Firm-Level Climate Risk Exposure and Earnings Management

Abstract

We explore the influence of firm-level climate risk exposure on both accrual-based and real earnings management with a sample of 10,197 US firm-year observations between 2003 and 2018. We use a firm-level climate risk measure recently developed by Sautner et al. (2020) and find that firm-level climate risk exposure is positively related with earnings management. We also show that the positive association between firm-level climate exposure and earnings management is more pronounced for firms belonging to climate-sensitive industries. In additional analyses, we use an international sample (3,598 firm-year observations) from 21 countries outside the US to investigate the incremental effect of firm-level *versus* country-level climate change exposures on earnings management. Our findings show that climate change exposure at the firm level, rather than at the country-level, is the greatest driving factor of corporate accounting choices. Furthermore, we document a moderating effect of the Paris Climate Agreement on the association between firm-level climate risk exposure and earnings management, only in jurisdictions outside the US.

Keywords: Climate risk; Earnings management; Paris Climate Agreement

1 Introduction

Following the Paris Climate Agreement adopted in 2015 to limit global warming to 1.5 degrees Celsius, climate change has become a critical concern for both businesses, governments and civil society. Climate Change expose corporation to both physical and transition risks. Physical risks result from extreme meteorological events, such as hurricanes, wildfires, storms, and floods, while transition risks arise from the transition to a low-carbon economy and consist mostly of reputational, regulatory and technology-related risks.

Both types of climate-related risks to which firms are exposed may have a variety of potential financial impacts, such as asset impairment, including goodwill, increased expenses due to higher operating costs related to energy or decreased demand for products whose carbon footprint is considered too high by consumers (CSA, 2019; IFRS, 2020). Li et al. (2019) contend that climate risk recognition in financial statements is expected to significantly affect reported earnings. Huang et al. (2018) find that climate risk at the country-level is negatively associated with reported earnings and firm performance and positively associated with earnings volatility. Further, climate risks can negatively affect firms' cost of capital (Javadi and Masum, 2021; Seltzer et al., 2022). Given all these consequences. managers may have incentives to mitigate the negative influence of climate risks on corporate outcomes. Consistent with this, Ding et al. (2021) document that firms operating in countries highly exposed to climate risks are more likely to manipulate reported earnings than their counterparts from countries less exposed to climate-related risks.

In this study, we investigate whether firm-level climate risk exposure is positively associated with earnings manipulation. Given that investors state that climate-related risks are important for their decision making (Ilhan et al., 2022; Krueger et al., 2020), managers of those

firms exposed to a high degree of climate risks could have a greater incentive to enhance reported earnings to alleviate the negative financial impact of these risks. Following Ding et al. (2021), we conjecture that high climate risk exposure will likely result in more earnings manipulation. However, while Ding et al. (2021) examine exposure to climate risk at the country level, we focus in this study on firm-level climate risk exposure. We may expect that corporate exposure to the financial impacts of climate related risks may differ among firms within the same country depending on their mitigation and adaptation strategies. We rely on a novel measure recently developed by Sautner et al. (2020) which captures firm-level exposure to climate risks from earnings conference calls. We also rely on two measures of earnings manipulation based on both accruals and real earnings management. In addition, we investigate the potential moderator effect of the Paris Climate Agreement. We argue that regulatory shock may increase investors attention to the financial impacts of climate risks which may affect managers' willingness to manipulate reported earnings in response to their firms' exposure to climate risks.

Based on a sample of US firms over the period 2003-2018 (10,197 firm-year observations), we find evidence that firm-level climate exposure plays a significant role in earnings management. Among the two climate risk categories, we find that firm-level exposure to regulatory risks is positively related to accrual-based and real earnings management. Contrary to our expectation, we do not find any significant effect of the Paris climate agreement on the association between climate risks and earnings management. Additional results show that the association between climate risk at the firm-level and earnings management is strengthened for firms operating in climate-sensitive industries compared to those in non-climate sensitive industries..

Given that Ding et al. (2021) documented a significant association between country-level climate exposure and earnings management, we also investigate the incremental effect of firm-level *versus* climate-level climate exposures on earnings management by using an international sample (3,598 firm-year observations) from 21 countries outside the US during the period 2003-2018. Following Ding et al. (2021) and Huang et al. (2018), we use the Global Climate Risk Index (CRI), which is published by *GermanWatch* and captures the level of influence of climate-related disasters in various countries, to proxy for country-level climate exposure.

Our additional results obtained with the international sample not only confirm the main effect of firm-level climate exposure on earnings management but also show that its influence is much higher than that of country-level climate exposure. Once we account for climate change exposure at the firm level, country-level exposure does not influence the firm's propensity to engage in earnings management. Finally, we find a moderating role of the Paris Climate Agreement in jurisdictions outside the US. Managers' willingness to manipulate reported earnings when their firms are exposed to climate risks is weaker in the aftermath of the adoption of global climate accords in 2015.

This study contributes to the literature in several ways. First, we extend prior studies linking climate risk exposure with firms' corporate outcomes (e.g., Ding et al., 2021; Huang et al., 2018; Javadi and Masum, 2021; Seltzer et al., 2022). More specifically, we document a positive impact of firm-level climate exposure on earnings management and show that firm-level climate exposure is a more significant driving factor of firms' accounting choices than is country-level climate exposure. Furthermore, we show that the Paris Agreement plays a moderating role outside the US and reduces managers' incentives to manipulate earnings when firms are exposed to climate risks.

Second, we contribute to the extant literature by using Sautner et al.'s (2020) novel measure as a proxy of a firm's exposure to climate risks, a measure that differs from those used in previous studies. Indeed, measuring a firm's exposure to climate change is particularly challenging. At the country level, prior studies used the CRI published by *GermanWatch* (Ding et al., 2021; Huang et al., 2018),[1] while at the firm level, they relied on those environmental performance metrics (*e.g.*, carbon emissions) voluntarily disclosed via the Carbon Disclosure Project (CDP) or Global Reporting Initiatives (GRIs) (Matsumura et al., 2014; Saka and Oshika, 2014) or on ratings provided by KLD Research & Analytics (Matsumura et al., 2014).[2] However, Sautner et al. (2020) argue that the external validity of the use of carbon emissions data as a proxy for climate change risks is questionable. First, carbon emissions data are available only for a limited number of firms, increasing the amount of potential bias resulting from the use of a nonrandom sample (Sautner et al., 2020). Second, the use of carbon emissions reflects mainly the historic business model of firms, which is likely to omit some relevant aspects of climate change exposure (Sautner et al., 2020). For these reasons, we use Sautner et al.'s (2020) measure to proxy for firm-level exposure to climate risks.

Finally, our study may have important policy implications and echoes the recent regulatory initiatives that highlight the growing attention being paid by regulators to the

[1] This index captures the extent to which countries have suffered loss associated with extreme weather-related events and indicates the severity of the climate risk that will be faced by a country in the future.

[2] KLD attributes a score based on several dimensions of a firm's proactive (or damaging) activity, such as recycling, using clean energy or violating environmental regulations.

disclosure related to climate change issues. For instance, in 2021, the UK decided to make climate risk reporting that aligns with the standards set forth by the Task Force on Climate-Related Financial Disclosures (TCFD) mandatory for listed companies. The US and Canada have also issued disclosure proposals requiring listed firms to report climate information in line with TCFD (2017) recommendations. In March 2022, the International Sustainability Standard Board (ISSB) issued a draft of a climate-related disclosure standard, International Financial Reporting Standards (IFRS) S2. Finally, since our results show that firms exposed to climate risks are likely to engage in earnings manipulation, we expect making climate reporting mandatory to mitigate the willingness of managers to manipulate reported earnings.

The remainder of this paper is organized as follows. Section 2 examines the relevant literature and develops the hypotheses. In Section 3, the research methodology is described. In Section 4, the empirical results are presented and discussed. Finally, Section 5 concludes the paper.

2 Literature review and hypothesis development

2.1 Climate risk and earnings management

Climate-related risks, including both physical and transition risks, have been found to be recognized by businesses as one of their most material issues (KPMG, 2017). Such risks can have severe negative financial implications for firms (CSA, 2019; IFRS, 2020). For example, Huang et al. (2018) found the likelihood of loss from major weather events to be associated with lower and more volatile earnings and cash flows. In addition, climate risks can affect firms' cost of capital, as Javadi and Masum (2021) found evidence that firms in locations with higher

exposure to climate change pay significantly higher spreads on their bank loans than do other firms. Similarly, Seltzer et al. (2022) showed that firms with poor environmental profiles or high carbon footprints tend to have lower credit ratings. Furthermore, according to Capasso et al. (2020), firms with a high carbon footprint are perceived by the market as being more likely to default.

Given the potential financial impact of climate risks, managers can aim to adopt different financial reporting strategies to change firms' performance perception of outsiders. However, at this stage, studies linking climate risks and financial reporting choices remain relatively rare. Some of such studies examined firms' earnings management in response to increasing political costs due to major weather events. For example, Byard et al. (2007) examined earnings management carried out by US-based oil companies after the impact of Hurricanes Katrina and Rita, showing that large petroleum refining firms managed their earnings through income-decreasing accruals in the fiscal quarter immediately after the impact of these hurricanes (Q4 of 2005). Similarly, Yang and Tang (2022) found that firms that pollute the air engage in income-decreasing earnings management in response to the political costs induced by air pollution.

While these previous studies documented that firms have a greater incentive to manage earnings downward in reaction to political cost pressures, Ding et al. (2021) investigated the attempts of managers to enhance reported earnings and moderate the negative effects of climate risk exposure on firms' performance. Given that investors state that climate-related risks are important for their decision making (Ilhan et al., 2022; Krueger et al., 2020), the managers of those firms exposed to a high degree of climate risk could have a greater incentive to enhance reported earnings to improve the image of their performance. Moreover, Ding et al. (2021) found

that climate risk exacerbates firms' motivation to accounting manipulation measured both by accruals-based and real earnings management.

Therefore, in the present study, to the extent that investors perceive climate change as a relevant risk factor, we hypothesize that managers are likely to manage earnings when their firms are exposed to climate risk. Thus, Hypothesis H1 is as follows:

H1: Firm-level climate risk exposure is positively associated with earnings management.

2.2 Moderating role of the Paris Climate Agreement

Following Ginglinger and Moreau (2019), Capasso et al. (2020), and Seltzer et al. (2022), we consider the Paris Climate Agreement (COP 21) a pivotal setting for climate risk awareness. The COP 21 is a historic global climate deal, signed in December 2015, under which 195 countries have agreed to take actions to limit global temperature increases. As noted by Ginglinger and Moreau (2019, p. 12), *"The Agreement sends a strong signal that all finance, both public and private, needs to be directed towards the climate challenge*".

Therefore, we use the Paris Climate Agreement as a moderator or external shock and consider 2015 a key year in which outsiders (investors, lenders, etc.) were more aware of firms' climate change exposure. Consequently, we argue that the Paris Climate Agreement could affect managers' willingness to manipulate reported earnings when their firms are exposed to climate risks. On the one hand, we can expect that the Agreement reduces the likelihood of earnings management because the pressures faced by firms to hide the negative effects of climate risks are weaker. On the other hand, while investors are becoming aware of the risks associated with climate change since 2015, managers may be more likely to manage earnings upward. Based on

these contrasting views, we argue the moderating role of the Paris Climate Agreement in the association between climate risk and earnings management. Thus, Hypothesis H2 is as follows:

H2: The Paris Climate Agreement moderates the association between firm-level exposure to climate risks and earnings management.

3 Methodology

3.1 Sample and data

The initial sample consists of listed international firms that are present in the climate change exposure dataset provided by Sautner et al. (2020).[3] The study period is from 2003 to 2018 because of the measurement of earnings management, which requires the inclusion of the year prior to the estimation year.

We manually collected firm-level climate change exposure data from Sautner et al. (2020) dataset, removing "Utilities" and "Financials" firms that are in regulated industries and firms in countries with fewer than 50 observations. For each firm and year, we collected financial data from *Refinitiv Datastream* and corporate governance data from the *Worldwide Governance Indicators* (WGI) index. At the country level, we gathered climate exposure data from the CRI (collected and published by *GermanWatch*), which captures the level of influence of climate-related disasters in various countries (Huang et al., 2018). In addition, for US firms

[3] Their original sample contained more than 80,000 firm-year observations from 34 countries during the period 2002-2019.

only, we collected data on climate change exposure at the state level using the *Billion-Dollar Weather* database of the National Centers for Environmental Information (NCEI). This database provides a history of all the disasters that occurred in the US and the costs associated with each event. Finally, after merging all datasets and removing firms with missing data, we obtained two samples over the period 2003-2018: the US sample with 10,197 firm-year observations and the international sample with 3,598 firm-year observations from 21 countries outside the US. Table 1 presents the sample selection procedure.

(Insert Table 1 about here)

In this study, the US sample was used to conduct our main empirical investigation, whereas the international sample was used only in additional analysis to investigate the incremental effect of firm-level *versus* country-level climate exposures on earnings management.

3.2 Variables

3.2.1 Climate change exposure

In this study, we used Sautner et al.'s (2020) measure to proxy for firm-level exposure to climate risks, as the authors relied on a machine learning algorithm to capture the proportion of an earnings conference call that is centered on a particular topic as a measure of the firm's exposure to that issue. This algorithm required only a set of initial bigrams to identify sentences of interest, i.e., those that clearly involve climate change[4]. These initial bigrams allowed the algorithm to

[4] A strength of that methodology is that the algorithm does not need a comprehensive climate change training library.

construct a model predicting whether or not a sentence was related to climate change. To discover new climate change bigrams, the prediction model was applied to sentences that did not include any initial bigrams. The resulting set of climate change bigrams (CC) included both the initial bigrams and those newly identified from the algorithm[5].

Sautner et al. (2020) adapted this bigram-searching algorithm to discover two unique sets of climate change bigrams that capture the regulatory (CC_EXPO^{RG}) and physical shocks (CC_EXPO^{PH}) related to climate change. For that purpose, the above authors fed a set of initial bigrams reflecting each topic and allowed the algorithm to discover bigrams related to the topic of interest. For both topics, the authors customized the set of initial bigrams using the top 500 bigrams collected from climate change bigrams that were present in conference call transcripts, and then, they reran the search algorithm to find a broader set of bigrams for each topic. Using the three sets of bigrams (CC, CC_EXPO^{RG} and CC_EXPO^{PH}), Sautner et al. (2020) constructed a (broad) measure of climate change exposure (CC_EXPO) based on how frequently the specified bigrams appeared in a given transcript. To account for differences in the length of the conference calls, the authors scaled the total count by the number of bigrams in the transcript. Appendix 1 gives the definitions of the variables used.

3.2.2 Earnings management

We considered three commonly used measures of earnings management (Cheng et al., 2016; Cohen and Zarowin, 2010; Kothari et al., 2005; Roychowdhury, 2006). The first was an accrual-

[5] For instance, "rooftop solar" and "photovoltaic panel" come from "solar energy" while "nuclear power" or "event fukushima" come from "renewable energy" and "tesla battery".

based earnings management measure, and the other two were real earnings management measures.

Discretionary accruals (DAs) are defined as the difference between total accruals and non-DAs. Following Kothari et al. (2005), we estimated DAs as the residuals of the cross-sectional regression based on the modified Jones model (Eq. 1):

$$\frac{ACC_{it}}{TA_{it-1}} = \alpha_0\left(\frac{1}{TA_{it-1}}\right) + \alpha_1\frac{(\Delta REV_{it} - \Delta REC_{it})}{TA_{it-1}} + \alpha_2\left(\frac{PPE_{it}}{TA_{it-1}}\right) + \alpha_3\left(\frac{NI_{it}}{TA_{it-1}}\right) + \varepsilon_{it} \quad (1)$$

In Eq. (1), total accruals (ACC) are the difference between net income before minority interests and cash flows from operations. TA_{it-1} is defined as the lagged value of total assets. ΔREV_{it} is measured as the change in revenue from the prior year. ΔREC_{it} represents the change in net receivables. NI_{it} is measured as the net income from continuing operations, and PPE_{it} represents the gross value of property, plant, and equipment on the balance sheet.

The two real earnings management measures are based on Roychowdhury (2006) and Cohen and Zarowin (2010). First, managers can accelerate the recognition of revenues to manage earnings upward. In such a case, the actual cash flows from operations do not match the inflated sales revenue. Thus, abnormal cash flows are calculated as the difference between actual cash flows and the predicted cash flows estimated in Eq. (2).

$$\frac{CFO_{it}}{TA_{it-1}} = \alpha_0 + \alpha_1\left(\frac{1}{TA_{it-1}}\right) + \alpha_2\left(\frac{REV_{it}}{TA_{it-1}}\right) + \alpha_3\left(\frac{\Delta REV_{it}}{TA_{it-1}}\right) + \varepsilon_{it} \quad (2)$$

Similar to the accrual-based earnings management measure, we regress Eq. (2) on each industry-year group and use the residuals from Eq. (2) as abnormal cash flows (ABN_CFO). CFO_{it} denotes the cash flows from operating activities. Furthermore, lower ABN_CFO values indicate a higher degree of real earnings management.

Second, by overproducing inventory, managers can lower the overhead costs assigned to each unit of inventory, which results in a decrease in the total cost of goods sold, thereby increasing earnings. Thus, abnormal inventory production is calculated as the difference between actual production and the predicted production estimated in Eq. (3):

$$\frac{PROD_{it}}{TA_{it-1}} = \alpha_0 + \alpha_1\left(\frac{1}{TA_{it}}\right) + \alpha_2\left(\frac{REV_{it}}{TA_{it-1}}\right) + \alpha_3\left(\frac{\Delta REV_{it}}{TA_{it-1}}\right) + \alpha_4\left(\frac{\Delta REV_{it-1}}{TA_{it-1}}\right) + \varepsilon_{it} \qquad (3)$$

Abnormal inventory production (ABN_PROD) is the residual from Eq. (3) estimated on each industry-year group. $PROD_{it}$ is defined as the sum of the cost of goods sold and the change in inventory. Furthermore, higher ABN_PROD values indicate a higher level of real earnings management.

Third, managers can manage earnings upward by cutting or delaying discretionary expenditures. Thus, abnormal discretionary expenditures are calculated as the difference between actual discretionary expenditures and the predicted discretionary expenditures estimated in Eq. (4).

$$\frac{DISCR_{it}}{TA_{it-1}} = \alpha_0 + \alpha_1\left(\frac{1}{TA_{it}}\right) + \alpha_2\left(\frac{REV_{it-1}}{TA_{it-1}}\right) + \varepsilon_{it} \qquad (4)$$

Abnormal discretionary expenditures (ABN_DISCR) are the residuals from Eq. (4) estimated on each industry-year group. $DISCR_{it}$ is defined as the sum of selling, general and administrative expenses, research and development (R&D) expenses, and advertising. Following Chen et al. (2021), we set R&D and advertising expenses to zero if they were missing. Lower ABN_DISCR values indicate a higher level of real earnings management.

Finally, similar to Cohen and Zarowin (2010), we captured the aggregate effects of real earnings management practices through two comprehensive measures:

REAL_EM1 = ABN_PROD + [(-1)*ABN_DISCR]

REAL_EM2 = [(-1)*ABN_DISCR] + [(1-)*ABN_CFO]

The first proxy REAL_EM1 is defined as the sum of abnormal inventory production and abnormal discretionary expenditures. The second proxy REAL_EM2 is the sum of abnormal discretionary expenditures and abnormal cash flows from operating activities. We multiplied ABN_DISCR and ABN_CFO by -1 so that higher values of each aggregate measure indicate a higher level of real earnings management. Appendix 1 provides a summary of all variables used in the study.

3.3 Empirical models

In Eq. (5), we investigate the impact of climate change exposure on earnings management using the following pooled ordinary least squares (OLS) regression equation:

$$EM_{it} = \alpha + \beta_1\, CC\_EXPO_{it} + \beta_2\, TA_{it} + \beta_3 LEVERAGE_{it} + \beta_4 LOSS_{it} + \beta_5 ROA_{it} + \beta_6 INTANGIBLE_{it} + \beta_7 PPE_{it} + \beta_8 SALES\_GROWTH_{it} + \beta_9 BTM_{it} + \beta_{10} STATE\_EXPO_{it} + YEAR + INDUSTRY + \varepsilon_{it} \quad (5)$$

EM is a measure of earnings management, as previously described. The variable of interest is CC_EXPO, which captures firm-level climate change exposure (Sautner et al., 2020).[6] Following Ding et al. (2021), we included a set of control variables likely to be associated with earnings management. First, we measured firm size as the natural logarithm of total assets (TA). We also included a measure of firm leverage, calculated as long-term debt divided by total assets (LEVERAGE). Return on assets (ROA) was calculated as income before tax divided by total

[6] The details regarding variable measurements are presented in Section 3.2.2.

assets. INTANGIBLE was measured as intangible assets divided by total assets. To capture firms' growth opportunities, we controlled for both sales growth (SALES_GROWTH) and book-to-market ratio (BTM). We also controlled for capital intensity: PPE was measured as net property, plant and equipment divided by total assets. Finally, we also included a binary variable that captured a firm's exposure to climate change at the state level (STATE_EXPO). Furthermore, from the *Billion-Dollar Weather* database, we collected, for each state, the total costs associated with climate disasters that occurred during a given year (scaled by growth state product (GSP)). Hence, STATE_EXPO was coded as 1 when the firm's headquarters belonged to a state where the costs associated with climate disasters were above the median value of the total costs of the US and 0 otherwise. We included industry fixed effects based on the North American Industry Classification System (NAICS) two-digit classification and year fixed effects. Standard errors were clustered at the firm level to account for potential cross-sectional dependence in our models.

Eq. (6) captures the moderating impact of the Paris Agreement. We created a binary variable, POSTAGREEMENT, coded as 1 for fiscal years 2016, 2017 and 2018 (the Paris Agreement was adopted at the end of 2015), and interact this variable with climate change exposure:

$$EM_{it} = \alpha + \beta_1\, CC\_EXPO_{it} + \beta_2\, POSTAGREEMENT_{it} + \beta_3\, CC\_EXPO * POSTAGREEMENT_{it} + \beta_i CONTROLS + \varepsilon_{it} \quad (6)$$

4 Empirical results

4.1 Descriptive statistics

Table 2 presents the US sample distribution by year (Panel A) and industry (Panel B). Table 2, Panel A, shows an increase in the number of observations over the period 2003-2018, suggesting that climate-related topics are more discussed during conference calls over time. Table 2 (Panel B) shows that the industry distribution is strongly unbalanced in the sample. The manufacturing industry (NAICS 31-33) is the most represented, accounting for 65.37% of all firm-year observations. This evidence is not surprising since manufacturing firms are more likely to face a higher degree of climate change exposure due to their higher level of greenhouse gas (GHG) emissions, resulting in more climate-change-related topics in the conference call transcripts.

(Insert Table 2 about here)

Table 3 presents the descriptive statistics for the study variables. The mean value of climate change exposure CC_EXPO is 0.814 (standard deviation (SD): 1.458)[7]. This variable is positively skewed, as suggested by the median value of 0.327. The mean values of CC_EXPO^{RG} and CC_EXPO^{PH} are 0.034 and 0.010, respectively (for both, the median equals 0). Regarding earnings management measures, discretionary accruals (DAC) are, on average, -0.001 (median: -0.001; SD: 0.087). The two other "real earnings management" measures REAL_EM1 and REAL_EM2 are, on average, 0.081 and 0.058, respectively, and very volatile. For instance, the SD of REAL_EM1 is 0.418. Overall, those statistics are consistent with those of the prior literature (Chen et al., 2021; Ding et al., 2021; Kim et al., 2017). Average firm size is 7.062 (TA), with an SD of 2.012. The mean leverage ratio (LEVERAGE) is 23.8%, while 23.7% of sample firms report a net income of continuous operations before extraordinary items below 0

[7] To facilitate the readability of climate change exposure variables, all the scores have been multiplied by 10^3.

(LOSS). On average, the total of property, plant, and equipment (PPE) accounts for 48.7% of total assets, whereas the proportion of intangible assets (INTANGIBLE) among total assets is 11.2%. Furthermore, average sales growth is 11.1%, and the book-to-market ratio is 48.1%.

(Insert Table 3 about here)

Table 4 summarizes the Pearson correlations among the variables of interest. Not surprisingly, the three earnings management variables are found to be correlated. Furthermore, most of the control variables are found to be significantly correlated. However, with the exception of LOSS and ROA, none of the pairwise correlation coefficients are above 0.50. To avoid potential multicollinearity issues, we also calculate the variance inflation factors (VIF) for the independent variable included in the models and find that none of them are above 10, indicating that multicollinearity is not a serious threat in this study.

(Insert Table 4 about here)

4.2 Main findings

4.2.1 Impact of firm-level climate change exposure on earnings management

The results of Eq. (5) are reported in Columns (1) to (3) of Table 5[8]. The coefficient of firm-level climate change exposure (CC_EXPO) is positive and significant at the 1% level for each proxy

[8] Given the skewed distribution of our climate change exposure variables, the OLS estimation could be biased due to the violation of the normality assumption. Thus, we replicate each model by transforming CC_EXPO, CC_EXPO^{RG} and CC_EXPO^{PH} into percentile ranks, the results of which are quite similar.

of earnings management (Columns (1)-(3)). Therefore, consistent with H_1, a firm's exposure to climate change (as captured in conference call transcripts) increases the extent to which managers engage in accrual and real earnings management activities. The standardized coefficients (not tabulated) are 0.038 for Column (1) (accruals earnings management) and 0.136 and 0.125 for Columns (2) and (3) (real earnings management), respectively. In other words, a 1% SD in CC_EXPO translates into a 3.8% variation in the SD of DAC and into a 13.6% (12.5%) variation in that of REAL_EM1 (REAL_EM2). This result suggests that the economic impact of climate change exposure on earnings management is much more pronounced for real earnings management than for accruals earnings management.

Regarding control variables, similar to Ding et al. (2021), we find that firm size (TA) is negatively (positively) associated with accrual (real) earnings management. In addition, firms with a higher leverage ratio and with growth opportunities are more likely to engage in earnings management, as suggested by the coefficients of LEVERAGE, BTM and SALES_GROWTH. Contrary to Ding et al. (2021), we find that PPE and INTANGIBLE are negatively associated with real earnings management. This contradictory result might be due to differences in model specification and in the sample used. Finally, STATE_EXPO is positively and significantly associated with real earnings management measures (which is not the case with the accruals-based earnings management measure). To identify which variable—firm- or state-level climate exposure—is the most important driving factor of real earnings management, we test the difference in coefficients estimated with REAL_EM1 and REAL_EM2 as dependent variables (in Columns (2) and (3)). The Fischer test confirms that the coefficient of CC_EXPO is significantly higher than that of STATE_EXPO, suggesting that the impact of firm-level climate

change exposure on earnings management is stronger than that of its exposition due to the location of a firm's headquarters.

(Insert Table 5 about here)

We further investigate which components of firm-level climate change exposure drive firms' propensity to engage in earnings management. We replace, in Eq. (5), CC_EXPO with both CC_EXPO^{RG} and CC_EXPO^{PH}, which capture climate change exposure to regulatory threats and to physical shocks, respectively. The results in Table 6 show that the coefficient of CC_EXPO^{RG} is positive and significant for each proxy of earnings management. In Column (1), this coefficient is significant at the 10% level. The standardized coefficient (not tabulated) reveals that a 1% SD in CC_EXPO^{RG} translates into a 1.77% variation in the SD of DAC. Therefore, the economic impact of climate exposure related to regulatory threats seems to be limited when considering accrual earnings management. Conversely, the economic impact of CC_EXPO^{RG} on real earnings management seems more important (Columns (2) and (3)). For instance, the standardized coefficient of CC_EXPO^{RG} is 0.083 for REAL_EM1. In contrast, the coefficient of CC_EXPO^{PH} is not found to be significant, regardless of the variables used to measure earnings management. Overall, these results suggest that firms facing higher climate exposure related to regulatory shocks engage in more earnings management activities, while firm exposure to physical shocks does not encourage managers to manipulate their firms' reported earnings. Finally, as previously mentioned, the variable STATE_EXPO is positively associated with REAL_EM1 and REAL_EM2, but its impact on earnings management is lower than that due to climate risk exposure at the firm level (CC_EXPORG). Henceforth, we confirm our prediction (H1) in which firm-level climate exposure plays a significant role in firms' earnings management behavior.

(Insert Table 6 about here)

4.2.2 Moderating effect of the Paris Climate Agreement

Table 7 presents the results of Eq. (6) considering the moderating effect of the Paris Agreement on the association between firm-level climate exposure and earnings management. The variable CC_EXPO is found to be positively and significantly associated with each measure of earnings management. In contrast, neither the coefficient of the binary variable POSTAGREEMENT (except for Column (1)) nor the coefficient of the interaction term CC_EXPO*POSTAGREEMENT is found to be significant. This result contradicts our prediction (H_2) and suggests that the accounting behavior of US firms exposed to climate risks is not affected by the Paris Agreement, which was adopted in 2015. Thus, this result could be explained by the decision made by President Donald Trump after his election in 2016 to pull the US out of the Paris Climate Accord.

(Insert Table 7 about here)

4.3 Additional analysis

4.3.1 Climate Sensitive versus non-sensitive industries

As an additional analysis, we investigate whether the main results reported in Tables 5 and 6 are driven by a subsample of firms operating in climate-sensitive industries (Ding et al., 2021). To do so, we create a binary variable (SENSITIVE) that captures whether a firm belongs to a

climate sensitive industry[9]. We include SENSITIVE in Eq. (5) and interact it with firm-level climate change exposure to investigate whether operating in a sensitive industry moderates the association between climate change exposure and earnings management.

The results are reported in Columns (1) to (3) of Table 8 and show that operating in a climate-sensitive industry results in an increase in real earnings management. The coefficients of the interaction term (CC_EXPO*SENSITIVE) in Columns (2) and (3) are positive and significant at the 1% level. In contrast, operating in a climate-sensitive industry does not encourage earnings management based on DAs (in Column (1), the coefficient of interaction term β_3 is not significant). Consequently, the effect of firm-level climate exposure in motivating real earnings management is strengthened for firms operating in climate-sensitive industries. This finding indicates that our prediction in H1 is supported. Firm-level climate exposure provides incentives to managers to manipulate reported earnings, the impact of which is more pronounced for firms belonging to sensitive industries than for other firms.

(Insert Table 8 about here)

We rerun the regression model by decomposing firm-level climate change exposure into CC_EXPO^{RG} and CC_EXPO^{PH}. The results are reported in Table 9 and are consistent with those in Table 6. We find that the association between climate change exposure related to regulatory threats (CC_EXPO^{RG}) and real earnings management is more pronounced for sensitive firms, as the interaction term β_4 is positive and significant, than for non-sensitive firms. In contrast, we

[9] As presented in Table 1, industry-sensitive firms are defined as those with the following NAICS three-digit codes: 211, 212, 213, 322, 324, 325, 331, 332, 481, 482, 483, 484, 486, and 488.

find that climate change exposure related to physical shocks (CC_EXPO^{PH}) is not associated with earnings management.

(Insert Table 9 about here)

4.3.2 Propensity score matching

Significant differences in control variables among firms with high climate-change exposure and of those with low climate-change exposure could bias our results. To address this concern, we use a propensity score matching approach similar to that of Ding et al. (2021). We match firm-year observations with high climate change exposure with those with low climate change exposure. In doing so, we ensure that any differences in observable characteristics across the sample can be considered random.

First, we estimate a logit regression of a treatment indicator on the control variables used in Eq. 1 (first stage).[10] Treatment_CC_EXPO is a dummy variable coded as 1 for those firm-year observations for which CC_EXPO is above the median value and 0 otherwise. Following Leung and Veenman (2018), we obtain the propensity score by matching observations without replacement and by using a maximum distance (caliper) of 0.05. However, because of this caliper restriction, some observations cannot be matched. For instance, it might be difficult to identify suitable matches within some industries. Hence, the matching procedure results in a loss

[10] We use the following covariates in the matching procedure: TA, LEVERAGE, LOSS, ROA, INTANGIBLES, PPE, SALES_GROWTH, BTM, STATE_EXPO, and industry and year fixed effects.

of 2,569 firm-year observations. To check the quality of the matching, we compare the mean values of each covariate between the treatment and control groups. Except for INTANGIBLE and BTM, we find that after matching, none of the covariates have mean values that are significantly different from each other.

Second, we estimate the average treatment effect of being a firm with high climate change exposure on earnings management by replicating Eq. (5) on the matched sample (second stage). The results are presented in Table 10 and suggest that when we use the matched sample, climate change exposure is positively associated with earnings management measures. Finally, even when observations are matched based on observable characteristics, firm-level climate change exposure is still show to be associated with earnings management. Our primary findings are robust with propensity score matching and confirm our prediction in H1.

(Insert Table 10 about here)

4.4 Incremental effect of firm-level versus country-level climate exposure on earnings management

Our previous results suggest that climate change exposure at the firm level significantly influences the extent to which managers engage in earnings management. However, it is not clear whether this effect substitutes or complements that documented in prior studies at the country level (Ding et al., 2021). To investigate the incremental effect of firm-level *versus* country-level climate change exposure on earnings management, we replicate previous empirical investigation by using an international sample with 3,598 firm-year observations from 21 countries. Table 11 provides the distribution of this international sample by year (Panel A), by

industry (Panel B) and by country (Panel C). Firms from the UK, Canada and Japan are the most represented in this new sample.

(Insert Table 11 about here)

Consistent with Ding et al. (2021), we use the CRI published by *GermanWatch*, which captures the level of influence of climate-related disasters in various countries (Huang et al., 2018). This index is measured by averaging each of the following indicators: (1) total number of deaths, (2) number of deaths per 100,000 inhabitants, (3) total number of losses at purchasing power parity, and (4) total number of losses per unit of gross domestic product (GDP). Following Huang et al. (2018), the CRI score is multiplied by -1 so that a higher score represents a higher level of climate risk. We estimate the following regression (Eq. 7):

$$EM_{it} = \alpha + \beta_1 CC_{EXPO_{it}} + \beta_2 CRI_{it} + \beta_3 TA_{it} + \beta_4 LEVERAGE_{it} + \beta_5 LOSS_{it} + \beta_6 ROA_{it} + \beta_7 INTANGIBLE_{it} + \beta_8 PPE_{it} + \beta_9 SALES_{GROWTH_{it}} + \beta_{10} BTM_{it} + \beta_{11} GOVERNANCE_{it} + \beta_{12} LGDP_{it} + \beta_{11} GDP_{GROWTH_{it}} + YEAR + INDUSTRY + \varepsilon_{it} \quad (7)$$

The variables are defined in Appendix 1. In addition to the set of control variables used in Eq. (5)[11], we add three country-level variables. We include the quality of governance by using the WGI index, which captures an aggregated measure based on the following six indicators: (i) voice and accountability, (ii) political stability, (iii) government effectiveness, (iv) regulatory quality, (v) adherence to the rule of law and (vi) control of corruption (Ding et al., 2021; González and García-Meca, 2014). We also add the logarithm of real GDP (LGDP) and the

[11] In the investigation conducted on the international sample, we remove state-level climate exposure, as it is specific to US firms.

annual growth rate of GDP (GDP_GROWTH). Table 12 provides the descriptive statistics for the study variables and the international sample.

(Insert Table 12 about here)

The results of Eq. (7) are reported in Columns (1) to (3) of Table 13. The variable CC_EXPO is positive and significant at the 1% level for each measure of earnings management. A firm's exposure to climate change positively influences the level of earnings management outside the US. setting. In contrast, the variable CRI is not significantly associated with earnings management. In other words, once we account for climate change exposure at the firm level, country-level exposure no longer influences the firm's propensity to engage in earnings management[12].

(Insert Table 13 about here)

We obtain similar results when using disaggregated measures of firm-level exposure. In Table 14, the variable CC_EXPO^{RG} is shown to be positively associated with each proxy of earnings management, whereas CRI is not significant. Furthermore, we find that climate change exposure related to physical shocks (CC_EXPO^{PH}) is not associated with earnings management, which is consistent with the results presented in Table 6.

(Insert Table 14 about here)

[12] We also replicate the original model of Ding et al. (2021), without including firm-level climate change exposure variables. In that case, we find that CRI is positively and significantly associated with each measure of earnings management.

In Eq. (8), we investigate the moderating effect of the Paris Agreement by including, in Eq. (7), an interaction term between firm-level climate exposure and the binary variable POSTAGREEMENT:

$$EM_{it} = \alpha + \beta_1\, CC\_EXPO_{it} + \beta_2 POSTAGREEMENT_{it} + \beta_3\, CC\_EXPO * POSTAGREEMENT_{it} + \beta_4\, CRI_{it} + \beta_i CONTROLS + \varepsilon_{it} \quad (8)$$

The results are reported in Table 15 and show that the variable CC_EXPO is positively associated with earnings management, while this is not the case for the variable CRI, suggesting that country-level exposure does not explain earnings management once we account for climate exposure at the firm level. Furthermore, the results in Table 15 highlight that the association between firm-level climate change exposure and earnings management is moderated by the Paris Agreement. The coefficient β_3 of the interaction term (CC_EXPO*POSTAGREEMENT) is shown to be negative and significant at the 5% level in Columns (2) and (3). Outside the US, firms facing higher exposure to climate change have been less willing to use real earnings management activities after the agreement was adopted (after 2015). This result confirms our prediction in H2 and contrasts with our findings in the US setting. The Paris Agreement moderates the association between firm-level climate exposure and earnings management only outside the US.

(Insert Table 15 about here)

5 Concluding remarks

Ding et al. (2021) suggest that there is limited evidence on the effect of climate risk on firms' accounting policies. The current study aims to fill this gap by investigating the association

between firm-level climate exposure and both accrual-based and real earnings management. In addition, we consider a setting in which expectations regarding future climate regulations receive an exogenous shock, such as the December 2015 Paris Climate Agreement, and investigate whether firms' accounting practices have changes since 2015.

Our empirical results based on a sample of US firms over the period 2003-2018 suggest that firms with higher firm-level climate risk exposure are more likely to engage in earnings manipulation. This association is more pronounced for those firms belonging to climate-sensitive industries. Our findings are robust for weighted least squares regression and a propensity score matching approach. In addition, we investigate, by using an international sample composed of firms in 21 countries outside the US, whether the effect of firm-level climate exposure on earnings management is higher than that of country-level climate exposure. Our results show that climate exposure at the firm level is the top driving factor for accounting choices. Moreover, the results show a moderator effect of the Paris Agreement on the association between firm-level climate exposure and earnings management only outside the US.

Our results have important implications for how firm-level climate exposure influences financial reporting choices and firms' performance image. Institutional investors, lenders and policy makers have been paying growing attention to firms' disclosures related to climate change issues. Therefore, mandatory climate disclosure requirements could enhance the quality of financial reporting because managers would be under less pressure to employ earnings management strategies to mitigate the negative impact of climate change risks on corporate performance.

Appendix 1. Variable definitions

Variable	Definition	Source
CC_EXPO	Relative frequency with which bigrams related to climate change occur in analyst conference call transcripts	Sautner et al. (2020)
CC_EXPO^{RG}	Relative frequency with which bigrams that capture regulation shocks related to climate change occur in analyst conference call transcripts	Sautner et al. (2020)
CC_EXPO^{PH}	Relative frequency with which bigrams that capture physical shocks related to climate change occur in analyst conference call transcripts	Sautner et al. (2020)
STATE_EXPO	Dummy variable coded as 1 when a firm's headquarters belongs to a state where the costs associated with climate disasters are above the median value of the total costs of the US and 0 otherwise	Billion-Dollar Weather
CRI	Measured by averaging each of the following four indicators: (1) total number of deaths, (2) number of deaths per 100,000 inhabitants, (3) total number of losses at purchasing power parity in US dollars, and (4) total number of losses per unit of gross domestic product (GDP), with the score of each country calculated as the weighted average ranking of the above four indicators	GermanWatch
DAC	Accruals-based earnings management measured by the performance-adjusted modified Jones model (Kothari et al., 2005)	Self-constructed
REAL_EM1	Real earnings management, measured as the sum of abnormal inventory production and abnormal discretionary expenditures	Self-constructed
REAL_EM2	Real earnings management, measured as the sum of abnormal discretionary expenditures and abnormal cash flows from operating activities	Self-constructed
TA	Natural logarithm of total assets	Refinitiv Datastream
LEVERAGE	Long-term debt divided by total assets	Refinitiv Datastream
LOSS	Dummy variable coded as 1 if net income before extraordinary items is below 0 and 0 otherwise	Refinitiv Datastream
ROA	Net income before extraordinary items (NI) divided by total assets	Refinitiv Datastream
INTANGIBLE	Intangible assets divided by total assets	Refinitiv Datastream
PPE	Net value of property, plant, and equipment divided by total assets	Refinitiv Datastream
SALES_GROWTH	Annual growth rate of net sales	Refinitiv Datastream
BTM	Book value of equity divided by market value of equity	Refinitiv Datastream
GOVERNANCE	Aggregated measure of country-level quality of governance, consisting of six individual indicators: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption	Worldwide Governance Indicators (WGI)
GDP_GROWTH	Annual growth rate of gross domestic product (GDP) per capita	World Bank
LGDP	Natural logarithm of real GDP per capita	World Bank
POSTAGREEMENT	Dummy variable coded as 1 for fiscal years 2016, 2017 and 2018 and 0 otherwise	
SENSITIVE	Those firms with the following three-digit NAICS codes: 211 – Oil & Gas extraction, 212-213 – Mining activities, 322- Paper manufacturing; 324 – Petroleum and coal manufacturing, 325 – Chemical manufacturing, 331-332 – Metal manufacturing, 481- Air transportation, 482 – Rail transportation, 483 – Water transportation, 484 – Truck transportation, 486 – Pipeline transportation, and 488 – Support activities for transportation	Refinitiv Datastream

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Tables

Table 1. Sample selection

	Firm	**Firm-year**
Climate change dataset (2003-2018)	**10,729**	**77,696**
- Financial firms (*NAICS 520-525*)	(1,419)	(10,273)
- Utilities firms (*NAICS 221*)	(289)	(2,295)
- Countries with fewer than 50 observations	(116)	(487)
Subtotal	**8,905**	**64,641**
- Missing data from *Refinitiv Datastream*	(4,112)	(32,966)
- Missing data from *GermanWatch* and *WGI*	(2,438)	(17,880)
Final sample	**2,355**	**13,795**
US sample	*1,417*	*10,197*
International sample	*938*	*3,598*

Table 2. US sample distribution by year and industry

Panel A. By year

Year	N	%
2003	349	3.42
2004	355	3.48
2005	419	4.11
2006	476	4.67
2007	542	5.32
2008	568	5.57
2009	595	5.84
2010	644	6.32
2011	675	6.62
2012	677	6.64
2013	682	6.67
2014	739	7.25
2015	754	7.39
2016	797	7.82
2017	941	9.23
2018	984	9.65
Total	**10,197**	**100**

Panel B. By industry

Industry (two-digit NAICS)	N	%
Mining, Oil & Food Services (21)	333	3.27
Construction (23)	67	0.66
Manufacturing (31-33)	6,666	65.37
Wholesale Trade (42)	612	6.00
Retail Trade (44-45)	623	6.11
Transportation & Warehousing (48-49)	414	6.06
Information (51)	707	6.93
Real Estate (53)	24	0.24
Professional, Scientific & Technical (54)	436	4.28
Accommodation & Food Services (72)	315	3.09
Total	**10,197**	**100**

Table 3. Summary statistics

Variables	N	Mean	SD	Q25	Median	Q75
CC_EXPO	10,197	0.814	1.458	0.116	0.327	0.832
CC_EXPO^{REG}	10,197	0.034	0.114	0	0	0
CC_EXPO^{PHY}	10,197	0.010	0.042	0	0	0
STATE_EXPO	10,197	0.199	0.393	0	0	0
DAC	10,197	-0.001	0.087	-0.037	-0.001	0.036
REAL_EM1	10,197	0.081	0.418	-0.086	0.145	0.344
REAL_EM2	10,197	0.058	0.279	-0.047	0.104	0.227
TA	10,197	7.062	2.012	6.134	7.004	8.101
LEVERAGE	10,197	0.238	0.194	0.091	0.209	0.340
ROA	10,197	0.010	0.181	0.003	0.041	0.078
INTANGIBLE	10,197	0.112	0.124	0.018	0.094	0.156
LOSS	10,197	0.237	0.425	0	0	0
SALES_GROWTH	10,197	0.111	0.304	-0.010	0.067	0.168
PPE	10,197	0.487	0.352	0.219	0.390	0.687
BTM	10,197	0.481	0.509	0.219	0.390	0.631

Table 4. Correlation matrix (Pearson)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) DAC	1														
(2) REAL_EM1	**0.08*** **	1													
(3) REAL_EM2	**0.17*** **	**0.92*** **	1												
(4) CC_EXPO	**0.03*** **	**0.12*** **	**0.11*** **	1											
(5) CC_EXPO^{RG}	**0.02*** **	**0.09*** **	**0.08*** **	**0.46*** **	1										
(6) CC_EXPO^{PH}	0.01	**0.03*** **	**0.03*** **	**0.18*** **	**0.10*** **	1									
(7) TA	0.00	**0.14*** **	**0.15*** **	**0.01** **	**0.04*** **	**0.02*** **	1								
(8) LEVERAGE	**-0.04*** **	**0.12*** **	**0.14*** **	**-0.04** **	**-0.01*** **	-0.00	**0.05** **	1							
(9) ROA	**0.28*** **	**0.04*** **	-0.00	**-0.03** **	-0.00	0.01	**0.31*** **	**-0.12*** **	1						
(10) INTANGIBLE	**-0.08*** **	**0.02** **	**0.03*** **	**-0.11** **	**-0.07*** **	**-0.03*** **	**-0.03*** **	**0.16*** **	**-0.05*** **	1					
(11) LOSS	**-0.21*** **	**-0.03** **	0.00	**0.02*** **	-0.00	**-0.00**	**-0.30*** **	**0.09*** **	**-0.57*** **	**0.02*** **	1				
(12) SALES_GROWTH	**0.02*** **	**-0.12** **	**-0.14** **	0.00	-0.00	-0.00	**-0.08*** **	-0.00	0.01	**0.04*** **	**-0.02*** **	1			
(13) PPE	**-0.02*** **	**0.09*** **	**0.06*** **	**0.06*** **	**0.08*** **	**0.05*** **	**0.19*** **	**0.12*** **	**-0.00**	**-0.20*** **	**0.01** **	**-0.08*** **	1		
(14) BTM	**0.04*** **	**0.17*** **	**0.16*** **	**0.05*** **	**0.03*** **	0.00	**0.06*** **	**-0.09*** **	**-0.04*** **	**-0.06*** **	**0.15*** **	**-0.08*** **	**0.09*** **	1	
(15) STATE_EXPO	-0.01	**0.08*** **	**0.06*** **	**-0.02** **	0.00	**0.02** **	**0.05*** **	**0.06*** **	**0.02** **	**-0.05*** **	**-0.02***	0.00	**0.22*** **	**0.06*** **	1

Note: *, ** and *** represent significance at the 10%, 5% and 1% levels, respectively.

Table 5. Firm-level climate change exposure and earnings management

	(1)	(2)	(3)
Dependent variable	**DAC**	**REAL_EM1**	**REAL_EM2**
CC_EXPO	2.312***	39.140***	23.744***
	(2.82)	(8.55)	(8.56)
TA	-0.007***	0.046***	0.034***
	(-8.52)	(8.49)	(10.22)
LEVERAGE	0.031***	0.348***	0.262***
	(4.35)	(6.57)	(8.43)
LOSS	-0.033***	-0.063***	-0.033**
	(-8.21)	(-3.24)	(-2.53)
ROA	0.153***	-0.158**	-0.144***
	(8.47)	(-2.37)	(-3.19)
INTANGIBLES	-0.068***	0.127	0.081
	(-5.43)	(1.47)	(1.52)
PPE	-0.009**	0.106***	0.042**
	(-2.33)	(3.63)	(2.39)
SALES_GROWTH	-0.001	-0.122***	-0.107***
	(-0.26)	(-5.54)	(-6.91)
BTM	0.012***	0.195***	0.130***
	(4.74)	(11.74)	(12.38)
STATE_EXPO	-0.003	0.104***	0.061***
	(-1.09)	(4.44)	(4.54)
_cons	0.084***	-1.043***	-0.731***
	(6.36)	(-9.88)	(-12.60)
N	10,197	10,197	10,197
Adj. R^2	0.1604	0.1608	0.1733
Industry fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES

Note: The coefficients are unstandardized. *t*-statistics clustered at the firm level are reported in parentheses. *, ** and *** represent significance at the 10%, 5% and 1% levels, respectively.

Table 6. Components of firm-level climate change exposure and earnings management

	(1)	(2)	(3)
Dependent variable	**DAC**	**REAL_EM1**	**REAL_EM2**
CC_EXPO^{RG}	13.688*	303.733***	172.777***
	(1.66)	(6.40)	(5.97)
CC_EXPO^{PH}	-6.181	165.850	127.521
	(-0.30)	(1.17)	(1.55)
TA	-0.007***	0.045***	0.034***
	(-8.65)	(8.21)	(9.93)
LEVERAGE	0.031***	0.340***	0.257***
	(4.31)	(6.40)	(8.24)
LOSS	-0.032***	-0.060***	-0.031**
	(-8.15)	(-3.06)	(-2.38)
ROA	0.153***	-0.159**	-0.144***
	(8.47)	(-2.39)	(-3.21)
INTANGIBLES	-0.070***	0.095	0.067
	(-5.60)	(1.09)	(1.14)
PPE	-0.008**	0.102***	0.040**
	(-2.30)	(3.51)	(2.29)
SALES_GROWTH	-0.001	-0.116***	-0.104***
	(-0.25)	(-5.23)	(-6.66)
BTM	0.012***	0.197***	0.131***
	(4.74)	(11.77)	(12.37)
STATE_EXPO	-0.003	0.100***	0.059***
	(-1.14)	(4.30)	(4.38)
_cons	0.085***	-1.024***	-0.719***
	(6.47)	(-9.65)	(-12.37)
N	10,197	10,197	10,197
Adj. R^2	0.1621	0.1537	0.1674
Industry fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES

Note: The coefficients are unstandardized. *t*-statistics clustered at the firm level are reported in parentheses. *, ** and *** represent significance at the 10%, 5% and 1% levels, respectively.

Table 7. Effect the Paris Agreement on the association between climate exposure and earnings management

	(1)	(2)	(3)
Dependent variable	**DAC**	**REAL_EM1**	**REAL_EM2**
CC_EXPO	2.926***	41.102***	25.283***
	(3.10)	(7.41)	(7.40)
POSTAGREEMENT	0.006***	0.012	0.004
	(2.98)	(0.96)	(0.52)
CC_EXPO*POSTAGREEMENT	-1.305	-5.095	-4.026
	(-1.01)	(-0.93)	(-1.08)
TA	-0.007***	0.046***	0.034***
	(-8.40)	(8.51)	(10.19)
LEVERAGE	0.033***	0.339***	0.254***
	(4.59)	(6.44)	(8.23)
LOSS	-0.032***	-0.066***	-0.036***
	(-8.01)	(-3.40)	(-2.74)
ROA	0.151***	-0.150**	-0.138***
	(8.41)	(-2.26)	(-3.10)
INTANGIBLES	-0.066***	0.145	0.091
	(-5.29)	(1.71)	(1.76)
PPE	-0.009*	0.107***	0.043**
	(-2.30)	(3.67)	(2.46)
SALES_GROWTH	-0.004	-0.116***	-0.102***
	(-0.75)	(-5.53)	(-6.86)
BTM	0.013***	0.185***	0.123***
	(5.13)	(11.60)	(12.17)
STATE_EXPO	-0.003	0.104***	0.062***
	(-1.06)	(4.47)	(4.57)
_cons	0.085***	-1.005***	-0.702***
	(6.55)	(-9.42)	(-11.96)
N	10,197	10,197	10,197
Adj. R^2	0.1520	0.1549	0.1647
Industry fixed effects	YES	YES	YES
Year fixed effects	NO	NO	NO

Note: The coefficients are unstandardized. t-statistics clustered at the firm level are reported in parentheses. *, ** and *** represent significance at the 10%, 5% and 1% levels, respectively.

Table 8. Firm-level climate change exposure and earnings management considering (non-) climate-sensitive industries

	(1)	(2)	(3)
Dependent variable	**DAC**	**REAL_EM1**	**REAL_EM2**
CC_EXPO	2.550**	19.459***	11.655***
	(2.34)	(3.70)	(3.38)
SENSITIVE	0.044***	-0.004	-0.002
	(2.62)	(-0.04)	(-0.03)
CC_EXPO*SENSITIVE	-1.814	24.877***	16.345***
	(-1.12)	(2.55)	(2.95)
TA	-0.008***	0.039***	0.031***
	(-9.56)	(7.73)	(9.70)
LEVERAGE	0.027***	0.238***	0.195***
	(3.60)	(5.20)	(7.09)
LOSS	-0.032***	-0.037**	-0.014
	(-7.95)	(-2.03)	(-1.16)
ROA	0.155***	-0.145**	-0.138***
	(8.57)	(-2.28)	(-3.16)
INTANGIBLES	-0.074***	0.269***	0.154***
	(-5.52)	(3.23)	(2.97)
PPE	-0.010**	0.054	0.008
	(-2.30)	(1.78)	(0.43)
SALES_GROWTH	-0.001	-0.126***	-0.108***
	(-0.19)	(-5.90)	(-7.07)
BTM	0.012***	0.167***	0.113***
	(4.50)	(11.07)	(11.62)
STATE_EXPO	-0.003	0.066***	0.039***
	(-0.81)	(2.65)	(2.70)
_cons	0.088***	-0.865***	-0.620***
	(6.44)	(-7.35)	(-9.96)
N	10,197	10,197	10,197
Adj. R^2	0.1701	0.2555	0.2483
Industry fixed effects	NO	NO	NO
Year fixed effects	YES	YES	YES

Note: The coefficients are unstandardized. t-statistics clustered at the firm level are reported in parentheses. *, ** and *** represent significance at the 10%, 5% and 1% levels, respectively.

Table 9. Components of firm-level climate change exposure and earnings management considering (non-) climate-sensitive industries

	(1)	(2)	(3)
Dependent variable	**DAC**	**REAL_EM1**	**REAL_EM2**
CC_EXPO^{RG}	8.491	149.368**	73.121
	(0.78)	(2.50)	(1.85)
CC_EXPO^{PH}	-10.605	4.383	-10.148
	(-0.39)	(0.02)	(-0.09)
SENSITIVE	0.044***	0.008	0.006
	(2.61)	(0.08)	(0.12)
CC_EXPO^{RG}*SENSITIVE	3.045	226.787**	149.651**
	(0.18)	(2.23)	(2.48)
CC_EXPO^{PH}*SENSITIVE	1.010	291.850	266.492
	(0.02)	(1.03)	(1.67)
TA	-0.008***	0.038***	0.030***
	(-9.66)	(7.53)	(9.49)
LEVERAGE	0.026***	0.229***	0.189***
	(3.54)	(5.01)	(6.89)
LOSS	-0.031***	-0.035	-0.013
	(-7.85)	(-1.92)	(-1.05)
ROA	0.155***	-0.145**	-0.138**
	(8.60)	(-2.28)	(-3.16)
INTANGIBLES	-0.075***	0.261***	0.148**
	(-5.59)	(3.11)	(2.85)
PPE	-0.010**	0.054	0.008
	(-2.23)	(1.80)	(0.46)
SALES_GROWTH	-0.001	-0.123***	-0.106***
	(-0.11)	(-5.70)	(-6.91)
BTM	0.012***	0.167***	0.112***
	(4.46)	(11.04)	(11.56)
STATE_EXPO	-0.003	0.064**	0.038**
	(-0.90)	(2.55)	(2.60)
_cons	0.089***	-0.852***	-0.612***
	(6.50)	(-7.20)	(-9.77)
N	10,197	10,197	10,197
Adj. R^2	0.1689	0.2525	0.2453
Year fixed effects	YES	YES	YES

Note: The coefficients are unstandardized. *t*-statistics clustered at the firm level are reported in parentheses. *, ** and *** represent significance at the 10%, 5% and 1% levels, respectively.

Table 10. Firm-level climate change exposure and earnings management – propensity score matching (2nd stage)

	(1)	(2)	(3)
Dependent variable	**DAC**	**REAL_EM1**	**REAL_EM2**
Treatment_CC_EXPO	0.01**	0.12***	0.08***
	(3.28)	(8.57)	(8.75)
TA	-0.01***	0.04***	0.03***
	(-8.38)	(7.53)	(9.22)
LEVERAGE	0.03***	0.38***	0.29***
	(3.65)	(7.07)	(8.95)
LOSS	-0.03***	-0.08***	-0.05***
	(-7.19)	(-4.02)	(-3.63)
ROA	0.15***	-0.24***	-0.22***
	(7.73)	(-3.68)	(-4.99)
INTANGIBLES	-0.07***	0.10	0.07
	(-4.25)	(1.13)	(1.20)
PPE	-0.01*	0.11***	0.04
	(-2.37)	(3.36)	(1.92)
SALES_GROWTH	0.00	-0.13***	-0.12***
	(0.11)	(-4.87)	(-6.00)
BTM	0.01***	0.22***	0.14***
	(3.87)	(11.17)	(11.76)
STATE_EXPO	-0.00	0.09***	0.06***
	(-0.48)	(3.52)	(3.73)
_cons	0.09***	-1.11***	-0.76***
	(5.61)	(-9.56)	(-11.42)
N	7,628	7,628	7,628
Adj. R^2	0.1616	0.1637	0.1822
Industry fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES

Note: The coefficients are unstandardized. t-statistics clustered at the firm level are reported in parentheses. *, ** and *** represent significance at the 10%, 5% and 1% levels, respectively.

Table 11. International sample distribution

Panel A. By year	**N**	**%**
2003	0	0
2004	33	0.92
2005	48	1.33
2006	80	2.22
2007	110	3.06
2008	131	3.64
2009	167	4.64
2010	192	5.34
2011	190	5.28
2012	248	6.89
2013	250	6.95
2014	270	7.50
2015	256	7.12
2016	299	8.31
2017	587	16.31
2018	737	20.48
Total	**3,598**	**100**
Panel B. By industry (two-digit NAICS)		
Mining, Oil & Food Services (21)	190	5.28
Construction (23)	.	
Manufacturing (31-33)	3,269	90.86
Wholesale Trade (42)	.	
Retail Trade (44-45)	56	1.56
Transportation & Warehousing (48-49)	.	
Information (51)	51	1.42
Real Estate (53)	.	
Professional, Scientific & Technical (54)	32	0.98
Accommodation & Food Services (72)	.	
Total	**3,598**	
Panel C. By country		
Australia	88	2.45
Austria	14	0.39
Brazil	124	3.45
Canada	498	13.84
China	74	2.06
Denmark	40	1.11
Finland	65	1.81
France	290	8.06
Germany	366	10.17
India	335	9.31
Israel	9	0.25
Italy	35	0.97
Japan	420	11.67
Mexico	15	0.42
Netherlands	35	0.97
Norway	17	0.47
South Africa	13	0.36
Sweden	193	5.36
Switzerland	310	8.62
Taiwan	85	2.36
UK	572	15.90
Total	**3,598**	**100**

Table 12. Summary statistics – International sample

Variables	N	Mean	SD	Q25	Median	Q75
CC_EXPO	3,598	1.221	1.914	0.126	0.469	1.380
CC_EXPO^{REG}	3,598	0.050	0.140	0	0	0
CC_EXPO^{PHY}	3,598	0.009	0.042	0	0	0
CRI	3,598	0.407	0.708	0.062	0.518	0.929
DAC	3,598	0.000	0.057	-0.024	0.000	0.026
REAL_EM1	3,598	0.006	0.310	-0.134	0.033	0.180
REAL_EM2	3,598	0.008	0.207	-0.082	0.029	0.117
TA	3,598	8.191	1.312	7.226	8.001	9.068
LEVERAGE	3,598	0.168	0.129	0.062	0.158	0.244
ROA	3,598	0.043	0.109	0.019	0.049	0.083
INTANGIBLE	3,598	0.086	0.104	0.016	0.052	0.116
LOSS	3,598	0.152	0.359	0	0	0
SALES_GROWTH	3,598	0.071	0.236	-0.015	0.051	0.130
PPE	3,598	0.587	0.428	0.270	0.474	0.799
BTM	3,598	0.623	0.594	0.272	0.464	0.778
GOVERNANCE	3,598	1.129	0.725	0.843	1.450	1.620
GDP_GROWTH	3,598	2.466	2.801	1.217	2.307	3.439
LGDP	3,598	10.343	0.912	10.358	10.652	10.817

Table 13. Firm-level climate change exposure and earnings management – International sample

	(1)	(2)	(3)
Dependent variable	**DAC**	**REAL_EM1**	**REAL_EM2**
CC_EXPO	2.629***	29.617***	18.623***
	(4.19)	(6.24)	(6.66)
CRI	-0.000	-0.010	-0.007
	(-0.06)	(-0.78)	(-0.84)
TA	-0.001**	0.005	0.004
	(-2.56)	(1.24)	(1.51)
LEVERAGE	0.013	0.282***	0.202***
	(1.27)	(3.32)	(4.52)
LOSS	-0.017***	-0.003	-0.000
	(-3.87)	(-0.14)	(-0.01)
ROA	0.204***	-0.174	-0.181***
	(10.06)	(-1.94)	(-3.26)
INTANGIBLES	-0.035***	-0.178**	-0.104**
	(-2.77)	(-2.02)	(-2.12)
PPE	-0.001	0.068***	0.019
	(-0.39)	(3.33)	(1.52)
SALES_GROWTH	0.005	-0.014	-0.049**
	(0.83)	(-0.38)	(-2.21)
BTM	0.009***	0.090***	0.058***
	(4.28)	(5.89)	(6.83)
GOVERNANCE	0.002	0.018	0.009
	(0.49)	(0.56)	(0.41)
GDP_GROWTH	-0.001	0.007	0.005**
	(-0.92)	(1.95)	(2.08)
LGPD	-0.000	0.000	0.000
	(-0.17)	(0.35)	(0.42)
_cons	0.012	-0.044	-0.087
	(0.64)	(-0.47)	(-1.70)
N	3,598	3,598	3,598
Adj. R^2	0.1798	0.1214	0.1145
Industry and year fixed effects	YES	YES	YES

Note: The coefficients are unstandardized. t-statistics clustered at the firm level are reported in parentheses. *, ** and *** represent significance at the 10%, 5% and 1% levels, respectively.

Table 14. Components of firm-level climate change exposure and earnings management – International sample

	(1)	(2)	(3)
Dependent variable	**DAC**	**REAL_EM1**	**REAL_EM2**
CC_EXPO^{RG}	27.047***	171.134**	130.516***
	(3.71)	(2.57)	(3.60)
CC_EXPO^{PH}	13.331	-11.788	45.109
	(0.81)	(-0.11)	(0.70)
CRI	0.000	-0.006	-0.004
	(0.13)	(-0.44)	(-0.49)
TA	-0.001***	0.004	0.003
	(-2.78)	(0.92)	(1.23)
LEVERAGE	0.012	0.279***	0.199***
	(1.18)	(3.18)	(4.36)
LOSS	-0.017***	-0.008	-0.003
	(-3.97)	(-0.35)	(-0.22)
ROA	0.202***	-0.209*	-0.199***
	(10.18)	(-2.21)	(-3.45)
INTANGIBLES	-0.038***	-0.246***	-0.138***
	(-3.08)	(-2.75)	(-2.81)
PPE	-0.001	0.068***	0.020
	(-0.44)	(3.26)	(1.55)
SALES_GROWTH	0.006	-0.009	-0.046**
	(0.89)	(-0.24)	(-2.08)
BTM	0.010***	0.096***	0.061***
	(4.49)	(6.17)	(7.03)
GOVERNANCE	0.002	0.020	0.010
	(0.49)	(0.60)	(0.48)
GDP_GROWTH	-0.001	0.008**	0.005**
	(-0.90)	(2.12)	(2.17)
LGPD	-0.000	0.000	0.000
	(-0.20)	(0.27)	(0.34)
_cons	0.014	-0.044	-0.086
	(0.74)	(-0.46)	(-1.66)
N	3,598	3,598	3,598
Adj. R^2	0.1778	0.0954	0.0965
Industry and year fixed effects	YES	YES	YES

Note: The coefficients are unstandardized. t-statistics clustered at the firm level are reported in parentheses. *, ** and *** represent significance at the 10%, 5% and 1% levels, respectively.

Table 15. Effect of the Paris Climate Agreement on the association between climate exposure and earnings management – International sample

	(1)	(2)	(3)
Dependent variable	**DAC**	**REAL_EM1**	**REAL_EM2**
CC_EXPO	2.520***	37.379***	22.517***
	(2.71)	(5.85)	(6.01)
POSTAGREEMENT	0.001	-0.008	-0.015
	(0.06)	(-0.17)	(-0.38)
CC_EXPO*POSTAGREEMENT	0.206	-14.328**	-7.177**
	(0.21)	(-2.56)	(-2.01)
CRI	-0.000	-0.011	-0.007
	(-0.05)	(-0.79)	(-0.86)
TA	-0.001**	0.005	0.004
	(-2.57)	(1.31)	(1.55)
LEVERAGE	0.013	0.282***	0.202***
	(1.27)	(3.33)	(4.53)
LOSS	-0.017***	-0.005	-0.001
	(-3.86)	(-0.21)	(-0.05)
ROA	0.204***	-0.174*	-0.181***
	(10.06)	(-1.95)	(-3.26)
INTANGIBLES	-0.035***	-0.177**	-0.103*
	(-2.77)	(-2.00)	(-2.11)
PPE	-0.001	0.067***	0.019
	(-0.38)	(3.32)	(1.51)
SALES_GROWTH	0.005	-0.015	-0.049**
	(0.83)	(-0.40)	(-2.21)
BTM	0.009***	0.090***	0.058***
	(4.27)	(5.93)	(6.86)
GOVERNANCE	0.002	0.018	0.008
	(0.49)	(0.56)	(0.40)
GDP_GROWTH	-0.001	0.007*	0.005**
	(-0.92)	(1.92)	(2.06)
LGPD	-0.000	0.000	0.000
	(-0.16)	(0.34)	(0.43)
_cons	0.012	-0.061	-0.091
	(0.65)	(-0.64)	(-1.77)
N	3,598	3,598	3,598
Adj. R^2	0.1797	0.1231	0.1153
Industry and year fixed effects	YES	YES	YES

Note: The coefficients are unstandardized. t-statistics clustered at the firm level are reported in parentheses. *, ** and *** represent significance at the 10%, 5% and 1% levels, respectively.