountability and concerted action. Based on the institutional theory, the nature and variety of institutional processes influence the behavioral variation of an organization (Oliver, 1991). DiMaggio and Powell (1983) suggest that, so as to optimize efficiency in a specific environment, firms follow three possible types of isomorphism: coercive, mimetic and normative. While mimetic isomorphism focuses on imitation of peers, normative isomorphism emphasizes adherence to professional norms and standards. In the context of rigid climate governance, firms are compelled to develop response strategies to address environmental contingencies and align with institutional expectations. According to contingency theory , the effectiveness of organizational strategies depends on the fit between the firm's internal characteristics and its external environment (Burns and Stalker, 1961).The literature has suggested that there is a certain type of fit between environment and organization, which explains the business results (Drazin and Van de Ven, 1985 ; Venkatraman, 1989).In the case of firms operating under strict climate governance, this fit involves adapting their strategies to comply with environmental regulations while navigating pressures from institutional processes. Based on the aforementioned arguments, we posit the following hypothesis :

Hypothesis 5: The relationship between managerial interpretation of climate change and zombification risk is stronger in countries with more stringent climate governance.

3 Data and Variables

3.1 Sample

In this study, we use several firm-level climate change exposure data from Sautner et al.(2023). Financial data is provided by the Refinitiv database and county-level variables are obtained from the OECD database. After dropping firms operating in the financial and real estate sectors, our final sample consists of 192,717 firm-year observations during the 2002-2022 period.

3.2 Dependent Variable

We employ the OECD measure to identify zombie firms. According to the OECD, a firm is considered as a "zombie" if the age is at least ten years old and the operating income is insufficient to cover interest expenses for three consecutive years (Hassine and Le Grand,2019).This proxy addresses the pro-cyclicality concerns on the zombie status and allows the comparison between different countries. We create the dummy variable

"Zombie" that takes one if the company satisfies the two conditions mentioned above and zero otherwise.

3.3 Key Independent Variable

Our key independent variables are provided by Sautner et al.(2023): FCCE, CCPP and CCNP. These proxies are calculated with machine learning on the basis of conference calls transcripts. FCCE captures the attention, perceptions, and judgments of earnings call participants of firms' climate change exposures. This measure counts the frequency of certain climate change biagrams in the earnings conference call transcripts and then divides the frequency by the total number of biagrams in the transcript. The exposure to climate change of firm i in quarter q is defined as:

$$CC_expo_i = \frac{1}{B_i} \sum_{b=1}^{B_i} D(b) \cdot 1000 \tag{1}$$

where $b = 1, 2, \ldots, B_i$ are all the biagrams of firm i in quarter q. $D(b)$ is a dummy variable equal to one if biagram b is related to climate change and zero otherwise. This measure is then multiplied by 1000 for expositional purposes.

CCPP (CCNP) captures the manager's positive (negative) perception of climate change exposure. This measure is derived from the relative frequency with which bigrams related to climate change appear alongside positive or negative tone words, as defined by Loughran and McDonald (2011). These co-occurrences are identified within the same sentence in the transcripts of earnings conference calls, providing a nuanced indicator of managerial sentiment toward climate change.

3.4 Model Specification

We estimate the following probit model to investigate the impact of FCCE and its 3 types on zombification risk:

$$\begin{aligned} \Pr(\text{ZOMBIE}_{i,t} = 1) = \Phi(&\beta \cdot \text{FCCE}_{i,t-1} + \beta_2 \cdot \text{PFCCE}_{i,t-1} + \beta_3 \cdot \text{RFCCE}_{i,t-1} \\ &+ \beta_4 \cdot \text{OFCCE}_{i,t-1} + \delta \cdot \text{Controls}_{i,t-1} \\ &+ \text{Ind FEs} + \text{Country FEs} + \text{Year FEs} + \varepsilon_{i,t}). \end{aligned} \tag{2}$$

Where i indexes firm, t indexes year, and $\epsilon_{i,t}$ is the error term. Zombie is the measure of zombification risk. FCCE denotes the transcript-based proxy for overall climate change exposure. Additionally, we decompose FCCE into three distinct dimensions: PFCCE, which captures climate-related physical shocks; RFCCE, which reflects regulatory shocks

related to climate change ; and OFCCE, which captures opportunities related to climate change. Industry fixed effects are included to account for any time-invariant industry-specific shocks that might influence the probability of a firm turning into zombie. The probit model also includes country and year fixed effects to control for the time-variant heterogeneity among countries, such as macroeconomic conditions, which can simultaneously affect FCCE and financial distress.

The model includes a battery of controls that are more likely to be correlated with the zombification risk. The first group of control variables captures firm characteristics, including firm size (*Ln_MarketCapitalization*) and firm age (*Ln_age*). *Firm_size* is the natural logarithm of market capitalization, and *Ln_age* is the natural logarithm of the number of years since the firm was founded. We also control for financial performance as measured by the *ROE*. The third group of variables captures firm growth opportunities. *Market_to_book* is the market value of assets divided by the book value of assets, and *Sales_growth* is the growth rate of sales revenue. Furthermore, we control for asset tangibility and *PPE* as measured by net property, plant, and equipment divided by total assets. Finally, we employ several financial and operating risk proxies. In particular, *Leverage* is total debt divided by total assets, *Debt_issue* represents the growth of total liabilities, and *Cash_Flow* is the sum of cash income before extraordinary items, plus depreciation and amortization, minus common dividends, over total assets. All variables are winsorized at the 1st and 99th percentiles to mitigate the effects of outliers and mean-centered to reduce multicollinearity issues.To address potential heteroscedasticity and autocorrelation of errors, we cluster standard errors at the firm level, ensuring more reliable inference.

3.5 Descriptive Statistics

Table 2 presents the descriptive statistics. The mean value of FCCE is $1.15e^{-3}$. The average age is about 38 years. The ROE stands at -5.46, highlighting potential profitability issues within the sample. The market-to-book ratio average is 2.75, and the sales growth rate average is 23.7%. The average leverage ratio is 25.3%, indicating the level of financial risk. Furthermore, the growth rate of total liabilities is 165.1% on average, suggesting a significant variation in firms' financial obligations. Finally, cash flows represent 25.8% of total assets on average. The sample distribution by country and by industry is reported in Panel A and Panel B of Table 3, respectively. As can be noticed, our sample is dominated by the United States (66.26%) and the technology industry (23.76%).

4 Empirical Results

4.1 Baseline Estimation Results

Table 4 reports the regression results of Equation (2). In column (1), The coefficient on FCCE is positive and statistically significant at the 1% level, suggesting a positive effect of FCCE on zombification risk, confirming H1.Columns (3) to (5) present the results for the three types of FCCE. The coefficient on PFCCE is positive and significant at the 5% level, indicating that firms frequently exposed to discussions about climate-related physical shocks face a higher probability of zombification. This suggests that firms struggling with climate-related disruptions may experience financial distress, leading to a greater risk of zombification. The coefficient on RFCCE is negative but not statistically significant, implying that climate-related regulatory exposure does not have a clear impact on zombification risk. This may suggest that firms adjust more effectively to climate policies compared to physical threats. The coefficient on OFCCE is positive and highly significant at the 1% level, suggesting that firms that frequently discuss climate-related business opportunities are more likely to become zombies. This could reflect overinvestment in green initiatives or a tendency to shift focus towards environmental strategies at the expense of core operations.

For the control variables, the coefficients on $Firm_Size$ and ROE are negative, suggesting that smaller firms exhibit a poor performance and have a higher risk of zombification. Both $Cash_Flow$ and $sales_growth$ are negatively associated with the zombification risk. The regression results further suggest that firms with a higher level of financial leverage are more likely to become zombies.

4.2 Diffrences-in-diffrences in FCCE and zombification risk: the 2015 Paris agreement

Although our findings indicate a positive relationship between FCCE and zombification risk, this relationship might not be causal due to endogeneity concerns. These concerns stem from the fact that firms do not randomly choose their locations and operational strategies, and there may be unobserved factors that simultaneously influence both their exposure to climate change and their access to financing tools.To address potential endogeneity concerns, we perform a difference-in-differences approach, leveraging the 2015 Paris Agreement as an exogenous shock.The following research design is used to test this prediction:

$$\begin{aligned}\Pr(\text{ZOMBIE}_{i,t}=1) =&\beta_1 \cdot \text{DiD}_{i,t} + \beta_2 \cdot \text{Treatment}_i + \gamma \cdot \text{Controls}_{i,t} + \text{Ind FEs} \\ &\text{Country FEs} + \text{Year FEs} + \varepsilon_{i,t}\end{aligned}$$

Where DiD is the diffrence-in-diffrences interaction term defined as Tretament*Post. Post is an indicator variable that is equal to one for the period sincr 2015, and zero otherwise. Following Ginglinger and Moreau (2021), Treatment is a dummy variable equal to 1 if the climate risk indicator is above the 60th percentile and 0 if the climate risk indicator is below the 40th percentile.Table 6 reports the empirical results. The coefficient on DiD is negative and significant at the 5% level, suggesting that FCCE has a less pronounced effect on the zombification risk during the period following the Paris Agreement as the firm begins to pay particular attention to climate issues and adapt their business strategies in response.The result is consistent with theoretical assumptions and lends strong support to a causal interpretation of the main finding. To further validate the DiD approach, we tested the parallel trends assumption[1].

4.3 Further analyses: Does managerial issue interpretation matter?

The first results support a positive relationship between FCCE and zombification risk. In this section, we further examine whether the managerial interpretation of FCCE (perception of an opportunity or a threat) plays a role in this relationship.

The following probit models are estimated to test H2:

$$\Pr(\text{ZOMBIE}_{i,t} = 1) = \Phi\beta_2 \cdot (\text{FCCE}_{i,t-1} \times \text{CCPP}_{i,t-1}) + \delta \cdot \text{Controls}_{i,t-1} + \text{Ind FEs} + \text{Country FEsYear FEs} + \varepsilon_{i,t} \tag{3}$$

$$\Pr(\text{ZOMBIE}_{i,t} = 1) = \Phi\beta_2 \cdot (\text{FCCE}_{i,t-1} \times \text{CCNP}_{i,t-1}) + \delta \cdot \text{Controls}_{i,t-1} + \text{Ind FEs} + \text{Country FEs} + \text{Year FEs} + \varepsilon_{i,t} \tag{4}$$

The results of models (3) and (4) are reported respectively in column(1) and (2) of Table 6. We observe that the direct relationship between FCCE and zombification risk has disappeared. The coefficient of the direct effect of CCPP on zombification risk is negative and significant at 5% level .However the coefficient of the interaction term between FCCE and CCPP is positive and significant at the 1% level. The coefficient of the direct effect of CCNP on zombification risk is positive and significant at 5% level. However, the coefficient of the interaction term between FCCE and CCNP is negative and significant at the 1% level.

[1]For brevity concerns, results of the parallel trends test are available upon request.

The findings reveal both direct and interaction effects on zombification risk. Directly, CCPP has a negative effect, reducing zombification risk, while CCNP has a positive effect, increasing it. However, the interaction effects suggest a more nuanced relationship. The interaction term FCCE × CCPP has a positive effect on zombification risk, whereas FCCE × CCNP has a negative effect. This reversal in signs indicates that the impact of managerial perception depends on the intensity of FCCE. When FCCE levels are low, the direct effects dominate: CCPP lowers zombification risk, while a negative perception CCNP increases it. However, as FCCE intensifies, the interaction effects become more pronounced, altering the initial relationships. Specifically, CCPP amplifies the effect of FCCE on zombification risk, whereas CCNP mitigates it. This suggests that managerial interpretation of climate change exposure plays a dynamic role, shifting in influence depending on the degree of firm-level exposure.Thus, confirming H2.

4.4 Sensitivity analysis

To ensure the robustness of our findings, we employ a battery of sensitivity tests. These additional checks are designed to verify that our results remain consistent across different model specifications and sample selections, thereby strengthening the validity of our conclusions. The regression results are presented in Table 7.

In models (1) and (2) of Table 7, we test alternative definitions of zombie firms. Specifically, we extend the age threshold to 15 years instead of 10 years and use persistence measures based on 5 years instead of 3 years for ICR. In model (3), we address missing values in our dependent variable, ZOMBIE, by replacing them with 0. In model (4), following prior literature (Brockman et al., 2009; Ng, 2011), we include additional control variables such as CFO, Loss, Total_Assets, Div_Cash, and R&D.

Overall, the results remain consistent with our previous findings, confirming that the effect of managerial interpretation of FCCE on zombification risk is robust across various model specifications.

4.5 Evidence from sample splits

After establishing a significant relationship between managerial interpretation of FCCE and zombification risk, we examine the role of the underlying economic mechanisms as follows.

4.5.1 Environmental capabilities channel

To investigate this channel, we employ five common proxies that capture environmental expenditures. These include the environmental performance score as well as the corresponding three category scores: resource use, emissions, and innovation performance.

Additionally, we use environmental expenditures, defined as the ratio of a firm's environmental expenditures to its total assets.

To examine whether the relationship between managerial interpretation of FCCE and zombification risk is stronger in firms with greater environmental performance, we divide our sample into high-level (above median) and low-level (below median) categories for all proxies. The results, presented in Table 8, reveal distinct patterns based on firm-specific environmental capabilities. For firms with higher environmental performance, the coefficients of positive managerial interpretations of FCCE are significantly positive, while those for negative managerial interpretations are significantly negative. This suggests that the direct effects of managerial perceptions on zombification risk are only significant in firms with strong environmental performance and in contexts of low FCCE exposure.

One possible explanation is that these firms already possess the necessary resources and capabilities to translate managerial perceptions into concrete actions. For instance, firms with high environmental performance can leverage CCPP to make strategic investments in sustainability, thereby reducing their zombification risk. On the other hand, CCNP in these firms may hinder such initiatives, making them more vulnerable by limiting their adaptability to climate risks. However, in firms with low environmental capabilities, these effects are not observed, suggesting that firms lacking environmental capacities struggle to translate managerial perceptions into meaningful strategic action.

When considering high FCCE exposure contexts, For firms with higher environmental capabilities, FCCE*CCPP is significantly positive, while FCCE*CCNP is significantly negative. The positive impact can be attributed to managerial overconfidence in the firm's ability to manage climate risks. In fact,firms with strong environmental capabilities, when highly exposed to climate change, this overambition often leads to poor risk management and excessive investment in environmental initiatives which can result in a misallocation of resources, diverting attention from core business operations and strategic investments, thereby increasing financial inefficiencies and exacerbating zombification risk.

In contrast, the negative association between negative managerial interpretation of FCCE and zombification risk highlights a more cautious approach. Firms with higher environmental capabilities already possess the systems and expertise to manage climate-related risks effectively. In this context, managers with a skeptical view of climate change tend to focus on leveraging existing capabilities rather than unnecessarily expanding environmental expenditures. Furthermore, such managers are more likely to align with shareholders who prioritize short-term financial performance over long-term environmental investments. This alignment minimizes shareholder conflicts over excessive spending, thereby promoting financial stability and reducing zombification risk.

Conversely, for firms in the low environmental capabilities subsample, the coefficients for both positive and negative managerial interpretations are not statistically significant across different levels of FCCE exposure .This indicates that managerial perceptions

of climate change have a weaker influence on zombification risk in firms with limited environmental capabilities.
In sum, our findings suggest that the impact of managerial interpretations of FCCE on zombification risk is stronger in firms with greater environmental capabilities, thereby supporting H3.

4.5.2 Firm visibility channel

Another possible channel through which managerial interpretation of climate change may influence the zombification risk is firm visibility. To test this hypothesis, we use four distinct proxies for firm visibility: stock turnover, analyst coverage, market capitalization, and the sustainability reporting score. The sample is divided into high-visibility (above median) and low-visibility (below median) groups based on these proxies. The results, presented in Table 9, show both direct and interaction effects on zombification risk. In highly visible firms, CCPP reduces zombification risk.This can be due to the fact that highly visible firms benefit more from their environmental efforts, as their sustainability initiatives strengthen their brand image, enhance investor confidence, and improve customer loyalty, all of which reduce their financial vulnerabilities and lower the likelihood of zombification. Conversely, CCNP increases zombification risk in highly visible firms. Visibility not only heightens expectations but also intensifies external pressure, meaning that firms failing to meet environmental standards are subject to greater criticism. Managers with a negative perception may respond with inaction or overly cautious strategies, fearing regulatory scrutiny and reputational damage. This hesitancy can lead to missed opportunities, loss of investor confidence, and stagnation, all of which exacerbate the firm's risk of zombification.
When considering high FCCE exposure contexts, the interaction effects become even more pronounced. In highly visible firms, FCCE $\times$ CCPP is significantly positive, meaning that strong climate exposure combined with a positive perception paradoxically increases zombification risk. The positive impact of CCPP in highly visible firms can be attributed to several interconnected factors. First, highly visible firms are subject to greater scrutiny from stakeholders, such as investors, customers, and regulators, and are often positioned as role models within their industries. Managers who perceive climate change as an opportunity may feel compelled to commit to ambitious environmental goals and high-profile environmental projects to meet or exceed stakeholder expectations and maintain their public image as market leaders. While this can enhance a firm's reputation in the short term, it may lead to over-investment in environmental initiatives that are not financially sustainable, straining financial resources and operational efficiency. Additionally, in highly visible firms, any perceived failure to meet environmental commitments or accusations of "greenwashing" can severely damage their reputation. Managers with a

positive managerial interpretation of climate change may take extreme measures to avoid such criticism, potentially engaging in defensive spending that exacerbates financial inefficiencies and increases the likelihood of zombification. In sum, positive managerial interpretations in high-visibility firms often result in overcommitment to environmental initiatives, resource misallocation, and overconfidence to gain public and market approval, collectively contributing to a higher likelihood of zombification.

Conversely, FCCE × CCNP is significantly negative, indicating that a negative perception, when coupled with high FCCE exposure, helps mitigate zombification risk in highly visible firms. This result can be explained through several mechanisms. Highly visible firms face greater public scrutiny, leading skeptical managers to prioritize profitability and core operations over expansive environmental commitments. Such managers often resist the temptation to over-commit to environmental goals, thereby avoiding excessive costs or risky investments that could destabilize the firm. Furthermore, managers with a negative managerial interpretation of climate change in highly visible firms may adopt a conservative approach to avoid reputational damage from over-promising on environmental performance. These cautious strategies help maintain financial stability and reduce zombification risk in highly visible firms.

In contrast, in the low-visibility subsample, the coefficients for both positive managerial interpretation and negative managerial interpretation are not statistically significant. These results support the prediction of H4, confirming that the relationship between managerial interpretation of FCCE and zombification risk is stronger in highly visible firms.

4.6 On the role of the country-level climate governance

In this section, we control for the role of country-level climate governance proxied as follows: environmental protection expenditures, environmental taxes, and climate change performance index (CCPI) retrieved respectively from the OECD database and CCPI website.

We divide our sample into high-level (above median) and low-level (below median) for these three proxies.We estimate the same model as in Equation (3) and (4) for the two subgroups and report the results in Table 10. In countries with better climate governance (higher environmental protection expenditures/ environmental taxes), the coefficients for positive managerial interpretation of FCCE are significantly positive, while those for negative managerial interpretation are significantly negative. Conversely, in the lower climate governance subsample (lower environmental protection expenditures/ environmental taxes), the coefficients for both positive and negative managerial interpretations are not statistically significant. Interestingly, when analyzing the CCPI, we find no vari-

ation in significance in either the high or low CCPI subgroups. This discrepancy suggests that while the CCPI provides a broad overview of a country's climate policy effectiveness and ambition, it may not capture the direct financial mechanisms or incentives that influence firm-level behavior. The results suggest that the institutional support shapes managerial efforts-whether proactive or defensive- via specific policy tools like environmental protection expenditures and environmental taxes that represent direct economic instruments,thus can immediately affect corporate behavior. The results support the prediction of H5, highlighting the role of the institutional context in moderating the relationship between managerial interpretation of climate change and zombification risk.

5 Conclusion

This study provides consistent evidence that mangerial interpretation of FCCE has a significant on the zombification risk, consistent with the managerial issue interpretation theory. Particularly, our results show that the zombification risk depends on whether managers perceive climate change as an opportunity or a threat.

Additional analyses shed light on the underlying mechanisms driving this relationship. We find that the impact of FCCE on the zombification risk is more pronounced in highly visible firms facing greater scrutiny from stakeholders. Similarly, firms with higher environmental capabilities appear to experience a stronger relationship, potentially because excessive environmental expenditures can strain financial resources, leading to inefficiencies in resource allocation and potential conflicts among shareholders regarding the prioritization of environmental initiatives over profitability. Moreover, our findings indicate that this relationship is amplified in countries with stringent climate governance frameworks, suggesting that external regulatory pressures can exacerbate the challenges firms are facing when they attempt to manage climate-related risks.

This study emphasizes the critical role of managerial perception in shaping how firms respond to climate change and manage corresponding risks. We also highlight the importance of external conditions, such as regulatory environments and societal expectations, in influencing the extent of zombification risk. Overall, our results call for a more nuanced understanding of the interplay between internal managerial environmental strategies and external pressures in mitigating the adverse effects of climate change exposure.

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Table 1: **Variables description**

Variable	Definition	variables description
Dependent variables		
ZOMBIE	Zombification risk	As defined by the OECD, equals 1 if the company is at least 10 years old and its interest expenses exceed operating income for 3 consecutive years; equals 0 otherwise.
Independent variables		
FCCE	Firm-level climate change exposure	Total number of climate change bigrams scaled by the total number of all bigrams in the quarterly earnings conference call transcript, multiplied by 1000. An annual transcript-based climate change exposure proxy is constructed by averaging the quarterly measures.
PFCCE	Physical climate change exposure	As developed by Sautner et al. (2023),counts the relative frequency with which bigrams that capture physical shocks related to climate change
RFCCE	Regulatory climate change exposure	As developed by Sautner et al. (2023),counts the relative frequency with which bigrams that capture regulatory shocks related to climate change
OFCCE	Opportunity climate change exposure	As developed by Sautner et al. (2023),counts the relative frequency with which bigrams that capture opportunity shocks related to climate change
CCPP	Climate change positive perception	As developed by Sautner et al. (2023), counts the relative frequency of climate change bigrams occurring near positive tone words (Loughran and McDonald, 2011).

Table 1: Variables description (continued)

Variable	Definition	variable description
CCNP	Climate change negative perception	As developed by Sautner et al. (2023), counts the relative frequency of climate change bigrams occurring near negative tone words (Loughran and McDonald, 2011).
Control variables		
Firmsize	Size proxy	Natural log of market capitalization.
ROE	Return on Equity	Net income divided by shareholder's equity.
Sales growth	Sales growth	(Sales in year t - Sales in year $t-1$) / Sales in year $t-1$.
PPE	Tangibility	Net property, plant, and equipment divided by total assets.
MTBVALUE	Market-to-book value	Market value of assets divided by book value of assets.
Lev	Leverage	Book value of debt divided by book value of assets.
Debt_issue	Debt issue	(Total liabilities in year t - Total liabilities in year $t-1$) / Total liabilities in year $t-1$.
Cash_Flow	Cash flow	(Sum of cash income before extraordinary items + depreciation and amortization - common dividends) / Total assets.
ln_Age	Age	Natural log of the number of years since the firm's foundation.
Other variables		
Innovation score	Environmental innovation score	Innovation score measured according to the Refinitiv database, expressed in percentages and standardized between 0 and 100%.
Resource use score	Resource use score	Resource use score measured according to the Refinitiv database, expressed in percentages and standardized between 0 and 100%.

Table 1: Variables description (continued)

Variable	Definition	variable description
Emissions score	Emissions score	Emissions score measured according to the Refinitiv database, expressed in percentages and standardized between 0 and 100%.
Environmental performance	Environmental performance	Total score on environmental performance, constructed based on resource use, emissions, and innovation indicators. Measured according to the Refinitiv database and standardized between 0 and 100%.
Environmental expenditures	Firm-level environmental expenditures	Environmental expenditures divided by total assets.
Trading volume	Trading volume	Refinitiv.
Analyst coverage	Number of analysts	Natural log of (number of analysts + 1).
Market capitalization	Market capitalization	Natural log of market capitalization.
Sustainability reporting score	Sustainability reporting score	Refinitiv.
Environmental protection expenditures	Country-level environmental protection expenditures	Data sourced from the OECD database.
Environmental taxes	Environmental taxes	Data sourced from the OECD database.
CCPI	Climate Change Performance Index	Data sourced from the CCPI website.

Table 2: **Summary statistics**

Variable	N	Min	Max	Mean	SD	p25	Median	p75
ZOMBIE	98,006	0	1.000	0.118	0.323	0	0	0
FCCE	79,770	0	$1.46e^{-2}$	$1.15e^{-3}$	$2.36e^{-3}$	$1.11e^{-4}$	$3.47e^{-4}$	$9.60e^{-4}$
PFCCE	79,770	0	$3.17e^{-4}$	$9.77e^{-6}$	$4.48e^{-5}$	0	0	
RFCCE	79,770	0	$1.24e^{-3}$	$5.53e^{-5}$	$1.87e^{-4}$	0	0	
OFCCE	79,770	0	$6.94e^{-3}$	$3.48e^{-4}$	$1.03e^{-3}$	0	0	
CCPP	79,770	0	$5.87e^{-3}$	0 $4.41e^{-4}$	$9.53e^{-4}$	0	$9.4e^{-5}$	$3.97e^{-4}$
CCNP	79,770	$-3.00e^{-3}$	0.000	$-2.05e^{-4}$	$4.63e^{-4}$	$-1.90e^{-4}$	0	0
Market-to-book ratio	138,340	-21.84	33.180	2.752	5.611	1.02	1.9	3.45
Firm_size	108,581	0	21.794	13.496	2.237	12.076	13.604	15.014
Ln_totalassets	118,926	6.787	18.413	13.396	2.338	11.897	13.541	15.006
Cash_Flow	116,400	-2.004	0.356	-0.026	0.317	-0.007	0.055	0.098
PPE	119,362	0.001	0.913	0.271	0.248	0.068	0.186	0.416
Sales_Growth	110,142	-0.975	7.534	0.237	0.956	-0.04	0.076	0.235
ROE	108,427	-404.53	121.940	-5.46	62.757	-6.48	7.92	16.92
Debt_Issue	110,634	-1	14,728.500	1.652	72.908	-0.094	0.077	0.312
Leverage	118,264	0	1.400	0.253	0.250	0.039	0.213	0.374
Ln_age	163,985	0	4.812	3.638	0.947	3.091	3.761	4.466

This table reports the descriptive statistics of all the variables under analysis. In addition to the mean and median controlling for the distribution's central tendency, this table reports the minimum, maximum, standard deviation, 25th percentile, and 75th percentile. All variables are defined in Table 1. The sample spans from 2002 to 2022.

Table 3: **Sample distribution**

Panel A. Sample distribution by country

Country	Frequency	Percent	Cumulative
Australia	7329	3.80	3.80
Austria	525	0.27	4.07
Belgium	735	0.38	4.45
Canada	14763	7.65	12.10
Chile	504	0.26	12.37
Colombia	231	0.12	12.49
Denmark	966	0.50	12.99
Estonia	21	0.01	13.00
Finland	1218	0.63	13.63
France	2835	1.47	15.10
Germany	4914	2.55	17.64
Greece	294	0.15	17.80
Hungary	63	0.03	17.83
Iceland	63	0.03	17.86
Ireland	819	0.42	18.28
Israel	441	0.23	18.51
Italy	2175	1.13	19.64
Japan	16141	8.36	28.00
Lithuania	42	0.02	28.02
Luxembourg	63	0.03	28.05
Mexico	231	0.12	28.17
Netherlands	1455	0.75	28.92
New Zealand	525	0.27	29.19
Norway	819	0.42	29.61
Peru	42	0.02	29.63
Poland	105	0.05	29.68
Portugal	315	0.16	29.84
Singapore	567	0.29	30.13
South Africa	1071	0.55	30.68
South Korea	10374	5.37	36.05
Spain	1827	0.95	36.99
Sweden	3255	1.69	38.68
Switzerland	2058	1.06	39.74
Taiwan	3360	1.74	41.48
Turkey	168	0.09	41.57
United Kingdom	9435	4.89	46.46
United States	127827	66.26	100.00

Panel B. Sample distribution by industry

Sector Name	Frequency	Percent	Cumulative
Academic Educational Services	945	0.52	0.52
Basic Materials	14364	7.88	8.40
Consumer Cyclicals	31164	17.10	25.50
Consumer Non-Cyclicals	11214	6.15	31.65
Energy	16023	8.79	40.45
Financials	96415	57.41	57.41
Healthcare	30911	16.96	57.41
Industrials	29169	16.01	73.42
Technology	43303	23.76	97.18
Telecommunication Services	21	0.01	97.19
Utilities	5124	2.81	100.00

Table 4: **Correlation matrix**

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
(1) ZOMBIE	1.000										
(2) FCCE	-0.021*	1.000									
	(0.000)										
(3) ROE	-0.398*	0.016*	1.000								
	(0.000)	(0.000)									
(4) CASH_FLOW	-0.351*	0.008	0.722*	1.000							
	(0.000)	(0.023)	(0.000)								
(5) SALES_GROWTH	0.076*	0.002	-0.137*	-0.194*	1.000						
	(0.000)	(0.596)	(0.000)	(0.000)							
(6) PPE	-0.072*	0.217*	0.081*	0.147*	-0.031*	1.000					
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)						
(7) DEBT_ISSUE	-0.002	0.003	-0.004	-0.009*	0.029*	0.001	1.000				
	(0.586)	(0.381)	(0.165)	(0.005)	(0.000)	(0.755)					
(8) LEV	0.109*	0.061*	-0.063*	-0.155*	-0.024*	0.232*	0.003	1.000			
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.348)				
(9) ln_age	-0.119*	0.104*	0.193*	0.209*	-0.159*	0.060*	-0.016*	0.069*	1.000		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)			
(10) FIRMSIZE	-0.298*	0.086*	0.345*	0.388*	-0.106*	0.120*	-0.004	0.021*	0.336*	1.000	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.153)	(0.000)	(0.000)		
(11) MTBVALUE	0.017*	-0.044*	-0.008	0.004	0.019*	-0.099*	-0.007	-0.121*	-0.053*	0.105*	1.000
	(0.000)	(0.000)	(0.012)	(0.236)	(0.000)	(0.000)	(0.030)	(0.000)	(0.000)	(0.000)	

This table reports pairwise relationships between our variables of interest during the 2002-2022 period. All variables are defined in Table 1. ***, ** and * denote statistical significance at the 1, 5, and 10% levels, respectively.

Table 5: **Firm-level climate change exposure and zombification risk: Baseline results**

	(1)	(2)	(3)	(4)
	ZOMBIE			
FCCE	0.043**			
	(2.23)			
PFCCE		0.023**		
		(1.98)		
RFCCE			-0.022	
			(-1.43)	
OFCCE				0.054***
				(3.17)
MTBValue	0.015***	0.015***	0.015***	0.015***
	(4.92)	(4.91)	(4.87)	(4.91)
LEV	0.330***	0.323***	0.319***	0.332***
	(3.82)	(3.74)	(3.70)	(3.85)
PPE	0.054	0.048	0.050	0.058
	(0.64)	(0.56)	(0.59)	(0.68)
Cash_Flow	-1.090***	-1.096***	-1.099***	-1.088***
	(-8.11)	(-8.15)	(-8.16)	(-8.10)
Sales_Growth	-0.035*	-0.035*	-0.034*	-0.035*
	(-1.71)	(-1.69)	(-1.65)	(-1.70)
ln_age	-0.252***	-0.252***	-0.251***	-0.252***
	(-9.83)	(-9.80)	(-9.78)	(-9.85)
ROE	-0.006***	-0.006***	-0.006***	-0.006***
	(-15.87)	(-15.87)	(-15.87)	(-15.88)
Firmsize	-0.189***	-0.190***	-0.189***	-0.189***
	(-19.33)	(-19.34)	(-19.29)	(-19.33)
Debt_Issue	-0.008*	-0.008*	-0.008*	-0.008*
	(-1.86)	(-1.89)	(-1.91)	(-1.84)
constant	-1.046***	-1.043***	-1.042***	-1.046***
	(-6.07)	(-6.05)	(-6.05)	(-6.07)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Observations (N)	46,825	46,825	46,825	46,825
Adj. R^2	0.3422	0.3421	0.3420	0.3420

This table presents the relationship between FCCE and zombification risk. The dependent variable is a binary indicator equal to 1 if a firm is classified as a zombie and 0 otherwise. The key independent variable, FCCE, measures climate change exposure as the relative frequency of climate-related bigrams in quarterly earnings call transcripts, scaled by total bigrams and multiplied by 1000. We also examine three types of exposure: physical (bigrams related to climate shocks), regulatory (bigrams capturing climate-related regulations), and opportunity (bigrams reflecting potential climate-driven business opportunities). Fixed effects for year, country, and industry are included. T-statistics, based on clustered robust standard errors, are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Variable definitions and data sources are in Table 1

Table 6: **Difference-in-differences in zombification risk around the 2015 Paris Agreement**

	ZOMBIE
	(1)
Treatment × Post (DiD)	-0.093**
	(2.11)
Treatment_Group	-0.009
	(0.30)
Observations	48,625
Pseudo R^2	0.3401
Controls	Yes
Year FE	Yes
Industry FE	Yes
Country FE	Yes

The table reports the result from a probit regression in which the dependent variable is *ZOMBIE*. DiD is the interaction term between Treatment_Group and Post. Robust standard errors are used. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. z-statistics in parentheses.

Table 7: **FCCE and zombification risk: Does managerial issue interpretation matter?**

	ZOMBIE	
	(1)	(2)
FCCE*CCPP	0.020***	
	(3.93)	
FCCE*CCNP		-0.020***
		(6.95)
CCPP	-0.049**	
	(-2.27)	
CCNP		0.039**
		(2.12)
FCCE	0.016	0.011
	(0.7)	(0.62)
Controls	Yes	Yes
Year FE	Yes	Yes
Industry FE	Yes	Yes
Country FE	Yes	Yes
Number of Obs	48,625	48,625
Pseudo. R^2	0.3401	0.3401

In this table, we investigate the relationship between the managerial interpretation of FCCE and zombification risk. The dependent variable is a dummy variable that equals 1 if the firm is classified as a zombie and 0 otherwise. The first independent variable, FCCE, is defined as the total number of climate change bigrams scaled by the total number of all bigrams in quarterly earnings conference call transcripts, multiplied by 1000. Positive managerial interpretation of FCCE (FCCE× CCPP), developed by Sautner et al. (2023), measures the relative frequency of climate change bigrams occurring near positive tone words, as defined by Loughran and McDonald (2011). Negative managerial interpretation of FCCE (FCCE×CCNP) measures the relative frequency of climate change bigrams occurring near negative tone words, as defined by Loughran and McDonald (2011).Year, country, and industry fixed effects are included in the regressions. T-statistics, computed using clustered robust standard errors, are reported in parentheses. Significance levels are denoted by *, **, and ***, corresponding to the 10%, 5%, and 1% levels, respectively. Variable definitions and data sources are provided in Table 1.

Table 8: **Sensitivity analysis**

		ZOMBIE		
		Coeff.	Pseudo R^2	N
(1) Change in time window of ICR	FCCE	0.052*	0.3266	43,029
	FCCE*CCPP	0.023***		
	FCCE*CCNP	-0.023***		
(2) Change of Age threshold	FCCE	0.006	0.2883	46,825
	FCCE*CCPP	0.020***		
	FCCE*CCNP	-0.020***		
(3) Replacing missing values by 0	FCCE	0.008	0.2858	52,487
	FCCE*CCPP	0.022***		
	FCCE*CCNP	-0.022***		
(4) Other Controls	FCCE	0.015	0.5073	46,741
	FCCE*CCPP	0.021***		
	FCCE*CCNP	-0.020***		
Controls		Yes		
Year FE		Yes		
Industry FE		Yes		
Country FE		Yes		

This table reports the results of several robustness tests. For brevity, the table reports only the coefficients on the 3 independent variables, FCCE, FCCE*CCPP and FCCE*CCNP. In models (1) and (2), we test alternative definitions of the zombification risk. Specifically, we extend the age threshold to 15 years instead of 10 years and use persistence measures based on 5 years instead of 3 years for ICR. In model (3), we address missing values in the dependent variable by replacing them with 0. In model (4), following prior literature (Brockman et al., 2009; Ng, 2011), we include additional control variables such as CFO, Loss, Total Assets, Div Cash, and R&D. Year, country and industry fixed effects are included. T-statistics computed using standard errors robust to heteroscedasticity are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Variable definitions and data sources are in Table 1.

Table 9: **Environmental capabilities channel**

	Environmental Innovation Score				Ressource-use Score				Emission Score				Environmental Pillar Score				Environmental Expenditures			
	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
FCCE	0.015	-0.006	0.002	0.059	0.014	0.022	0.021	-0.021	0.012	0.033	0.009	0.022	0.017	0.012	0.011	0.022	0.022	-0.354*	0.018	-0.301*
	(0.45)	(-0.08)	(0.06)	(1.07)	(0.57)	(0.42)	(1.05)	(-0.47)	(0.47)	(0.65)	(0.45)	(0.48)	(0.67)	(0.24)	(0.56)	(0.52)	(0.65)	(-1.86)	(0.75)	(-1.91)
CCPP	-0.052*	-0.003			-0.053**	-0.022			-0.055**	-0.010			-0.056**	-0.009			-0.052**	0.120		
	(-1.84)	(-0.04)			(-2.28)	(-0.37)			(-2.32)	(-0.19)			(-2.37)	(-0.16)			(-1.82)	(0.59)		
CCNP			0.032	0.103			0.058***	-0.034			0.040**	0.043			0.044**	0.037			0.046**	-0.172
			(1.39)	(1.59)			(2.85)	(-0.67)			(2.00)	(0.84)			(2.18)	(0.74)			(2.02)	(-1.10)
FCCE × CCPP	0.021***	0.016			0.025***	0.000			0.024***	0.001			0.023***	0.008			0.021***	-0.034		
	(2.83)	(0.97)			(4.41)	(0.01)			(4.25)	(0.09)			(4.08)	(0.64)			(2.83)	(-0.74)		
FCCE × CCNP			-0.022***	-0.020			-0.025***	-0.000			-0.023***	-0.012			-0.023***	-0.012			-0.021***	0.081*
			(-3.26)	(-1.25)			(-4.55)	(-0.00)			(-4.04)	(-1.01)			(-4.12)	(-1.02)			(-3.43)	(1.76)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	40,289	6,113	40,289	6,113	36,052	10,562	36,052	10,562	35,965	10,419	35,965	10,419	35,315	11,285	35,315	11,285	46,825	18,988	44,810	1,219
Pseudo R^2	0.3295	0.3596	0.3295	0.3601	0.3373	0.4226	0.3373	0.4259	0.3365	0.4052	0.3365	0.4052	0.3402	0.4118	0.3402	0.4118	0.3373	0.4226	0.3373	0.4259

This table examines the role of a environmental capabilities, as proxied by the environmental performance score and the corresponding three category scores - resource use, emissions, and innovation performance — as well as environmental expenditures. Our analysis tests the relevance of managerial interpretation of FCCE for the zombification risk for companies with high vs. low environmental capabilities. Environmental performance scores are sourced from the Refinitiv database, while environmental expenditures are calculated as the ratio of a firm's environmental expenditures to total assets. Our dependent variable takes 1 if the firm is a zombie and 0, otherwise. Our models include year, country, and industry fixed effects. T-statistics, computed using robust standard errors to account for heteroskedasticity, are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Variable definitions and data sources are detailed in Table 1.

Table 10: **Firm visibility channel**

	Trading Volume				Analyst Coverage				Market Capitalization				Sustainability Reporting Score			
	High	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**
FCCE	0.043	-0.026	0.031	-0.015	0.040	-0.022	0.021	0.002	0.065	-0.009	0.009	0.034	0.020	0.038	0.021	-0.017
	(1.06)	(-0.60)	(1.03)	(-0.46)	(1.08)	(-0.47)	(0.75)	(0.05)	(1.48)	(-0.22)	(0.27)	(1.11)	(0.58)	(0.53)	(0.81)	(-0.29)
CCPP	-0.080**	-0.000			-0.086**	0.018			-0.117***	-0.000			-0.064**	0.100		
	(-2.21)	(-0.01)			(-2.52)	(0.42)			(-2.97)	(-0.01)			(-2.30)	(1.28)		
CCNP			0.048*	0.024			0.061**	0.000			0.043	0.038			0.054**	-0.107**
			(1.73)	(0.77)			(2.25)	(0.01)			(1.32)	(1.33)			(2.24)	(-2.02)
FCCE × CCPP	0.025***	0.011			0.024***	0.010			0.026***	0.014			0.025***	-0.026		
	(2.91)	(1.04)			(2.89)	(0.90)			(2.89)	(1.48)			(3.26)	(-1.23)		
FCCE × CCNP			-0.021***	-0.016			-0.024***	-0.009			-0.025***	-0.012			-0.023***	-0.010
			(-2.80)	(-1.57)			(-3.42)	(-0.93)			(-2.96)	(-1.49)			(-3.38)	(0.68)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	31,685	19,988	31,685	19,988	27,511	14,908	27,511	14,908	27,511	19,988	27,511	19,988	39,994	6,156	39,994	6,156
Pseudo R^2	0.2450	0.2210	0.2450	0.2210	0.3120	0.1980	0.3120	0.1980	0.2870	0.1990	0.2870	0.1990	0.3360	0.1760	0.3360	0.1760

This table examines the role of firm visibility, as proxied by the stock turnover, the number of analysts and market capitalization as well as the sustainability reporting score. Our analysis tests the relevance of managerial interpretation of FCCE for the risk of zombification for companies with high and low visibility separately. All the proxies used are obtained from the Refinitiv database. Our dependent variable takes 1 if the firm is a zombie and 0, otherwise. Our models include year, country and industry fixed effects. T-statistics, computed using robust standard errors to account for heteroskedasticity, are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Variable definitions and data sources are detailed in Table 1.

Table 11: **The role of country-level climate governance**

	Environmental Protection Expenditures				**Environmental Taxes**				**CCPI**			
	High	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**
FCCE	0.020	0.015	0.013	0.018	0.025	0.016	0.002	0.024	0.039	-0.013	0.044	-0.016
	(0.56)	(0.21)	(0.51)	(0.28)	(0.65)	(0.37)	(0.05)	(0.73)	(1.00)	(-0.28)	(1.41)	(-0.46)
CCPP	-0.050*	-0.042			-0.070*	-0.028			-0.011	-0.086**		
	(-1.66)	(-0.62)			(-1.94)	(-0.77)			(-0.31)	(-2.26)		
CCNP			0.045*	-0.015			0.016	0.056*			0.002	0.094***
			(1.87)	(-0.24)			(0.53)	(1.91)			(0.08)	(2.81)
FCCE × CCPP	0.021***	0.008			0.028***	0.010			0.015	0.025**		
	(2.67)	(0.37)			(3.23)	(1.12)			(2.18)	(3.12)		
FCCE × CCNP			-0.023***	0.012			-0.024***	-0.015**			-0.012	-0.028***
			(-3.41)	(0.61)			(-3.12)	(-1.78)			(-1.56)	(-2.88)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs	38,820	7,848	38,820	7,848	23,189	23,419	23,189	23,419	26,332	20,308	26,332	20,308
Pseudo R^2	0.3401	0.3058	0.3401	0.3058	0.3205	0.3189	0.3205	0.3189	0.2987	0.2742	0.2987	0.2742

This table investigates the role of country-level climate governance, proxied by environmental protection expenditures, environmental taxes, and the climate change performance index (CCPI). Our analysis compares companies operating in countries with high vs. low climate governance. Data on environmental protection expenditures and environmental taxes are obatained from the OECD database, while CCPI data is obtained from the CCPI website. The dependent variable equals 1 if the firm is classified as a zombie and 0 otherwise. Our models account for year, country, and industry fixed effects . T-statistics, computed using robust standard errors to account for heteroskedasticity, are presented in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Variable definitions and data sources are provided in Table 1.