The impact of climate risk on accounting conservatism: A cross-country study

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Abstract

Objective: We examine the effect of climate risk on accounting conservatism for a sample of listed companies operating in 26 developing countries.

Method: We employ the Climate Risk Index developed by Germanwatch to capture the severity of losses due to extreme weather events at the country level. We use different approaches to measure firm-level accounting conservatism.

Findings: We find that greater climate risk leads to a lower level of accounting conservatism. The results hold even after using different estimation methods.

Research limitations and implications: Although our analysis is limited to the period 2007-2016, it could be helpful for standard setters such as International Accounting Standards Board (IASB) and International Sustainable Standards Board (ISSB) as they may consider the potential effect of climate risk in their international standards.

Practical implications: The negative impacts of climate risk on the quality of financial reporting as proxied by accounting conservatism could trigger regulators and standard setters to require disclosure of information relating to climate risks and to incorporate climate-related risks in their risk management systems. In addition, for policymakers, incorporating accounting conservatism as a financial quality reporting standard could help promote greater transparency, accuracy, and reliability in financial reporting in the context of climate risk.

Originality: We add to the literature on international differences in accounting conservatism by showing that climate risk significantly affects unconditional and conditional conservatism. Our results provide fresh evidence of the dark side of climate change. That is, climate risk is shown to decrease financial reporting quality.

Keywords: Accounting conservatism; climate risk; natural disasters; conditional conservatism; unconditional conservatism; developing countries.

1. Introduction

In the last decades, climate change and its impacts on human beings have raised awareness and interest among policymakers, regulators, practitioners, and academics. The

Germanwatch, a non-governmental organization, outlines on their annual report[1] that about 475,000 people died and $2.56 trillion in damages were sustained as a direct result of more than 11,000 severe weather events between 2000 and 2019. Growing impacts would result in increased global adaptation costs, according to the UNEP[2] Adaptation Gap Report 2016: These costs are expected to be between US$ 140 billion and US$ 300 billion per year by 2030 (UNEP 2016, p.40).

Climate change related to extreme weather events like storms, floods, heatwaves, and heavy rainfalls has drastic effects on the ecological environment and socio-economic systems (Sun et al, 2020; Ding et al., 2021). The frequency and intensity of extreme weather events have sparked research interest in their impacts and received widespread attention from academics. For example, using a sample of 170 countries over the period 1962-2004, Gassebner et al. (2010) study the impact of major disasters on import and export flows. They find that extreme weather events negatively impact capital flows and international trade. Huang et al. (2018) employ the climate risk index reported by the Germanwatch to examine the impact of risks caused by climate change on financing choices and firm performance. They find that big storms, hurricanes, heat waves, and other natural disasters are linked to lower and more volatile earnings and cash flows.

In the same vein, Ginglinger and Moreau (2019) examine the effect of climate risk on capital structure. By using forward-looking physical climate risk measures, they claim that in the post-2015 context, i.e. after the Paris Agreement, greater climate risk leads to lower leverage. In a related study, Capasso et al. (2020) investigate the connection between climate change exposure and firm credit risk. Based on a sample of 458 companies observed from 2007 to 2017, they find that the amount of a firm's carbon emissions and carbon intensity is negatively associated with credit risk as measured by the distance-to-default ratio.

In a recent study, Ding et al. (2021) study the effect of climate risk on earnings management. Using a sample of firms from 64 countries observed between 2005 and 2016, they find that managers have more incentives to engage in both real and accruals-based earnings management for firms operating in countries with repeated extreme weather

[1] Climate risk index 2021; https://germanwatch.org/sites/germanwatch.org/files/Global%20Climate%20Risk%20Index%202021_1.pdf

[2] UNEP: United Nations Environment Programme.

events. Furthermore, they document that the above-mentioned effect is moderated by the public governance quality.

To the best of our knowledge, the study of Ding et al. (2021) is the first one that considers the effect of climate risk on the properties of a firm's financial reporting practices, especially on earnings management (accruals and real based) comparing to the existing literature on the impact of climate risk. Our paper complements Ding et al. (2021) by considering the impact of climate change on accounting conservatism. However, our paper is different from Ding et al. (2021) in that earnings management refers to the practice of using accounting methods and other techniques to manipulate financial results to meet or exceed investor expectations. This can be done by altering revenue recognition, manipulating expenses or reserves, or engaging in other accounting practices that artificially boost earnings. That is, earnings management is a discretionary policy applied by managers that involves manipulating financial results to meet specific targets or expectations.

On the other hand, accounting conservatism is a principle that suggests companies should be cautious and prudent when reporting financial results. This means that companies should err on the side of understating earnings and overstating liabilities and expenses to avoid overstating their financial performance and to account for potential losses or risks. Unlike earnings management, accounting conservatism is considered as a qualitative characteristic of financial reporting (Watts, 2003a, 2003b).

Referring to existing literature, different definitions of accounting conservatism have been proposed in attempting to capture its several aspects (Basu, 2001). Traditionally, conservatism was expressed by the adage "anticipate no profit but anticipate all losses" (Bliss, 1924). Basu (1997) interprets this admonition as "the accountants' tendency to require a higher degree of verification for recognizing good news than bad news in financial statements". Under this interpretation, bad news would be reflected in earnings faster than good news. This is commonly called conditional conservatism or news-dependent conservatism. Alternatively, some researchers interpret accounting conservatism as an accounting policy that results in downward-biased estimates of book values of net assets compared to its market values (Watts, 2003a, Ruch and Taylor, 2015). Unconditional conservatism or news-independent conservatism are two terms used to describe this second form of conservatism.

Theoretically, Watts (2003a) has proposed four explanations for accounting conservatism: (i) contracting, (ii) litigation, (iii) taxation, and (iv) regulation. The contracting explanation suggests that accounting conservatism enhances the efficiency of debt contracts by mitigating conflicts of interest between bondholders and shareholders (Ahmed et al., 2002; Ball and Shivakumar, 2005; Bushman and Piotroski, 2006; Nikolaev, 2010). The litigation explanation points out that under accounting conservatism, firms are less likely to be sued. The taxation hypothesis states that managers will have more incentives to use accounting conservatism because the asymmetric timeliness recognition of losses and gains allows companies to differ in tax costs (Watts, 2003a, Qiang, 2007; Garcia-Lara et al., 2009). Finally, the regulation explanation asserts that regulators and standard-setters encourage firms to use conservative accounting reporting because when firms overstate net assets, standard-setters and regulators may face political pressure and public criticism (Watts, 2003a; Xia and Zhou, 2009).

Since Watts (2003a, 2003b), scholars have identified many factors that may affect accounting conservatism such as corporate governance mechanisms (Ahmed and Duellman, 2007; Beekes et al., 2004; Chi et al., 2009; Garacia-Lara et al, 2009; Goh and Li, 2011; Kieschnick and Shi, 2020; Lafond and Roychowdhury, 2007; Lafond and Watts, 2008; Xia and Zhu, 2009), national culture, religion and institutions (Pope and Walker, 1999; Ball et al, 2000; Giner and Rees, 2001; Ball et al., 2003; Ball et al., 2008; Bushman and Piotroski, 2006; Guay and Verrecchia, 2006; Salter et al, 2013; Kanagaretnam et al, 2014, Zghal et Lahmer, 2018, Ma et al. 2019), product market competition (Dhaliwal et al, 2014; Haw et al., 2015), firm's life cycle (Hansen et al. 2018), international accounting standards and economic condition (Barth et al. 2008; Zeghal et al., 2012; Ahmed et al., 2013; André et al., 2015, Guermazi et al., 2018; Manawadu et al., 2019; Lopez et al.,2020;).

Although there is an extensive body of literature on the factors, influencing accounting conservatism, as far as we are aware, no prior study has investigated the effect of environmental change, especially climate risk, on accounting conservatism. Huang et al. (2018) suggest that extreme weather is likely to influence the firms' performance. According to them, climate risk will have a negative impact on company performance due to the depreciation of fixed assets, which would lower the value of these assets and the income generated from them. Furthermore, Huang et al. (2018) claim that climate risk would increase the volatility of earnings.

All in all, extreme weather and natural disasters might have an undesirable influence on firm performance. As argued by Ding et al (2021), managers of firms in countries with a higher level of climate risk have incentives to adopt accounting policies that result in inflated reported earnings. Therefore, to mitigate the negative impact of earnings volatility and to secure their performance-based compensation, managers are prompted to engage in earnings management by adopting aggressive accounting practices in contrast to accounting conservatism (Ruch and Taylor, 2015; Gao, 2013).

Besides, performance impairment due to climate risk increases the likelihood of firms breaching debt covenants. According to the debt covenant hypothesis as noted in the positive accounting theory, the closer a firm is to breaching accounting-based debt covenants, the more likely managers are to select an accounting policy that inflates income by shifting earnings from future periods to the current period and to avoid costly covenant violations. This suggests that accounting conservatism will decrease. Given these arguments, we expect that accounting conservatism is negatively ~~associated~~ affected by ~~with~~ climate risk. That is, firms facing higher exposure to climate risk will produce less conservative accounting numbers.

To test our hypothesis, we based our analysis on cross-country data collected from 26 developing countries during the period 2007-2016. Developing countries provide an interesting context for examining the effect of climate risk on accounting conservatism for many reasons. First, developing countries are often more vulnerable to the effects of climate change. The majority of the damage caused by natural disasters is produced in these particular countries (Freeman et al., 2003). This is because they may lack the resources and infrastructure to adapt to changing weather patterns, rising sea levels, and extreme weather events. As a result, firms in developing countries may face greater climate-related risks that could affect their financial reporting practices. Second, these countries have weaker institutional infrastructure, such as legal frameworks and regulatory regimes compared to developed countries, as well as different accounting standards implementation, supervision monitoring, and cultural values (Bushman and Piotroski, 2006; Khalifa et al., 2020; Isidro et al. 2020; Klish et al. 2022). This could potentially affect the quality of financial reporting and the extent to which accounting conservatism is implemented. Therefore, studying the effect of climate risk on accounting conservatism in this context could provide insights into how firms respond to environmental risk in the absence of strong institutional infrastructure and how they incorporate climate risk into their financial reporting.

As hypothesized, we find that climate risk affects negatively both conditional conservatism and unconditional conservatism. That is, firms operating in countries with higher climate risk are likely to produce financial statements with less conservatism. We also conduct a battery of robustness analysis. Overall, the primary results remain unchanged.

Our research adds to the body of knowledge in many ways. First, we advance to the increasing body of research about the determinants of accounting conservatism, especially the literature on international differences in conservatism (Bushman and Piotroski, 2006; Ball et al., 2008; Khalifa et al. 2016). Our findings suggest that firms in countries with high climate risk use less accounting conservatism. Second, our study contributes to the accounting literature by showing that climate risk significantly affects both unconditional and conditional conservatism. To the best of our knowledge, no prior study has investigated these research issues. This study adds new evidence on the effect of climate risk on corporate business, especially on the quality of financial reporting. Because conservatism is considered a governance mechanism that enhances contracting efficiency and mitigates agency conflicts between managers and stakeholders as well as between managers and debtholders (Garcia et al. 2009, Ruch and Taylor, 2015). Consequently, our findings enhance the existing body of accounting literature by providing additional evidence regarding the adverse impacts of climate change. Specifically, our study demonstrates that climate-related risks have a detrimental effect on the accuracy and reliability of financial reporting.

The paper is organized as follows. Section 2 reviews the literature and develops the hypothesis. Section 3 discusses the research method. Section 4 presents the empirical results and Section 5 concludes.

2. Literature review and hypothesis development

The scientific community, policymakers as well as academic researchers have long recognized that climate change may have negative impacts on the socio-economic system. The literature on the effect of climate change on economic activities is well-developed (i.e. Nordhaus, 2006; Dell et al., 2009; Ding et al., 2010; Hayes and Widhalm, 2011; Dell et al., 2014; Fernández et al., 2018; Martinich and Crimmins, 2019; Scott et al., 2020; Ricke et al. 2018; Rivera and Wamsler, 2014). Today, one of the key research areas in this field is to explore the effect of climate risk on business performance. For instance, Huang et al. (2018) explore the impact of climate change on the performance and financing of listed companies. To do so, the authors use a sample of 353,906 firm-year observations from 55 countries observed between 1993 and 2012 and the Climate Risk Index as estimated and reported by Germanwatch (Kreft & Eckstein, 2014) to measure the level of climate risk. Overall, they find that climate risk harms firms' performance. They also report that companies operating in countries with higher climate risk have more volatile and are likely to hold more cash and rely on more long-term borrowing. Secinaro et al. (2020) investigate the association between climate risk and firm performance in the context of European listed firms during the period 2013-2018. They find that, that the implementation of good environmental practices has a significant positive effect on a company's financial performance.

While recent studies have focused on examining the effects of climate risk on business performance, little is known about how climate change would affect financial reporting quality. To the best of our knowledge, only Ding et al. (2021) examine the impact of extreme weather events on the quality of financial reporting. Indeed, Ding et al. (2021) examine the impact of climate risk on earnings management and test how the quality of public governance moderates this relationship. They document that in countries with higher levels of climate risk, managers have incentives to engage in earnings management. Indeed, climate risk arising from extreme weather events can result in the destruction or even loss of tangible assets (Huang et al, 2018), reducing not only the value of assets but earnings that could be generated by these assets. Therefore, to protect themselves against the negative shocks generated by extreme weather events, managers are encouraged to manipulate earnings to cover up losses that can be caused by climate risk. Furthermore, Ding et al. (2021) report that the positive relationship between climate risk and earnings management is more pronounced in countries with higher public governance quality.

We extend the study of Ding et al. (2021) by examining the effect of climate risk on another aspect of corporate financial reporting practices, namely accounting conservatism. For a long time, conservatism in accounting has been considered one of the most accounting policies that influenced financial reporting. Traditionally, accounting conservatism is characterized by the adage "anticipate no profit, but anticipate all losses" (Bliss, 1924). The extant literature offers different interpretations of this adage resulting in two distinct forms of accounting conservatism. The first form, which is commonly called conditional conservatism or news-dependent conservatism, is defined by Basu (1997) as "the accountants' tendency to require a higher degree of verification for recognizing good news than bad news in financial statements". Under this interpretation, earnings will reflect bad news more quickly than good news. Examples of conditional conservatism include the impairment write-downs for non-current and intangible assets and the adoption of the lower-of-cost-or-market accounting rule for inventory (Ruch and Taylor, 2015). The second form of accounting conservatism, namely unconditional conservatism or news-independent conservatism refers to accounting choices that bias earnings and result in the understatement of the book value of assets compared to its market value. This yields lower earnings and lower net assets without relating them to future economic events unlike conditional conservatism (Show and Whitworth, 2022). Examples of unconditional conservatism are the depreciation of property, plant, and equipment faster than economic depreciation, the immediate expensing of R&D and internally generated intangibles (Ruch and Taylor, 2015).

Theoretically, Watts (2003a) offers four explanations for accounting conservatism: (i) contracting, (ii) litigation, (iii) taxation, and (iv) regulatory. Under the contracting hypothesis, accounting conservatism is desired because it enhances the efficiency of debt contracts by mitigating conflicts of interest between bondholders and shareholders (Ahmed et al., 2002; Ball and Shivakumar, 2005; Bushman and Piotroski, 2006; Nikolaev, 2010). The litigation explanation points out that under accounting conservatism, firms are less likely to be sued. The taxation hypothesis suggests that managers have incentives to use accounting conservatism because the asymmetric timeliness recognition of losses and gains allows firms to differ in tax costs (Watts, 2003a, Qiang, 2007; Garcia-Lara et al., 2009). Finally, the regulation explanation asserts that regulators and standard-setters encourage firms to use conservative accounting reporting because when firms overstate net assets, standard-setters and regulators may face political pressure and public criticism (Watts, 2003a; Xia and Zhou, 2009).

Since the seminal work of Basu (1997) and the papers of Watts (2003a, 2003b), a research stream has developed to examine the determinants of accounting conservatism. A closer look at this empirical literature reveals that a set of factors has been examined as having an impact on accounting conservatism such as corporate governance mechanisms (Beekes et al., 2004; Ahmed and Duellman, 2007; Lafond and Roychowdhury, 2007; Lafond and Watts, 2008; Xia and Zhu, 2009; Garacia-Lara et al, 2009; Chi et al., 2009; Goh and Li, 2011; Kieschnick and Shi, 2020), national culture, religion and institutions (Pope and Walker, 1999; Ball et al, 2000; Giner and Rees, 2001; Ball et al., 2003; Ball et al., 2008; Bushman and Piotroski, 2006; Guay and Verrecchia, 2006; Salter et al, 2013; Kanagaretnam et al, 2014, Zghal et Lahmer, 2018, Ma et al. 2019), product market competition (Dhaliwal et al, 2014; Haw et al., 2015), firm's life cycle (Hansen et al. 2018), international accounting standards and economic conditions (Barth et al. 2008; Zeghal et al., 2012; Ahmed et al., 2013; André et al., 2015, Guermazi et al., 2018; Manawadu et al., 2019; Lopez et al.,2020;).

However, there is a gap in such research stream concerning the effect of climate risk on both conditional conservatism and unconditional conservatism. We expect that firms operating in countries with higher climate risk are likely to adopt less conservatism principles in producing their financial statements. As argued by Huang et al. (2018), climate risk can negatively impact the firm performance by inflicting drastic damage to fixed assets such as property, plant and equipment, decreasing not only the economic value of firm assets but also the cash flow that could have been generated by those fixed assets. Ding et al. (2021) state that extreme weather and natural disasters can destroy physical assets by accelerating the depreciation of firms' physical capital and therefore reducing the final output level, translating into an escalating decline in firms' financial performance.

Consequently, Ding et al. (2021) claimed lower financial performance caused by climate risk would encourage managers of firms operating in countries with higher climate risk to manipulate earnings for fear of losing their welfare through the adoption of more aggressive accounting policies by contrast to accounting conservatism (Watts and Zimmerman, 1986).

Furthermore, poor performance would increase the likelihood of debt covenant violations (Ding et al. 2021). However, the debt covenant hypothesis as noted in positive accounting theory points out that managers, especially when they are about the breach debt covenants, have an incentive to adopt accounting policies that result in increasing income to avoid these costly violations. This suggests that for firms operating in countries with high climate risk, managers will use less accounting conservatism. Based on the above discussion we state the following main hypothesis:

H: Climate risk affects negatively accounting conservatism levels.

3. Data and research design

3.1. Sample construction

We begin our sample construction process by extracting accounting data from Datastream. The retrieved data are used to construct the accounting conservatism measures and control variables used in our regressions. Following Huang et al. (2018) and Ding et al. (2021), we employ the Climate Risk Index (CRI) compiled and published by Germanwatch as a proxy of climate risk at the country level. Germanwatch is a non-profit organization that works on various issues related to climate change, human rights, and sustainable development. The CRI is constructed to capture the degree to which countries have experienced direct losses linked to extreme weather events such as floods, hurricanes, heatwaves and other natural disasters (Kreft and Eckstein, 2014). The CRI has been published annually since 2006, the 2021 edition being the fourteenth and most recent one. Two forms of CRI scores are compiled: (i) The long-term climate risk index and (ii) the annual index for the respective year.

The annual scores are calculated using data from two years before the edition year. For instance, the 2020 edition includes annual scores derived from data collected in 2018. The long-term indexes are based on 20 years period ending two years before the edition year. In this study, we adopt the annual scores from the 2009 to 2018 editions. Kreft and Eckstein (2014) state that the Global Climate Risk Index by Germanwatch is an assessment that relies on a highly reliable dataset encompassing the effects of extreme weather events and related socio-economic data, the MunichRe NatCatSERVICE.

The data is compiled by MunichRe, the world's leading reinsurance company. MunichRe collects data on the total losses incurred by countries worldwide due to extreme weather events (i.e. storms, floods, as well as temperature extremes and heat and cold waves), including the number of fatalities, insured damages, and overall economic damages (Kreft and Eckstein, 2014).

The construction of CRI is based on the following four factors: (1) the total number of deaths, (2) the number of deaths per 100,000 inhabitants, (3) the total losses at purchasing power parity (PPP) in U.S. dollars, and (4) losses per unit of gross domestic product (GDP).

The CRI of a country is determined by taking the average ranking of all four indicators. The absolute indicators (1) and (3) carry a weight of 1/6 each, while the relative indicators (2) and (4) carry a weight of 1/3 each. A lower ranking is associated with a higher CRI score, which corresponds to lower climate risk. Following Huang et al. (2018) and Ding et al. (2021), the resulting index is multiplied by a negative one (-1) so that lower scores will refer to lesser climate risk and vice versa.

Our final sample results from the interaction of the CRI country-level climate scores, accounting data and stock price return data from Datastream. The original dataset contains observations from more than 40 developing countries. However, by removing duplicates data, excluding financial firms (SIC codes 6000-6999) and utility industries (SIC codes 4000-4999)[3], dropping firms with a negative book value of equity and excluding firms with less than five consecutive yearly observations[4]. Moreover, the consolidation of all control variables into the same econometric model leads to a substantial reduction in the size of

[3] We exclude these firms because their financial reporting and capital structure are different from those of other firms and because of their specific regulations and different nature of business (Li, 2015; Khalifa et al. 2020).

[4] Some of the calculated variables in our model require five consecutive yearly observations.

our dataset, primarily attributable to the unavailability of data. We are left with 26 developing countries[5][6] with a maximum of 19,251 firm-year observations from the years 2007 to 2016. Table 1 describes the distribution of our sample by year for each country. Our final sample size by country varies from 14 (Morocco) and 24 (Bahrain) to 2,100 (Malaysia) and 8,622 (India).

(Insert Table 1 about here)

3.2. Accounting conservatism measures

Prior accounting literature (Basu, 1997; Ball and Shivakumar, 2005; Beaver and Ryan, 2005; Qiang, 2007, Ball et al., 2008; Rush and Taylor, 2015) has identified two distinct forms of accounting conservatism: (1) conditional conservatism, and (2) unconditional conservatism. The first form depends on economic news events and refers to an accounting system that recognizes negative economic news in earnings faster than positive economic news. That is, conditional conservatism is characterized by the asymmetric recognition of positive and negative economic news (Basu, 1997, Watts, 2003a). The second form of accounting conservatism, also named balance sheet conservatism or news-independent conservatism (Chandra, 2011), pertains to the deliberate understatement of the book value of net assets in comparison to their market value. (Beaver and Ryan, 2005).

Several measures of both forms of accounting conservatism are used in the literature (Rush and Taylor, 2015). To test the relationship between climate risk and the two types of accounting conservatism, we use the following firm-year conservatism proxies: (i) The *Cscore*, as developed by Khan and Watts (2009), (ii) the asymmetric earnings persistence measure (*PCscore*) proposed by Ball and Shivakumar (2006), (iii) a *Modified_Cscore* as constructed by Banker et al. (2016) and which deals with cost stickiness, and (iv) the skewness measure as proposed by Givoly and Hyan (2000). *Cscore*, *PCscore* and *Modifef_Cscore* are considered an extension of Basu's (1997) model, which provides the best measure of conditional conservatism (Ryan, 2006; Ball et al. 2013). However,

[5] The countries included in this study are Argentina, Bahrain, Brazil, Chile, Colombia, Egypt, Indonesia, India, Israel, Jordan, Kuwait, Sri Lanka, Morocco, Mexico, Malaysia, Nigeria, Pakistan, Peru, Philippines, Qatar, Saudi Arabia, Singapore, South Africa, Thailand, Turkey, United Arab Emirates.

[6] We use the classification of the *World Economic Situation and Prospects, Morgan Stanley Capital International (MSCI) and Standard and Poor's(S&P) for countries classification.*

skewness is used as a proxy for unconditional conservatism. This measure is a time-series measure of skewness between cash flows and earnings. According to Givoly and Hayn (2000), a significant indicator of conservatism was the disparity between reported earnings and actual economic performance, represented by cash flows. Since cash flows are not influenced by accruals, this measure of skewness is employed to assess the level of unconditional conservatism. Unconditional conservatism is increasing in Skewness.

3.2.1. Firm-year measure of accounting conservatism (Cscore; Khan and Watts, 2009)

Basu's (1997) piecewise linear regression model is considered one of the most popular measures of accounting conservatism (Ryan, 2006; Wang et al., 2009). This measure which is commonly called differential timeliness (DT), captures how good news and bad news, as measured by stock return, are asymmetrically recognized in accounting earnings. DT is calculated either at an industry-year level using a cross-section of firms or at a firm level using time-series data by estimating the following Basu's (1997) cross-sectional linear model:

$$NI_{it} = \beta_0 + \beta_1 D_{it} + \beta_2 R_{it} + \beta_3 D_{it} R_{it} + \varepsilon_{it} \quad \textbf{(1)}$$

Where NI_{it} represents net income before extraordinary items (IB) scaled by the market value of equity (MVE) at the beginning of the period for firm i in fiscal year t. R_{it} is the annual return on firm i calculated as the sum of twelve-monthly returns endings three months after the fiscal-year end t. D_{it} is a dummy variable equal to 1 if R_{it} is negative, and 0 otherwise. Under model (1) β_2 reflects the timeliness of good news recognition while β_3 relates the asymmetric timeliness of earnings in recognizing bad news compared to good news.

Based on Basu's (1997) piecewise regression model as given in Equation (1), Khan and Watts (2009) constructed a firm-year measure of accounting conservatism. Specifically, they modeled the timeliness of both bad news (Cscore) and good news (Gscore) recognition as a linear combination of firm size (SIZE), market-to-book ratio[7] (MTB) and leverage (LEV), as follows:

$$Cscore_{it} = \beta_3 = \mu_{1t} + \mu_{2t} SIZE_{it} + \mu_{3t} MTB_{it} + \mu_{4t} LEV_{it} \quad \textbf{(2)}$$

[7] MTB is the market-to-book ratio measured as the market value of equity (MVE) scaled by the book value of equity BV)

$$Gscore_{it} = \beta_2 = \theta_{1t} + \theta_{2t}SIZE_{it} + \theta_{3t}MTB_{it} + \theta_{4t}LEV_{it} \quad \textbf{(3)}$$

Substituting Equation (2) and Equation (3) into Equation (1) gives:

$$\begin{aligned} NI_{it} = \beta_0 + \beta_1 D_{it} &+ (\theta_{1t} + \theta_{2t}SIZE_{it} + \theta_{3t}MTB_{it} + \theta_{4t}LEV_{it})R_{it} \\ &+ (\mu_{1t} + \mu_{2t}SIZE_{it} + \mu_{3t}MTB_{it} + \mu_{4t}LEV_{it})D_{it}R_{it} + \delta_{1t}SIZE_{it} \\ &+ \delta_{2t}MTB_{it} + \delta_{3t}LEV_{it} + \delta_{4t}D_{it}SIZE_{it} + \delta_{5t}D_{it}MTB_{it} \\ &+ \delta_{6t}D_{it}LEV_{it} + \varepsilon_t \end{aligned} \quad \textbf{(4)}$$

Therefore, Equation (4) is estimated on an annual basis to obtain the coefficients μ_1, μ_2, μ_3 and μ_4. The estimated firm-specific measure of accounting conservatism is hence obtained as follows:

$$Cscore_{it} \equiv \hat{\beta}_{3i,t} = \hat{\mu}_{1,t} + \hat{\mu}_{2,t}SIZE_{i,t} + \hat{\mu}_{3,t}MTB_{i,t} + \hat{\mu}_{4,t}LEV_{i,t} \quad \textbf{(5)}$$

The level of accounting conservatism is increasing with the value of Cscore in Equation (5). The greater the value of Cscore, the greater the level of conditional conservatism.

3.2.2. Asymmetric earnings persistence measure (PCscore; Basu, 1997)

The second measure used in this study is based on the asymmetric persistence of negative and positive earnings. According to Basu (1997), conservatism causes earnings to represent poor economic events faster and more thoroughly than good economic events. Accordingly, he predicts that negative outcomes changes have a greater tendency to reverse in the following period than positive outcomes changes which leads to negative outcomes changes being less persistent than positive outcomes changes. Consistent with this, Basu (1997) develops the following model to measure the asymmetric persistence between negative and positive earnings:

$$\Delta NI_{it} = \beta_0 + \beta_1 DNI_{it-1} + \beta_2 \Delta NI_{it-1} + \beta_3 DN_{it-1}\Delta NI_{it-1} + \varepsilon_{it} \quad (\mathbf{6})$$

where ΔNI is the change in earnings before extraordinary items for firm i in fiscal year t over fiscal year t-1 scaled by the market value of equity (MVE) at the beginning of the fiscal year t. DNI_{it-1} is a dummy variable that is equal to one if ΔNI_{it-1} (change in earnings in the previous year) is negative and zero otherwise. According to Basu (1997), the coefficient β_2 in Equation (6) measures the persistence of positive earnings changes; however, the coefficient β_3 in Equation (6) measures the differential persistence of negative earnings changes.

To derive a firm-specific measure of conditional conservatism, consistent with Khan and Watts (2009), we estimate the following cross-sectional regressions model on an annual basis:

$$\begin{aligned}\Delta NI_{it} = \beta_0 + \beta_1 DNI_{it-1} + (\theta_{1t} + \theta_{2t}SIZE_{it} + \theta_{3t}MTB_{it} + \theta_{4t}LEV_{it})\Delta NI_{it-1} \\ + (\mu_{1t} + \mu_{2t}SIZE_{it} + \mu_{3t}MTB_{it} + \mu_{4t}LEV_{it})DNI_{it-1}\Delta NI_{it-1} \\ + \delta_{1t}SIZE_{it} + \delta_{2t}MTB_{it} + \delta_{3t}LEV_{it} + \delta_{4t}DNI_{it-1}SIZE_{it} \\ + \delta_{5t}DNI_{it-1}MTB_{it} + \delta_{6t}DNI_{it-1}LEV_{it} + \varepsilon_{it}\end{aligned} \quad \textbf{(7)}$$

Therefore, PCscore can be obtained as:

$$PCscore_{it} = \hat{\beta}_3 = \hat{\mu}_{1t} + \hat{\mu}_{2t}SIZE_{it} + \hat{\mu}_{3t}MTB_{it} + \hat{\mu}_{4t}LEV_{it} \quad \textbf{(8)}$$

Under this specification, a higher value of *PCscore* indicates a lower level of conditional conservatism, so the resulting proxy is multiplied by a negative one (-1) to make it an increasing measure of conditional conservatism.

3.2.3. Modified Cscore measure (Modified_Cscore; Banker et al., 2016)

Banker et al. (2016) propose to modify Basu's (1997) piecewise linear regression model by incorporating the effect of cost stickiness. Cost stickiness, first introduced by Anderson et al. (2003), refers to the asymmetric response of costs to sales increases versus decreases (Anderson al. 2003; Weiss, 2010; Banker et al. 2016). Banker et al. (2016) consider that the existence of cost stickiness may lead to an asymmetric relationship between earnings and stock returns. So, the estimation of the differential timeliness is likely to be biased when sticky costs are frequent.

To deal with this issue, Banker et al. (2016) suggest introducing sticky costs into the standard Basu's (1997) model as follows:

$$NI_{it} = \alpha_0 + \alpha_1 D_{it} + \alpha_2 R_{it} + \alpha_3 D_{it}R_{it} + \beta_1 DS_{it} + \beta_2 \frac{\Delta S_{it}}{P_{it-1}} + \beta_3 DS_{it}\frac{\Delta S_{it}}{P_{it-1}} + \varepsilon_t \quad \textbf{(9)}$$

where DS_{it} is a dummy variable that is equal to 1 if sales decreased from year t-1 to year t, and is equal to 0 otherwise, $\Delta S_{it}/P_{it-1}$ is the sales change from year t-1 to year t that is scaled by the market value of equity (MVE) at the beginning of the year, and the other variables are as previously defined.

Based on the same approach by Khan and Watts (2009), Ha (2019) and Ha and Feng (2018), we construct a firm-specific measure of conditional conservatism by estimating the following annual cross-sectional regression model

$$\begin{aligned} NI_{it} = \beta_{0t} + \beta_{1t}D_{it} + R_{it}(\mu_{1t} + \mu_{2t}SIZE_{it} + \mu_{3t}MTB_{it} + \mu_{4t}LEV_{it}) \\ + D_{it}R_{it}(\theta_{1t} + \theta_{2t}SIZE_{it} + \theta_{3t}MTB_{it} + \theta_{4t}LEV_{it}) \\ + (\delta_{1t}SIZE_{it} + \delta_{2t}MTB_{it} + \delta_{3t}LEV_{it} + \delta_{4t}D_{it}SIZE_{it} + \delta_{5t}D_{it}MTB_{it} \\ + \delta_{6t}D_{it}LEV_{it}) + DS_{it}(\gamma_{1t} + \gamma_{2t}SIZE_{it} + \gamma_{3t}MTB_{it} + \gamma_{4t}LEV_{it}) \\ + \frac{\Delta S_{it}}{P_{it-1}}(\gamma_{5t} + \gamma_{6t}SIZE_{it} + \gamma_{7t}MTB_{it} + \gamma_{8t}LEV_{it}) \\ + DS_{it}\frac{\Delta S_{it}}{P_{it-1}}(\gamma_{9t} + \gamma_{10t}SIZE_{it} + \gamma_{11t}MTB_{it} + \gamma_{12t}LEV_{it}) + \varepsilon_i i \end{aligned} \quad \textbf{(10)}$$

where all variables are as previously defined. The estimations of θ_1, θ_2, θ_3 and θ_4 are constant across firms but vary each year. Therefore, the modified *Cscore* can be obtained from the following equation:

$$Modified\_Cscore_{it} = \hat{\theta}_{1t} + \hat{\theta}_{2t} * SIZE_{it} + \hat{\theta}_{3t} * MTB_{it} + \hat{\theta}_{4t} * LEV_{it} \quad \textbf{(11)}$$

3.2.4. Skewness measure of unconditional conservatism

Consistent with the study of Givoly and Hyan (2000), we measure unconditional conservatism as the difference between cash flow skewness and profits skewness. The skewness of cash flows (profits) is computed as follows:

$$Skewness = \frac{(x-\mu)^3}{\sigma^3} \quad \textbf{(12)}$$

where x is the cash flows (profits), μ and σ are the mean and the standard deviation of cash flows computed over the last five years. All variables are scaled by total assets.

3.3. Econometric model and control variables

To test the effect of climate risk on accounting conservatism and consistent with previous studies (Khan and Watts, 2009; Ahmed and Duellman, 2013; Ha, 2019) we use the firm-specific measures of both conditional and unconditional conservatism estimating the following model:

$$CONSERV_{it} = \beta_0 + \beta_1 Climate\ Risk_{it} + \beta_2 Size_{it} + \beta_3 LEV_{it} + \beta_4 MTB_{it} + \beta_5 CFO_{it} + \beta_6 ROA_{it} + \beta_7 SG_{it} + \beta_8 SDROA_{it} + \beta_9 SDSALES_{it} + Year_{Fixed} + Industry_{fixed} + Country_{fixed} + \varepsilon_{it} \qquad (\mathbf{13})$$

where CONSERV is either a measure of conditional conservatism or unconditional conservatism as described in the previous section. Based on the Germanwatch methodology the final climate risk index is computed as the weighted average of the following four factors: (1) the number of deaths, (2) the number of deaths per 100000 inhabitants, (3) the total losses in U.S. dollars (at purchasing power parity (PPP)), and (4) the losses per unit of gross domestic product (GDP). In the end, the final score for each country is calculated as the weighted average ranking of the above indicators using the following rule: factors (1) and (3) take a weighting of one-sixth each, and factors (2) and (4) are weighted one-third each. A higher score leads to a lower ranking which corresponds to a lower level of climate risk. Consistent with Huang et al. (2018) and Ding et al. (2021), we multiply the obtained index by a negative one (-1) so that higher scores indicate greater climate risk.

Consistent with previous studies (i.e. LaFond and Roychowdhury, 2008; Khan and Watts, 2009; Chen et al., 2010; Ahmed and Duellman, 2013; Ha, 2019) we control for a set of factors considered to have an impact on accounting conservatism. The set of controls includes SIZE, LEV, MTB, CFOA, ROA, SG, SDROA and SDSALES.

SIZE represents the firm size and it is computed as the natural logarithm of the market value of equity at the end of the fiscal year. Khan and Watts (2009) predict that larger firms have less asymmetry information and hence less incentive to report conservatively. This was confirmed by Lafond and Watts (2008) who find that the asymmetric timeliness of earnings is smaller for large firms. LEV refers to the firm leverage and it is measured as the amount of total long-term debt divided by total assets. It is used in our model to control for the impact of debt contracting on accounting conservatism (Watts, 2003a, Khan and Watts, 2009). Indeed, firms with higher leverage are subject to more agency conflicts between shareholders and debt-holders leading to more accounting conservatism (Khan and Watts, 2009). MTB refers to the market-to-book ratio and is used to control for growth opportunity options. CFOA represents cash flows from operating activities deflated by total assets. It is included to account for the effect of a firm's profitability on conservatism in reporting (Ha, 2019). ROA is the return on assets ratio measured as pretax profit scaled by total assets to control for the effect of firm performance, as reported by Ahmed et al. (2002) and Watts (2003a, 2003b), firms with high profitability are expected to be more conservative. SG refers to sales growth which is computed as the percentage of annual growth in total sales. Sales growth is controlled because it is one of the indicators of earnings quality and increases accounts receivable or inventories which may affect accounting conservatism (Ahmed and Duellman, 2007, 2013). SDROA represents earnings volatility measured by the standard deviation of return on assets and it is considered as one of the factors that can affect accounting conservatism. Indeed, when earnings are volatile, firms are more likely to use conservative accounting to avoid overestimating their earnings. Besides, when earnings are volatile, it can be more difficult to predict accurately future financial performance or asset values leading to greater uncertainty and risk in financial reporting.

We also include operating uncertainty (SDSALES) which is measured by the standard deviation of sales. Ha (2019) suggests that operating uncertainty can affect information asymmetry between managers and shareholders as well as debtholders. All the variables used in the regression model are winsorized at 5% and 95% levels. The definitions of all variables are given in Table 2.

The model in Equation (13) is estimated using pooled ordinary least squares (OLS). However, estimating a panel model with OLS could lead to biased estimators (Petersen, 2009). To overcome this issue, we use pooled-OLS regression clustered at the firm level as suggested by Petersen (2009). Therefore, to avoid serial correlation and heteroscedasticity issues, the regression model in Equation (13) is estimated with robust standard errors clustered at the firm level.

(Insert Table 2 about here)

4. Empirical Results

4.1. Descriptive statistics and correlation

Tables 3 and 4 present descriptive statistics and the correlation matrix for our variables. Table 3 shows that the mean values of the three measures of conditional conservatism (*Cscore, PCscore and Modified_Cscore*) are 0.023, 0.045 and 0.033, respectively. These values are consistent with those reported in the study by Khalifa et al. (2019). However, the mean value of unconditional conservatism for the entire sample is 0.290. Regarding the climate risk index (CRI), we report a mean value of -0.487 and a median of -0.398 with a higher score referring to a country with a higher level of climate risk. Table 4 provides the Pearson correlations between climate risk and our four measures of accounting conservatism as well as between the tested and control variables. The annual climate risk index (CRI) is negatively correlated with Cscore, PCscore, modified_Cscore and Skewness. The values of Pearson correlation coefficients are -0.049, -0.047, -0.153 and -0.079, respectively. These univariate correlations are consistent with our prediction, that is, climate risk is negatively associated with both conditional and unconditional conservatism. Turning our attention to control variables, we find that most of them are significantly correlated, but there is no correlation above 0.5 which indicates that multicollinearity is not likely a concern[8].

(Insert Table 3 about here)

(Insert Table 4 about here)

4.2. Multivariate analysis: the effect of climate on both conditional and unconditional conservatism

Table 5 reports the estimation result of Equation (13), which models the effect of climate risk on both conditional and unconditional conservatism. Columns (1), (2) and (3) presents the regression result testing the effect of climate risk on the raw values of conditional conservatism, however, column (4) presents the effect of climate risk on the raw values of unconditional conservatism. Overall, the model fits the data well for all specifications as the values of R-squared and adjusted R-squared are quite high. For instance, the values of R-squared vary between 22% (column (4)) and 50% (columns (1-3)). The coefficient on the climate risk index (CRI) is negative and statistically significant at 1% in columns (1),

[8] We further our pairwise Pearson correlation test by calculating the variance inflation factors for each exogenous variable and find that all of them are less than 10.

(2) and (3) and at 5% in column (4). This is in line with our predictions, which suggests that climate risk increases debt covenants violation and therefore increases managers' incentives to report less conservatively. Overall, the results reported in Table 5 suggest that when firms are facing a higher degree of climate risk, the likelihood of using accounting conservatism decreases. That is, firms operating in countries with higher levels of climate risk are likely to employ more aggressive accounting reporting. This result is consistent with the findings of Ding et al. (2021) who find that climate risk motivates managers to engage in earnings management in contrast to accounting conservatism. Besides, our findings are in line with the results reported by Huang et al. (2018) who deduce that climate risk increases earnings volatility and reduces financial performance and therefore firms are motivated to use aggressive financial reporting since adopting accounting conservatism will further induce earnings volatility and decreases contemporaneous financial returns (Givoly and Hyan, 2000). That is, when firms are facing climate risk, which would produce a negative outcome, engaging in conservative financial reporting will further accelerate the negative effects of climate risk on the firm's performance. Therefore, under such circumstances, this may enhance the risk of debt contracting violations (Nikolaev, 2010, Huang et al, 2018). As a result, and facing climate risk, managers will have more incentives to use aggressive accounting practices to maximize their personnel welfare, especially their performance-based compensation.

(Insert Table 5 about here)

Turning to the control variables, the coefficient on most of them is in line with previous studies. For example, the coefficient on SIZE is consistently negative and statistically significant for all specifications, except in column (3) where the coefficient is negative but not significant. This provides evidence indicating larger firms provide less conservative financial reports than their smaller counterparts. The result is consistent with the findings of Khan and Watts (2009), supporting their argument that larger firms are likely to possess richer information environments and to be more mature which in turn helps to reduce information asymmetries and uncertainty related to future cash flows. Therefore, larger firms are likely to reduce the contracting demand for conservatism. Large companies with more divisions are also more likely to bundle gains with losses across those divisions and have more accounts and funds to smooth out (or defer) high revenues, thereby reducing the present value of their tax liability and reducing the taxation demand for conservatism (Khan and Watts, 2009).

The coefficient on leverage (LEV) is positive for conditional conservatism measures indicating that highly leveraged firms are more asymmetrically timely in recognizing bad news versus good news. The coefficient on the CFOA variable is consistently negative and statistically significant in columns (1) to (3) which indicates that firms generating large cash flows from operations on average report less conservative financial reports. The coefficient on SDSALES is consistently positive and statistically significant, meaning that firms that have high sales volatility are likely to report more conservatively, probably to reduce information asymmetry resulting from operational uncertainty (Ha, 2019).

4.3. Robustness analysis

In this subsection, we conduct a series of robustness tests to check the sensitivity of our results to other research designs.

4.3.1. Estimating the effect of climate risk using rank deciles of conservatism measures

In the previous estimation, we used the raw values of both conditional and unconditional conservatism to test the effect of climate risk on accounting conservatism. However, the firm-specific measures are obtained using other regression models, which may enhance the likelihood of errors when measuring these variables. Consistent with Chan et al (2009), Garcia et al. (2016) and Khalifa et al. (2019), to mitigate measurement error in the accounting conservatism measures, we transform the raw values of conservatism measures into rank deciles. Table 6 presents the estimation of the effect of climate risk on accounting conservatism using rank deciles of conservatism measures. Overall, the findings are quantitatively unchanged.

(Insert Table 6 about here)

4.3.2. Panel data regression: fixed and random effects models

In the previous estimations, we used the pooled OLS approach. Despite the notoriety of this method in empirical literature to estimate cross-sectional regression models, the pooled OLS can suffer from serious problems especially when dealing with time-invariant heterogeneity. Since our dataset is in the form of panel results, it's crucial to employ panel regression techniques. Baltagi (2005) argues that when the sample takes the form of panel data, pooled OLS are likely to produce biased estimations. We re-estimate our baseline regression using a fixed effects (FE) model to minimize possible bias due to time-invariant unobservable heterogeneity. FE models are commonly used in the empirical literature because they allow the introduction of unobservable firm-fixed specific factors in the econometric model (Wooldridge, 2002). However, the fixed effect model may have certain drawbacks. For example, Baltagi (2005, p.4) stipulates the FE model produce inconsistent estimators where there is a large number of firms 'N' and a fixed small time 'T', which is the case of our study (N =4640 firms, and T = 10) (Wooldridge, 2002, p. 286). So, consistent with Baltagi and Wu (1999), we also estimate our model using the generalized least square (GLS) random effect (RE) technique as an alternative approach to the FE model. Table 7 reports the estimation results. All in all, the results show that the findings are quantitatively unchanged indicating that our baseline results are robust to the estimation approaches.

(Insert Table 7 about here)

5. Conclusion

Our paper expands on the economic effects of climate change. Policymakers are warned about the exposure of firms to risks associated with natural disasters and extreme weather such as storms, floods, heat waves, and heavy rainfalls. While many studies have focused on examining the effect of climate risk on socio-economic behavior, little is known about how climate risk may affect firms' financial reporting. To fill this gap, we investigate the effect of climate risk on accounting conservatism. To do so, we use a sample of non-financial firms operating in 26 developing countries during the period 2007-2016 and find that climate risk affects negatively both conditional conservatism and unconditional conservatism. That is, firms operating in countries with higher climate risk are more likely to use less conservative financial reporting. Our findings are robust to alternative research designs.

The findings of our study may be of interest to policymakers and standard-setters. The negative impacts of climate risk on the quality of financial reporting as proxied by accounting conservatism could trigger regulators and standard setters to require disclosure of information relating to climate risks and to incorporate climate-related risks in their risk management systems. Besides, standard setters such as Financial Accounting Standards Board may include the potential effect of climate risk in their international standards.

Despite the importance of our results presented in this research, it is necessary to acknowledge the existence of certain limitations that may present opportunities for future investigations. For instance, our sample is limited to 26 developing countries, and it would be interesting to extend the research scope to other countries with different institutional frameworks. Additionally, it is important to consider that the impact of climate risk on accounting conservatism might be influenced by several other factors, such as public governance quality and cultural values. Moreover, the current study involves firms from a variety of industries, and while the analysis controls for this by employing industry fixed effects, this method may not fully account for the effect of industry heterogeneity. Thus, exploring the influence of climate risk on accounting conservatism across various industries would be worthwhile[9]. Notably, previous studies have demonstrated that accounting conservatism levels can significantly vary across different sectors of activity (Khalifa et al., 2016).

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Table 1: Distribution of the number of firm-year observations

Country	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total firms	% firms
Argentina	0	0	0	1	3	2	31	39	38	22	136	0.71%
Bahrain	0	0	1	2	4	4	4	3	3	3	24	0.12%
Brazil	0	0	1	1	1	1	3	34	40	49	130	0.68%
Chile	0	0	0	0	0	0	66	73	63	71	273	1.42%
Colombia	0	0	0	0	0	4	13	14	14	9	54	0.28%
Egypt	0	0	2	6	11	28	39	0	45	40	171	0.89%
Indonesia	2	4	1	0	2	24	127	161	187	125	633	3.29%
India	244	306	376	446	971	1,175	1,255	1,256	1,206	1,387	8,622	44.79%
Israel	3	5	8	28	58	68	83	87	89	93	522	2.71%
Jordan	1	2	3	5	11	10	15	15	12	12	86	0.45%
Kuwait	0	7	13	24	33	36	36	36	32	28	245	1.27%
Sri-Lanka	9	12	14	19	18	20	21	22	25	22	182	0.95%
Morocco	0	0	0	0	2	2	4	1	3	2	14	0.07%
Mexico	1	1	2	4	11	15	44	44	43	29	194	1.01%
Malaysia	1	1	2	18	77	113	374	534	497	483	2,100	10.91%
Nigeria	0	2	4	6	15	16	18	14	15	7	97	0.50%
Pakistan	43	44	47	54	62	24	63	67	67	67	538	2.79%
Peru	0	0	0	0	1	2	31	29	29	11	103	0.54%
Philippines	0	2	4	10	16	18	71	97	102	60	380	1.97%
Qatar	0	3	5	11	13	14	18	19	19	17	119	0.62%
Saudi Arabia	0	4	3	8	22	34	56	66	73	71	337	1.75%
Singapore	0	2	2	14	24	114	258	343	326	282	1,365	7.09%
Thailand	10	5	3	3	4	21	223	254	257	246	1,026	5.32%
Turkey	3	6	75	117	146	152	159	163	163	120	1,104	5.73%
South Africa	15	9	14	34	40	57	93	133	139	120	654	3.40%
United Arab Emirates	0	2	6	9	12	13	23	25	26	26	142	0.74%
Total firms	332	417	586	820	1,557	1,967	3,128	3,529	3,513	3,402	19,251	100

Table 2: Variable definitions

Variables	Definitions
Climate risk index	
CRI	Climate Risk Index (CRI) taken from Germanwatch's 2009–2018 annual editions (for the years 2007–2016) scaled by (-1). Higher score indicates higher Climate risk (Huang et al., 2018; Ding et al., 2021)
Conditional Conservatism Measures	
Cscore	Firm-year specific measure of conditional conservatism based on the Basu's (1997) model and obtained following the Khan and Watts (2009) approach.
PCscore	Firm-year specific measure of conditional conservatism based on the asymmetric persistence of negative and positive earnings (Basu's, 1997; Khan and Watts, 2009)
Modified_Cscore	Firm-year specific measure of conditional conservatism based on the modified Basu's (1997) model as suggested by Banker et al. (2016) and which is calculated following the Khan and Watts (2009) approach.
Skewness	A proxy for unconditional conservatism computed as the difference between cash flow skewness and earnings skewness (Givoly and Hayn,2000).
Conservatism Models Specifications	
NI	Net income before extraordinary items divided by market value of equity at beginning of fiscal year (Basu, 1997; Khan and Watts, 2009)
MVE	Market value of equity at the end of a given fiscal year, defined as number of shares outstanding times closing price available for the last month of the fiscal year (Khan and Watts, 2009).
BV	Book value of equity at the end of a given fiscal year. (Khan and Watts, 2009).
R	R is the annual return calculated as the compound of twelve-monthly returns endings three months after the end of the fiscal year. (Basu, 1997; Khan and Watts, 2009)
D	A dummy variable that is equal to one if R is negative, zero otherwise. (Basu, 1997; Khan and Watts, 2009).
Firm-level Control Variables	
SG	Sales growth is the percentage of annual growth in the firm's total net sales. (Ahmed and Duellman, 2007, 2013)
SIZE	Firm size, defined as the natural logarithm of market value of equity. (Khan and Watts, 2009; Lafond and Watts, 2008).
MTB	Market-to-book ratio is end-of-year market value of equity scaled by book value of equity. (Khan and Watts, 2009).
LEV	Leverage is defined as total debt deflated by market value of equity. (Khan and Watts, 2009; Watts, 2003a).
ROA	Profitability computed as the ratio of net income to total assets. (Ahmed et al., 2002, Watts, 2003a)
CFOA	Cash-flow from operations divided by total assets. (Ha, 2019)
SDSALES	Sales variability is computed as the standard deviation of rolling 5-year sales revenues scaled by total assets (Garcia et al., 2007)
SDROA	Profitability volatility computed as the standard deviation of rolling 5-year return on assets (Garcia et al., 2007)

Table 3: Descriptive statistics

Variables	N	Mean	Std. Dev	Median	Q1	Q3	Min	Max
CRI	19222	-0.487	0.338	-0.398	-0.655	-0.183	-1.170	-0.127
Cscore	19251	0.023	0.054	0.027	-0.007	0.055	-0.090	0.128
PCscore	13605	0.033	0.077	0.038	-0.017	0.095	-0.166	0.196
Modified_Cscore	19251	0.045	0.068	0.033	0.001	0.080	-0.074	0.197
Skewness	14563	0.290	1.421	0.000	-0.348	0.707	-2.467	3.692
SG	14512	0.143	0.274	0.117	-0.038	0.287	-0.320	0.786
SIZE	19251	4.642	1.944	4.547	3.140	6.029	1.416	8.355
MTB	19251	1.767	1.610	1.179	0.644	2.240	0.283	6.353
LEV	19251	0.847	1.178	0.355	0.066	1.069	0.000	4.425
ROA	19251	0.072	0.069	0.066	0.030	0.112	-0.063	0.223
CFOA	19251	2.564	8.050	0.073	0.006	0.173	-0.227	33.660
SDSALES	14572	0.124	0.101	0.094	0.047	0.169	0.011	0.385
SDROA	14572	0.040	0.035	0.029	0.014	0.053	0.004	0.136

Note: This table provides descriptive statistics for our main variables. We report the number of observations (N), the mean value, the standard deviation (Std. Dev), the first quartile (Q1), the third quartile (Q3), the minimum (Min) and the maximum (Max). Variable definitions are given in Table 2.

Table 4: Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13
Cscore: 1	1.000												
Modified_Cscore:2	0.712***	1.000											
	(0.000)												
PCscore:3	-0.011	0.010	1.000										
	(0.206)	*(0.243)*											
Skewness:4	-0.140***	-0.053***	0.155***	1.000									
	(0.000)	*(0.000)*	*(0.000)*										
CRI:5	-0.049***	-0.047***	-0.153***	-0.079***	1.000								
	(0.000)	(0.000)	(0.000)	(0.000)									
SIZE:6	-0.513***	-0.430***	-0.216***	-0.000	0.155***	1.000							
	(0.000)	(0.000)	(0.000)	(0.959)	(0.000)								
MTB:7	-0.241***	-0.407***	0.062***	-0.045***	-0.070***	0.482***	1.000						
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)							
LEV:8	0.228***	0.289***	0.267***	0.041***	-0.175***	-0.376***	-0.362***	1.000					
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)						
SG:9	-0.059***	-0.154***	0.082***	-0.126***	-0.030***	0.159***	0.170***	-0.088***	1.000				
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)					
CFOA:10	-0.377***	-0.198***	0.362***	0.334***	0.018**	0.259***	0.097***	-0.100***	0.091***	1.000			
	(0.000)	(0.000)	(0.000)	(0.000)	(0.011)	(0.000)	(0.000)	(0.000)	(0.000)				
ROA:11	-0.172***	-0.223***	-0.072***	-0.191***	-0.083***	0.348***	0.388***	-0.315***	0.245***	0.107***	1.000		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)			
SDROA:12	0.028***	0.003	-0.012	0.026***	0.056***	-0.083***	0.041***	-0.071***	-0.079***	-0.042***	-0.063***	1.000	
	(0.001)	(0.717)	(0.215)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
SDSALES:13	0.093***	0.053***	0.035***	0.016*	-0.107***	-0.142***	0.050***	0.037***	0.019**	-0.065***	0.014	0.216***	1.000
	(0.000)	(0.000)	(0.000)	(0.056)	(0.000)	(0.000)	(0.000)	(0.000)	(0.021)	(0.000)	(0.092)	(0.000)	

Note: This table reports Person correlation coefficients between variables used in the regression model. The value between parentheses refers to the P-values of the correlation test. (*), (**), and (***) represent significance at 10%, 5%, and 1%, respectively. Variable definitions are given in Table 2.

Table 5: The effect of climate risk on both conditional and unconditional conservatism

	Conditional conservatism			Unconditional conservatism
	(1)	(2)	(3)	(4)
	Cscore	PCscore	Modified_Cscore	Skewness
Constant	0.094***	0.104***	0.085***	0.516**
	(16.49)	*(17.13)*	*(7.79)*	*(2.87)*
CRI	-0.012***	-0.011***	-0.016***	-0.183**
	(-6.15)	*(-5.03)*	*(-3.27)*	*(-2.36)*
SIZE	-0.015***	-0.013***	-0.000	0.031***
	(-49.75)	*(-46.89)*	*(-0.14)*	*(3.30)*
MTB	0.001***	-0.004***	-0.012***	0.007
	(2.86)	*(-15.38)*	*(-14.56)*	*(0.82)*
LEV	0.003***	0.000	0.052***	-0.054***
	(8.62)	*(1.53)*	*(34.40)*	*(-5.04)*
SG	-0.002	-0.000	-0.002	-0.527***
	(-1.81)	*(-0.32)*	*(-0.64)*	*(-12.52)*
CFOA	-0.065***	-0.028***	-0.042***	5.814***
	(-20.03)	*(-13.55)*	*(-6.83)*	*(33.02)*
ROA	0.001	0.006	-0.001	-5.110***
	(0.15)	*(1.19)*	*(-0.10)*	*(-27.70)*
SDROA	-0.011	0.008	0.004	0.373
	(-1.35)	*(0.94)*	*(0.20)*	*(1.18)*
SDSALES	0.0016***	0.002****	0.0044***	0.017*
	(6.04)	*(5.16)*	*(5.01)*	*(1.76)*
Country fixed effects	*included*	*included*	*included*	*included*
Industry fixed effects	*included*	*included*	*included*	*included*
Year fixed effects	*included*	*included*	*included*	*included*
N	14,464	14,464	10,579	14,457
R^2	0.494	0.466	0.478	0.219
adj. R^2	0.492	0.464	0.475	0.216

Note: the values in parentheses refer to t-statistics which are estimated with standard errors clustered at the firm level consistent with Petersen (2009). Variable definitions are given in Table 2. (***) and (**) represent significance levels of 1% and 5%, respectively.

Table 6: Estimating the effect of climate risk on accounting conservatism using rank deciles

Independent variables	Conditional conservatism			Unconditional conservatism
	(1)	(3)	(2)	(4)
	Cscore_Rank	PCscore_Rank	Modified_Cscore_Rank	SKEWNESS_RANK
Constante	11.160***	5.700***	11.748***	6.625***
	(38.73)	*(15.39)*	*(42.19)*	*(17.46)*
CRI	-1.156***	-0.746***	-0.827***	-0.477***
	(-9.28)	*(-4.80)*	*(-6.87)*	*(-2.93)*
SIZE	-1.011***	0.096***	-0.925***	0.084***
	(-65.76)	*(4.40)*	*(-62.26)*	*(4.16)*
MTB	0.145***	-0.329***	-0.328***	0.009
	(10.51)	*(-14.33)*	*(-24.61)*	*(0.49)*
LEV	0.290***	2.140***	-0.145***	-0.073***
	(16.88)	*(60.46)*	*(-8.72)*	*(-3.26)*
SG	-0.012	0.206*	0.048	-1.153***
	(-0.17)	*(2.33)*	*(0.73)*	*(-13.01)*
CFOA	-0.035***	-0.058***	-0.046***	0.091***
	(-12.30)	*(-15.86)*	*(-16.89)*	*(24.58)*
ROA	-0.133	-1.601***	-0.207	-12.083***
	(-0.45)	*(-4.11)*	*(-0.72)*	*(-31.08)*
SDROA	-0.621	-0.589	0.334	1.553**
	(-1.23)	*(-0.89)*	*(0.68)*	*(2.34)*
SDSALES	0.001***	0.001***	0.001***	0.000
	(7.41)	*(4.92)*	*(8.57)*	*(1.54)*
Country fixed effects	*included*	*included*	*included*	*included*
Industry fixed effects	*included*	*included*	*included*	*included*
Year fixed effects	*included*	*included*	*included*	*included*
N	14,464	10,579	14,464	14,457
R^2	0.503	0.397	0.532	0.135
adj. R^2	0.502	0.394	0.531	0.132

Note: the values in parentheses refer to t-statistics which are estimated with standard errors clustered at the firm level consistent with Petersen (2009).Cscore_Rank, PCscore_Rank, Modified_Cscore_Rank and SKEWNESS_RANK are rank deciles of conservatism measures. Variable definitions are given in Table 2. (***) and (**) represent significance levels of 1% and 5%, respectively.

Table 7: The effect of climate risk on accounting conservatism: Panel regression

	Cscore		Modified_Cscore		PCscore		Skewness	
	FE	GLS_RE	FE	GLS_RE	FE	GLS_RE	FE	GLS_RE
Constante	0.102^{***}	0.095^{***}	0.124^{***}	0.123^{***}	0.002	-0.011^{**}	0.728^{***}	0.731^{***}
	(12.38)	*(47.32)*	*(18.87)*	*(90.62)*	*(0.14)*	*(-3.22)*	*(4.56)*	*(15.03)*
CRI	-0.012^{***}	-0.003^{***}	-0.012^{***}	-0.006^{***}	-0.015^{**}	-0.007^{***}	-0.369^{***}	-0.464^{***}
	(-5.81)	*(-4.84)*	*(-5.26)*	*(-8.77)*	*(-2.90)*	*(-3.50)*	*(-5.91)*	*(-13.30)*
SIZE	-0.015^{***}	-0.015^{***}	-0.021^{***}	-0.014^{***}	-0.017^{***}	-0.000	0.076^{**}	-0.003
	(-10.54)	*(-51.78)*	*(-16.32)*	*(-49.57)*	*(-4.75)*	*(-0.57)*	*(2.16)*	*(-0.31)*
MTB	-0.001	0.001^{**}	-0.002^{***}	-0.004^{***}	-0.003	-0.012^{***}	-0.027	0.007
	(-1.79)	*(2.30)*	*(-3.08)*	*(-15.91)*	*(-1.62)*	*(-14.95)*	*(-1.43)*	*(0.73)*
LEV	-0.006^{***}	0.003^{***}	-0.005^{***}	0.001^{**}	0.042^{***}	0.052^{***}	0.018	-0.028^{**}
	(-5.86)	*(8.71)*	*(-6.05)*	*(2.13)*	*(12.43)*	*(35.37)*	*(0.71)*	*(-2.49)*
SG	-0.002	-0.002	0.001	0.000	-0.005	-0.001	-0.305^{***}	-0.576^{***}
	(-1.03)	*(-1.94)*	*(0.81)*	*(0.02)*	*(-1.30)*	*(-0.27)*	*(-6.13)*	*(-13.63)*
CFOA	-0.065^{***}	-0.067^{***}	-0.026^{***}	-0.030^{***}	-0.015^{*}	-0.044^{***}	6.911^{***}	6.197^{***}
	(-17.32)	*(-20.50)*	*(-10.44)*	*(-14.82)*	*(-1.94)*	*(-7.40)*	*(48.61)*	*(42.15)*
ROA	-0.020^{**}	-0.000	0.024^{**}	0.007	0.054^{**}	-0.003	-12.899^{***}	-4.764^{***}
	(-1.96)	*(-0.06)*	*(2.52)*	*(1.27)*	*(2.27)*	*(-0.21)*	*(-36.90)*	*(-22.36)*
SDROA	0.021	-0.006	0.058^{***}	0.008	-0.037	0.003	2.422^{***}	1.059^{***}
	(0.97)	*(-0.72)*	*(2.59)*	*(0.97)*	*(-0.70)*	*(0.16)*	*(3.55)*	*(3.11)*
SDSALES	0.000^{***}	0.000^{***}	0.000	0.000^{***}	0.000^{***}	0.000^{***}	0.001^{***}	0.000^{**}
	(2.89)	*(5.90)*	*(0.96)*	*(5.27)*	*(3.33)*	*(5.32)*	*(5.17)*	*(2.45)*
Country fixed effects	*included*	*included*	*included*	*included*	*included*	*included*	*included*	*included*
Industry fixed effects	*included*	*included*	*included*	*included*	*included*	*included*	*included*	*included*
Year fixed effects	*included*	*included*	*included*	*included*	*included*	*included*	*included*	*included*
N	14,464	14,464	14,464	14,464	10,579	10,579	14,457	14,457
R^2	0.321	0.4924	0.228	0.4630	0.398	0.4739	0.331	0.1902

Note: the values in parentheses refer to t-statistics which are estimated with standard errors clustered at the firm level consistent with Petersen (2009). Variable definitions are given in Table 2. (***) , (**) and (*) represent significance levels of 1%, 5% and 10%, respectively.