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Dividends in the storm: Navigating firm-level climate change risk exposure

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ABSTRACT

Exploiting a cross-country sample of 3213 firms operating in 28 countries during the period 2002–2020, we find that firm-level climate change exposure is negatively associated to firms' dividend policy. Based on the precautionary behaviour of firms, we find that stock market volatility and systematic risk are two economic channels explaining the negative effect of climate change risk on dividends. Robust to additional tests and quasi-natural experiments built around three major natural disasters, we confirm that climate change risk directly harms the dividend distribution. Taken together, our evidence suggests that shareholders should consider the dividend reduction potential effect associated with firm-level climate change.

1. Introduction

According to the results of the 27° Annual Global CEO Survey of Pwc (2024), only 45% of CEOs included climate change into financial planning, or are working in this direction, while the 31% have not yet planned to include it. However, climate risk consistently ranks among the top five threats to their business and financing.

Climate change introduces new business risks that can impair firms' performance and profitability. These risks operate through two main channels: physical risks and transition risks. Physical risks arise from changes in average temperatures and the increasing frequency and intensity of extreme weather events, which can disrupt supply chains, hinder business operations, reduce asset values and earnings, and raise operating costs, thereby threatening firms' long-term sustainability. Transition risks stem from societal and regulatory responses to climate change, as evolving technologies, markets, and climate policies may increase compliance costs, undermine the viability of existing products and services, and devalue firms' investments. Together, these risks affect firms' financial performance, increase uncertainty about future returns, and amplify the financial risks associated with long-term investments such as innovation and research and development (R&D) (Ginglinger, 2020; EIB, 2021; Li et al., 2024).

A rapidly growing body of literature explores the implications of climate risk for corporations, examining its impact on the cost of equity capital (Huynh et al., 2020), on the capital structure (Ginglinger and Moreau, 2023), the reallocation of information-processing resources by institutional investors (Blanco et al., 2024), firms' investment and financing decisions (Benincasa et al., 2024), workplace gender diversity (Altunbas et al., 2022), the behavior of socially responsible investment (SRI) funds (Heath et al., 2023), working capital (Ahmad et al., 2023) and the real effects of climate regulation (Bartram et al., 2022; Li et al., 2022). Our paper contributes to this literature by investigating the relationship between firm-level climate change risk and corporate dividend policy distribution.

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Literature relies on the premises of the agency theory to explain the dividend increase hypothesis, affirming the crucial role played by dividends in compelling managers to address climate change, whereas hinges on the so-called precautionary motive to explain the dividend reduction hypothesis, emphasizing the importance of dividends as a precautionary measure against climate change events.

Empirical literature addressing the linkage between firm-level climate change risk and corporate dividend policy is scant and finds overall mixed results. Two studies analyse the impact of climate change on dividends distribution in terms of climate policy uncertainty. The former highlights tax avoidance practices whose cash savings are used to pay dividends (Amin et al., 2023) whereas the latter finds a positive relationship with dividend payouts (Ayed et al., 2024). Other two studies address specifically firm-level climate change risk. The former finds a mitigating effect of higher dividends with respect to the negative impact of firm-level climate change risk to firm value (Ongsakul et al., 2023) whereas the latter finds a negative relationship between firm-specific exposure and the propensity to pay dividends (Ongsakul et al., 2024).

The limited and mixed evidence on dividends is particularly relevant in light of growing concerns raised by institutional investors. Recent initiatives stress that investors have a direct interest in the capital strength and dividend-paying capacity of companies, and increasingly expect them to disclose how climate-related risks and scenarios are incorporated into financial statements when assessing dividend capacity, as well as whether alternative climate pathways could materially affect this assessment (Institutional Investors Group on Climate Change, 2025). In this context, our study of the relationship between firm-level climate change risk and corporate dividend policy addresses a timely and relevant gap in the literature while responding to increasing demands from institutional investors.

Then, our paper advances the analysis by focusing on how idiosyncratic and systematic risk shape the relationship between firm-level climate change risk and corporate dividend policy.

From both a theoretical and practical perspective, dividend policy is closely linked to firms' risk exposure. According to the bird-in-the-hand theory (Gordon, 1962), investors value stable dividend payments more than uncertain future capital gains, particularly in risky environments, while interpretations of signaling and agency cost theories suggest that heightened uncertainty may weaken the efficacy of dividend signals and strengthen managers' incentives to retain earnings for precautionary motives (Bhatta and Duwal, 2021). It therefore becomes relevant to incorporate idiosyncratic and systematic risk into the relationship between climate risk and dividends, as these risks represent key economic channels through which climate risk affects dividends decisions. Doing so allows managers to make more informed dividend policy choices in the presence of competing theoretical predictions (i.e. either maintaining dividends to reassure markets or retaining earnings to preserve financial flexibility) while also enabling investors to make more rational and effective investment decisions by better assessing how climate-related risks influence firms' ability to sustain dividend payments.

Our contribution with respect to the existing literature is threefold. First, whereas prior studies focus predominantly on U.S. firms, we examine a large international sample of 3213 firms operating in 28 countries, which allows us to exploit greater cross-country heterogeneity in both climate-related exposures and dividend policies. Second, to address potential endogeneity concerns, we identify the causal effect of climate change risk on dividends by exploiting natural disasters in a quasi-natural experiment approach. Third, we advance the analysis by showing that the effect of climate change risk on dividends operates through market-based risk channels (i.e. volatility and systematic risk) helping to disentangle the competing predictions of classical dividend theories and to clarify the mechanism linking climate risk to firms' payout decisions.

The rest of the paper is organized as follows. Section 2 discusses the related literature and present our hypotesis; Section 3 describes the dataset; Section 4 presents the baseline specification; Section 5 presents the results; Section 6 provides some robustness checks; and Section 7 concludes.

2. Literature review

The relationship between firm-level climate change risk and corporate dividend policy is usually represented in literature by the dividend increase and dividend reduction hypotheses (Ongsakul et al., 2024).

Hereafter, we review the empirical evidence, starting with studies supporting the dividend increase hypothesis, which examine dividend responses to climate policy uncertainty and firm-level climate change exposure.

With regard to the former, Amin et al. (2023) explore the impact of climate policy uncertainty on the interlink between tax avoidance and corporate dividend policy employing a sample of publicly traded US firms over the period 2000–2022 to document a negative relationship between the Gavriilidis' (2021) index of climate policy uncertainty and effective tax rates. They suggest that the cash savings from lower tax payments are used to pay dividends and not retained for reinvestments, in line with the dividend increase hypothesis.

Also Ayed et al. (2024) use Gavriilidis' (2021) measure of climate policy uncertainty and a sample of US publicly traded firms over the period 1987–2022 finding a positive relationship between climate policy uncertainty and dividend payouts, in line with the dividend increase hypothesis. The authors emphasize their contribution of focusing on climate policy uncertainty claiming its difference with firm-level climate risk as the former stems from government actions that are exogenous and beyond managerial control.

With respect to studies addressing the link between firm-level climate change risk and dividends distribution, Ongsakul et al. (2023) recognize and incorporate the claim expressed by Ayed et al. (2024) in their study on the relationship between climate change exposure and firm value. Using a sample of US firms over the period 2001–2019, they use climate policy uncertainty to generate exogenous variation in firm-specific vulnerability in an instrumental-variable analysis finding that the reduction in firm value associated with firm-specific exposure, measured using Sautner et al. (2023)'s data, is significantly less evident for firms that pay high dividends, coherently with the dividend increase hypothesis.

In contrast to the evidence supporting dividend increases, other studies find dividend decreases linked to periods of heightened uncertainty following exogenous shocks and to higher firm-level climate change exposure.

As regards the former, Hauser (2013) shows that during the 2008–2009 financial crisis firms were significantly less likely to pay dividends and more likely to cut them, even after controlling for their financial conditions, indicating a shift in dividend policy in response to heightened uncertainty. Similarly, Krieger et al. (2021) document that during the recent pandemic U.S. firms across all sectors substantially increased dividend cuts and omissions, highlighting how large adverse shocks affect corporate dividend decisions.

Similarly, but with a specific focus on firm-level climate change risk, Ongsakul et al. (2024) recently focused on the interlink between firm-specific exposure, measured using Sautner et al. (2023)'s data, and corporate dividend policy finding that an increase in firm-specific exposure by one standard deviation weakens the propensity to pay dividends by 5.11%.

These empirical findings supporting both a positive and negative relationship between firm-level climate change risk and dividends distribution are underpinned by theoretical arguments that we discuss hereafter.

The dividend increase hypothesis is supported by the governance role of dividends that commits managers to implement adequate strategies to counter the adverse impact of climate risk, in line with the premises of the agency theory (Fama and Jensen, 1983; Jensen and Meckling, 1976). The governance role consists with: i) reducing management's free cash flow that might be allocated for personal gain rather than increasing shareholder's value (Grossman and Hart, 1980; DeAngelo et al., 2006); and ii) increasing the need of issuing new shares, therefore, subjecting firms to stricter scrutiny by capital markets. Both solutions explain how higher dividends, as a governance tool, reduce agency conflicts (Attig et al., 2021) and compel managers to properly address climate change risk.

The dividend increase hypothesis is also supported by the dividend signalling theory (Deng et al., 2024) that grounds on the assumption that higher firm-level climate change risk foster information asymmetry between managers and shareholders as the former have a clearer picture of the firm's exposure to climate risk which is, in turn, not fully disclosed to investors. The resulting misalignment between managers and shareholders could lead to an inefficient allocation of resources and a discount on the value of equity. The dividend signalling theory posits, therefore, that a higher exposure to climate change risk would require a signal from the firm, in the form of higher dividends, to reduce information asymmetries.

Conversely, the dividend reduction hypothesis is supported by the so-called precautionary motive which posits that firms reduce dividends to address climate change risk as: i) they accumulate cash buffers to protect against unpredictable events; ii) the investments undertaken to tackle climate change reduce their ability and/or willingness to pay dividends; iii) they prefer to preserve cash and avoid distributing dividends to offset the higher external financing costs caused by the investors' fragile perception of highly exposed firms. With regard to the latter point, the cash conservation hypothesis emphasizes the difficulties faced by firms in securing external financing from equity and debt markets due to high climate change risk exposure and posits that firms respond accumulating cash by reducing corporate tax payments through a decrease in effective tax rates (Amin et al., 2023).

Additionally, from a capital standpoint, reducing dividends allows firms to strengthen their equity base and thereby: i) undertake investments to mitigate climate change risk; ii) enhance their capital ability to absorb losses stemming from climate-related shocks; and iii) lower funding costs, as better-capitalized firms are perceived as less risky.

Given the recent and limited empirical literature with opposite results, that is largely based on US firms and relies on standards empirical designs, we deem important to further investigate the relationship between firm-level climate change risk and corporate dividend policy using a broader international sample and a more rigorous identification strategy. Hence, we hypothesize, on the one hand, a positive relationship, supported by the dividend increase hypothesis, where dividends play a governance role by compelling managers to address climate change risk, and, on the other hand, a negative relationship, supported by the dividend reduction hypothesis, where firms reduce dividends to build cash reserves, to undertake climate-related investments, and offset costly external financing as investors perceive firms more exposed to climate change as riskier.

In short, we formally elaborate the following research question:

H1. The higher (lower) climate-change risk and the lower (higher) dividend distribution

3. Data and sample

The dataset consists of listed non-financial firms retrieved from Refinitiv database for which the climate change risk (*CCRisk)* measure provided by Sautner et al. (2023) is available, during the period 2002–2020. The final sample accounts for 3213 firms operating in 28 countries worldwide. Following Sautner et al. (2023), we use the natural logarithm of the *CCRisk* in the regression. As for the dependent variables, we strictly follow Hossain et al. (2023), taking the natural logarithm of the total amount of firm-level dividends.[1] In Table 1 we illustrate the definition and data source of all variables used. Similarly, Table 2 reports the descriptive statistics of all variables in the sample, while Fig. 1 shows the trend of both *dividends* and *CCRisk* during the period of interest. The trends are coherent with previous literature (Sautner et al., 2023).

Fig. 1 shows that firms' dividends to total asset grew during the period 2003–2008, while dropped significantly during the eruption of the 2008–2012 global financial crises (GFC). Similarly, after the GFC, firms' dividends grew until the 2020 Covid-19 crisis, when their remarkable contraction signalled the precautionary behaviour adopted by firms to face the pandemic uncertainty. Their trend seems to suggest a precautionary behaviour by worldwide firms that are prone to reduce dividends' distribution during financial and

[1] As in Hossain et al. (2023), we also use alternative measures of dividends, such as the dividend to cash ratio and the dividend to sales ratio. Results are shown in robustness test section.

Table 1
Variable definition and data source.

	Definition	Source
Dividends	Natural logarithm of firm dividends. Log (1+Dividends).	Refinitiv
CCRisk	Natural logarithm of CCRisk. Log (1+CCRisk).	Sautner et al. (2023)
Size	Natural logarithm of total asset (USD)	Refinitiv
Ebit_ta	Earnings before interest and taxes divided by total assets.	
PPE_ta	Property, plant, and equipment divided by total assets.	
Lev	Sum of the book value of long-term debt and short-term debt divided by total assets.	
Ato	Total revenues divided by total assets.	
Liq	Total cash divided by total assets	
GDP_Grw	Gross domestic product annual growth rate	World Bank
Infl_GRW	Inflation annual growth rate	

This table sows the definition and data source of all variables used in the sample.

Table 2
Descriptive statistics.

	Mean	p50	sd	p25	p75
Dividends	.7061	.1310	1.225	0	.7975
CCRisk	.4519	.2632	.5638	.0911	.5776
Size	7.301	7.332	2.108	5.878	8.711
Ebit_ta	.0290	.0583	.1772	.0153	.1042
PPE_ta	.3179	.2581	.2564	.1030	.4794
Lev	.2540	.2212	.2222	.0622	.3831
Ato	.0084	.0069	.0084	.0035	.0112
Liq	.1773	.0955	.2054	.0353	.2360
GDP_Grw	.0319	.0270	.0349	.0169	.0501
Infl_Grw	.0254	.0208	.0221	.0126	.0322

This table shows the descriptive statistics of all variables used in the sample.

non-financial turmoil. With respect to the trend of CCRisk, it is in line with Sautner et al. (2023), showing high variability alongside the 2002–2020 period and a remarkable drop after the 2015, which may intuitively correspond to the effect of the Paris Agreement.

4. Baseline specification

To test whether firm climate change risk affects dividends policy, we use the following OLS model:

$$Dividends_{i,t} = c + \beta_1 CCRisk_{i,t-1} + \gamma' X_{i,t-1} + ind_i * time_t + country_i + \varepsilon_{i,t} \quad (1)$$

where *Dividends* measures the natural logarithm of total firms' dividends at time t ($t = 2002, \ldots, 2020$); $CCRisk_{i,t}$ is firm-level measure of climate change risk provided by Sautner et al. (2023), the measure is constructed by applying a machine-learning algorithm to identify the frequency of specific climate-related word pairs (bigrams) in firms' earnings call transcripts. It quantifies the attention paid by call participants (managers and analysts) to three key dimensions of climate change: technological opportunities, physical shocks, and regulatory shocks. The measure should be interpreted as capturing the market's perception of a firm's exposure to climate-related factors at a given point in time, reflecting "soft" information arising from the dialogue between firms and investors; $\boldsymbol{X}$ is a vector of control variables, named *Size* (natural logarithm of total assets), earnings before interest scaled by total asset (*Ebit_ta*), debt to total asset ratio (*Lev*), asset turnover (*Ato*), cash to asset ratio (*Liq*) and Property, Plant and Equipment divided by total assets (*PPE_ta*), country level gross domestic product growth ratio (*GDP_Grw*) and annual inflation rate (*Infl_Grw*) for the *i*-th firm in year *t*-1; $ind_i * time_t$, $country_i$ and $\varepsilon_{i,t}$ represent industry interacted with time and member state fixed effects and the error terms, respectively. Due to the industry-time specific heterogeneity of *CCRisk* developed by Sautner et al. (2023), we clustered standard errors at year * Industry level. Therefore, the coefficient of interest in Eq. (1) is β_1 which captures the firms' (*Dividends*) change when *CCRisk* increases.

The choice of control variables follows the dividend policy literature and captures firm-level financial characteristics and macroeconomic conditions that are known to affect decisions on dividends.

Firm size (Size) and profitability (Ebit_ta) are included because larger and more profitable firms are more likely to pay dividends, reflecting greater cash-flow stability, lower information asymmetries, and a higher propensity to distribute earnings to shareholders (Fama and French, 2001). Accordingly, we expect a positive association between both firm size and profitability and dividend payouts.

Leverage (Lev) is included to account for the role of capital structure in shaping dividend policy. On the one hand, higher leverage can support dividend payments by committing future cash flows to debt service, thereby reducing managerial discretion over free cash flow. On the other hand, debt contracts often include dividend-restricting covenants aimed at protecting creditors, which may limit firms' ability to distribute cash to shareholders. As a result, the expected effect of leverage on dividends is ambiguous (Jiraporn et al., 2011).

Cash holdings (Liq) capture firms' internal liquidity. High cash holdings may reflect accumulated free cash flows, in which case

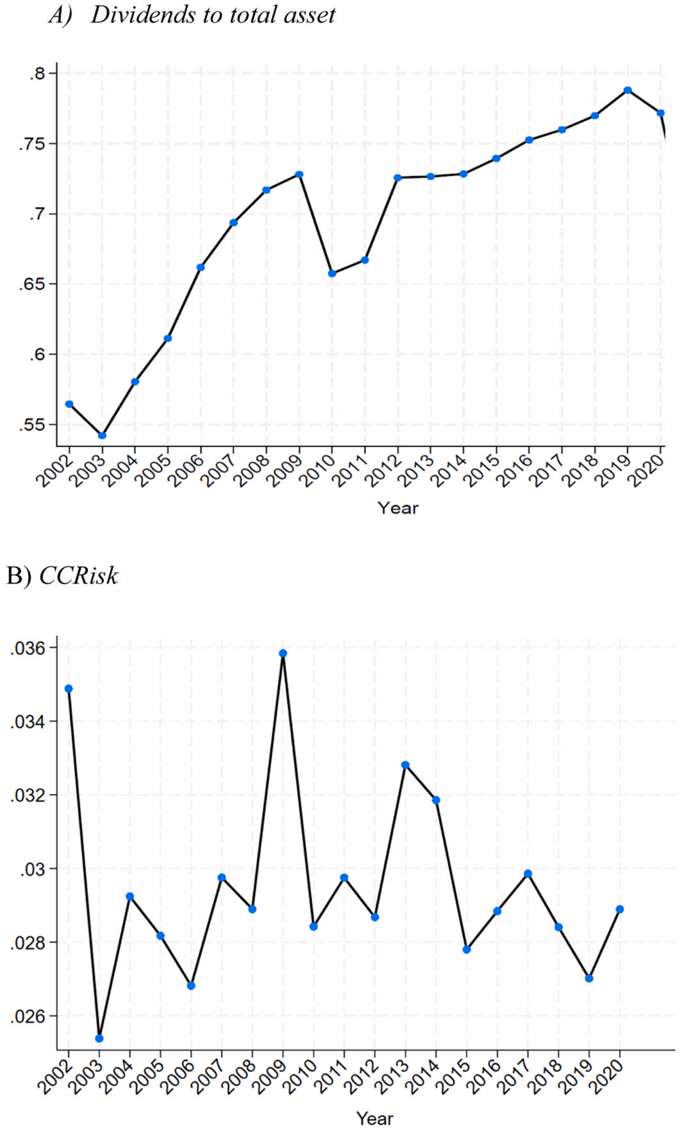

Fig. 1. Dividends and CCRisk trend. This figure shows the trend for *dividends* and *CCRisk* during the period of interest (2002–2020).

firms are more likely to distribute dividends, or precautionary savings intended to finance future investment opportunities, which would reduce dividend distributions. Therefore, the impact of liquidity on dividends is also ambiguous ex ante (Brockman and Unlu, 2009).

Asset turnover (Ato) and asset tangibility (PPE_ta) control for differences in operating efficiency and asset structure, which influence firms' cash-generation capacity and investment needs, and thus indirectly affect dividend policy.

Finally, macroeconomic controls, including GDP growth (GDP_Grw) and inflation (Infl_Grw), account for country-level economic conditions that shape firms' payout decisions by affecting earnings prospects, investment opportunities, and the real value of distributed dividends (Brockman and Unlu, 2009).

5. Results

Table 3 shows that the variable of interest (*CCRisk*) is negatively correlated with dividends and statistically significant in all models with different specifications of firms, time, industry and country fixed effects, as well as their different interactions. Economically, an increase of one standard deviation of climate risk is associated to a decrease of dividends spanning from 2% (first column Table 2) to 1,5% (last column Table 3). Results from Table 3 support our hypothesis of precautionary incentive for managers to reduce dividends to face uncertainty (Bates et al., 2009), with climate change risk representing a statistically significant source of uncertainty and cost that negatively affects dividends' distribution.

Table 3
Baseline results.

	Dividends						
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CCRisk (-1)	-0.0270**	-0.0245*	-0.0254**	-0.0223*	-0.0219***	-0.00769*	-0.0219**
	(0.0110)	(0.0125)	(0.0123)	(0.0117)	(0.00832)	(0.00455)	(0.00858)
Size (-1)		0.00264	0.00263	0.00193	0.000162	-0.00225*	0.000119
		(0.00333)	(0.00332)	(0.00323)	(0.00228)	(0.00128)	(0.00234)
Ebit_ta (-1)		4.93e-05	0.0170	0.0152	-0.0136	-0.0238	-0.00607
		(0.0390)	(0.0382)	(0.0370)	(0.0241)	(0.0148)	(0.0247)
PPE_ta (-1)		0.377***	0.406***	0.431***	0.271***	-0.154***	0.287***
		(0.0417)	(0.0442)	(0.0605)	(0.0364)	(0.0438)	(0.0373)
Lev (-1)		-0.0547*	-0.0532*	-0.0536*	-0.0552***	-0.00490	-0.0540***
		(0.0311)	(0.0311)	(0.0307)	(0.0202)	(0.0116)	(0.0209)
Ato (-1)		-1.909	-1.102	0.0766	1.186	1.695*	1.108
		-1.285	-1.318	-2.012	-1.052	(0.921)	-1.102
Liq (-1)		-0.0467	-0.0410	-0.0277	0.00644	-0.00335	0.0114
		(0.0328)	(0.0321)	(0.0310)	(0.0210)	(0.0126)	(0.0214)
GDP_Grw (-1)		-1.752***	-5.655***	-5.225***	0.788	1.319**	0.625
		(0.651)	(0.952)	(0.947)	(0.814)	(0.542)	(0.872)
Infl_Grw (-1)		-6.377***	-8.761***	-9.246***	-1.703*	0.290	-1.590*
		(0.892)	-1.306	-1.307	(0.911)	(0.603)	(0.956)
Year fe	No	No	Yes	Yes	Yes	Yes	No
Industry fe	No	No	No	Yes	Yes	No	No
Year * Industry fe	No	No	No	No	No	No	Yes
Country fe	No	No	No	No	Yes	No	Yes
Firm fe * Industry	No	No	No	No	No	Yes	No
Cluster Industry * Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	26,948	16,996	16,996	16,995	16,994	16,517	16,887
R-squared	0.000	0.024	0.044	0.100	0.598	0.911	0.617

This table reports results of baseline regressions over the 2002–2020 period. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1%. 5%. and 10% levels, respectively, in two-tailed tests.

To interpret this finding, it is helpful to consider the main channels through which climate change risk may pressure firms' dividends. A possible mechanism concerns insurance premium, supply-chain disruption costs, and infrastructural resilience investments. These costs materially impair firms' capacity to sustain dividend payments over time.

In detail, climate change costs arise from higher insurance premiums paid to cover climate-related risks such as extreme weather events, changes in supply chain logistics due to shifting weather patterns, or investments in physical assets such as buildings, machinery, and supply chain infrastructure to reduce their vulnerability to changing environmental conditions, therefore reducing the funds available for dividend payouts.

Another mechanism is linked to compliance and regulatory costs. Climate-related standards and policy requirements compel firms to invest in emission reduction, energy efficiency, and reporting adjustments. These costs reduce the funds available for shareholder distributions and encourage more conservative dividend policies.

Specifically, as governments worldwide implement stricter regulations to mitigate climate change, firms may face compliance costs associated with reducing carbon emissions, implementing energy-efficient technologies, or transitioning to renewable energy sources. These compliance costs can be significant and may require substantial investments, thereby decreasing the amount of profit available

Table 4
Channel analysis.

Variables	Vol (1)	Dividends (2)	Beta (3)	Dividends (4)
Vol (t-1)		-1.107***		
		(0.0347)		
Beta (t-1)				-0.154***
				(0.00851)
CCRisk (-1)	0.00619***	-0.0158*	0.0202**	-0.0201**
	(0.00224)	(0.00828)	(0.00849)	(0.00876)
Control (-1)	Yes	Yes	Yes	Yes
Year * Industry fe	Yes	Yes	Yes	Yes
Country fe	Yes	Yes	Yes	Yes
Cluster Industry * Year	Yes	Yes	Yes	Yes
Observations	16,764	16,448	16,589	16,257
R-squared	0.305	0.661	0.250	0.636

This table reports results of channel regression analysis over the 2002–2020 period. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1%. 5%. and 10% levels, respectively, in two-tailed tests.

for dividends.

Another possible interpretation of the results is that the exposure to climate change risk may cause firms reputational damage and loss of market value (Vestrelli et al., 2024). As investors and consumers are increasingly considering environmental sustainability in their decision-making processes, the exposure to climate change risk may thus reduce investors' confidence and lower stock prices. Moreover, since climate change presents long-term risks to business operations and financial performance (i.e. Chiaramonte et al., 2024), firms' exposure to such risks may cause increased volatility and heightened uncertainty. Together these effects can negatively impact firms' ability to generate consistent profits and sustain dividend payments over the long term.

Such links are consistent with theoretical arguments suggesting that firms reduce dividend distributions when risk increases, due to precautionary motives (Brown and Kapadia, 2007). A reason is that companies facing greater uncertainty or increased risk might prioritize retaining earnings to ensure their financial stability and mitigate the potential adverse impacts of those risks. Additionally, firms operating in volatile markets, subject to uncertain economic conditions, or experiencing revenue fluctuations may encounter scenarios where their cash flows become highly unpredictable and may therefore opt to reduce dividend payouts as a strategic measure to conserve cash and maintain liquidity, thereby enhancing their capacity to navigate potential downturns or economic disruptions.

These mechanisms suggest that climate exposure may influence dividend policy through risk-based channels. We therefore run in Table 4 a channel analysis using the firms' stock market volatility (Vol) and systematic risk (Beta)[2] as possible variables explaining the *CCRisk-dividends* relationship.

Table 4 shows the consistency of the precautionary hypothesis, showing that *CCRisk* is positively correlated with firms' Vol and Beta (1–3) and statistically significant, and that both are negatively correlated with firms' dividends (2–4) and statistically significant. Such relationships support the economic materiality of climate change risk, warning investors and shareholders about its growing detrimental effects.

These findings indicate that climate risk affects payout decisions through firms' risk profiles, as higher CCRisk is associated with higher idiosyncratic and systematic risk and, in turn, with lower dividend payouts. Incorporating Vol and Beta into the analysis therefore helps clarify the mechanism through which climate risk shapes dividend policy.

From a managerial perspective, heightened uncertainty associated with climate risk tends to reinforce precautionary motives, consistent with interpretations of signaling and agency theories, and leads managers to retain earnings rather than distribute dividends (Bhatta and Duwal, 2021). Conversely, in line with the bird-in-the-hand view (Gordon, 1962), investors would typically value current dividends more when uncertainty is high. Our findings suggest which of these views prevails in practice, thereby helping managers make more informed payout decisions under climate-related risk and enabling investors to better assess dividend sustainability when forming their investment strategies.

Subsequently, in the spirit of Chiaramonte et al. (2024), we investigate the causal effect of *CCRisk* on firms' dividends using a quasi-natural experiment approach built around the following natural disasters: the 2011 US Irene Hurricane, the 2012 Bopha/Pablo typhoon in Asia-Pacific region and the 2017 European Ophelia Hurricane.

Such disasters are useful to show the detrimental effects of exogenous climate shocks on financial performance happened in the period of interest (2002–2020). The selection of the disasters also reflects the data availability of the sample, since it covers almost all regions listed in dataset (US; EU; Asia-Pacific). Here is a description of the selected disasters.

The Hurricane Irene which struck in August 2011, was a massive tropical cyclone that had a significant impact on the Caribbean and the East Coast of the United States. This powerful hurricane originated from an Atlantic tropical storm that quickly intensified, reaching a Category 3 classification on the Saffir-Simpson scale. The destructive consequences of Irene were extensive, posing a risk to over 65 million US citizens and causing disruptions in various sectors such as utilities, transportation facilities, ports, industries, oil refineries, and even nuclear power plants. Consequently, the aftermath of this natural disaster quickly spread to affect the real economy and the financial industry.

Typhoon Bopha/Pablo stands out as one of the most formidable storms ever witnessed in the Southern Philippines, attaining the highest ranking of '5' on the Saffir-Simpson scale. This incredibly powerful typhoon had a profound effect on the regional economy, including a significant impact on the financial and non-financial industry.

The 2017 Hurricane Ophelia, ranked as the third most severe on the Saffir-Simpson scale, emerged in the Eastern Atlantic and swiftly became the furthest-east major hurricane recorded in the satellite era. The powerful winds inflicted severe damage on regions including Ireland, the United Kingdom, Spain, Portugal, and France, resulting in property destruction, loss of life, injuries, and considerable economic costs. In this setting *Treated*Disaster* is the coefficient of interest capturing dividends' change for firms most exposed to climate change risk after selected natural disasters.

Table 5 shows that firms with higher levels of CCRisk exhibit lower dividend distribution after natural disasters consistency with the precautionary interpretation therefore strengthening baseline results in a causal interpretation. Exogenous climate shocks appear to intensify firms' incentives to retain liquidity rather than commit to dividend payments. Natural disasters also act as salient signals for investors, regulators and managers, increasing the visibility of climate-related risks and accelerating adjustments in payout and liquidity management. From a practical standpoint, dividend policies become more conservative following climate-related events, offering guidance to managers operating under climate uncertainty and enabling investors to more accurately assess dividend resilience.

[2] Specifically, as in Piserà (2024) and Piserà et al. (2024), we retrieved stock market volatility and systematic risk from Refinitiv Database, calculated as the annualized standard deviation of stock price and annualized stock market correlation with its specific benchmark.

Table 5
Evidence from natural disasters.

	Dividends			
Treated * Disaster	-0.384***	-0.297***	-0.309***	-0.0593**
	(0.0301)	(0.0455)	(0.0436)	(0.0251)
Controls (-1)	No	Yes	Yes	Yes
Year * Industry fe	No	No	Yes	Yes
Country fe	No	No	No	Yes
Cluster Industry * Year	Yes	Yes	Yes	Yes
Observations	31,512	19,913	19,826	19,825
R-squared	0.033	0.217	0.301	0.619

This table reports results of quasi-natural experiment regressions over the 2002–2020 period. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1%. 5%. and 10% levels, respectively, in two-tailed tests.

6. Robustness checks

Our baseline results show a remarkable negative effect of firm-level climate change exposure to dividends distribution. Nevertheless, our results may be subjected to endogeneity biases like reverse causality, omitted variables and measurement errors. For example, companies facing higher climate change risks may alter their dividend distribution policies, and at the same time, dividend policies may influence a company's ability to mitigate climate change risks (reverse causality). In such cases, the endogeneity arises because the decision on dividend distribution is not independent of climate change risk. Additionally, there may be unobserved factors that influence both climate change risk and dividend distribution. For instance, regulatory policies, market conditions, or firm-specific characteristics can affect both variables simultaneously. Failing to account for these factors in the analysis can lead to biased estimates (omitted variables bias). Finally, inaccuracies or biases in measuring climate change risk or dividend distribution can introduce endogeneity bias. For example, if climate change risk is measured with error, this measurement error can be correlated with the error term in the dividend distribution model, leading to biased estimates (measurement error).

Therefore, in this section we run a battery of robustness checks aimed at strengthening our baseline results trying to reduce aforementioned endogeneity concerns as well as expanding our baseline findings.

Specifically, we run the following tests: 1) we re-estimate Eq. (1) using alternative measures, thereby testing whether the negative effect of CCRisk on dividends is sensitive to the definition of the dependent variable. This helps to mitigate biases arising from measurement error and potential reverse causality; 2) we exploit the correlation between CCRisk and key corporate performance indicators (ROA, ROE, Opex, Capex) therefore testing the theoretical mechanism through which climate risk may influence dividends, this step mitigates concerns related to omitted variables bias; 3) we implement a nearest-neighbour Propensity Score Matching (PSM) with a 0.1% caliper to improve covariate balance between treated and control firms. This helps mitigate omitted variables bias arising from observable heterogeneity and reduces sensitivity to sample-composition concerns.

Additionally, we implement a Heckman two-step model to correct for potential sample selection bias arising from the non-random distribution of firms across climate risk exposure. This ensures that our estimates are not driven by systematic differences between high- and low-risk firms and strengthens the robustness of the baseline results.

Table 6 shows our first robustness check, where we replaced the natural logarithm of dividends with the following alternative measures: the dividend to cash ratio (Dividends_cash) and the dividends to revenues ratio (Dividends_revenues).

Looking at Table 6, results confirm the negative and statistically significant effect of *CCRisk* on firms' dividends.

Subsequently, we enrich our investigation by examining the relationship between firm-level climate change risk and corporate performance, focusing on return on assets (ROA), return on equity (ROE), operating expenses (Opexp), and capital expenditures (Capex).

From a theoretical perspective, firm-level climate change risks (i.e physical or transition) may affect financial performance increasing direct operating costs, boosting regulatory pressures, reputational damage, supply chain disruptions, legal liabilities, and

Table 6
Alternative measure of dividends.

Variables	Dividends_cash	Dividends_revenues
CCRisk (t-1)	-0.0002**	-0.0009*
	(0.0001)	(0.0005)
Control (-1)	Yes	Yes
Year * Industry fe	Yes	Yes
Country fe	Yes	Yes
Cluster Industry * Year	Yes	Yes
Observations	16,842	16,823
R-squared	0.063	0.239

This table shows the baseline results using an alternative measure of firms' dividends over the 2002–2020 period. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1%. 5%. and 10% levels, respectively, in two-tailed tests.

constraints on access to capital and growth opportunities.

Such risks can impair firms' profitability by damaging productive assets reducing not only their value but also their income-generating capacity, thereby affecting key performance measures such as return on assets (ROA) and return on equity (ROE). As a result, the lower profitability reduces the cash flows available for distribution, constraining firms' ability to sustain dividend payments (Huang et al., 2018).

At the same time, climate risk may increase operating costs and earnings volatility, strengthening incentives to adopt more conservative financial policies. Moreover, firms operating in climate-vulnerable environments, particularly those with capital-intensive production structures, may need to allocate additional resources to capital expenditures to repair, replace, or adapt physical assets, increasing the demand for internal funds and reducing firms' capacity to distribute dividends (Huang et al., 2018).

Therefore, in Table 7 we show how CCRisk alter not only dividends distribution but also firms' return on asset (Roa), return on equity (Roe), operating expenses (Opexp), and capital expenditures (Capex).

Table 7 shows the statistically significant relationship between *CCRisk* and firms' *Roa* and *Roe* but not between *CCRisk and Opexp* and *Capex*, confirming the relevance of climate change risk for firm profitability.

This evidence is consistent with the fact that physical risks, such as extreme weather events or rising sea levels, can lead to damage or depreciation of firms' physical assets and disrupt supply chains, causing production delays, input shortages, and higher transportation costs. These disruptions can weaken firms' revenue-generating capacity and reduce the value of their asset base, thereby adversely affecting ROA and ROE. In addition, heightened exposure to climate change risk may generate reputational concerns and shifts in consumer preferences toward environmentally responsible firms, leading to lower sales, reduced margins, or difficulties in attracting investment. Overall, the evidence in Table 7 supports the detrimental effect of CCRisk on firms' return on assets and return on equity and complements our dividend analysis by linking climate risk to key corporate fundamentals within a coherent theoretical framework.

Finally, we try to face the omitted variables, measurement error and unbalanced panel biases by running the following three robustness tests (Table 8): 1) The nearest neighbour Propensity Score Matching (PSM) with 0,1% caliper algorithm; 2) the Heckman two-step regression; 3) replacing the natural logarithm of *CCRisk* with the unweighted measure of climate risk, proposed again by Sautner et al. (2023).

Table 8 still shows the strength of the negative correlation between *CCRisk* and firms' dividends after the PSM, Heckman two-step regression and using alternative proxy of *CCRisk*.

7. Conclusions

Our paper shows robust and detailed evidence on how firm-level climate change risk should be considered as a factor affecting corporate dividend policy distribution. Based on a unique sample of 3213 firms operating in 28 countries during the period 2002–2020, we find that firm-level climate change exposure is negatively associated to firms' dividend policy. Moreover, in line with the precautionary behaviour of firms during uncertainty economic phases, we rely on two possible economic channels explaining the relationship between climate change risk and dividends: namely equity risk and systematic risk. Economically, our results stress that an increase of one standard deviation of climate risk, is associated to a decrease of dividends spanning from the 2% to 1,5% of the average dividends' distribution worldwide.

Further, our analysis demonstrates that the detrimental effect of CCRisk on dividends is more pronounced after recent relevant natural disasters such as the 2011 US Irene Hurricane, the 2012 Bopha/Pablo typhoon in Asia-Pacific region and the 2017 European Ophelia Hurricane.

Based on the precautionary incentive for managers, our results provide useful insight for investors and shareholders which should worry about the exposition of firms to climate change. Taken together our results offer relevant policy implications. Beside the recent trend in regulating climate change exposure, Governments should strengthen regulations requiring companies to disclose their exposure to climate change risks. This transparency would enable investors to make informed decisions about the long-term viability of their investments, including dividend-paying stocks. Corporate governance frameworks should be updated to include climate risk as a core component of risk management strategies ensuring climate risk assessments which could ultimately safeguard dividend stability.

Table 7
Firms' performance effects.

Variables	Roa	Roe	Opexp	Capex
CCRisk (t-1)	-0.003**	-0.869*	0.006**	-0.0220
	(0.001)	(0.479)	(0.003)	(0.0847)
Control (-1)	Yes	Yes	Yes	Yes
Year * Industry fe	Yes	Yes	Yes	Yes
Country fe	Yes	Yes	Yes	Yes
Cluster Industry * Year	Yes	Yes	Yes	Yes
Observations	17,025	16,570	16,922	16,984
R-squared	0.159	0.141	0.875	0.380

This table shows the effect of climate change risk on firms' return on asset (Roa), return on equity (Roe), operating expenses (Opexp) and capital expenditure (Capex). The superscripts ***, **, and * denote coefficients statistically different from zero at the 1%. 5%. and 10% levels, respectively, in two-tailed tests.

Table 8
PSM regression, Heckman two-step regression and alternative measure of CCRisk.

Variables	PSM Dividends	Heckman two-step	Alternative measure of CCRisk
CCRisk (t-1)	-0.0243**	-0.0232***	
	(0.0121)	(0.00852)	
CCRisk (t-1) Tfidif			-0.0007*
			(0.0004)
Control (-1)	Yes	Yes	Yes
Year * Industry fe	Yes	Yes	Yes
Country fe	Yes	Yes	Yes
Cluster Industry * Year	Yes	Yes	Yes
Observations	9321	14,283	19,825
R-squared	0.651	0.621	0.619

This table shows the result of the propensity score matching weighted regression (PSM), the Heckman two-step regression and baseline results using an alternative measure of climate-change risk (CCRisk Tfidif). The superscripts ***, **, and * denote coefficients statistically different from zero at the 1%. 5%. and 10% levels, respectively, in two-tailed tests.

This could include implementing carbon pricing mechanisms, promoting renewable energy investments, and establishing sustainability standards that reward companies for reducing their carbon footprint. By fostering a transition to more sustainable business models, policymakers can mitigate climate risks and enhance the long-term viability of dividends.

Nevertheless, our results must be taken with caution. Beside a detailed econometric analysis, we focus on the recent climate change risk measure introduced by Sautner et al. (2023) and therefore it is possible that using other proxy may somewhat present different results. Moreover, we focus on the period 2002–2020, which includes the Covid-19 period. Further studies may expand our research questions to the post-Covid-19 world, trying to understand if the correlation between CCRisk changes orbc not as well as exploring similar topic in the banking industry. Finally, robust to additional econometric specifications and endogeneity, our results only show a “correlation” pathway between firm-level climate change risk and dividends, so our evidence must be interpreted correctly.

CRediT authorship contribution statement

Marco di Antonio: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Giulio Velliscig:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Laura Nieri:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

Table A. 1
Correlation matrix.

		1	2	3	4	5	6	7	8	9	10
1	Dividends	1									
2	CCRisk	0.0108*	1								
3	Size	-0.0004*	-0.0058	1							
4	Ebit_ta	-0.0028*	-0.0021*	0.0060*	1						
5	PPE_ta	0.0646*	0.0030*	-0.0074*	-0.0021*	1					
6	Lev	-0.0015*	-0.0019	0.0016	-0.0003*	-0.0045*	1				
7	Ato	0.0331*	-0.0031*	-0.0031*	-0.0032*	-0.1671*	-0.0080	1			
8	Liq	-0.0104*	0.0057	-0.0080*	0.0015*	0.0023*	-0.0081*	0.0054*	1		
9	GDP_Grw	-0.1795	-0.0030*	0.0006*	-0.0040*	0.0103*	0.0045*	-0.0210*	-0.0005*	1	
10	Infl_Grw	-0.0999*	0.0054	0.0065*	0.0009*	0.0243*	0.0020*	0.0079 *	0.0072*	0.2762*	1

Data availability

Data will be made available on request.

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