Long-Term Climate Change and Corporate Dividend Payout: US State-Level Evidence

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1. Introduction

Climate change as the public bad is ultimately challenging the global economy (Nordhaus, 2019). On the bright side, exposing firms to climate risks incentivizes them to invest more in research and development (R&D) to develop climate change mitigation technology (Li et al., 2021). On the downside, climate risks induce firms to reserve more cash to hedge potential illiquidity (Dimitrios Gounopoulos & Yu Zhang, 2024; Siamak Javadi et al., 2023) and a higher cost of funding or equity capital (Huynh et al., 2020), leading to lower financial leverage (Ginglinger & Moreau, 2023; Nguyen & Phan, 2020; Nguyen et al., 2022). Arguably, the impacts of climate change on corporate behaviors and adaptive policies are complex, given both the demand and supply effects on corporate financial policies, with the involvement of stakeholders. On the demand side, investors demand compensation when firms are exposed to transition risk (e.g., carbon returns, etc.) (Bolton & Kacperczyk, 2021; P. Bolton & M. Kacperczyk, 2023). Based on a survey of perceptions of climate risks, Krueger et al. (2020) document that institutional investors believe in the financial implications of climate-related regulatory risks in investment portfolios. Many larger, long-term, and ESG-driven investors consider risk engagement and management as their approaches to dealing with climate risks. Using holdings data, Ilhan et al. (2023) provide empirical evidence of the positive association between climate-sensitive institutional ownership and increased climate risk disclosures by firms. On the supply side, financial systems (e.g., banks) have become more sensitive to climate risks (Beirne et al., 2024; Cai & Li, 2024; Nguyen & Wilson, 2020; Noth & Schüwer, 2023; Uesugi et al., 2025; Zhang et al., 2024), leading to the potential volatility of firms' access to credit. Given climate-induced volatility to corporate liquidity, firms might be incentivized to adjust their corporate payout policies to be more flexible in paying back to shareholders. For instance, with evidence from contemporary physical-related risks (e.g., storms, hurricanes, flooding, etc.), Chang et al (2024) show that firms prefer share repurchasing over dividend payouts when firms are exposed to weather-related events[1]. In climate science, temperature anomaly is a benchmarking measure for capturing long-term climate change, indicating global warming worldwide. The reason is that climatic conditions are abnormally changing after decades of global warming, leading to frequent physical risks. In other words, temperature anomaly captures long-term climate change that imposes climate-related risks on firms, as recently employed by the literature (Y. Chang et al., 2024; Huang et al., 2018). For the US, climatic conditions and climate patterns are heterogeneous and geographically divergent across US states. Therefore, understanding the impacts of state-level temperature anomaly (e.g., SLTA) is critical to firms' financial policies dealing with long-term climate-induced risks[2].

For this study, we examine the financial impacts of SLTA on corporate payout policies with state-level evidence for firms located across the US states. The rationale is that payout policies reflect firms' growth prospects and are closely linked to other corporate decisions (e.g., investments, financing choices, etc.). As posited, understanding the impacts of SLTA on corporate payout policies is crucial for leading financial markets like the US, given its statewide climate divergence. Furthermore, corporate dividend payout is important to investors and managers (Agarwal & Chakraverty, 2023; Bae et al., 2021; Chay & Suh, 2009; DeAngelo et al., 2006; HAIL et al., 2014; Kahle & Stulz, 2021). As mentioned earlier, in a recent study by Y. Chang et al. (2024), the authors argue that firms in countries with higher climate risk exposure substitute dividends with share repurchases to hedge physical and transition risks. Our focus is on one specific component of climate change – temperature anomaly. The complexity of how climate change, especially abnormal temperature changes, affects dividend payout is even more crucial and worth examining for economies like the United States (U.S.), where climatic conditions across the US states due to temperature anomalies affect dividend payout. One limitation of Y. Chang et al. (2024) is that it cannot capture the impact of within-country climatic variation on firms' identifying locations of firms. By

[1] The authors employ the global climate risk index (GCRI) that investigates, to what extent, our countries and and associated regions have been affected by weather-related events (e.g., storm, floods, heat waves, etc.). See details at https://www.germanwatch.org/en/cri
[2] Climate-related risks are acknowledged as the number-one long-term global risks, see Global Risks Report 2024 | World Economic Forum | World Economic Forum

utilizing the location of headquarters of the firms in the U.S., which is the most developed capital market in the world, and where the highest number of firms are listed publicly, we explore the relationship between the temperature anomaly and cash dividends. The temperature anomaly is the difference between the current state-level temperature in which the firm is located and its baseline/average temperature estimated by averaging 30 or more years of temperature data by NCEI-NOAA.

The study employs US state-level data matched with firms' locations (headquarters) on temperature anomaly to quantify the impacts of climate change on dividend payout for the following reasons. For climate science, temperature anomalies play a more important role than an absolute temperature value. Temperature anomaly captures the difference from a baseline average temperature estimated with at least thirty years (or more) of temperature data on average. A positive value of temperature anomaly indicates that the observed temperature is warmer than the historical baseline value. In contrast, a negative value of temperature anomaly indicates that the observed temperature is cooler than the historical baseline value. Using US state-level temperature anomalies matched with the locations of US firms would mitigate potential issues caused by the geographical divergence of temperature trends. Furthermore, temperature change is a benchmarking measure for climate change as it causes severe consequent climatic conditions, such as drought risks and also other physical climate risks that are used by recent studies (Adrian et al., 2023; Do et al., 2021; Ginglinger & Moreau, 2023; Hong et al., 2019; Huang et al., 2018; Huynh et al., 2020; Siamak Javadi et al., 2023; Nguyen et al., 2022). Even though modern literature employs firm-level climate exposure measures to convey soft information on multifaceted climate risks (Sautner et al., 2023), temperature anomalies purely reflect acute and chronic climate change in the US states[3]. To examine the impacts of temperature anomalies on payout, the study tracks firms across US states back to 1971, as the earliest corporate payout data available. Our firm-level data extracted from the COMPUSTAT annual file

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[3] We acknowledge that different measures convey specific information about the nature of climate-related risk drivers and are unique with their own nature. For empirical studies, it could be fruitfully to the literature when we employ diverse sets of measures to examine the impacts of climate risk on corporate policies (e.g., dividend policy in this study). No single measure might be perfect to covey all the information needed to quantify the effects of climate risks.

is comparable to related literature on corporate payout (Kahle & Stulz, 2021) for US firms. We consequently match COMPUSTAT data with yearly average climate data with temperature anomalies extracted from NCEI-NOAA based on the US states where firms are located. Our merged data includes 220,658 state-firm-year observations between 1971 and 2020 for a total of forty-nine US states for empirical works.

Our broad findings show that long-term state-level climate change induces firms to decrease dividends paid to their shareholders. Our findings are robust when we test alternative measures of dividend payouts, share repurchases, and payout flexibility. We do not observe any evidence of firms favoring share repurchases over dividends to increase payout flexibility in the context of climate change, measured by state-level temperature anomalies [SLTA]. Our study contributes directly to Y. Chang et al. (2024) by showing that the proneness to physical risks could even induce firms to maintain positive dividends paid to their shareholders for mitigating agency problems with positive signals about firms' growth prospects (Allen & Michaely, 2003; Brav et al., 2005; Brockman & Unlu, 2009; Chay & Suh, 2009; Easterbrook, 1984; Farre-Mensa et al., 2014; La Porta et al., 2000). Regarding life-cycle theory (Chay & Suh, 2009; DeAngelo et al., 2006; Faff et al., 2016; Kuo et al., 2013), large firms with higher asset tangibility are highly vulnerable to climate change. In other words, firms in their later cycle stages with fixed assets located across US states become more prone when physical risks emerge, compared to younger firms with lower tangibility, and are unlikely to make payouts with less profitability. Trade credit acts as an alternative financing choice; firms with progressive credit policies maintain positive dividend payouts to their shareholders. Firms with a proactive average increase in financing their operating needs could maintain positive payouts to their shareholders. Overall, our evidence from state-level climate change [SLCC] shows that long-term climate risks impose severe impacts on firms' payout policies with a persistent predicted decrease in dividends paid to shareholders. The proneness to climate disasters could motivate suitable risk management for positive equity payouts to mitigate agency problems with positive signaling to shareholders about their growth prospects. Payout choices are related to other corporate policies, financial flexibility, and firm characteristics (Allen & Michaely, 2003; Bonaimé et al., 2013; Brav et al., 2005; Chay & Suh, 2009; Denis, 2011; Farre-Mensa et al., 2014; Jagannathan et al., 2000; Kahle & Stulz, 2021; Kumar & Vergara-Alert, 2020; Kuo et al., 2013; La Porta et al., 2000; Erik Lie, 2005; Michaely & Moin, 2022; Rapp et al., 2014; Zhou & Ruland, 2006) with (dis)appearing dividends.

The study contributes to related literature with the following critical contributions. This study, to the best of our knowledge, is the first to quantify the effects of US state-level temperature anomaly as the benchmark measure of global warming related to climate change on dividend payout. For the US context, Dimitrios Gounopoulos and Yu Zhang (2024) employ county-level temperature value data to capture their effects on corporate cash holdings with a shorter sample, but the measures used by the authors might not fully capture the acute and chronic long-term effects of climate change. For the US state level, our study empirically shows that temperature anomaly benchmarks the effects of climate change over the recent decades back to the early 1970s. Global warming has appeared since the late 1900s and induced systematic adverse effects on corporate dividend policy for the US firms[4]. Due to potential climate-induced liquidity shortfalls, firms are exposing their global warming reserve to more cash, consequently paying less dividends to shareholders. This study contributes to the related literature, which attempts to quantify the impacts of climate-related risks ranging from drought risks (Adrian et al., 2023; Do et al., 2021; Huynh et al., 2020; Nguyen et al., 2022), temporary heating trends (Dimitrios Gounopoulos & Yu Zhang, 2024), to other physical climate risks (Ginglinger & Moreau, 2023; Huang et al., 2018).

The remaining parts of the study are structured as follows. Section 2 reviews related literature with hypothesis development. Section 3 represents data, variables, and methodologies. Section 4 presents findings and related discussions. Section 5 concludes the main findings and implications.

[4] Climate Change Indicators: U.S. and Global Temperature | US EPA

2. Literature Review and Hypotheses

2.1. Literature Review

Climate change and risk drivers.

The theory of public goods acknowledges climate change as a negative externality (Nordhaus, 2019). The thorniness of climate change is reflected by its global consequences (Goulder & Pizer, 2006). Global externalities are defined as those whose impacts are indivisibly spreading worldwide and dissimilar from national or local public goods because of their resistance to the control of national governments and markets. Due to climate change, global warming is now the most noticeable environmental externality that menaces our planet. Between 1980 and 2018, losses from worldwide natural disasters amounted to around $ 270 billion as of 2022, with roughly 55% not insured (Munich-RE, 2024).

The physical and transition risks are two channels through which climate change affects financial sectors. The physical risks raised by damage to infrastructure, land, and properties, and the transition risks caused by climate policies, technologies, and the sentiment of consumers and markets during the transition to a lower-carbon economy. Climate exposure varies across income groups and regions, where the high vulnerability of lower- and middle-income economies is typically due to physical risks (Grippa et al., 2019).

Physical risks can be directly exposed to financial institutions through their impacts on households, corporations, and countries that incur extreme climate events or through indirect channels through the impacts of climate change on the wider economy, with feedback effects within financial systems Grippa et al. (2019). The magnification of climate risks is presented through loan portfolios' increased default risk and decrease in asset values. Climate change also puts corporate credit portfolios at risk. For instance, the Wall Street Journal (Gold, 2019)[5] identified the first "climate-change bankruptcy" with California's largest utility company, Pacific Gas and Electric (PG&E), which put $5.4 billion in cash plus 22.19

[5] PG&E: The First Climate-Change Bankruptcy, Probably Not the Last - WSJ

percent of its stock into a trust for victims after the wildfires caused by the utility's equipment[6]. Prolonged droughts caused by rapid climatic changes that consequently increase the risk of fires from the operations of PG&E in California, leading to tighter financial conditions on bank lending, particularly in times of climate events, pose severe impacts on many institutions. For insurance sectors, physical risks are more crucial to the asset side for insurers and reinsurers. However, risks may also emerge from the liability side as claims from insurance policies can be generated at a higher frequency and more severely than normal. Evidence of increasing losses from natural disasters has already been defined, making insurance more expensive and unavailable in areas with higher climate risk exposure worldwide. Physical risks such as droughts and floods due to the increased likelihood of severe climatic events are previously considered uncorrelated, leading to decreased diversification in insurers, reinsurers, and banks due to climate change.

Transition risk drivers are societal shifts resulting from transitioning to a low-carbon economy. They can occur as a result of changes in public sector policies, innovation, and changes in the affordability of current technologies (for example, making renewable energies cheaper or allowing for the removal of atmospheric GHG emissions) or investor and consumer sentiment toward a cleaner environment (BIS, 2021). While banks have been impacted by, and hence closely monitored by, these types of changes, the expected scale and simultaneous nature of transition-related developments have the potential to magnify the impact far more than previously thought[7]. Transition risks are important to the asset side of financial institutions that could experience losses due to climate change to firms with business models not built around the economics of climate change, toward a low-carbon economy. According to Bank of England Governor Mark Carney, if the estimate is approximately correct, it would induce those regarded as stranded or "literally unburnable" for fossil fuel firms in a world transiting toward a low-carbon economy. Fossil fuel firms could experience a decline in earnings, disruption in businesses, and an increase in funding costs due to changes in climate policies, technologies, and the sentiment (demand) of consumers

[6] PG&E, Troubled California Utility, Emerges from Bankruptcy - The New York Times (nytimes.com)
[7] Climate policy success depends on transition risk mitigation | World Economic Forum (weforum.org)

and investors for alignment with environmental policies to cope with climate risks. Not just fossil fuel firms, coal producers must deal with new climate policies to cope with global warming, and several large banks have committed to not delivering financing for new facilities for coal producers. So, how the mining industry can respond to the impact of climate change and the new environmental policies for decarbonization has increasingly been a discussion topic for every mining CEO over the past decade (Delevingne et al., 2020).

Climate change and global warming

According to the Intergovernmental Panel on Climate Change (IPCC (2018), there has been an increase of 0.87 °C in the Earth's measured mean surface temperature since 1900. It is anticipated that the increasing rate of global warming will persist and lead to changes that will affect all economies. Based on scientific evidence, it is highly likely that the primary cause of this global warming is a rise in greenhouse gas concentrations in the atmosphere (IPCC, 2014). Moreover, if nothing is done to mitigate them, the warming brought on by human emissions will last for years to millennia (IPCC, 2018). Therefore, scientists advise economies to cut GHG emissions by transitioning to a "low-carbon" economy to lessen global warming and the severity of future climate change consequences (IPCC, 2014).

Global warming will increase if human emissions of GHGs persist. According to (IPCC, 2014)There will probably be more extreme precipitation occurrences and extreme temperatures around the mean. Over long horizons, these physical hazards would continue to develop. They would include rising sea levels, more variable precipitation (Allen & Ingram, 2002; Solomon et al., 2009), more frequent wildfires (Abatzoglou et al., 2019), and recurrent and increasingly severe floods and increased frequency of extreme temperatures. Regarding to BIS (2021), banks and the banking system are vulnerable to climate change via macroeconomic and microeconomic transmission channels, resulting from physical and transition risk drivers.

Global temperature increases can generate acute climate changes through repeated heatwaves and wildfires (Abatzoglou et al., 2019; Jones et al., 2021) and the spread of forest fires (Abatzoglou & Williams, 2016), causing damage to fauna and to local economies. A warmer atmosphere can hold more moisture, which is expected with high confidence to increase heavy and concentrated precipitation in several regions (c). The increase in the severity of rainfall and its concentration over relatively short periods is expected to produce acute climate events, such as destructive flash floods that give rise to physical damage to properties, infrastructure, and agriculture. When associated with heatwaves, concentrated rainfall may increasingly result in periods of severe drought followed by periods of flooding in certain regions. This type of climate impact has the potential to generate, and in some cases has generated significant and recurring financial losses.

Ocean acidification, average temperature increases, and rising sea levels are usually regarded as chronic physical threats. Prolonged temperature increases can potentially exacerbate long-term climate events like desertification. Likewise, prolonged elevated mean temperatures could also affect the ecosystem, namely the agricultural sector. Heatwaves claimed the lives of over 166,000 people between 1998 and 2017, with over 70,000 of those deaths occurring in Europe during the 2003 heatwave. There is a global trend towards an increase in the frequency, length, and size of extreme temperature events. There was an approximate 125 million increase in the number of persons exposed to heatwaves between 2000 and 2016. Additionally, the IPCC issued a warning stating that rising temperatures will hasten the melting of glaciers and ice sheets, increasing sea levels (IPCC, 2019). IPCC estimates a carbon budget limiting global temperature rises to 2 degrees above pre-industrial levels, ranging from 1/5th to 1/3rd of the world's oil, gas, and coal reserves[8].

[8] The IPCC provides the budgets predicted for future emissions that are dependent on proven assumptions about other drivers of climate change and the risk levels of temperatures increasing by more than 2 degrees that society is likely to accept. Visit Table 2.2 in the IPCC (2014), setting these in the context of current reserves of fossil fuel resources including oil, gas, and coal, at AR5 Synthesis Report: Climate Change 2014 (ipcc.ch).

Climatic conditions and temperature anomaly in the United States

Climatic conditions are diverse in the United States. For instance, South Florida and Hawaii have tropical conditions, while the Rocky Mountains and Alaska have alpine and arctic conditions. Temperatures present a strong gradient in the United States across seasons and regions. While the southern coastal states are hot, with very high temperatures that could exceed 21°C, the northern states along the Canadian border have cooler conditions, with a great divergence between annual temperatures from 10 °C up to 50 °C in the winter and summer of the northern Great Plains. Similarly, precipitation is different by season and across the US states. Precipitation is measured at more than 127 cm annually along the Gulf of Mexico, while precipitation could be less than 30 cm in the Southwest and Intermountain West regions. The seasons for peak rainfall are extremely variable across the US. For instance, several regions in the Midwest and Great Plains have late-spring rainfall peaks, while the US states on the West Coast experience a distinct rainy season in winter. Many coastal Atlantic and Gulf regions have summertime peaks, and the North American monsoon in the summer affects the Desert Southwest. The United States is sensitive to many kinds of extreme weather, such as hurricanes and thunderstorms, that induce landfall along the Atlantic and Gulf coasts every decade. For any specific time, the United States could experience drought conditions affecting up to 20% of the country[9].

Also, climatic conditions in the United States present historical variations across the economy. According to NOAA[10], the US presents diverse microclimates and climates. For instance, the southern states, namely Arizona (AZ), California (CA), Texas (TX), Florida (FL), and California (CA) have annual average temperatures of at least 70 degrees. The figure shows that the rainfall amounts are also divergent, from just 10 inches or less in the Southwest region to more than 50 inches for the rainfall amount in Florida. North and South Dakota regions present yearly droughts comparable to New Mexico (NM). Parts of the mountains, including isolated ridges and plateaus, are wetter than their neighbouring lowlands. The most

[9] United States - Climatology | Climate Change Knowledge Portal (worldbank.org)

[10] New maps of annual average temperature and precipitation from the U.S. Climate Normals | NOAA Climate.gov

extreme wet conditions are shown in Washington (WA) and Oregon (OR), where the Cascade Ranges and Coast in the west are eight times wetter than parts of the Columbia River Plateau to the east. By contrast, the local areas of the Appalachian Mountains, ranging from the North to the South in the East, show less dramatic contrasts, including New Hampshire's White Mountains, West Virginia's Alleghenies, and the intersection areas of North Carolina (NC), South Carolina (SC), and Georgia (GA).

The rich divergence of climatic conditions is present across the US states and is volatile over time, in the era of global warming in particular[11]. The annual average temperatures have changed in the contiguous 48 US states since 1901. EPA records that the average surface temperature for the US contiguous 48 states has increased at a mean rate of 0.17°F per decade since 1901[12]. The average temperatures have increased faster since the late 1970s (from 0.32 to 0.55 °F per decade since 1979). Nine of the ten recorded warmest years have occurred since 1998 across the contiguous 48 states; 2012 and 2016 were the two warmest recorded years. Compared to the temperature worldwide, the United States has warmed faster than the global rate since the late 1970s. Furthermore, some parts of the United States have experienced even more warming than others. States, including the North, the West, and Alaska, have exhibited the most temperature increases, while the Southeast, with its parts, has experienced little change in temperature.

Climate risks and corporate policies

Emerging literature has documented the links between climate risks and corporate policies. Severe climatic conditions, such as heat waves, flooding, storms, etc., adversely affect corporate retained earnings and cash flows. Using the country climate risk index, (Huang et al., 2018) find that firms in countries with more frequent severe climatic conditions are more likely to hold cash to attain corporate

[11] Global Warming (nationalgeographic.org)

[12] Climate Change Indicators: U.S. and Global Temperature | US EPA with the surface data extracted from the stations for land-based weather. The measurements of the satellite cover the lower troposphere, the lowest level of the Earth's atmosphere. "UAH" and "RSS" represent two different analytical approaches for the measurement of the original satellite. Regarding EPA, this graph uses the 1901–2000 average temperature as a baseline for depicting change and selecting another baseline period would not make a difference in the shape of the data over time.

resilience with potential financial slack due to higher climate risk exposure. Those firms likely have more long-term debt than short-term debt and are unlikely to make dividend payouts in cash. Extreme weather is less severe in some specific industries, leading to lower climate risk exposure than high-climate-sensitive industries, including energy (mining and oil extraction), agriculture, healthcare, communications, food products, transportation, and business services. Regarding the literature (Ginglinger & Moreau, 2023), the effects of climate physical risk on corporate capital structure in the US lead to a decrease in leverage. The Kyoto Protocol ratification in Australia impedes corporate leverage, and polluting firms suffer from financial distress risk (Nguyen & Phan, 2020). The ratification of the Kyoto Protocol also leads to lower financial performance for carbon-intensive firms.

Firms' carbon risk exposure has received increasing attention in business. The Carbon Disclosure Project (dividend payout) survey reports that firms may experience an increase in the cost of debt if they, especially carbon-intensive firms, are unwilling or fail to respond to the dividend payout survey (Jung et al., 2018). Not just associated with higher debt financing costs, carbon risk adversely affects corporate investment, and more extreme impacts are exposed to higher carbon-intensive firms, leading to changes in financial constraints, including firm size, age, and dividend payout (Phan et al., 2022). Consequently, the emissions trading scheme (ETS) puts a price on greenhouse gases for eco-friendly behavior. For example, Australia introduced the National Greenhouse and Energy Reporting Act 2007 (NGER Act) to disseminate and report information related to greenhouse gas projects, emission intensity, energy consumption, production, etc.[13], for which banks do consider carbon risk in their lending decisions. (Herbohn et al., 2019) highlight the value of banks as financial intermediation in the context of asymmetric information about firms' carbon risk exposure with modern banking needs to be extended for additional considerations on issues such as the corporate social responsibility (CSR) reputation of banks on lending practices.

[13] National Greenhouse and Energy Reporting Act 2007 (legislation.gov.au)

Furthermore, the literature highlights that high carbon emissions may induce a decrease in firms' market value. (Clarkson et al., 2015; Griffin et al., 2017; Matsumura et al., 2014), while CSR is positively associated with firm value, lowering the cost of equity, and increasing earnings persistence (Gregory et al., 2014). Overall, it is inevitable that climate risks pose threats to financial markets. However, on the bright side, we could acknowledge that such threats provide institutions and economies to pursue a more sustainable path for economic development. Giglio et al. (2021) elaborate on diverse approaches in microfinance models incorporating climate change risks in the asset pricing context with various asset classes such as equities, fixed-income securities, and real estate, and show how investors structure their investment portfolios to hedge climate risks.

2.2.Hypotheses

The sensitivity to climate change makes corporate earnings volatile and, consequently, causes potential liquidity shortfalls and divergent financing choices. (Ginglinger & Moreau, 2023; Huang et al., 2018; Nguyen, 2018; Nguyen & Phan, 2020). Extreme climate conditions, such as drought risks, induce firms to incur a higher cost of equity capital due to their drought duration and intensity (Huynh et al., 2020). Under such severe climate-induced risks, firms hoard more cash and increase their corporate diversification to attenuate the impacts of drought risks. Such climatic conditions also adversely affect corporate leverage and the speed of leverage adjustment in the US (Nguyen et al., 2022), highlighting the roles of cash holdings in coping with environmental externalities.

Many studies show the importance of corporate payout policy, such as dividends (as well as share repurchases), which represent substantial cash outflows from firms to shareholders (Allen & Michaely, 2003; DeAngelo & DeAngelo, 2007; Farre-Mensa et al., 2014; Kahle & Stulz, 2021). The explanations for dividend policy range from the agency theory of Jensen (1986) to the signalling hypothesis (JOHN & WILLIAMS, 1985; MILLER & ROCK, 1985), clientele (Allen et al., 2000; Shefrin & Statman, 1984), catering (Baker & Wurgler, 2004; Desai & Jin, 2011), and life cycle (DeAngelo et al., 2006; Faff et al., 2016; Zhou & Ruland, 2006). Like any other climate-related D. Gounopoulos and Y. Zhang (2024)incidences, anomalies in temperature are more likely to increase the financial risk that firms face. The physical and transition risks related to such anomalies are more likely to affect firms' strategies and operations, resulting in extra costs and further reducing profitability and earnings. Increased cash holdings are the mechanisms for firms to safeguard against potential liquidity shocks due to climate risks (Dimitrios Gounopoulos & Yu Zhang, 2024; Siamak Javadi et al., 2023). Such financial risks may lead to the distribution of earnings to shareholders in the form of dividends. Yuyuan Chang et al. (2024), using a large sample of 45 countries, show that firms reduce their cash dividends by substituting dividends with repurchases in response to higher climate risk. D. Gounopoulos and Y. Zhang (2024) use local temperature trends by county in the U.S. as a proxy for climate uncertainty and find that firms increase their cash holdings in response to such risks. While dividend policy is a mechanism to mitigate agency problems, the effects of climate change on dividend payout might be costly for firms exposed to climate risk, inducing a higher cost of equity (Huynh et al., 2020). Due to such systemic effects of climate change on firm performance and cash holdings to hedge against potential earnings uncertainty, we propose the following hypotheses:

H1: Increased temperature anomaly is associated with decreased corporate dividend payout in the US states.

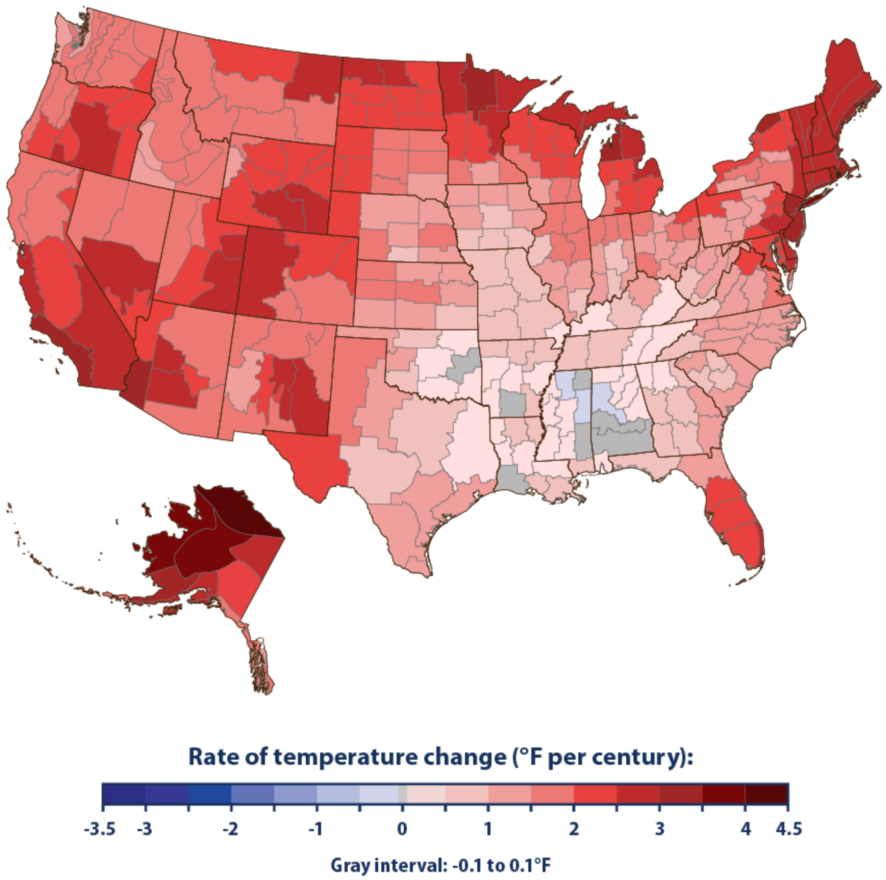

Fig. 1: US rate of temperature change. Data source: NOAA, 2022[14].

Corporate liquidity is critical to firms under climate risk exposure (D. Gounopoulos & Y. Zhang, 2024; S. Javadi et al., 2023; Li & Wan, 2024). Since the Stern review, an exogenous shock to a firm's climate change awareness, firms with higher exposure to transition risk are likely to hoard cash (S. Javadi et al., 2023). Regarding the precautionary motive, the study suggests that cash reserves are critical to firms in safeguarding them from the adverse impacts of climate change that lead to financial constraints. For temperature trends, hoarding cash is empirically exhibited to be a hedging policy for firms exposed to heatwaves (D. Gounopoulos & Y. Zhang, 2024). The study shows that environmental enforcement and physical risk are the two channels to explain firms' cash management given temperature trends. The roles

[14] NOAA (National Oceanic and Atmospheric Administration). 2022. Climate at a glance. Accessed February 2022. www.ncdc.noaa.gov/cag

of cash holdings are evident from Emission Trading Schemes (ETS) (Sakariyahu et al., 2023). The study argues that ETS-member firms hoard cash to mitigate financial climate-induced risks with possible investment opportunities while meeting regulatory costs. Increasing cash reserves under climate change exposure could be a rational decision under the potential impacts of climate risk drivers for the following reasons. External financing choices could be even more costly under climate change exposure (S. Javadi & A. A. Masum, 2021), and climate risks could deteriorate bank liquidity creation (Xu et al., 2024). Therefore, climate change could (in)directly affect firms' access to credit, and cash holdings might play as a possible solution. Also, deleveraging is a reliable choice for firms to secure their ample financial flexibility because financial leverage could be challenging for firms to reconcile (DeAngelo et al., 2017). Consequently, cash holdings and leverage adjustments could be a reliable choice for firms to deal with climate change impacts, hedging demand and supply effects. Trade credit is an alternative financing decision for firms. Firms could rely more on trade credit when banking crises emerge, causing reduced credit lines with weak creditors (Li et al., 2024). Firms with quality-disclosed CSR practices could improve financing capacity through trade credit (Cai & Huang, 2024). Trade credit could play a crucial role in the impacts of fiscal policy uncertainty on corporate financial leverage (Bhatia et al., 2024). Under climate change uncertainty, firms could significantly limit trade credit provision (Cao et al., 2024). The study posits that a firm's adjustment to its trade credit policy is due to the managerial prediction of associated costs caused by physical damage instead of regulatory costs. Carbon assurance supports firms with increasing trade credit from suppliers with reduced risk and asymmetric information (Safiullah & Nguyen, 2024). As payout policies are closely linked to other financing decisions (Allen & Michaely, 2003; Brav et al., 2005; DeAngelo et al., 2008), our second hypothesis is below.

H2: The impacts of climate risk on dividend policy are mediated by corporate cash holdings, trade credit, and market leverage policies.

Since the Paris Agreement, for the US and global equity markets, investors have cared more about firms' environmental performance (Bolton & Kacperczyk, 2021; P. Bolton & M. Kacperczyk, 2023). The studies show that investors demand a premium for carbon-intensive firms. Polluting firms are subject to lower financial leverage (Nguyen & Phan, 2020). Employing Australia's Kyoto Protocol ratification, Nguyen and Phan (2020) show that climate policy reduces carbon-intensive firms ' access to credit with decreased financial leverage. With decreased leverage, climate policy could induce corporate financial constraints and distress risk to polluting firms. Since the Paris Agreement, Ginglinger and Moreau (2023) show that firms' deleveraging is caused by both the demand side (optimal capital structure) and the supply side (higher lending spreads), leading to costly operations and financial distress. Transition risk (e.g., environmental policy stringency) does matter to corporate leverage adjustment (Lee et al., 2024). The effects could be prominent for firms with higher financial constraints and located in places with significantly higher climate change exposure. In the US, there are states where firms are located experiencing long-term proneness to natural disasters (e.g., disaster-prone states, abbreviated as DPS) that such physical risks induce distress costs to firms (Ginglinger & Moreau, 2023). Corporate payout choices are adjustable to maintain financial flexibility based on corporate operating performance (E. Lie, 2005). While corporate liquidity is critical to firms when they are prone to climate risks (D. Gounopoulos & Y. Zhang, 2024; S. Javadi et al., 2023; Lee et al., 2023), investors could specialize in firms with excessive cash, problematic ESG reputation, and no payouts (Wong & Zhang, 2024). Therefore, payout policies could play influential roles in mitigating the antipathy of shareholders to firms with excessive cash for reliable reasons (e.g., firms maintain higher liquidity to hedge climate risks, etc.). Instead of paying dividends, firms might repurchase more shares for flexible payout choices under climate risks (Yuyuan Chang et al., 2024), and payout policy is critical to firms' risk management and financial flexibility (Bonaimé et al., 2013; Denis, 2011). Given that firms are increasingly vulnerable to climate change impacts, based on the related literature discussed, our third hypothesis is as follows.

H3: The Paris Agreement, proneness to disasters, and corporate vulnerability moderate the impacts of SLTA on corporate dividend policy.

Aligned with prior literature, the Paris Agreement (COP21) is a timed dummy variable that is set equal to 1 for the years after COP21 was adopted in 2015; otherwise, it is set equal to 0. COP21 is critical to test, regardless of the complex commitment of the US to our global climate action[15]. Carbon premium has been increasingly demanded by investors since the COP21 (Bolton & Kacperczyk, 2021; P. Bolton & M. Kacperczyk, 2023). Also, the payout policy conveys signals about a firm's growth prospects to investors (Allen & Michaely, 2003; Brav et al., 2005). Therefore, COP21 could present a possible moderation to the impacts of SLTA on corporate payout policy.

Regarding US News and World Reports[16], we classify disaster-prone states (DPS) and set our DPS dummy equal to 1 if a firm is headquartered in a US state that is prone to natural disasters; otherwise, it is set equal to 0. The US most disaster-prone states include 1) Texas, 2) California, 3) Oklahoma, 4) Washington, 5) Florida, 6) Oregon, 7) New York, 8) New Mexico, 9) Arizona, 10) Colorado and Nevada (tie). While Yuyuan Chang et al. (2024) examine the temporary impacts of climate-related events with disaster events, we control for the long-term proneness of firms to state-level natural disasters. Our tests for DPS aim to provide the following complementarities plus added novelties. First, payout policy is critical to mitigating agency problems (Allen & Michaely, 2003; Brav et al., 2005), hence, firms located in DPS could have more well-prepared risk management to maintain possible payouts to shareholders. Second, assuming that a firm is in a chronic disaster-prone state, should the firm ignore payouts all? The first possible answer is that it depends on diverse determinants of corporate payouts in the literature. The second possible rationale is that it should not always be the case, as no payouts could raise agency problems with signaling effects on firms' growth prospects related to the literature on (dis)appearing dividends (Fama & French, 2001; Fatemi & Bildik, 2012; Kuo et al., 2013; Michaely & Moin, 2022). Therefore, controlling for DPS provides insightful empirical findings to mitigate biased interpretations caused by endogeneity, reflecting the long-term nature of climate change risks for this study.

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[15] Climate change: US formally withdraws from Paris agreement; The United States Officially Rejoins the Paris Agreement - United States Department of State

[16] See The Most Disaster-Prone States in the U.S.

Consistent with related literature (Nguyen & Phan, 2020), Vulnerability is a dummy variable that is set equal to 1 for firms that are polluting; otherwise, we set our dummy variable equal to 0. Vulnerable firms are not just carbon-intensive with great vulnerability to climate risks but are also prone to biodiversity risks (Giglio et al., 2023). Regarding prior literature (Ginglinger & Moreau, 2023; Sautner et al., 2023), corporate vulnerability (e.g., polluting firms, etc.) is sensitive to climate risk drivers with expected moderation to dividend payout under SLTA where firms are located. Therefore, potential moderations are hypothesized to provide in-depth investigations and serve as an additional robustness check for the association between STLA and corporate dividend policy. Based on GIC sectors [GSECTOR code in CUMPUSTAT]. Firms belonging to the following sectors are classified as vulnerable firms (Vulnerability): 1) Energy (GIC code = 10), 2) Materials (GIC code = 15), Industrials (GIC code = 20), and 4) Utilities (GIC code = 55)[17]. It is critical to examine the potential moderation of corporate vulnerability for the following reasons. While carbon-intensive firms might attract higher awareness of stakeholders to their environmental performance (Bolton & Kacperczyk, 2021; P. Bolton & M. Kacperczyk, 2023) with possible decreased leverage under stringent climate policies (Lee et al., 2024), payout policies are adjustably conditional on corporate operating performance (E. Lie, 2005). In the context of Australia, polluting firms have exhibited lower leverage since the Kyoto Protocol (Nguyen & Phan, 2020); however, polluting firms contribute a large fraction of the country's gross domestic product (GDP) to economic growth[18]. Consequently, the rationale is questionable that the lower leverage of polluting firms is driven by either stringent climate policies, financial flexibility, or both. While the polluting levels of firms are subject to transition risks (e.g., investors, policies, etc.), climate physical risks impose widespread impacts on firms and the wider economy worldwide. Therefore, we test corporate vulnerability to i) provide more insightful findings with mitigated endogeneity issues and ii) robustly check the impacts of SLTA on corporate payout policy with a possible moderation of corporate

[17] GICS® - Global Industry Classification Standard - MSCI; The Global Industry Classification Standard (GICS) - Classification.Codes; GICS®: Global Industry Classification Standard | S&P Dow Jones Indices
[18] See Composition of the Australian Economy Snapshot | Education | RBA

vulnerability. Overall, we aim to highlight the long-term consequences of SLTA benchmarking climate change risks across the US states.

3. Data and Methodology

3.1. Data

We extract data from multiple sources. We first extract data on statewide monthly temperature series from the National Centers for Environmental Information of the National Oceanic and Atmospheric Administration (NCEI-NOAA)[19]. The webpage provides monthly statewide time series for temperature values and anomalies within the US states from 1985 onward. The temperature data are available for 49 states across the US. We extract firm-level financial accounting data from Compustat - Capital IQ offered by Wharton Research Data Services (WRDS)[20]. Consistent with the literature on corporate payouts and data availability, we collect a comprehensive coverage of US firms from 1971 to 2020[21]. We exclude financial and utility firms with SICs between 6000-6999 and 4000-4949, respectively. We further exclude firms with missing data on dividend payout (DV), assets total (AT), and market capitalization (CSHO and PRCC_F). Our unbalanced panel data includes 20,144 listed firms for the US, with data on state locations (STATE) available for the sample firms. Given the data available on monthly statewide time series for temperature anomaly, our final merged panel data includes 49 US states with 220,658 state-firm-year observations for the US between 1971 and 2020.

3.2. Methodology

We investigate the association between US state-level temperature anomalies and corporate dividend payout (dividend payout) by proposing the following linear regression model:

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[19] National Centers for Environmental Information (NCEI) (noaa.gov)

[20] We use the licensed account for PhD candidate/Doctoral Researcher offered by the School of Economics and Finance, Massey University, Private Bag 11 222 Palmerston North, 4442, New Zealand.

[21] We stop our sample period at 2020 to mitigate the unexpected impacts of the post Covid-19 period on corporate payouts/ Please find WHO Coronavirus (COVID-19) Dashboard | WHO Coronavirus (COVID-19) Dashboard With Vaccination Data

$$DIVIDEND_{i,j,t} = \alpha + \beta_1 TEMPERATURE\_ANOMALY_{i,j,t-1} + \beta_k \sum_{i=0}^{n} X_{i,j,t-1} + \emptyset + \partial + \varepsilon \quad (1)$$

where, $DIVIDEND_{i,j,t}$ is the total amount of dividends as a fraction of the total assets of a firm i from state j at year t. Following related literature (Chay & Suh, 2009; HAIL et al., 2014; Hossain et al., 2023; Zhou & Ruland, 2006), we also use alternative dividend policy measures, including dividends as a fraction of common shares outstanding (CSHO), dividends to Sales, and the logarithm of one plus dividends. $TEMPERATURE\_ANOMALY_{i,j,t-1}$ is the temperature anomaly by state *j* where the firm *i* is located in year *t-1*, defined as the difference between the state-level temperature in which the firm is located and a baseline/average temperature following NCEI-NOAA. The baseline temperature is normally estimated by an average of 30 or more years of temperature data. A positive anomaly implies a warmer temperature relative to the baseline, while a negative anomaly represents a cooler temperature relative to the baseline within the US states[22].

Following related literature on corporate payout (Chay & Suh, 2009; DeAngelo et al., 2006; Kahle & Stulz, 2021), we include a comprehensive set of control variables $X_{i,j,t-1}$, which includes firm size (log of assets total), tangibility, operating income to assets, net income to assets total, capital expenditures to assets total, acquisitions to assets total, research and development expenditure to assets total, selling, the general and administrative expense to sales, advertising expenses to sales, Tobin's Q, cash holdings, book and market leverage ratios, operating cash flow to assets total, interest and related expense to assets total, income taxes to assets, free cash flow to assets total, change in debt to assets total and change in cash to assets total (Kahle & Stulz, 2021). We use a combination of year, industry, state, and firm fixed effects. The standard errors are clustered by firm. We present all variable descriptions in the Appendix (Table A1).

[22] Anomalies vs. Temperature | Did You Know? | National Centers for Environmental Information (NCEI) (noaa.gov)

4. Empirical results

4.1. Summary statistics

Table 1 reports descriptive statistics of the variables. Our full sample includes 147,836 state-firm-year observations. State-Level Temperature Anomaly [SLTA] presents a mean value of 0.9029, ranging from -1.9167 for the minimum value to 4.2500 for the maximum value, with a standard deviation of 1.3094. The median value of SLTA is 0.7500. Our findings show that our sample firms have experienced global warming over the recent decades. Statistically speaking, on a state-level average, our sample firms experience an abnormally warmer temperature of 0.9029 Fahrenheit [°F] compared to their 1901-2000 baseline temperature. Over the sample period from 1971 onward, our sample firms experienced the coolest abnormal temperature value of -1.9167 °F and abnormal hottest abnormal temperature of 4.2500°F. With a median abnormal temperature of 0.7500, overall, our sample firms experience global warming where their headquarters are located across the US states, with a standard deviation of 1.3094. While prior studies look at temporary climate change along with its short-term climatic outcomes (Dimitrios Gounopoulos & Yu Zhang, 2024; Huang et al., 2018), our current study shows abnormal temperature values that benchmark long-term climate change, showing the divergence between current temperature values and their baseline 30-year average temperature values. Such anomalies have led to more severe physical risks with higher frequency in recent decades, with diverse kinds of natural disasters (Adrian et al., 2023; Blanco et al., 2024; Gu & Hale, 2023; Huang et al., 2018; Jha et al., 2021; Keerthiratne & Tol, 2017; Klomp, 2014; Mallucci, 2022; Munich-RE, 2024). The very first and substantial difference that the current study brings to prior studies is that we employ more benchmarked measures for capturing long-term climate change, which is geographically divergent to firms located across the US states, see NCEI-NOAA (2024a, 2024b); Stern (2008); Tol (2024). Furthermore, global warming with abnormally high temperatures induces abnormal drought risks that have been recently used in related literature (Adrian et al., 2023; Do et al., 2021; Huynh et al., 2020; S. Javadi & A.-A. Masum, 2021; Nguyen et al., 2022). Drought risks, biodiversity issues, and our ecosystems are shaped by temperature (NCEI-NOAA, 2024a, 2024b), therefore, temperature anomalies benchmark climate change in a multidimensional manner[23].

[Table 1 Inserted Here]

In the context of SLTA, which indicates widespread global warming in the US, our sample firms exhibit a mean value of common ordinary dividends to assets of 0.0077 with a standard deviation of 0.0151, ranging from 0.0000 for the minimum value to 0.0851 for the maximum value. With the median value [p50] of 0.0000, it seems our sample firms' dividends are disappearing. Disappearing dividends remain a case for our sample firms when we take the fraction of dividends to firms' common shares outstanding, sales, and the logarithm value of dividends commonly paid to shareholders. Share repurchases to assets total exhibit a mean value of 0.0100 with a standard deviation of 0.0293, ranging from 0.0000 for the minimum value to 0.1886 for the maximum value. The median value of share repurchases to assets is 0.0000. For payout flexibility, where firms' share repurchases are divided by their total payouts, presents a mean value of 0.4085, ranging from 0.0000 for the minimum value to 1.0000 for the maximum value, with a standard deviation of 0.4404. While prior literature argues that disappearing dividends are strongly correlated with firm characteristics, corporate life cycle, and volatile earnings (Fama & French, 2001; Fatemi & Bildik, 2012; Kuo et al., 2013; Michaely & Moin, 2022); so, what causes such correlations? Our initial findings imply the contribution of climate change, SLTA more specifically, for this current to be a possible important determinant of corporate payout policy, which is interactive with other corporate policies.

4.2. Regression results

Table 2 reports the results of the baseline ordinary least-squares linear (OLS) regression in equation (1), where corporate dividend payout defined as cash dividend/assets (DIVIDEND) and is regressed on the

[23] To some extent, we could acknowledge the cofounding effects of diverse kinds of climate risks with timely market responses. Abnormal temperature leans our focus to the long-term systematic consequences of climate change. Regarding the Paris Agreement, our goal is to limit the increase in our global temperature to 1.5°C and mitigate global warming by the end of this century. See, The Paris Agreement | UNFCCC

US state-level temperature anomaly (TEMPERATURE ANOMALY) along with a comprehensive set of firm characteristics. All control variables, including the temperature anomaly, are lagged by one year. We include year, industry, and state-level fixed effects. The standard errors are clustered around firms.

Columns 1 and 2 report coefficient estimates of temperature anomaly without and with the control variables, respectively. Irrespective of the inclusion of the control variables, the coefficient of temperature anomaly is -0.0001 and highly significant statistically, which means a one-degree increase in temperature anomaly induces firms to decrease dividend payout by approximately -0.01%. This effect is also economically significant: a one standard deviation change in temperature anomaly implies a decrease equal to 1.63% [(0.0001×1.307)/0.008] of the mean dividend payout or a 0.007 [(0.0001×1.307)/0.018] standard deviation decrease in dividends.

Under state-level climate change exposure [SLCCE], we consistently follow the literature with a set of control variables included for the study including Firm Size, Book to Market, Tobin's Q, capital expenditure (Capex), Research and Development Expenditure to Assets (R&D to Assets), Leverage, Operating Cash Flow; Selling, General and Administrative (Sga to Sales), and Advertising Expense to Sales (Xad to Sales) and additional literature-based control variables (Brav et al., 2005; Farre-Mensa et al., 2014; Hanlon & Hoopes, 2014; Huynh et al., 2020; Kahle & Stulz, 2021). Changes in dividends convey a signal about the current and potential prospects of firms. Miller and Modigliani (1961) provide a detailed discussion on factors influencing firms' dividend payouts their signaling information about dividends paid to shareholders. Dividend policy also conveys reasons that investors might interpret as a proxy for changes in the points of view of the management boards about firms' prospects. Such signaling information conveyed by changes in firms' dividend policy is formalized as dividend signaling models (JOHN & WILLIAMS, 1985; MILLER & ROCK, 1985). In the context of SLCCE, our baseline regressions show that firms with larger book assets and higher book-to-market [BM] ratios become conservative in their dividends paid to shareholders. Given changes in state-level temperature anomalies [SLTA], the conservativeness of increasing dividends by larger firms with higher BM ratios remains constant when we test for warmer and abnormal cooler temperature anomalies. Our baseline findings convey managerial optimism about the prospects of our sample firms for being sensitive to climate change across the US states. Given the consciousness of firms to SLTA, firms with promising investment opportunities, higher investments in corporate innovation [R&D], higher leverage, higher operating cash flow, and higher selling, general, and administrative expenses are likely to decrease dividends. Our baseline findings imply that SLCCE affects firms' managerial optimism about their prospects, leading to a predicted decrease in dividends. In other words, when firms are exposed to SLTA, climate risks with predicted decreases in dividends induce firms 'managers to expect unsound firm performance in the future. With signaling models discussed earlier, the findings imply a long-term climate-induced deterioration in the growth prospects of our sample firms with their subsequent dividend reduction.

Regarding FAMA and FRENCH (1995) with a rational pricing model, a higher BM ratio conveys poor, persistent earnings. Such forecasts about substandard earnings by firms could be explained further by firms' subsequent dividend reductions given a unit increase in SLTA that embarks on climate change across the US states. With a lower propensity to pay dividends when firm characteristics are changing (Fama & French, 2001), our findings are aligned with prior literature by showing a fall in corporate dividends when publicly listed firms have been increasingly exposed to SLCC over the recent decades. In the context of SLTA, climate change could induce firms with low profitability and retained growth opportunities to ignore dividend payouts. Given the sample period starting from the late 1970s, regardless of whether firms' characteristics are changing, our evidence from SLCCE supports Fama and French (2001) by showing that listed firms have a low motivation to make dividend payouts.

[Table 2 Inserted Here]

Regarding a life-cycle theory, DeAngelo et al. (2006) argue that the proportion of publicly listed firms with dividends paid is only high when their retained earnings cover a large portion of equity and total assets. The fraction of dividends paid by firms to their shareholders is decreased toward zero when their equity is distributed rather than earned. While dividend payouts could follow a firm's life cycle, in the context of climate change, dividend omissions could be a case for firms for the following reasons. On the supply side, climate risks induce higher volatility in a firm's retained earnings. Therefore, even large firms would become conservative in the amounts of dividends paid to shareholders (Huang et al., 2018). For locations that are prone to natural disasters due to climate risks, such consequences could induce the volatility of retained earnings of firms even more severely, leading to a lower propensity to pay dividends[24]. For different levels of earned/distributed capital mix, such physical risks might impose expected losses to larger firms with higher tangibility. Given the vulnerability of corporate tangibility, which firms might use to support more borrowings and further investments (Almeida & Campello, 2007), the investment-cash flow nexus could be more sensitive when firms' asset tangibility is exposed to severe climate change. in other words, larger firms might face a greater challenge in using tangible assets as a credit multiplier. With increasing awareness of investors about climate risks, costly external finance could demotivate firms to borrow borrowing more (Chava, 2014; Ginglinger & Moreau, 2023; S. Javadi & A.-A. Masum, 2021). Our evidence on SLCCE could support prior literature by documenting the long-term consequences of climate change on the effects of asset tangibility on firms' investment–cash flow sensitivity (Moshirian et al., 2017). Dividends are disappearing, our findings provide novelties added to related literature by showing how SLCC has contributed far to corporate payout policy with a life cycle where large firms are highly sensitive to climate risks. Given volatile retained earnings due to climate risks (Huang et al., 2018), paying fewer dividends to optimize corporate liquidity seems a reliable choice for firms in dealing with SLTA, see Yuyuan Chang et al. (2024); Denis (2011); Dimitrios Gounopoulos and Yu Zhang (2024); Siamak Javadi et al. (2023). Regarding DeAngelo et al. (2006); Fama and French (2001); Grullon et al. (2002), our baseline findings initially explain the impacts of SLCC on corporate dividend policy, with their consequences becoming even severe in larger and more mature firms in later stages of the life-cycle. Not just younger firms with higher growth opportunities, but the impacts of climate change, SLTA here in our case, could impose significant risks on larger firms with more constant

[24] See Billion-Dollar Weather and Climate Disasters | United States Summary | National Centers for Environmental Information (NCEI) (noaa.gov)

retained earnings to become conservative in their dividend payouts. Our baseline findings imply widespread and long-term consequences of climate change for firms to deal with in the form of their payout policies to be more resilient.

Since our temperature is calculated as the difference from the 30-year temperature average, the more (negative) positive values imply the (cooler) hotter temperature average. We investigate the impacts of positive and abnormal temperatures (Abnormal warmer and abnormal cooler) on dividend payout. Results reported in columns (3) and (4) show that abnormal warmer temperature anomalies are negatively associated with dividend payout as the coefficient estimates are -0.0002 and 0.0002, respectively, with statistical significance at the 1% level. A positive coefficient estimate of the abnormal cooler is because the values of this variable are all negative. Our results indicate that an increase in abnormal temperature, irrespective of abnormal warmer or cooler, induces farms to pay less dividends.

5. Robustness Check

In this section, we check the robustness of our baseline findings with alternative measures of dividend payout, additional controls, economic conditions across states, and alternative payout methods like share repurchases.

5.1. Alternative measures of dividends

Comparable to recent literature on corporate dividend policy (Hossain et al., 2023), we employ Dividend to Shares, Dividend to Sales, and Log of Dividend as alternative measures to Dividend to Assets for our dependent variable of interest. Regarding the literature, we use these three alternative measures to quantify firms' dividend policies because they are related to the magnitude of dividend payments. Our employment of alternative dividend measures is also motivated by La Porta et al. (2000), the authors make use of dividends scaled by firms' revenue/sales earned as a commonly-used measure of dividend payouts. Our measures for corporate dividend payouts are consistent with Chay and Suh (2009) by capturing corporate dividend policy as the dividend payout ratio, measured as firms' cash dividends declared on their common/ordinary shares (DVC), see also Attig et al. (2021); Brockman and Unlu (2009).

We use three alternative measures of dividends: dividend/common share outstanding (dividend per share), dividend/sales, and log(1+dividend). Results reported in columns (1) to (3) in Panel A of Table 3 show that the coefficient estimates of temperature anomaly are statistically significantly negative, at least at the 5% level for all measures.

[Table 3 Inserted Here]

5.2. Additional controls

Prior studies on the corporate payout and agency problems suggest that firms conduct payouts to mitigate prospective overinvestment practices by a firm's management (Farre-Mensa et al., 2014). Payouts are increased when firms become mature, and higher amounts of repurchases and dividends paid by firms are appreciated with more free cash flow [FCF]. Agency problem models motivate our study to include FCF to investigate how agency-based models are applicable to firms' payout policy when they are exposed to SLCC. Finance literature has paid attention to the paths that a firm's payout policy could be affected by potential conflicts of interest between a firm's management board and its shareholders, which is known as a free cash flow problem; see prior established studies by Easterbrook (1984); Jensen (1986); Jensen and Meckling (1976). Furthermore, such potential conflicts could drive corporate payout choices with potential conflicts between minority and majority shareholders, and between shareholders and debtholders (Myers, 1977). We hereby include FCF as our additional control variable to investigate whether the impacts of SLCC on corporate dividend policy remain robust in the presence of the FCF problem.

Further studies on corporate payouts document that variant firm characteristics and a lower propensity of dividend payouts retain firm characteristics less variant (DeAngelo et al., 2006). Firm characteristics with corporate maturity present their importance in explaining a decreasing fraction of dividend-paying firms. Regarding a maturity hypothesis by Grullon et al. (2002) older firms are likely to make more payouts.

Additionally, DeAngelo et al. (2006) suggest that corporate maturity can be captured by the earned/distributed mix, with evidence that such that such earned/distributed mix quantitatively imposes a greater effect on corporate payout decisions rather than firm financial performance and growth opportunities. In the context of SLTA, climate change could be facing a greater challenge because of its size and asset tangibility, which are sensitive to physical risks. Motivated by related literature, we control corporate maturity [Age] as our additional control variable to examine whether our expectation remains robust. By including firm age, we further explain how SLCCE affects corporate payout policy when larger firms are assumed to be greatly sensitive to climate drivers.

Payout policy remains the core of corporate finance is how much cash firms decide to pay out to their shareholders. Distributing cash reserves could drive a firm's investment decisions and valuation, with potential effects on tax amounts to be paid by its investors (Farre-Mensa et al., 2014). Such cash distribution for a firm's payout may convey informative insights to the market about how well the firm is performing compared to its peer firms. With the presence of market frictions, corporate payouts do not just imply operating cash flow residuals and a firm's net of investments. In real-life practice, a firm's managers might inform that they could refrain from projects with a positive net present value (NPV) before omitting dividend payouts (Brav et al., 2005). Given the context, a firm's payout policy drives its investment decisions, along with sound implications for the firm's value as well as the whole economy. Therefore, we might acknowledge that a firm's payout policy is closely related to its other firm policies, such as cash holdings, financing choices, and capital structure dynamics. For our investigation of the impacts of SLCCE on corporate payout policy, we hereby liaise our study with related literature by controlling additional corporate policies, including cash holdings, interest expense, income taxes, and changes in debt and cash ratios.

Column (4) in panel B of Table 3 shows that after controlling additional variables in the baseline regression, the coefficient estimate of temperature anomaly remains -0.0001 with statistical significance at the 1% level, implying that our finding is robust to additional controls.

5.3. Controlling for year dummies

Since the 21st century started, financial economists have paid attention to ‘disappearing dividends’ (Fama & French, 2001; Fatemi & Bildik, 2012; Kuo et al., 2013). Starting from the study of Fama and French (2001); (Fatemi & Bildik, 2012; Kuo et al., 2013), the authors document a decrease of 66.5% in 1978 and a decrease of 20.8% in 1999 for disappearing dividends of publicly traded firms. The study explains that such reductions in corporate dividends are due to changes in firm characteristics. Given the growing number of newly listed firms, disappearing dividends are explained by an increasing proportion of young firms with huge growth opportunities and low profitability. The study document that, firms exhibit their low propensity of paying dividends, regardless their characteristics regardless of their characteristics, firms have become less likely to pay dividends. Fama and French (2001) document that such a lower propensity of dividend payouts is also important as firm characteristics are changing, which leads to an occurrence of a decreasing proportion of dividend-paying firms. Roughly a decade later since the study of Fama and French (2001), Fatemi and Bildik (2012) document the disappearance of dividends worldwide. In a similar spirit to Fama and French (2001), Fatemi and Bildik (2012) document that a decrease in the propensity of dividend payouts is derived from a large proportion of smaller and less profitable firms with substantial growth opportunities. The study finds that the number of dividend-paying firms varies significantly across industries. Even when changes in firm characteristics are well controlled, the number of dividend-paying firms has proportionally decreased over the years, as globally documented by Fatemi and Bildik (2012). The proportional decrease in dividend payouts is documented to be more pronounced for firms located in civil law countries (Fatemi & Bildik, 2012). Just a year later, Kuo et al. (2013) investigated the potential factors that drive the disappearance of dividend payouts. The study sheds light on the role of liquidity, risk, and catering in the changing propensity to pay dividends. Kuo et al. (2013) argue that risk is a principal determinant of corporate dividend policy. For firms located in economies like the US, UK, France, and some other European markets, liquidity plays an important additional determinant of firms’ dividends. The study shows that catering incentives among firms are persistent in common-law countries only. Even when risk is adjusted, the study finds weak support for the catering theory for firms that are incorporated in common law economies. Kuo et al. (2013) document that catering incentives represent the risk-reward relation in the changes of dividend-paying propensity by firms. More recently,

Kahle and Stulz (2021) document a substantial increase in corporate payouts paid by public firms over the recent decades. Compared to the period of 1971-1999, the study documents that corporate payouts in the form of dividends and share repurchases are three times larger for the period of 2000-2019. The authors present that, listed firms' accumulated income accounts for an increase of roughly 37% in annual payouts of sample firms. Firms exhibit an increase of 63% in their payout rates. The study highlights that such an increase in corporate payouts is not just due to corporate maturity and firm size but is also due to a higher fraction of free cash flow dedicated by firms to be paid to their shareholders. Nevertheless, firms are likely to decrease their capital expenditures since the 2000s; a decrease in capital expenditure is documented to be a common phenomenon regardless of whether firms make payouts or not. A modern study by Michaely and Moin (2022) decomposes the disappearance of dividends for the period of 1970s–2000 and their subsequent for the period of 2000–2018 for dividend-paying firms. The study shows that changes in firm characteristics and propensity to pay dividends both drive a half proportion of disappearing dividends. A propensity to pay dividends accounts for 82% of reappearing dividends. A proportion of roughly 18% of reappearing dividends is derived from firms' stable earnings. Firms with volatile characteristics are linked to their less profitable performance with high volatility of earnings. Firms with a changing propensity to pay dividends are related to their profitable and stable performance. Newly (de)listed firms make the trends with the magnitude and durability of disappearing payouts significantly smaller for corporate dividends, with possible substitution implied between repurchases and dividends.

Given the heterogeneous literature on corporate (dis)appearing dividends, for the context of SLCCE in this study, we control for the time dummy variables for the 2000s, 2010s, and 2018s. While the recent two decades have seen an increasing abnormal climatic conditions for the US and worldwide, the inclusion of the year dummy variables offers two critical aspects. First, we aim to investigate whether the impacts of SLTA on corporate dividends remain robust with the decomposed periods of disappearing dividends as documented by Fama and French (2001); Fatemi and Bildik (2012); Kuo et al. (2013); Michaely and Moin (2022). Second, while Kahle and Stulz (2021) document a roughly triple increase in corporate payouts for the past two decades, if our findings were robust, our evidence from SLTA offers added novelties to prior literature by showing that climate risks are inevitable determinants of corporate payouts. In other words, our multiple-decade sample provides insight into the consequences of climate change on corporate payout policy, which prior literature on corporate dividends' (dis)appearance might have missed so far. In Panel C of Table 3 reports the results of year dummies without and with additional control variables in Columns 5 and 6, respectively. The coefficient estimates of temperature anomaly remain unchanged when we control for the dummy variables for the 2000s, 2010s, and 2018s.

[Table 3 Inserted Here]

As of 1999, dividend-paying firms fell to 20.8% compared to 66.5% in 1978 (Fama & French, 2001). The study argues that decreased corporate cash dividends are caused by changing firm characteristics. Also, decreased dividends are caused by new listings with small firms that appeared with strong growth opportunities. Besides firm characteristics, dividend disappearances are later explained by several studies after Fama and French (2001). With over 50% decrease in dividends is further explained by DeAngelo et al. (2004) for the following reasons. The study argues that dividend disappearances are for those firms with very small dividends paid to shareholders. Furthermore, DeAngelo et al. (2004) argue that top dividend-paying firms overshadow bottom dividend-paying firms. The study shows that industrial firms with high earnings dominate dividend supply, with aggregate impacts of earnings on dividends paid for a majority of firms. Hoberg and Prabhala (2008) examine the puzzle of disappearing dividends via the lens of risk, including explanatory variables market-to-book ratio, corporate asset growth, corporate profitability, and NYSE size percentile. The study shows that risk plays a significant role in determining dividend-paying prosperity, with dividend disappearances accounting for 40% approximately. Hoberg and Prabhala (2008) find little support for the view that dividend disappearances reflect the catering of firms to their transient fads. A related study by Baker and Wurgler (2004) documents a close association between dividend-paying fluctuations and catering incentives. The authors determine four distinct paths in dividend-paying prosperity for the period between 1963 and 2000. Baker and Wurgler (2004) show that every path is linked to a corresponding volatility in firms' catering incentives and that dividend-paying prosperity increases when the stock market dividend premium is positive and vice versa. Nearly a decade later, Fatemi and Bildik (2012) firmly document dividend disappearances with global evidence. With industry-wide heterogeneity, firm characteristics are a critical determinant of dividend-paying prosperity for firms. Over the years, dividend-paying proportions and the number of payers have decreased, with which disappearance of dividends by firms being pronounced for civil law countries. A decade later, Michaely and Moin (2022) historical patterns of dividend payouts for the period starting from the 1970s to 2018. The authors document a decreased fraction of dividend-paying firms before 2000 (1970s-2000) and a subsequent recovery in the recent decades (2000-2018). The authors argue that changing firm characteristics as well as dividend-paying proclivity jointly drive dividend disappearances of firms. Subsequent recovery of corporate dividend payouts is also supported by Kahle and Stulz (2021) with the triple increase in corporate payouts in the recent decades (2000-2019) compared to from 1971 to 1999. While dividend (dis)appearances remain their puzzling findings, we show that climate change is an important and inevitable determinant of corporate payouts, with persistently decreased dividends paid to shareholders. The adverse impacts of climate change (SLTA) on dividends remain robust when we control for the periods documented by Kahle and Stulz (2021). Our findings highlight the fact that global warming has escalated in the US, with complex associated risks[25] imposed on firms, leading to decreased dividends paid to shareholders. Controlling for different time periods with dividend (dis)appearances, our study complements prior literature by showing the long-term adverse impacts of climate change on

[25] Climate change impacts are increasing for Americans | National Oceanic and Atmospheric Administration

corporate dividend payouts (Baker & Wurgler, 2004; DeAngelo et al., 2004; Fama & French, 2001; Fatemi & Bildik, 2012; Hoberg & Prabhala, 2008; Michaely & Moin, 2022). For the long-term proneness of firms to climate risks, the trends of dividend (dis)appearances could be explained by the increasing threats of global warming across the US states.

Share repurchases and payout flexibility

Numerous studies (Babenko, 2009; Dittmar, 2000; Grullon et al., 2002; Ikenberry et al., 1995; Vermaelen, 1981; Wang et al., 2021) show share repurchases as a substitute for cash dividends. Michaely and Moin (2022) examine the reappearance of dividends after 2000 in the U.S., followed by "disappearing dividends" in the early 1970s, and show that more stable and profitable firms tend to pay dividends. While Bonaimé et al. (2013) also show that firms favor repurchases over dividends to achieve payout flexibility, which is negatively related to financial hedging, Arena and Julio (2023) find that the high litigation risk leads firms to substitute dividends for share repurchases. Yuyuan Chang et al. (2024), using a large sample of 45 countries, show that firms substitute dividends with repurchases to increase their payout flexibility in response to higher climate risk. To this end, we regress Share repurchases/Total assets on the temperature anomaly with controls. Results reported in Panel D of Table 3 (Column 7) show that the coefficient of temperature anomaly is negative but statistically insignificant, implying that firms do not substitute share repurchases with dividends in the U.S. In Column (8), when we regress Share repurchases/Total Payout to proxy for payout flexibility on the temperature anomaly, the coefficient estimate of the temperature anomaly is statistically insignificant. Thus, our results contrast with the findings of Y. Chang et al. (2024) for a large sample of countries that include U.S. firms.

6. Channel Analysis

This section examines the firm-level factors through which temperature anomaly is channeled to firms' decision to reduce dividends. We explore four possible channels: cash holdings, trade credit, and market leverage.

The optimal amount of cash distributed to a firm's shareholders is an important question in its payout policies (Allen & Michaely, 2003). It is because the payout policy is not only important to the amount of liquidity accounted by a firm and its subsequent repeating decision, but also because firms' payout policy is interactively linked to most of the investment and financial decisions the firms execute. Given the current levels of cash holdings, a firm's boards of directors and management need to decide how much cash the firm might optimally distribute to its shareholders in the form of dividends, and what shares the firm would repurchase. Potential financial slack the firm might incur for its capital investment in real assets, debt issuance, and mergers and acquisitions. In an inefficient capital market, a firm's payout policy interacts with cash policy as well as other financing decisions, see also Baker and Wurgler (2013); Kalay and Lemmon (2008). For the context of climate change, cash holdings modernly show critical roles when corporate profitability is shrunk due to climate risk drivers (Dimitrios Gounopoulos & Yu Zhang, 2024; Siamak Javadi et al., 2023). When corporate liquidity is affected by an externality (e.g., climatic anomalies), in the form of unused debt capacity, firms might make substantial debt issuance to finance their operating needs rather than making larger equity payouts (Denis & McKeon, 2012). Given the increasing awareness about climate risks by stakeholders (Andersson et al., 2016; Bolton & Kacperczyk, 2021; PATRICK BOLTON & MARCIN KACPERCZYK, 2023), a firm's (de)leveraging practices could play a critical role in its payout policy, which could be derived by climate change with greater complexity (DeAngelo et al., 2017; Ginglinger & Moreau, 2023; Huang et al., 2018). A Firm can be financed by its suppliers instead of being financed by financial institutions. This context leads us to trade credit theories. Given the widespread climate change and costly external finance due to climate risks (Chava, 2014; Huynh et al., 2020; S. Javadi & A.-A. Masum, 2021), trade credit could be an alternative financial source for firms that might have stringent accessibility to capital markets (Petersen & Rajan, 2015). In the context of stringent mortgage lending due to increasing awareness of loan offers about climate change (Duan & Li, 2024), trade credit could play as an external financing choice under the scenario that monetary transmission mechanisms are changing as extensively elaborated by the literature (Chen et al., 2019; Dafermos et al., 2018; Mateut, 2005; McKibbin et al., 2021; Nilsen, 2002; Petersen & Rajan, 1997, 2015; Schwartz, 1974; Wilner, 2000). When firms are exposed to physical risks, with both the supply and demand sides (Ginglinger & Moreau, 2023), our choices of selected variables for channel tests allow our study to elaborate on the ways that firms could have responded to SLCCE in the form of their dividend policies.

Results reported in Table 4 show that while the coefficient estimate of *Temperature anomaly* is statistically significantly positive in Column (1) with a very low value, the interaction of the interaction of temperature anomaly and Cash holdings, *Temperature Anomaly* × *Cash Holdings* is significantly negative at the 1% level with a value of -0.0020. While firms pay higher dividends with higher cash holdings, as the coefficient of the variable is 0.0082 with statistical significance at the 1% level, a higher temperature anomaly leads to lower dividends. The coefficient estimates of *Trade Credit* and *Market Leverage* are -0.0008 and -0.0274 in Columns (2) and (3), respectively, and are statistically highly significant, suggesting that both variables lead to lower dividend payout. However, the interaction terms, *Temperature Anomaly* × *Trade Credit* and *Temperature Anomaly* × *Market Leverage,* are statistically significantly negative. Given that the *Temperature Anomaly* is also significantly negative in both columns, our findings suggest that a higher abnormal temperature forces firms to pay lower dividends channeled through trade credit and market leverage.

[Table 4 Inserted Here]

For the direct associations, the findings show that firms with higher cash holdings maintain higher predicted dividends paid to shareholders (Column 1). On the other hand, firms with higher trade credit and market leverage are predicted to have decreased dividends paid to shareholders. Our findings complement prior literature streams as follows. First, we document the long-term impacts of climate change with US state-level evidence on corporate dividend policy with both supply and demand effects. On the demand side, firms reserving more cash imply that their financial conditions are being constrained by climate change impacts, leading to a decreased dividend paid to shareholders (Temperature Anomaly × Cash Holdings). Corporate liquidity is critical to firms with financial flexibility for a possible dividend payment to shareholders; however, when we control temperature anomaly, firms' on-year-head dividends are decreased by climate change exposure. The findings also imply that reserving more cash signals firms'

exposure to climate change. Our findings from the moderations of cash holdings are supported when firms employing trade credit as an alternative financing source decrease dividends paid to shareholders (Column 2). A similar rationale is evident from firms' market leverage with a subsequent decrease in dividend payouts (Column 3). Firms with access to credit (either trade credit or market leverage) could maintain positive dividends paid to shareholders under climate risk exposure. Our findings support our second hypothesis (H2), showing moderations of cash holdings, trade credit, and market leverage.
While recent studies highlight the roles of cash reserves for firms to safeguard from climate risks (D. Gounopoulos & Y. Zhang, 2024; S. Javadi et al., 2023; Lee et al., 2023)Our findings suggest not just the severe but also the long-term effects of climate change on the US. More importantly, heightened cash holdings imply that firms are severely exposed to climate risks with subsequent decreased dividends. Benchmarking multiple-decade climate change with its geographical divergence for the US, our findings imply the critical roles of credit access to firms when they are exposed to climate risks for operating needs (Dang et al., 2024). It is critical to note that, even though with access to credit (trade credit or market leverage) (Benincasa et al., 2024)Climate change impacts remain with a predicted decrease in dividends paid to firms' shareholders. Furthermore, prior literature focuses on proving the ways firms deal with contemporary climate risks (e.g., disasters and climate-related events) (Yuyuan Chang et al., 2024; Yen et al., 2024), our second hypothesis is empirically accepted, proving the long-term climate change impacts on firms, channeling through on corporate cash reserves and financing policies.

7. Moderating Effects

This section explores the moderating effects of three factors, mainly external to firms. We focus on three factors: COP21, disaster-prone states, and vulnerability. First, following P. Bolton and M. Kacperczyk (2023) and Y. Chang et al. (2024), we employ the Paris Agreement at the United Nations Climate Change Conference, COP21, enforced from 2016 as an event. The agreement aims to keep the global average temperature below 2°C above pre-industrial levels and limit the temperature increase to 1.5°C above pre-industrial levels. Although the Trump administration decided to withdraw from the Paris Agreement in

2017, President Joe Biden signed an executive order on 20th January 2021 to rejoin the agreement. The agreement is supposed to increase awareness of climate change and the associated transition risk among the firms. We define *COP21* as a dummy variable that equals 1 for post-agreement from 2016 and 0 otherwise. We include the interaction term, *Temperature anomaly×COP21,* to decipher the moderating effect of the Paris Agreement. Regardless of the changing commitments of the US to our global climate action[26], recent studies document the climate transition risks of the Paris Agreement [COP21] on corporate decisions for firms located in the US (Yuyuan Chang et al., 2024; Ginglinger & Moreau, 2023). Regarding Bolton and Kacperczyk (2021); PATRICK BOLTON and MARCIN KACPERCZYK (2023), COP21 imposes transitional effects on equity markets with an increasing awareness of stakeholders about climate risks. Under the exposure of firms to climate change, in the context of SLTA, for the internationalization of US equity markets (Frankel, 1994), a landmark global agreement like COP21 could spill over its transitional risks to shareholders with their stock portfolios of firms headquartered in states with abnormal positive temperature anomalies that indicate the increasingly severe phenomenon of global warming in those states. Given the context, COP21 could additionally impose transitional effects on firms to be more conservative in equity payouts. The regression results are reported in Table 5. Column (1) shows that the coefficient estimate of *Temperature anomaly×COP21* is negative and statistically significant at the 10% level, implying that after the Paris Agreement, firms decrease their dividend payout even further when facing an increase in abnormal temperature.

Natural disasters impose potential insolvency on banking systems, for which banks could experience financial fragility (Klomp, 2014). Dal Maso et al. (2024) show that banks located in U.S. counties that are prone to disaster risks are likely to have larger loan loss provisions [LLP]. The study implies an increasing concern about natural disasters with potential economic consequences affecting the ways that banking systems could proactively hedge such credit risk through LLP due to natural disasters. From the

[26] On the U.S. Withdrawal from the Paris Agreement - United States Department of State; The United States Officially Rejoins the Paris Agreement - United States Department of State

supply side, the financial fragility of banks could affect the accessibility of firms to external financing choices due to abnormal climactic outcomes (Huang et al., 2018). Finance sentiment is affected by its subsequent rises following the emergence of natural disasters (Jha et al., 2021), generating adverse consequences to the financial development of economies (Keerthiratne & Tol, 2017). Natural disasters lead to a rational reallocation by institutional investors for information-processing resources (Blanco et al., 2024). The study shows that, with firm-level evidence, institutional investors bear the consequences of disasters to non-affected stocks by decreasing the incorporation of firm-related information, specifically to stocks of the firms that represent a lower portfolio weight. Such behaviors by institutional investors are assumed to be rational in reallocating their information processing sources. Natural disasters could also affect earnings forecasts by firms' analysts in economies like the United States (Zhang & Kanagaretnam, 2024). The study shows that natural disasters are related to the deteriorated properties of analyst forecasts in terms of forecast dispersion and forecast errors. The reason is that natural disasters induce volatile return on assets and corporate cash flows as well as a lower comparability of firms' financial statements. With those three potential channels, Zhang and Kanagaretnam (2024) elaborates the ways that climate disasters affect the properties of analyst forecasts of firms. Such effects of natural disasters are pronounced for firms from industries with high vulnerability to natural disasters. The financial impacts of natural disasters on local firms are also documented by Collier et al. (2024) with evidence from Hurricane Harvey, as well as their spillover effects among firms with significant externalities for management forecast (Park, 2024). For validating the robustness of our predicted impacts of SLCCE proxied by SLTA, we control for the proneness of firms located in US states that are exposed to natural disasters. Regarding U.S.News (2024), natural disasters emerge in several and diverse forms, such as menacing earthquakes, tornadoes, flooding, fires, and many more climate disasters that could pose risks to firms in specific US states. Given the chronic proneness to natural disasters of specific US states, we test for the moderating effects of the proneness of firms to natural disasters by using a dummy variable to depict our sample firms located in the leading disaster-prone states [DPS] for the US. Regarding U.S.News (2024), the top ten disaster-prone states of the United States include 1) California, 2) Texas, 3) Oklahoma, 4)

Washington, 5) Florida, 6) New York, 7) Alabama, 8) Colorado, 9) New Mexico, 10) Louisiana, and Oregon (tie)[27]. Given the short-term climatic conditions that have been used recently in the literature (Yuyuan Chang et al., 2024; Huang et al., 2018), controlling for DPS allows us to not just validate the robustness of our empirical findings, but also support validating our arguments on the differences between climate change measures used for this current study compared to prior literature.

Our regression of dividends on SLTA moderated by Disaster-Prone States provides the following insightful implications. First, our predicted impacts of temperature anomaly on dividends remain negative and statistically significant at the 1% level. The robust standalone effects of SLCCE proxied by SLTA remain consistent for our prediction of the long-term and chronic consequences of climate change to corporate dividend policy, for which firms become conservative to making large equity payouts to shareholders. The rationale is that decreasing equity payouts allows firms to reserve their ample corporate liquidity to cope with costly financial distress and to finance operating needs under climate change exposure (Ginglinger & Moreau, 2023; Dimitrios Gounopoulos & Yu Zhang, 2024; Siamak Javadi et al., 2023; Nguyen et al., 2022). Regarding signaling theories, our findings show that firms located in Disaster-Prone States, under SLCCE across the US, have maintained positive dividend payouts to their shareholders. The findings bring critical implications as follows. First, to some extent, the payout policy being adversely affected by climate risks is conditional on corporate liquidity, risk management, and financing choices by firms. In our case, a predicted positive payout shows that firms located in DPS are capable of better risk management under state-level climate change. Even though firms are located in Disaster-Prone States, firms have prepared for periodic disaster events. Firms with positive payouts convey a positive signal to investors about their growth prospects, regardless of whether their locations are more prone to natural disasters compared to firms located in other states that are less prone to natural disasters. While mitigating climate change is our long-term effort with subsequent physical risks,

[27] The 10 Most Disaster-Prone States in the U.S. (usnews.com); Natural Disasters by State: The 25 Most Disaster-Prone Areas in the US | Moneywise

corporate payouts remain their roles in mitigating agency problems between directors, the management board, and shareholders of firms. Therefore, such proneness to natural disasters could have increased firms' awareness about long-term climate risks for suitable risk management toward a positive payout maintained to their shareholders. Our findings add to a recent study by Yuyuan Chang et al. (2024) by showing that the proneness to climate physical risks could induce firms to have more suitable risk management strategies in advance, for which those firms might still maintain positive equity payouts to their shareholders. Our explanations are aligned with signaling models and agency-based theories, corporate payouts with literature surveys (Allen & Michaely, 2003; Farre-Mensa et al., 2014; Kalay & Lemmon, 2008).

Third, firms in vulnerable industries are more likely to be highly affected by climate-related risk, inducing them to cut dividends in the future. Following Human et al. (2018) and Chang et al. (2024), we identify the industries as vulnerable based on Fama–French industry codes. These industries are agriculture, business services, communication, energy, coal, oil, food products, health care, and transportation. We define *Vulnerability* as a dummy variable that equals 1 for the vulnerable industries and 0 otherwise. We include the interaction term, *Temperature anomaly* × *Vulnerability,* to find the moderating effect of the vulnerable industries. An increase in abnormal temperatures is more likely to affect vulnerable industries, forcing firms to pay less dividends. Results reported in Column (3) show that the coefficient estimate of *Temperature anomaly* × *Vulnerability* is significantly negative at the 5% level, which is consistent with our expectation.

[Table 5 Inserted Here]

For the standalone associations, the adverse effects of SLTA on corporate dividends paid are persistent for all the fitted models (Columns 1-3), showing the long-term effects of state-level climate change on corporate payouts. We observe that, since the COP21, firms have been likely to maintain positive dividend payouts to their shareholders (Column 1). On the other hand, firms located in disaster-prone states decrease dividends paid to shareholders (Column 2), while we observe a positive but not significant increase in dividends for corporate vulnerability (Column 3). The joint effects between climate change and proneness to natural disasters (Temperature Anomaly × Disaster-Prone States) result in predicted positive dividends paid to shareholders, while the joint effects between climate change and Cop21 (Temperature Anomaly × Cop21) and corporate vulnerability (Temperature Anomaly × Vulnerability) show a strong predicted decrease in dividends paid by firms to shareholders. Our findings imply the following rationales which could be critical to related streams of literature. Transition risks (e.g., stringent environmental policies, etc.) could be (un)beneficial to firms for the following reasons. First, stringent climate policies could be beneficial to firms with progressive innovations that are friendly to the environment (e.g., progressive R&D, eco-innovation, overall ESG, etc.), while transition risks could be unfavorable to polluting firms (e.g., carbon risk), which are unfriendly to the environment. Our findings prove the moderation of COP21 (a binding, legally international treaty for climate action) by showing the negative joint effects of SLTA and COP21 (Temperature Anomaly × COP21) on corporate dividends. Not just domestic climate transition risks (Cao et al., 2024; Dang et al., 2024), firms are likely to decrease dividends paid to shareholders due to associated risks caused by our global climate action to firms located in the US states. The rationale is that polluting firms would likely have co-founding effects of transition risks for our climate action to mitigate climate change impacts (e.g., drought risks, etc.) (Do et al., 2021; Huynh et al., 2020; S. Javadi & A. A. Masum, 2021).

Another critical insight from our moderation analyses is that, under long-term climate change, firms might learn from historical climate events for risk management (e.g., natural disasters, etc.). Since natural disasters impose potential fragility on financial institutions (e.g., banks, etc.) (Celil et al., 2022; Hansen, 2022; Ivanov et al., 2022), firms might be more conservative with their financial policies to safeguard themselves from frequent occurrences of natural disaster risks. Under long-term global warming with SLTA, we find that firms located in disaster-prone states maintain positive dividends paid to shareholders (Temperature Anomaly × Disaster-Prone States). Our findings are crucial to prior literature focusing on physical risks by showing that adjustments of financial policies could be conditional on firms' awareness about climate risks. for instance, climate risks, depending on their nature (long-term vs short-term risks; physical vs transition risks) would possibly not always induce firms to ignore dividends (Y. Chang et al., 2024). Our findings also prove why prior literature on the impacts of climate risks is heterogeneously exhibited in corporate financing choices (Ginglinger & Moreau, 2023; Huang et al., 2018). Overall, our findings support the third hypothesis (H3), showing the long-term moderation of climate transition risk (Cop21), physical risks (Disaster-prone states), and corporate vulnerability (Vulnerability) to the impacts of SLTA on corporate dividend payouts. Our third hypothesis is empirically proved, showing the persistent and adverse impacts of state-level climate change on corporate dividends, moderated by related climate risk drivers.

8. Subsample Analysis

In this section, we conduct subsample analysis at three levels related to the life-cycle theory of firms. For the sub-sample analyses, we classify firms into two sub-groups with median values above and below our median values for the full sample. Regarding Fama and French (2001); Fatemi and Bildik (2012); Kahle and Stulz (2021); Kuo et al. (2013); Michaely and Moin (2022), we focus on firm size, corporate maturity measured by firm age, and tangibility for our sub-sample analyses.

[Table 6 Inserted Here]

The sub-sample analyses show that small and younger firms are highly sensitive to climate change with higher significant levels of temperature anomaly on corporate dividends. Firms with higher tangibility (fixed assets) are also highly sensitive to temperature anomalies. Our findings support the life-cycle theorem showing that the impacts of climate change on dividend policies could follow a firm's life cycle (DeAngelo et al., 2006). Regarding the life-cycle theory for corporate dividends, the proportions of publicly traded dividend-paying firms could be higher when their retained earnings to assets (to total equity) are sufficiently large, while it could decrease when a firm's retained earnings are near zero and the firm's equity is delivered instead of being earned. Corporate earnings could be more volatile under climate risk exposure (Huang et al., 2018) specifically for younger firms with lower financial flexibility (e.g., cash flows) for payouts when they are still in their earlier life cycle, see Faff et al. (2016). Corporate payouts signal firms' growth prospects to shareholders for which a firm's dividends could be (dis)appearing through life-cycle stages under climate change exposure. We also observe that firms with higher tangibility are significantly sensitive to temperature anomalies (global warming) leading to frequent and increasingly severe impacts of physical risks where firms are located (e.g., hurricanes, droughts, flooding, etc.) (Collier et al., 2024; Huang et al., 2018). Overall, our sub-sample analyses support our baseline findings for the long-term impacts of climate change benchmarked by SLTA for which climate change impacts are propounded for earlier-cycle firms and those with large tangible assets. under the long-term climate change impacts, our findings are aligned with prior literature showing that the impacts of SLTA on dividends are conditional on changing firm characteristics (e.g., growth opportunities, profitability, earnings, etc.) and dividend-paying proclivity (Kahle & Stulz, 2021; Michaely & Moin, 2022). Furthermore, our findings from sub-sample analyses show that climate change impacts on firms could be pronounced to firms that are in the later stages of their life cycle (e.g., larger firms with substantial fixed assets, etc.). For our study, global warming with its related climate risk drivers benchmarks long-term climate change impacts specifically for those with large tangible assets.

9. Conclusion

With evidence from US state-level climate change, this study quantifies the long-term effects of temperate anomalies on corporate dividend policy. The study provides prior literature following contributions. First, state-level temperature anomaly induces firms to become conservative in paying dividends to their shareholders. The predicted impacts of temperature anomalies on corporate dividend policy remain robust with alternative dividend measures. We do not observe strong evidence of firms favoring share repurchases over dividends for their payout flexibility. The adverse consequences of state-level climate change to dividend payouts are pronounced to firms with higher vulnerability to climate risks since the Paris Agreement. Regarding corporate payout policy, our channel and moderation tests offer the following critical insights into prior literature.

Under SLTA, our channel tests highlight the roles of corporate cash holdings, trade credit, and market leverage. Firms with higher cash reserves in the prior year continue being conservative to paying dividends to recover their ample liquidity (Denis, 2011). The consequences of climate change become even more severe for firms with stringent financial flexibility when revenues stop, during the global pandemic as presented by Fahlenbrach et al. (2020), inducing firms to reserve more cash and decrease dividends simultaneously. In the context of climate risks, our findings highlight the precautionary framework of firms' cash policy which is interactively related to their payout policy (Dimitrios Gounopoulos & Yu Zhang, 2024; Siamak Javadi et al., 2023). While Yuyuan Chang et al. (2024) argue that firms might favor share repurchases over dividends for higher payout flexibility in the context of physical risks, our evidence from SLTA does not show any findings that firms increase payout flexibility by making more shares repurchases. For the proneness to contemporary physical risks as used in Yuyuan Chang et al. (2024), our moderation test shows that firms headquartered in the leading disaster-prone states maintain a positive dividend payout to their shareholders. Our findings could provide important implications that the proneness to natural disasters induces firms to have higher awareness about climate change with suitable risk management. Regarding agency-based theories, firms with positive dividends paid could mitigate potential agency problems among management board, directors, and shareholders under the threats imposed by widespread climate change, see Easterbrook (1984); Jensen (1986); Jensen and Meckling (1976). Also, either temporary or long-term climate risks, changes in payout policy by firms are dependent on firm characteristics, life cycle, and corporate earnings (Fama & French, 2001; Fatemi & Bildik, 2012; Kuo et al., 2013; Michaely & Moin, 2022; Moshirian et al., 2017). Mitigating endogeneity issues with not just the proneness to natural disasters, our findings remain constant with a predicted decrease in dividend payouts when we control corporate cash holdings. In other words, chronic proneness to physical risks could elevate firms' awareness of climate risk drivers for suitable hedging approaches. Also, to some extent, the historical cash reserve might signal incremental conservativeness of firms to climate change exposure with their continuous disappearing dividends. Our channel tests show that firms with higher trade credit and market leverage maintain positive dividends paid to shareholders under the exposure to SLCC. Since the extension of trade credit is associated with a firm's operating performance (Box et al., 2018). With appearing dividends under climate change, firms with aggressive trade credit imply future profitability that is associated with their contemporary trade credit provision. Regarding Box et al. (2018) our findings imply potential revenues, market shares, and higher profit margins for firms that are making use of trade credit, compared to firm peers with comparable characteristics and operational needs exposed to SLCC. In the context of climate change, our findings suggest that aggressive policies for trade credit could support improved product market performance. While Denis and McKeon (2012) argue that firms predominantly increase leverage for their operating needs rather than large equity payouts, our findings show that, under CLCC, firms with proactive leverage maintain a positive dividend payout to their shareholders. Our findings imply that, if firms could make use of market leverage for their financing needs, they might still be able to make dividends to their shareholders. With possible leverage increase, paying dividends helps firms mitigate agency problems while conveying positive signals about their growth potential, see Allen and Michaely (2003); Brockman and Unlu (2009); Easterbrook (1984); Farre-Mensa et al. (2014). More importantly, dividends appear to firms that are located in disaster-prone states, for which they are likely to have adaptive climate management practices to deal with expected climatic changes. Our findings add a potential novelty to a recent study by Yuyuan Chang et al. (2024); Huang et al. (2018) that, the proneness to physical risks could help firms to manage positive payouts to their shareholders. Payout choices could be predominantly driven by how flexible a firm's financial conditions are, see Bonaimé et al. (2013); Byoun (2021); Yuyuan Chang et al. (2024); DeAngelo and DeAngelo (2007); DeAngelo et al. (2017); Denis (2011); Denis and McKeon (2012); Fahlenbrach et al. (2020); GAMBA and TRIANTIS (2008).

Table 1: Descriptive statistics

Variable	N	Mean	Min	p50	Max	SD
Corporate Payout Measures						
Dividend/Assets	147836	0.0077	0.0000	0.0000	0.0851	0.0151
Dividend/Common shares Outstanding	147807	0.2287	0.0000	0.0000	2.4637	0.4687
Dividend/Sales	147836	0.0069	0.0000	0.0000	0.0941	0.0153
Log (1+ Dividend)	147836	0.7592	0.0000	0.0000	6.3648	1.4543
Shares repurchase	141035	0.0100	0.0000	0.0000	0.1886	0.0293
Payout flexibility	79806	0.4085	0.0000	0.1642	1.0000	0.4404
State-Level Climate Change						
State-Level Temperature Anomaly	147836	0.9029	-1.9167	0.7500	4.2500	1.3094
State-Level Abnormal warmer	147836	0.7272	0.0000	1.0000	1.0000	0.4454
State-Level Abnormal cooler	147836	0.2728	0.0000	0.0000	1.0000	0.4454
Firm-Level Control Variables						
Firm size	147836	4.6744	0.0677	4.4952	10.2088	2.2013
Book to market	147807	0.6302	-6.9974	0.5479	4.4826	1.2352
Log (1+Tobin’s Q)	147836	4.7740	-0.1791	4.5545	10.4843	2.2989
Capex	147836	0.0647	0.0000	0.0427	0.4327	0.0709
R&D to Assets	147836	0.0415	0.0000	0.0000	0.9185	0.1022
Leverage	147836	0.2983	0.0000	0.2277	3.9645	0.4157
Operating cash flow	147836	-0.0557	-6.7868	0.0550	0.4286	0.6207
Sga to Sales	147836	0.5414	0.0247	0.2373	12.8216	1.4830
Xad to Sales	147836	0.0129	0.0000	0.0000	0.2116	0.0311
Additional Variables						
FCF/Assets	147836	31.1508	0.0000	0.0000	903.0000	124.7421
Log (1 + Age)	147836	1.0606	0.0000	0.0000	3.8712	1.5255

Cash/Assets	147833	0.1423	0.0000	0.0716	0.9598	0.1750
Interest/Assets	147836	0.0312	0.0000	0.0177	0.4644	0.0574
Income Taxes/Asset	147836	0.0233	-0.0878	0.0146	0.1512	0.0387
Change in Debt	147752	0.0162	-0.7728	0.0000	0.6639	0.1672
Change in Cash	147831	-0.0039	-0.6709	0.0009	0.4268	0.1330
2000s dummy	147836	0.3941	0.0000	0.0000	1.0000	0.4887
2010s dummy	147836	0.1716	0.0000	0.0000	1.0000	0.3770
2018 dummy	147836	0.0146	0.0000	0.0000	1.0000	0.1201
Trade credit	147474	0.2379	0.0119	0.1094	4.6250	0.5658
Market leverage	147836	0.2012	0.0000	0.1575	0.7597	0.1852
Tangibility	147280	0.5561	0.0192	0.4673	2.2502	0.4095
COP21	147836	0.0749	0.0000	0.0000	1.0000	0.2632
Disaster-Prone States	147836	0.4793	0.0000	0.0000	1.0000	0.4996
Vulnerability	147836	0.3377	0.0000	0.0000	1.0000	0.4729

Table 2: Baseline regressions

	(1)	(2)	(3)	(4)

VARIABLES	Dividend/Assets	Dividend/Assets	Dividend/Assets	Dividend/Assets
Temperature Anomaly	-0.0001**	-0.0001***		
	(0.0000)	(0.0000)		
Abnormal warmer			-0.0002***	
			(0.0001)	
Abnormal cooler				0.0002***
				(0.0001)
Firm Size		-0.0023***	-0.0023***	-0.0023***
		(0.0002)	(0.0002)	(0.0002)
Book to Market		-0.0009***	-0.0009***	-0.0009***
		(0.0001)	(0.0001)	(0.0001)
Log of Tobin's Q		0.0041***	0.0041***	0.0041***
		(0.0002)	(0.0002)	(0.0002)
Capex		-0.0119***	-0.0119***	-0.0119***
		(0.0011)	(0.0011)	(0.0011)
R&D to Assets		-0.0029***	-0.0029***	-0.0029***
		(0.0009)	(0.0009)	(0.0009)
Leverage		-0.0063***	-0.0063***	-0.0063***
		(0.0004)	(0.0004)	(0.0004)
Operating cash flow		-0.0004**	-0.0004**	-0.0004**
		(0.0002)	(0.0002)	(0.0002)
Sga to Sales		-0.0002***	-0.0002***	-0.0002***
		(0.0001)	(0.0001)	(0.0001)
Xad to Sales		0.0131**	0.0131**	0.0131**
		(0.0055)	(0.0055)	(0.0055)
Constant	0.0178***	0.0163***	0.0164***	0.0162***
	(0.0054)	(0.0053)	(0.0053)	(0.0053)
Observations	128,313	128,307	128,307	128,307
R-squared	0.1846	0.2788	0.2788	0.2788
Year-FE	Yes	Yes	Yes	Yes
Industry-FE	Yes	Yes	Yes	Yes
State-FE	Yes	Yes	Yes	Yes
Cluster SE	Yes	Yes	Yes	Yes

Table 3: Robustness Checks

	Panel A: Alternative measures of dividends		Panel B: Additional controls		Panel C: Year dummies		Panel D: Share repurchases	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Dividend /Shares	Dividend /Sales	Log(1+Dividend)	Dividend /Assets	Dividend/ Assets	Dividend /Assets	Repurchase /Assets	Repurchase /Total payout
Temperature Anomaly	-0.0042***	-0.0001***	-0.0060**	-0.0001***	-0.0001***	-0.0001***	-0.0000	0.0002
	(0.0009)	(0.0000)	(0.0026)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0014)
Firm Size	0.0708***	-0.0017***	0.2455***	-0.0009***	-0.0023***	-0.0009***	-0.0048***	-0.0309***
	(0.0052)	(0.0002)	(0.0155)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0073)
Book to Market	-0.0214***	-0.0005***	-0.0648***	-0.0004***	-0.0009***	-0.0004***	0.0003***	0.0364***
	(0.0022)	(0.0001)	(0.0067)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0051)
Log of Tobin's Q	0.0295***	0.0037***	0.2083***	0.0022***	0.0041***	0.0022***	0.0071***	0.0068
	(0.0044)	(0.0002)	(0.0131)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0069)
Capex	-0.2604***	-0.0134***	-0.8121***	-0.0119***	-0.0119***	-0.0119***	-0.0186***	0.0274
	(0.0328)	(0.0014)	(0.1002)	(0.0010)	(0.0011)	(0.0010)	(0.0017)	(0.0494)
R&D to Assets	0.1118***	-0.0035***	0.3029***	-0.0018**	-0.0029***	-0.0018**	-0.0083***	0.2134**
	(0.0221)	(0.0009)	(0.0741)	(0.0008)	(0.0009)	(0.0008)	(0.0015)	(0.0859)
Leverage	-0.1215***	-0.0048***	-0.3034***	-0.0034***	-0.0063***	-0.0034***	-0.0053***	0.0298*
	(0.0093)	(0.0003)	(0.0254)	(0.0003)	(0.0004)	(0.0003)	(0.0006)	(0.0161)
Operating cash flow	-0.0654***	-0.0005***	-0.2204***	0.0001	-0.0004**	0.0001	0.0018***	0.0500***
	(0.0046)	(0.0002)	(0.0132)	(0.0001)	(0.0002)	(0.0001)	(0.0004)	(0.0140)
Sga to Sales	0.0048***	-0.0003***	0.0116***	-0.0001***	-0.0002***	-0.0001***	-0.0002**	0.0227***
	(0.0012)	(0.0001)	(0.0040)	(0.0000)	(0.0001)	(0.0000)	(0.0001)	(0.0042)
Xad to Sales	0.1631	0.0111**	0.9652***	0.0129***	0.0131**	0.0129***	0.0114**	0.2832**
	(0.1186)	(0.0044)	(0.3632)	(0.0049)	(0.0055)	(0.0049)	(0.0057)	(0.1230)
FCF/Assets				0.0000***		0.0000***		
				(0.0000)		(0.0000)		
Log (1+Age)				-0.0009***		-0.0009***		
				(0.0001)		(0.0001)		
Cash/Assets				0.0060***		0.0060***		
				(0.0007)		(0.0007)		
Interest/Assets				0.0016		0.0016		
				(0.0013)		(0.0013)		
Income Taxes/Asset				0.1081***		0.1081***		
				(0.0034)		(0.0034)		
Change in Debt				0.0014***		0.0014***		
				(0.0002)		(0.0002)		
Change in Cash				-0.0069***		-0.0069***		
				(0.0004)		(0.0004)		
2000s dummy					-0.0066***	-0.0022***		
					(0.0005)	(0.0005)		

2010s dummy					-0.0014***	-0.0011***		
					(0.0004)	(0.0004)		
2018 dummy					0.0015***	0.0014***		
					(0.0003)	(0.0003)		
Constant	-0.0380	0.0214***	-0.8841***	0.0127**	0.0163***	0.0127**	0.0015	0.0664
	(0.0808)	(0.0067)	(0.2363)	(0.0051)	(0.0053)	(0.0051)	(0.0128)	(0.1085)
Observations	128,286	128,307	128,307	128,240	128,307	128,240	122,624	72,268
R-squared	0.3913	0.2407	0.5180	0.3485	0.2788	0.3485	0.1076	0.2870
Year-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4: Channel Test

	(1)	(2)	(3)

VARIABLES	Dividend/Assets	Dividend/Assets	Dividend/Assets
Temperature Anomaly × Cash Holdings	-0.0020***		
	(0.0003)		
Temperature Anomaly × Trade Credit		0.0004***	
		(0.0001)	
Temperature Anomaly × Market Leverage			0.0029***
			(0.0003)
Temperature Anomaly	0.0002***	-0.0002***	-0.0006***
	(0.0001)	(0.0000)	(0.0001)
Cash holdings	0.0082***		
	(0.0008)		
Trade credit		-0.0008***	
		(0.0001)	
Market leverage			-0.0274***
			(0.0007)
Firm Size	-0.0020***	-0.0023***	-0.0005***
	(0.0002)	(0.0002)	(0.0002)
Book to Market	-0.0008***	-0.0009***	-0.0001**
	(0.0001)	(0.0001)	(0.0001)
Log of Tobin's Q	0.0038***	0.0041***	0.0024***
	(0.0002)	(0.0002)	(0.0002)
Capex	-0.0100***	-0.0116***	-0.0127***
	(0.0011)	(0.0011)	(0.0011)
R&D to Assets	-0.0036***	-0.0028***	-0.0041***
	(0.0009)	(0.0009)	(0.0008)
Leverage	-0.0055***	-0.0063***	0.0027***
	(0.0004)	(0.0004)	(0.0003)
Operating cash flow	-0.0004***	-0.0004**	0.0015***
	(0.0002)	(0.0002)	(0.0002)
Sga to Sales	-0.0003***	-0.0002***	-0.0002***
	(0.0001)	(0.0001)	(0.0000)
Xad to Sales	0.0122**	0.0132**	0.0115**
	(0.0055)	(0.0055)	(0.0053)
Constant	0.0153***	0.0163***	0.0232***
	(0.0051)	(0.0053)	(0.0055)

Observations	128,304	128,129	128,307
R-squared	0.2823	0.2787	0.3149
Year-FE	Yes	Yes	Yes
Industry-FE	Yes	Yes	Yes
State-FE	Yes	Yes	Yes
Cluster SE	Yes	Yes	Yes

Table 5: Moderation effects

VARIABLES	(1) Dividend/Assets	(2) Dividend/Assets	(4) Dividend/Assets
Temperature Anomaly × Cop21	-0.0004*		
	(0.0002)		
Temperature Anomaly × Disaster-Prone States		0.0003***	
		(0.0001)	
Temperature Anomaly × Vulnerability			-0.0002**
			(0.0001)

Temperature Anomaly	-0.0001**	-0.0002***	-0.0000
	(0.0000)	(0.0001)	(0.0001)
Cop21	0.0050***		
	(0.0016)		
Disaster-Prone States		-0.0088*	
		(0.0049)	
Vulnerability			0.0007
			(0.0005)
Firm Size	-0.0023***	-0.0023***	-0.0023***
	(0.0002)	(0.0002)	(0.0002)
Book to Market	-0.0009***	-0.0009***	-0.0009***
	(0.0001)	(0.0001)	(0.0001)
Log of Tobin's Q	0.0041***	0.0041***	0.0041***
	(0.0002)	(0.0002)	(0.0002)
Capex	-0.0119***	-0.0119***	-0.0118***
	(0.0011)	(0.0011)	(0.0011)
R&D to Assets	-0.0029***	-0.0029***	-0.0029***
	(0.0009)	(0.0009)	(0.0009)
Leverage	-0.0063***	-0.0063***	-0.0063***
	(0.0004)	(0.0004)	(0.0004)
Operating cash flow	-0.0004**	-0.0004**	-0.0004**
	(0.0002)	(0.0002)	(0.0002)
Sga to Sales	-0.0002***	-0.0002***	-0.0002***
	(0.0001)	(0.0001)	(0.0001)
Xad to Sales	0.0130**	0.0130**	0.0134**
	(0.0055)	(0.0055)	(0.0055)
Constant	0.0163***	0.0164***	0.0164***
	(0.0053)	(0.0053)	(0.0052)
Observations	128,307	128,307	128,307
R-squared	0.2789	0.2789	0.2790
Year-FE	Yes	Yes	Yes
Industry-FE	Yes	Yes	Yes
State-FE	Yes	Yes	Yes
Cluster SE	Yes	Yes	Yes

Table 6: Subsample Analysis

	Panel A: Firm size		Panel B: Firm age		Panel C: Tangibility	
	(1)	(2)	(3)	(4)	(5)	(6)
	Small Firms	Large Firms	Young Firms	Old Firms	Lower Tangibility	Higher Tangibility
VARIABLES	Dividend/Assets	Dividend/Assets	Dividend/Assets	Dividend/Assets	Dividend/Assets	Dividend/Assets
Temperature Anomaly	-0.0001**	-0.0001*	-0.0001***	-0.0000	-0.0001	-0.0001***
	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0001)	(0.0000)
Firm Size	-0.0006***	-0.0043***	-0.0015***	-0.0040***	-0.0020***	-0.0027***
	(0.0002)	(0.0004)	(0.0002)	(0.0003)	(0.0004)	(0.0003)
Book to Market	-0.0007***	-0.0010***	-0.0008***	-0.0008***	0.0001	-0.0010***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Log of Tobin's Q	0.0019***	0.0064***	0.0029***	0.0061***	0.0026***	0.0046***
	(0.0002)	(0.0003)	(0.0002)	(0.0003)	(0.0003)	(0.0002)

Capex	-0.0082***	-0.0177***	-0.0153***	-0.0195***	-0.0093***	-0.0120***
	(0.0011)	(0.0021)	(0.0020)	(0.0012)	(0.0023)	(0.0012)
R&D to Assets	-0.0031***	-0.0103***	-0.0045***	-0.0035***	-0.0018*	-0.0029**
	(0.0007)	(0.0034)	(0.0011)	(0.0013)	(0.0011)	(0.0012)
Leverage	-0.0039***	-0.0140***	-0.0055***	-0.0075***	-0.0006	-0.0077***
	(0.0002)	(0.0013)	(0.0004)	(0.0005)	(0.0008)	(0.0004)
Operating cash flow	-0.0003**	0.0140***	-0.0005**	-0.0004	0.0006*	-0.0004*
	(0.0001)	(0.0018)	(0.0002)	(0.0003)	(0.0003)	(0.0002)
Sga to Sales	-0.0002***	0.0001	-0.0002***	-0.0002**	-0.0001**	-0.0002***
	(0.0000)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Xad to Sales	0.0004	0.0234**	0.0151**	0.0181**	-0.0029	0.0220***
	(0.0041)	(0.0091)	(0.0061)	(0.0084)	(0.0058)	(0.0069)
Constant	0.0106	0.0285***	0.0252	0.0140***	0.0320***	0.0129*
	(0.0083)	(0.0038)	(0.0163)	(0.0049)	(0.0092)	(0.0072)
Observations	61,034	67,273	62,020	66,287	19,775	106,227
R-squared	0.2137	0.3647	0.2448	0.3555	0.2178	0.3099
Year-FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-FE	Yes	Yes	Yes	Yes	Yes	Yes
State-FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster SE	Yes	Yes	Yes	Yes	Yes	Yes

Appendix A1: Definitions of variables

Variable	Definition	Data Source
	State-level climate change	
State-Level Temperature Anomaly	The state-level temperature anomaly that is captured is a divergence between a baseline average temperature. US states' baseline temperature is estimated by averaging 30 years or more of state-level temperature data. A positive temperature anomaly value indicates that a specific state's observed temperature was warmer than its baseline historical average temperature value. A negative value of temperature anomaly indicates the observed temperature of a specific state was cooler than its baseline average temperature value.	NCEI-NOAA
State-Level Abnormal warmer	A dummy variable is set equal to one for positive values of state-level temperature anomaly, otherwise is set equal to zero.	NCEI-NOAA Author's Calculation
State-Level Abnormal cooler	A dummy variable is set equal to one for negative values of state-level temperature anomaly, otherwise is set equal to zero.	NCEI-NOAA Author's Calculation
	Corporate payout measures	
Dividend/Assets	Dividends common/ordinary [DVC] to assets total.	COMPUSTAT ANNUAL File Author's Calculation
Dividend/Common shares Outstanding	Dividends common/ordinary [DVC] to common shares outstanding.	COMPUSTAT ANNUAL File Author's Calculation
Dividend/Sales	Dividends common/ordinary [DVC] to sales/turnover (Net).	COMPUSTAT ANNUAL File

		Author’s Calculation
Log (1+ Dividend)	The logarithm value of one plus Dividends Common/Ordinary [DVC].	COMPUSTAT ANNUAL File Author’s Calculation
Shares repurchase	Shares repurchase to assets total.	COMPUSTAT ANNUAL File Author’s Calculation
Payout flexibility	Shares repurchase to gross payouts.	COMPUSTAT ANNUAL File Author’s Calculation
	Main firm-level control variables	
Firm size	The logarithm value of one plus firms’ assets total [AT].	COMPUSTAT ANNUAL File Author’s Calculation
Book to market	Book to market ratio.	COMPUSTAT ANNUAL File Author’s Calculation
Log (1+Tobin’s Q)	The logarithm value of one plus Tobin’s Q.	COMPUSTAT ANNUAL File Author’s Calculation
Capex	Capital expenditures [CAPX] to assets total [AT].	COMPUSTAT ANNUAL File Author’s Calculation
R&D to Assets	Research and development expenditure [XRD] to assets total [AT]. Missing values are replaced by zero.	COMPUSTAT ANNUAL File Author’s Calculation
Leverage	Book leverage measured as the fraction of firms’ debt [DLC + DLTT] to book assets total [AT].	COMPUSTAT ANNUAL File Author’s Calculation
Operating cash flow	Firms’ operating cash flow [OCF] to assets total [AT]	COMPUSTAT ANNUAL File Author’s Calculation
Sga to Sales	Selling, general and administrative expense [SGA] to sales/turnover (Net) [SALE]	COMPUSTAT ANNUAL File Author’s Calculation
Xad to Sales	Advertising expense [XAD] to sales/turnover (Net) [SALE]	COMPUSTAT ANNUAL File Author’s Calculation
	Additional firm-level control variables	
FCF/Assets	Free cash flow [FCF] to assets total [AT]	COMPUSTAT ANNUAL File Author’s Calculation
Log (1 + Age)	The logarithm value of one plus firm age. Missing values are replaced by zero.	COMPUSTAT ANNUAL File Author’s Calculation
Cash/Assets	Cash and short-term investments [CHE] to assets total.	COMPUSTAT ANNUAL File Author’s Calculation
Interest/Assets	Interest and Related Expense – Total [XINT] to assets total [AT].	COMPUSTAT ANNUAL File

		Author’s Calculation
Income Taxes/Assets	Income Taxes [TXT] Total to Assets Total [AT]	COMPUSTAT ANNUAL File Author’s Calculation
Change in Debt	Change in debt total from year t-1 to year t.	COMPUSTAT ANNUAL File Author’s Calculation
Change in Cash	Change in cash holdings from year t-1 to year t.	COMPUSTAT ANNUAL File Author’s Calculation
Trade credit	Trade credit measured by accounts payable [AP] to cost of goods sold [COGS]	COMPUSTAT ANNUAL File Author’s Calculation
Market leverage	Market leverage is measured by debt total [DLC+DLTT] to market value of assets [MVA].	COMPUSTAT ANNUAL File Author’s Calculation
2000s dummy	A time dummy variable that is set equal to one for the years 2000s, otherwise is set equal to zero.	Author’s Calculation
2010s dummy	A time dummy variable that is set equal to one for the years 2010s, otherwise is set equal to zero	Author’s Calculation
2018 dummy	A time dummy variable that is set equal to one for the year 2018, otherwise is set equal to zero	Author’s Calculation
	Variables used for moderating regressions	
Cop21	A time dummy variable that is set equal to one for the years after the Paris Agreement adopted in 2015, otherwise is set equal to zero.	Author’s Calculation
Disaster-Prone States	A dummy variable that is set equal to one for firms headquartered in disaster-prone states, otherwise is set equal to zero. The 10 Most Disaster-Prone States in the U.S. (usnews.com)	
Vulnerability	A dummy variable that is set equal to one form firms that belong to vulnerable industries that are exposed to climate change risk drivers.	Author’s Calculation

Note: To mitigate the potential effects of outliers, we winsorize all the firm-level continuous variables at the 1st and 99th percentiles.

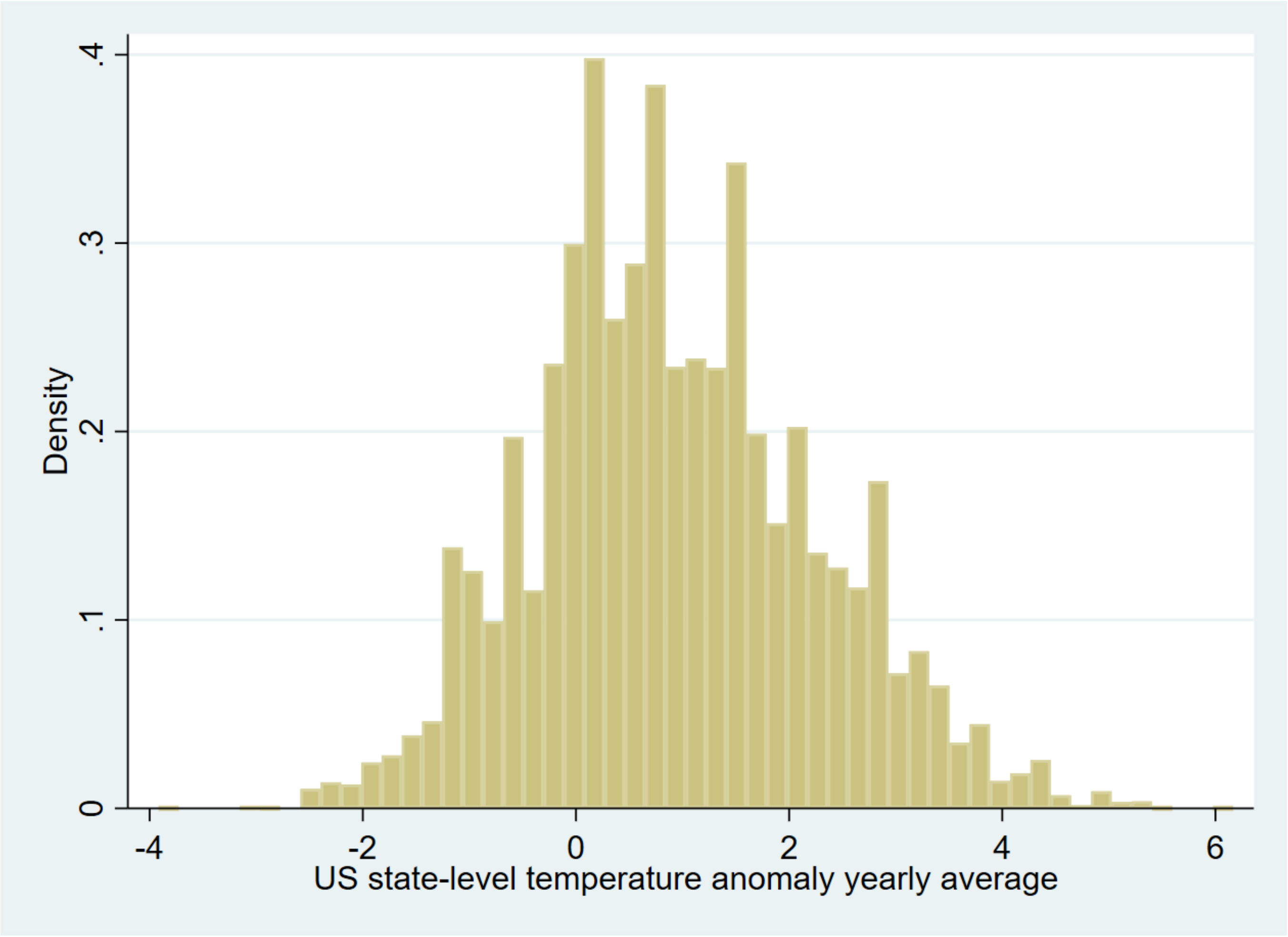

Figure. 1A: US state-level temperature anomaly yearly average 1971-2020[28]

[28] Anomalies vs. Temperature | Did You Know? | National Centers for Environmental Information (NCEI) (noaa.gov)

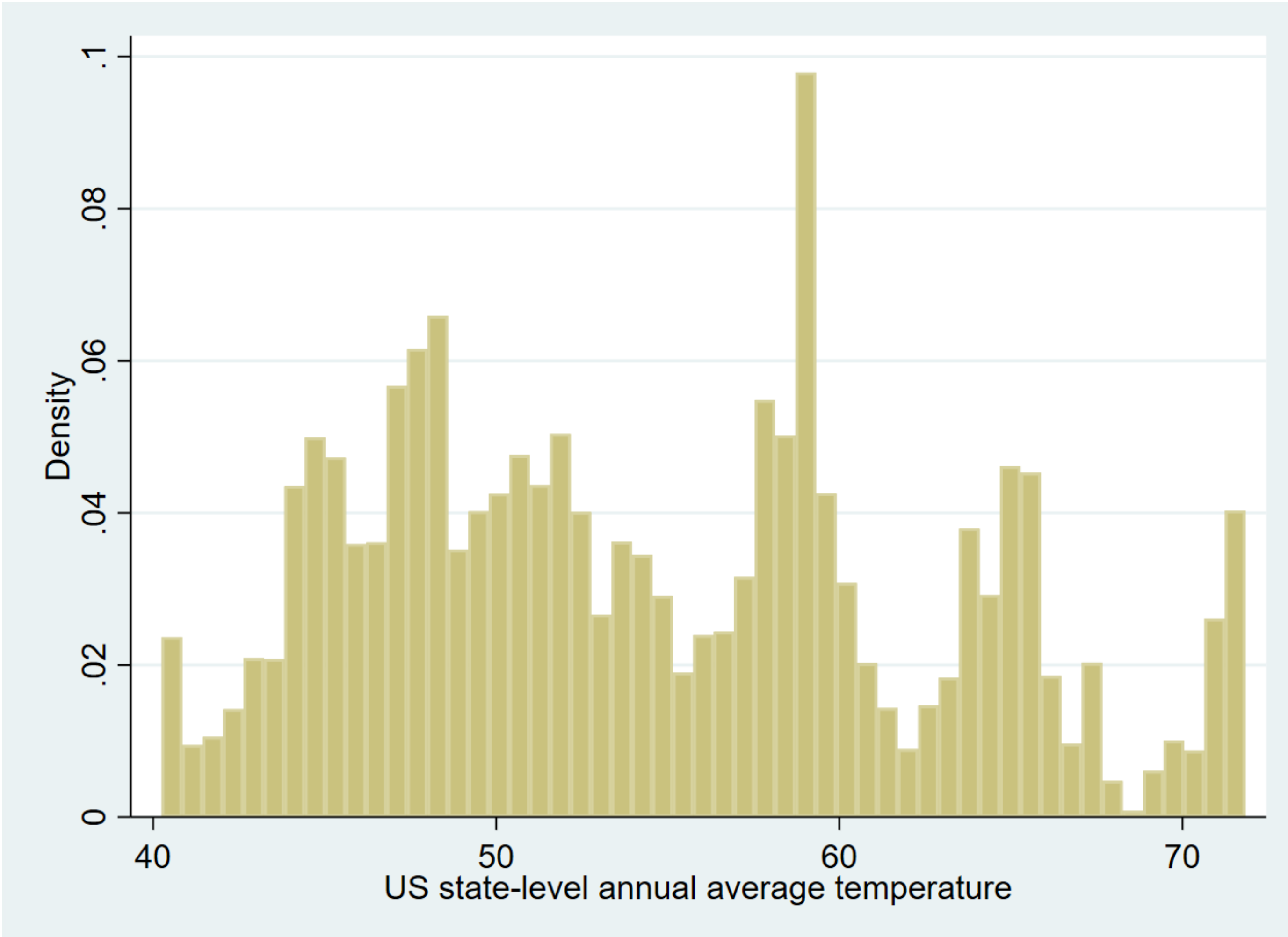

Figure. 2A: US state-level annual average temperature 1971-2020[29]

[29] New maps of annual average temperature and precipitation from the U.S. Climate Normals | NOAA Climate.gov

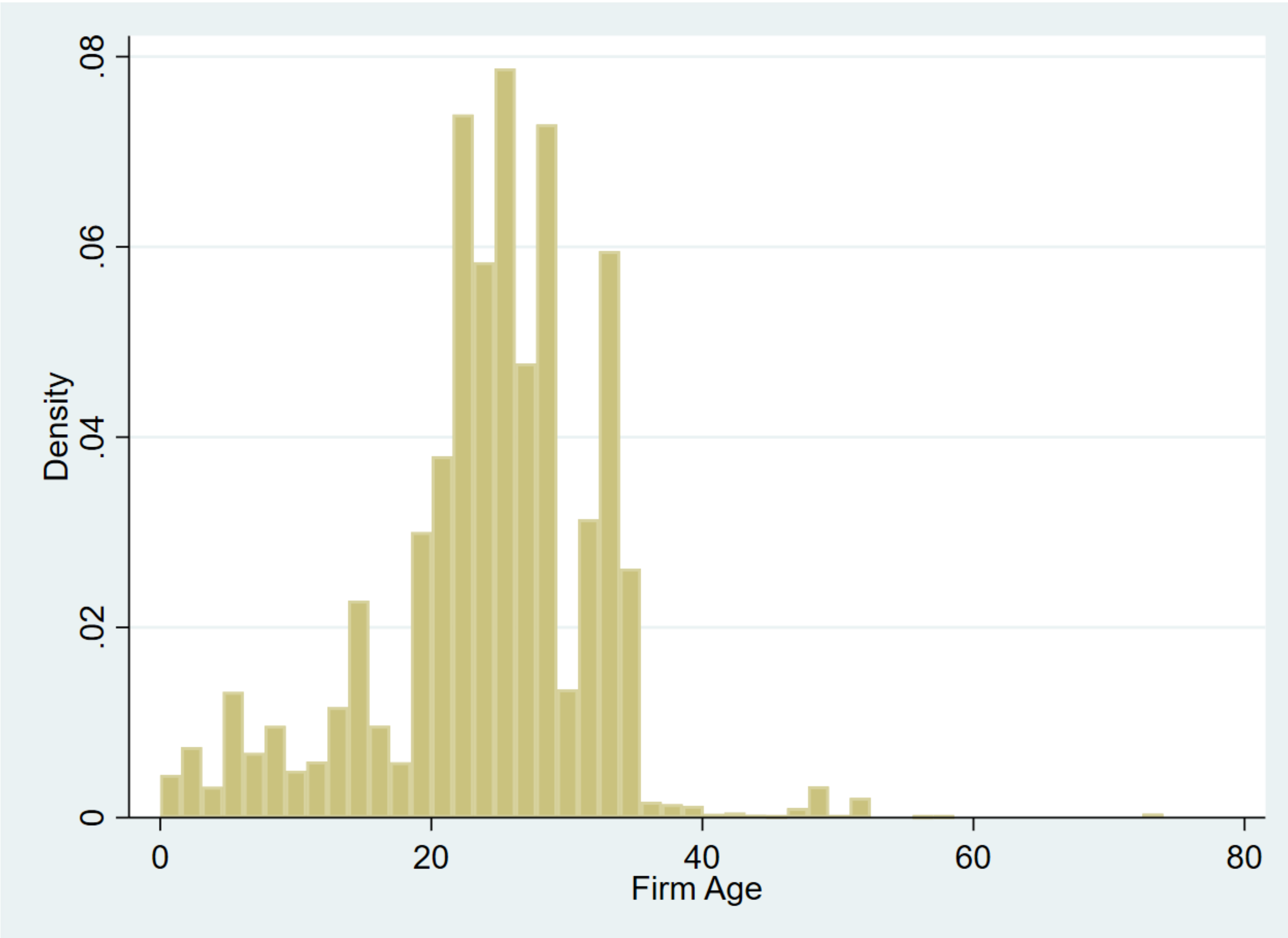

Figure. 3A: Firm Age 1971-2020

Reference

Abatzoglou, J. T., & Williams, A. P. (2016). Impact of anthropogenic climate change on wildfire across western US forests. *Proceedings of the National Academy of Sciences*, *113*(42), 11770-11775. https://doi.org/doi:10.1073/pnas.1607171113

Abatzoglou, J. T., Williams, A. P., & Barbero, R. (2019). Global Emergence of Anthropogenic Climate Change in Fire Weather Indices. *Geophysical Research Letters*, *46*(1), 326-336. https://doi.org/https://doi.org/10.1029/2018GL080959

Adrian, C., Garg, M., Pham, A. V., Phang, S.-Y., & Truong, C. (2023). Do Natural Disasters Affect Corporate Tax Avoidance? The Case of Drought. *Journal of Business Ethics*, *186*(1), 105-135. https://doi.org/10.1007/s10551-022-05250-7

Agarwal, N., & Chakraverty, A. (2023). Growth Opportunities, Information Asymmetry, and Dividend Payout: Evidence from Mandatory IFRS Adoption. *European Accounting Review*, *32*(1), 113-139. https://doi.org/10.1080/09638180.2021.1938622

Allen, F., & Michaely, R. (2003). Chapter 7 - Payout Policy. In G. M. Constantinides, M. Harris, & R. M. Stulz (Eds.), *Handbook of the Economics of Finance* (Vol. 1, pp. 337-429). Elsevier. https://doi.org/https://doi.org/10.1016/S1574-0102(03)01011-2

Allen, M. R., & Ingram, W. J. (2002). Constraints on future changes in climate and the hydrologic cycle. *Nature*, *419*(6903), 224-232. https://doi.org/10.1038/nature01092

Almeida, H., & Campello, M. (2007). Financial Constraints, Asset Tangibility, and Corporate Investment. *The Review of Financial Studies*, *20*(5), 1429-1460. https://doi.org/10.1093/rfs/hhm019

Andersson, M., Bolton, P., & Samama, F. (2016). Hedging Climate Risk. *Financial Analysts Journal*, *72*(3), 13-32. https://doi.org/10.2469/faj.v72.n3.4

Arena, M. P., & Julio, B. (2023). Litigation Risk Management Through Corporate Payout Policy. *Journal of Financial and Quantitative Analysis*, *58*(1), 148-174. https://doi.org/10.1017/S002210902200076X

Attig, N., El Ghoul, S., Guedhami, O., & Zheng, X. (2021). Dividends and economic policy uncertainty: International evidence. *Journal of Corporate Finance*, *66*, 101785. https://doi.org/https://doi.org/10.1016/j.jcorpfin.2020.101785

Babenko, I. (2009). Share Repurchases and Pay-Performance Sensitivity of Employee Compensation Contracts. *The Journal of Finance*, *64*(1), 117-150. https://doi.org/https://doi.org/10.1111/j.1540-6261.2008.01430.x

Bae, K.-H., El Ghoul, S., Guedhami, O., & Zheng, X. (2021). Board Reforms and Dividend Policy: International Evidence. *Journal of Financial and Quantitative Analysis*, *56*(4), 1296-1320. https://doi.org/10.1017/S0022109020000319

Baker, M., & Wurgler, J. (2004). Appearing and disappearing dividends: The link to catering incentives. *Journal of Financial Economics*, *73*(2), 271-288. https://doi.org/https://doi.org/10.1016/j.jfineco.2003.08.001

Baker, M., & Wurgler, J. (2013). Chapter 5 - Behavioral Corporate Finance: An Updated Survey. In G. M. Constantinides, M. Harris, & R. M. Stulz (Eds.), *Handbook of the Economics of Finance* (Vol. 2, pp. 357-424). Elsevier. https://doi.org/https://doi.org/10.1016/B978-0-44-453594-8.00005-7

Beirne, J., Dafermos, Y., Kriwoluzky, A., Renzhi, N., Volz, U., & Wittich, J. (2024). Weather-related disasters and inflation in the euro area. *Journal of Banking and Finance*, *169*, Article 107298. https://doi.org/10.1016/j.jbankfin.2024.107298

Benincasa, E., Betz, F., & Gattini, L. (2024). How do firms cope with losses from extreme weather events? *Journal of Corporate Finance*, *84*, Article 102508. https://doi.org/10.1016/j.jcorpfin.2023.102508

Bhatia, V., Pareek, B., & Das, D. (2024). Uncertainty of fiscal policy and corporate leverage decisions. *Economics Letters*, *243*, Article 111908. https://doi.org/10.1016/j.econlet.2024.111908

BIS. (2021). *Climate-related risk drivers and their transmission channels*. https://www.bis.org/bcbs/publ/d517.pdf
Blanco, I., Martin-Flores, J. M., & Remesal, A. (2024). Climate shocks, institutional investors, and the information content of stock prices. *Journal of Corporate Finance*, *86*, 102567. https://doi.org/https://doi.org/10.1016/j.jcorpfin.2024.102567
Bolton, P., & Kacperczyk, M. (2021). Do investors care about carbon risk? *Journal of Financial Economics*, *142*(2), 517-549. https://doi.org/https://doi.org/10.1016/j.jfineco.2021.05.008
Bolton, P., & Kacperczyk, M. (2023). Global Pricing of Carbon-Transition Risk. *Journal of Finance*, *78*(6), 3677-3754. https://doi.org/10.1111/jofi.13272
BOLTON, P., & KACPERCZYK, M. (2023). Global Pricing of Carbon-Transition Risk. *The Journal of Finance*, *78*(6), 3677-3754. https://doi.org/https://doi.org/10.1111/jofi.13272
Bonaimé, A. A., Hankins, K. W., & Harford, J. (2013). Financial Flexibility, Risk Management, and Payout Choice. *The Review of Financial Studies*, *27*(4), 1074-1101. https://doi.org/10.1093/rfs/hht045
Box, T., Davis, R., Hill, M., & Lawrey, C. (2018). Operating performance and aggressive trade credit policies. *Journal of Banking & Finance*, *89*, 192-208. https://doi.org/https://doi.org/10.1016/j.jbankfin.2018.02.011
Brav, A., Graham, J. R., Harvey, C. R., & Michaely, R. (2005). Payout policy in the 21st century. *Journal of Financial Economics*, *77*(3), 483-527. https://doi.org/https://doi.org/10.1016/j.jfineco.2004.07.004
Brockman, P., & Unlu, E. (2009). Dividend policy, creditor rights, and the agency costs of debt. *Journal of Financial Economics*, *92*(2), 276-299. https://doi.org/https://doi.org/10.1016/j.jfineco.2008.03.007
Byoun, S. (2021). Financial flexibility demand and corporate financial decisions. *Financial Review*, *56*(3), 481-509. https://doi.org/https://doi.org/10.1111/fire.12258
Cai, H., & Huang, Y. (2024). Corporate social responsibility on trade credit financing capacity: Facilitation or inhibition? *Finance Research Letters*, *69*, Article 106073. https://doi.org/10.1016/j.frl.2024.106073
Cai, Y., & Li, D. (2024). Modern banking development during natural disasters: Evidence from the early 20th century China. *Journal of Empirical Finance*, *77*, Article 101496. https://doi.org/10.1016/j.jempfin.2024.101496
Cao, Z., Chen, S. X., Dong, T., & Lee, E. (2024). Climate change uncertainty and supply chain financing. *British Accounting Review*, Article 101423. https://doi.org/10.1016/j.bar.2024.101423
Celil, H. S., Oh, S., & Selvam, S. (2022). Natural disasters and the role of regional lenders in economic recovery. *Journal of Empirical Finance*, *68*, 116-132. https://doi.org/10.1016/j.jempfin.2022.07.006
Chang, Y., He, W., & Mi, L. (2024). Climate risk and payout flexibility around the world. *Journal of Banking and Finance*, *166*, Article 107233. https://doi.org/10.1016/j.jbankfin.2024.107233
Chang, Y., He, W., & Mi, L. (2024). Climate risk and payout flexibility around the world. *Journal of Banking & Finance*, *166*, 107233. https://doi.org/https://doi.org/10.1016/j.jbankfin.2024.107233
Chava, S. (2014). Environmental Externalities and Cost of Capital. *Management Science*, *60*(9), 2223-2247. https://doi.org/10.1287/mnsc.2013.1863
Chay, J. B., & Suh, J. (2009). Payout policy and cash-flow uncertainty. *Journal of Financial Economics*, *93*(1), 88-107. https://doi.org/https://doi.org/10.1016/j.jfineco.2008.12.001
Chen, S., Ma, H., & Wu, Q. (2019). Bank credit and trade credit: Evidence from natural experiments. *Journal of Banking & Finance*, *108*, 105616. https://doi.org/https://doi.org/10.1016/j.jbankfin.2019.105616
Clarkson, P. M., Li, Y., Pinnuck, M., & Richardson, G. D. (2015). The Valuation Relevance of Greenhouse Gas Emissions under the European Union Carbon Emissions Trading Scheme. *European Accounting Review*, *24*(3), 551-580. https://doi.org/10.1080/09638180.2014.927782

Collier, B. L., Powell, L. S., Ragin, M. A., & You, X. (2024). Financing Negative Shocks: Evidence from Hurricane Harvey. *Journal of Financial and Quantitative Analysis*. https://doi.org/10.1017/S0022109024000103

Dafermos, Y., Nikolaidi, M., & Galanis, G. (2018). Climate Change, Financial Stability and Monetary Policy. *Ecological Economics*, *152*, 219-234. https://doi.org/https://doi.org/10.1016/j.ecolecon.2018.05.011

Dal Maso, L., Kanagaretnam, K., Lobo, G. J., & Mazzi, F. (2024). Does Disaster Risk Relate to Banks' Loan Loss Provisions? *European Accounting Review*, *33*(3), 825-854. https://doi.org/10.1080/09638180.2022.2120513

Dang, V. A., Gao, N., & Yu, T. (2024). Environmental Regulation and Access to Credit. *British Journal of Management*. https://doi.org/10.1111/1467-8551.12848

DeAngelo, H., & DeAngelo, L. (2007). Capital Structure, Payout Policy, and Financial Flexibility. *SSRN*. https://doi.org/https://dx.doi.org/10.2139/ssrn.916093

DeAngelo, H., DeAngelo, L., & Skinner, D. J. (2004). Are dividends disappearing? Dividend concentration and the consolidation of earnings. *Journal of Financial Economics*, *72*(3), 425-456. https://doi.org/https://doi.org/10.1016/S0304-405X(03)00186-7

DeAngelo, H., DeAngelo, L., & Skinner, D. J. (2008). Corporate payout policy. *Foundations and Trends in Finance*, *3*(2-3), 95-287. https://doi.org/10.1561/0500000020

DeAngelo, H., DeAngelo, L., & Stulz, R. M. (2006). Dividend policy and the earned/contributed capital mix: a test of the life-cycle theory. *Journal of Financial Economics*, *81*(2), 227-254. https://doi.org/https://doi.org/10.1016/j.jfineco.2005.07.005

DeAngelo, H., Gonçalves, A. S., & Stulz, R. M. (2017). Corporate Deleveraging and Financial Flexibility. *The Review of Financial Studies*, *31*(8), 3122-3174. https://doi.org/10.1093/rfs/hhx147

Denis, D. J. (2011). Financial flexibility and corporate liquidity. *Journal of Corporate Finance*, *17*(3), 667-674. https://doi.org/https://doi.org/10.1016/j.jcorpfin.2011.03.006

Denis, D. J., & McKeon, S. B. (2012). Debt Financing and Financial Flexibility Evidence from Proactive Leverage Increases. *The Review of Financial Studies*, *25*(6), 1897-1929. https://doi.org/10.1093/rfs/hhs005

Dittmar, A. K. (2000). Why Do Firms Repurchase Stock. *The Journal of Business*, *73*(3), 331-355. https://doi.org/10.1086/209646

Do, V., Nguyen, T. H., Truong, C., & Vu, T. (2021). Is drought risk priced in private debt contracts? *International Review of Finance*, *21*(2), 724-737. https://doi.org/https://doi.org/10.1111/irfi.12294

Duan, T., & Li, F. W. (2024). Climate change concerns and mortgage lending. *Journal of Empirical Finance*, *75*, 101445. https://doi.org/https://doi.org/10.1016/j.jempfin.2023.101445

Easterbrook, F. H. (1984). Two Agency-Cost Explanations of Dividends. *The American Economic Review*, *74*(4), 650-659.

Faff, R., Kwok, W. C., Podolski, E. J., & Wong, G. (2016). Do corporate policies follow a life-cycle? *Journal of Banking & Finance*, *69*, 95-107. https://doi.org/https://doi.org/10.1016/j.jbankfin.2016.04.009

Fahlenbrach, R., Rageth, K., & Stulz, R. M. (2020). How Valuable Is Financial Flexibility when Revenue Stops? Evidence from the COVID-19 Crisis. *The Review of Financial Studies*, *34*(11), 5474-5521. https://doi.org/10.1093/rfs/hhaa134

FAMA, E. F., & FRENCH, K. R. (1995). Size and Book-to-Market Factors in Earnings and Returns. *The Journal of Finance*, *50*(1), 131-155. https://doi.org/https://doi.org/10.1111/j.1540-6261.1995.tb05169.x

Fama, E. F., & French, K. R. (2001). Disappearing dividends: changing firm characteristics or lower propensity to pay? *Journal of Financial Economics*, *60*(1), 3-43. https://doi.org/https://doi.org/10.1016/S0304-405X(01)00038-1

Farre-Mensa, J., Michaely, R., & Schmalz, M. (2014). Payout Policy. *Annual Review of Financial Economics*, *6*(Volume 6, 2014), 75-134. https://doi.org/https://doi.org/10.1146/annurev-financial-110613-034259

Fatemi, A., & Bildik, R. (2012). Yes, dividends are disappearing: Worldwide evidence. *Journal of Banking & Finance*, *36*(3), 662-677. https://doi.org/https://doi.org/10.1016/j.jbankfin.2011.10.008
Frankel, J. A. (1994). *The Internationalization of Equity Markets*.
GAMBA, A., & TRIANTIS, A. (2008). The Value of Financial Flexibility. *The Journal of Finance*, *63*(5), 2263-2296. https://doi.org/https://doi.org/10.1111/j.1540-6261.2008.01397.x
Giglio, S., Kelly, B., & Stroebel, J. (2021). Climate Finance. *Annual Review of Financial Economics*, *13*(Volume 13, 2021), 15-36. https://doi.org/https://doi.org/10.1146/annurev-financial-102620-103311
Giglio, S., Kuchler, T., Stroebel, J., & Zeng, X. (2023). Biodiversity Risk. *National Bureau of Economic Research Working Paper Series*, *No. 31137*. https://doi.org/10.3386/w31137
Ginglinger, E., & Moreau, Q. (2023). Climate Risk and Capital Structure. *Management Science*, *69*(12), 7492-7516. https://doi.org/10.1287/mnsc.2023.4952
Goulder, L., & Pizer, W. (2006). The Economics of Climate Change. https://doi.org/10.3386/w11923
Gounopoulos, D., & Zhang, Y. (2024). Temperature trend and corporate cash holdings. *Financial Management*. https://doi.org/10.1111/fima.12451
Gounopoulos, D., & Zhang, Y. (2024). Temperature trend and corporate cash holdings. *Financial Management*, *n/a*(n/a). https://doi.org/https://doi.org/10.1111/fima.12451
Gregory, A., Tharyan, R., & Whittaker, J. (2014). Corporate Social Responsibility and Firm Value: Disaggregating the Effects on Cash Flow, Risk and Growth. *Journal of Business Ethics*, *124*(4), 633-657.
Griffin, P. A., Lont, D. H., & Sun, E. Y. (2017). The Relevance to Investors of Greenhouse Gas Emission Disclosures. *Contemporary Accounting Research*, *34*(2), 1265-1297. https://doi.org/https://doi.org/10.1111/1911-3846.12298
Grippa, P., Schmittmann, J., & Suntheim, F. (2019). *Climate Change and Financial Risk* https://www.imf.org/en/Publications/fandd/issues/2019/12/climate-change-central-banks-and-financial-risk-grippa
Grullon, G., Michaely, R., & Swaminathan, B. (2002). Are Dividend Changes a Sign of Firm Maturity? *Journal of Business*, *75*(3), 387-424. https://doi.org/10.1086/339889
Gu, G. W., & Hale, G. (2023). Climate risks and FDI. *Journal of International Economics*, *146*, 103731. https://doi.org/https://doi.org/10.1016/j.jinteco.2023.103731
HAIL, L., TAHOUN, A., & WANG, C. (2014). Dividend Payouts and Information Shocks. *Journal of Accounting Research*, *52*(2), 403-456. https://doi.org/https://doi.org/10.1111/1475-679X.12040
Hanlon, M., & Hoopes, J. L. (2014). What do firms do when dividend tax rates change? An examination of alternative payout responses. *Journal of Financial Economics*, *114*(1), 105-124. https://doi.org/https://doi.org/10.1016/j.jfineco.2014.06.004
Hansen, L. P. (2022). Central banking challenges posed by uncertain climate change and natural disasters. *Journal of Monetary Economics*, *125*, 1-15. https://doi.org/10.1016/j.jmoneco.2021.09.010
Herbohn, K., Gao, R., & Clarkson, P. (2019). Evidence on Whether Banks Consider Carbon Risk in Their Lending Decisions. *Journal of Business Ethics*, *158*(1), 155-175. https://doi.org/10.1007/s10551-017-3711-3
Hoberg, G., & Prabhala, N. R. (2008). Disappearing Dividends, Catering, and Risk. *The Review of Financial Studies*, *22*(1), 79-116. https://doi.org/10.1093/rfs/hhn073
Hong, H., Li, F. W., & Xu, J. (2019). Climate risks and market efficiency. *Journal of Econometrics*, *208*(1), 265-281. https://doi.org/https://doi.org/10.1016/j.jeconom.2018.09.015
Hossain, M. N., Rabarison, M. K., Ater, B., & Sobngwi, C. K. (2023). CEO marital status and dividend policy. *Journal of Corporate Finance*, *78*, 102342. https://doi.org/https://doi.org/10.1016/j.jcorpfin.2022.102342
Huang, H. H., Kerstein, J., & Wang, C. (2018). The impact of climate risk on firm performance and financing choices: An international comparison. *Journal of International Business Studies*, *49*(5), 633-656. https://doi.org/10.1057/s41267-017-0125-5

Huynh, T. D., Nguyen, T. H., & Truong, C. (2020). Climate risk: The price of drought. *Journal of Corporate Finance*, *65*, 101750. https://doi.org/https://doi.org/10.1016/j.jcorpfin.2020.101750
Ikenberry, D., Lakonishok, J., & Vermaelen, T. (1995). Market underreaction to open market share repurchases. *Journal of Financial Economics*, *39*(2), 181-208. https://doi.org/https://doi.org/10.1016/0304-405X(95)00826-Z
IPCC. (2014). *Climate Change 2014: Mitigation of Climate Change*. https://www.ipcc.ch/report/ar5/wg3/
IPCC. (2018). *Special Report - Global Warming of 1.5°C*. https://www.ipcc.ch/sr15/
Ivanov, I. T., Macchiavelli, M., & Santos, J. A. C. (2022). Bank lending networks and the propagation of natural disasters. *Financial Management*, *51*(3), 903-927. https://doi.org/10.1111/fima.12388
Jagannathan, M., Stephens, C. P., & Weisbach, M. S. (2000). Financial flexibility and the choice between dividends and stock repurchases. *Journal of Financial Economics*, *57*(3), 355-384. https://doi.org/https://doi.org/10.1016/S0304-405X(00)00061-1
Javadi, S., & Masum, A.-A. (2021). The impact of climate change on the cost of bank loans. *Journal of Corporate Finance*, *69*, 102019. https://doi.org/https://doi.org/10.1016/j.jcorpfin.2021.102019
Javadi, S., Masum, A.-A., Aram, M., & Rao, R. P. (2023). Climate change and corporate cash holdings: Global evidence. *Financial Management*, *52*(2), 253-295. https://doi.org/https://doi.org/10.1111/fima.12420
Javadi, S., & Masum, A. A. (2021). The impact of climate change on the cost of bank loans. *Journal of Corporate Finance*, *69*, Article 102019. https://doi.org/10.1016/j.jcorpfin.2021.102019
Javadi, S., Masum, A. A., Aram, M., & Rao, R. P. (2023). Climate change and corporate cash holdings: Global evidence. *Financial Management*, *52*(2), 253-295. https://doi.org/10.1111/fima.12420
Jensen, M. C. (1986). Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers. *The American Economic Review*, *76*(2), 323-329.
Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, *3*(4), 305-360. https://doi.org/https://doi.org/10.1016/0304-405X(76)90026-X
Jha, M., Liu, H., & Manela, A. (2021). Natural Disaster Effects on Popular Sentiment Toward Finance. *Journal of Financial and Quantitative Analysis*, *56*(7), 2584-2604. https://doi.org/10.1017/S0022109021000466
JOHN, K., & WILLIAMS, J. (1985). Dividends, Dilution, and Taxes: A Signalling Equilibrium. *The Journal of Finance*, *40*(4), 1053-1070. https://doi.org/https://doi.org/10.1111/j.1540-6261.1985.tb02363.x
Jones, B., Dunn, G., & Balk, D. (2021). Extreme Heat Related Mortality: Spatial Patterns and Determinants in the United States, 1979–2011. *Spatial Demography*, *9*(1), 107-129. https://doi.org/10.1007/s40980-021-00079-6
Kahle, K., & Stulz, R. M. (2021). Why are corporate payouts so high in the 2000s? *Journal of Financial Economics*, *142*(3), 1359-1380. https://doi.org/https://doi.org/10.1016/j.jfineco.2021.06.020
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Keerthiratne, S., & Tol, R. S. J. (2017). Impact of Natural Disasters on Financial Development. *Economics of Disasters and Climate Change*, *1*(1), 33-54. https://doi.org/10.1007/s41885-017-0002-5
Klomp, J. (2014). Financial fragility and natural disasters: An empirical analysis. *Journal of Financial Stability*, *13*, 180-192. https://doi.org/https://doi.org/10.1016/j.jfs.2014.06.001
Kumar, A., & Vergara-Alert, C. (2020). The Effect of Financial Flexibility on Payout Policy. *Journal of Financial and Quantitative Analysis*, *55*(1), 263-289. https://doi.org/10.1017/S002210901800114X

Kuo, J.-M., Philip, D., & Zhang, Q. (2013). What drives the disappearing dividends phenomenon? *Journal of Banking & Finance*, *37*(9), 3499-3514. https://doi.org/https://doi.org/10.1016/j.jbankfin.2013.05.003
La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. W. (2000). Agency Problems and Dividend Policies around the World. *The Journal of Finance*, *55*(1), 1-33. https://doi.org/https://doi.org/10.1111/0022-1082.00199
Lee, C. C., Wang, C. W., Thinh, B. T., Purnama, M. Y. I., & Sharma, S. S. (2024). Corporate leverage and leverage speed of adjustment: Does environmental policy stringency matter? *Pacific Basin Finance Journal*, *85*, Article 102344. https://doi.org/10.1016/j.pacfin.2024.102344
Lee, S. H., Choi, D. J., & Han, S. H. (2023). Corporate cash holdings in response to climate risk and policies. *Finance Research Letters*, *55*, Article 103910. https://doi.org/10.1016/j.frl.2023.103910
Li, X., Zhang, J., & An, D. (2024). Banking crises and corporate trade credit: The role of creditor protection. *Finance Research Letters*, *65*, Article 105508. https://doi.org/10.1016/j.frl.2024.105508
Li, Y., & Wan, T. (2024). How does corporate climate risk exposure affect cash holdings? *Applied Economics*. https://doi.org/10.1080/00036846.2024.2381131
Lie, E. (2005). Financial Flexibility, Performance, and the Corporate Payout Choice. *The Journal of Business*, *78*(6), 2179-2202. https://doi.org/10.1086/497043
Lie, E. (2005). Financial flexibility, performance, and the corporate payout choice. *Journal of Business*, *78*(6), 2179-2203. https://doi.org/10.1086/497043
Mallucci, E. (2022). Natural disasters, climate change, and sovereign risk. *Journal of International Economics*, *139*, 103672. https://doi.org/https://doi.org/10.1016/j.jinteco.2022.103672
Mateut, S. (2005). Trade Credit and Monetary Policy Transmission. *Journal of Economic Surveys*, *19*(4), 655-670. https://doi.org/https://doi.org/10.1111/j.0950-0804.2005.00262.x
Matsumura, E. M., Prakash, R., & Vera-Muñoz, S. C. (2014). Firm-Value Effects of Carbon Emissions and Carbon Disclosures. *The Accounting Review*, *89*(2), 695-724. https://doi.org/10.2308/accr-50629
McKibbin, W. J., Morris, A. C., Wilcoxen, P. J., & Panton, A. J. (2021). Climate change and monetary policy: issues for policy design and modelling. *Oxford Review of Economic Policy*, *36*(3), 579-603. https://doi.org/10.1093/oxrep/graa040
Michaely, R., & Moin, A. (2022). Disappearing and reappearing dividends. *Journal of Financial Economics*, *143*(1), 207-226. https://doi.org/https://doi.org/10.1016/j.jfineco.2021.06.029
Miller, M. H., & Modigliani, F. (1961). Dividend Policy, Growth, and the Valuation of Shares. *The Journal of Business*, *34*(4), 411-433.
MILLER, M. H., & ROCK, K. (1985). Dividend Policy under Asymmetric Information. *The Journal of Finance*, *40*(4), 1031-1051. https://doi.org/https://doi.org/10.1111/j.1540-6261.1985.tb02362.x
Moshirian, F., Nanda, V., Vadilyev, A., & Zhang, B. (2017). What drives investment–cash flow sensitivity around the World? An asset tangibility Perspective. *Journal of Banking & Finance*, *77*, 1-17. https://doi.org/https://doi.org/10.1016/j.jbankfin.2016.12.012
Munich-RE. (2024). *Natural disaster risks: Rising trend in losses*. https://www.munichre.com/en/risks/natural-disasters.html#-1624621007
Myers, S. C. (1977). Determinants of corporate borrowing. *Journal of Financial Economics*, *5*(2), 147-175. https://doi.org/https://doi.org/10.1016/0304-405X(77)90015-0
NCEI-NOAA. (2024a). *Global Surface Temperature Anomalies - Background Information - FAQ*. Retrieved 2024-09-05 from https://www.ncei.noaa.gov/access/monitoring/global-temperature-anomalies/
NCEI-NOAA. (2024b). *Temperature Data - Statewide Time Series*. https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/statewide/time-series
Nguyen, J. H. (2018). Carbon risk and firm performance: Evidence from a quasi-natural experiment. *Australian Journal of Management*, *43*(1), 65-90. https://doi.org/10.1177/0312896217709328

Nguyen, J. H., & Phan, H. V. (2020). Carbon risk and corporate capital structure. *Journal of Corporate Finance*, *64*, 101713. https://doi.org/https://doi.org/10.1016/j.jcorpfin.2020.101713

Nguyen, L., & Wilson, J. O. S. (2020). How does credit supply react to a natural disaster? Evidence from the Indian Ocean Tsunami. *European Journal of Finance*, *26*(7-8), 802-819. https://doi.org/10.1080/1351847X.2018.1562952

Nguyen, T., Bai, M., Hou, G., & Truong, C. (2022). Drought risk and capital structure dynamics. *Accounting & Finance*, *62*(3), 3397-3439. https://doi.org/https://doi.org/10.1111/acfi.12891

Nilsen, J. H. (2002). Trade Credit and the Bank Lending Channel. *Journal of Money, Credit and Banking*, *34*(1), 226-253.

Nordhaus, W. (2019). Climate Change: The Ultimate Challenge for Economics. *American Economic Review*, *109*(6), 1991–2014. https://doi.org/10.1257/aer.109.6.1991

Noth, F., & Schüwer, U. (2023). Natural disasters and bank stability: Evidence from the U.S. financial system. *Journal of Environmental Economics and Management*, *119*, Article 102792. https://doi.org/10.1016/j.jeem.2023.102792

Park, K. (2024). Spillover Effect of Climate Disaster for Management Forecast. *European Accounting Review*. https://doi.org/10.1080/09638180.2024.2301932

Petersen, M. A., & Rajan, R. G. (1997). Trade Credit: Theories and Evidence. *The Review of Financial Studies*, *10*(3), 661-691.

Petersen, M. A., & Rajan, R. G. (2015). Trade Credit: Theories and Evidence. *The Review of Financial Studies*, *10*(3), 661-691. https://doi.org/10.1093/rfs/10.3.661

Phan, D. H. B., Tran, V. T., Ming, T. C., & Le, A. (2022). Carbon risk and corporate investment: A cross-country evidence. *Finance Research Letters*, *46*, 102376. https://doi.org/https://doi.org/10.1016/j.frl.2021.102376

Rapp, M. S., Schmid, T., & Urban, D. (2014). The value of financial flexibility and corporate financial policy. *Journal of Corporate Finance*, *29*, 288-302. https://doi.org/https://doi.org/10.1016/j.jcorpfin.2014.08.004

Safiullah, M., & Nguyen, L. T. M. (2024). Does firm-level carbon assurance matter for trade credit? *Finance Research Letters*, *68*, Article 106001. https://doi.org/10.1016/j.frl.2024.106001

Sakariyahu, R., Lawal, R., Kwansa, N. A., Ahmed, A., & Adamolekun, G. (2023). Emissions trading scheme participation and firms' cash holdings. *Finance Research Letters*, *58*, Article 104565. https://doi.org/10.1016/j.frl.2023.104565

Sautner, Z., Van Lent, L., Vilkov, G., & Zhang, R. (2023). Firm-Level Climate Change Exposure. *Journal of Finance*, *78*(3), 1449-1498. https://doi.org/10.1111/jofi.13219

Schwartz, R. A. (1974). An Economic Model of Trade Credit. *Journal of Financial and Quantitative Analysis*, *9*(4), 643-657. https://doi.org/10.2307/2329765

Solomon, S., Plattner, G.-K., Knutti, R., & Friedlingstein, P. (2009). Irreversible climate change due to carbon dioxide emissions. *Proceedings of the National Academy of Sciences*, *106*(6), 1704-1709. https://doi.org/doi:10.1073/pnas.0812721106

Stern, N. (2008). The Economics of Climate Change. *American Economic Review*, *98*(2), 1–37. https://doi.org/10.1257/aer.98.2.1

Tol, R. S. J. (2024). A meta-analysis of the total economic impact of climate change. *Energy Policy*, *185*, 113922. https://doi.org/https://doi.org/10.1016/j.enpol.2023.113922

U.S.News. (2024). *America's 10 Most Disaster-Prone States*. Retrieved 2024-09-09 from https://www.usnews.com/news/best-states/slideshows/the-10-most-disaster-prone-states-in-the-us

Uesugi, I., Miyakawa, D., Hosono, K., Ono, A., & Uchida, H. (2025). The collateral channel versus the bank lending channel: Evidence from a massive earthquake. *Journal of Banking and Finance*, *170*, Article 107315. https://doi.org/10.1016/j.jbankfin.2024.107315

Vermaelen, T. (1981). Common stock repurchases and market signalling: An empirical study. *Journal of Financial Economics*, *9*(2), 139-183. https://doi.org/https://doi.org/10.1016/0304-405X(81)90011-8

Wang, Z., Yin, Q. E., & Yu, L. (2021). Real effects of share repurchases legalization on corporate behaviors. *Journal of Financial Economics*, *140*(1), 197-219. https://doi.org/10.1016/j.jfineco.2020.10.008
Wilner, B. S. (2000). The Exploitation of Relationships in Financial Distress: The Case of Trade Credit. *The Journal of Finance*, *55*(1), 153-178. https://doi.org/https://doi.org/10.1111/0022-1082.00203
Wong, J. B., & Zhang, Q. (2024). ESG reputation risks, cash holdings, and payout policies. *Finance Research Letters*, *59*, Article 104695. https://doi.org/10.1016/j.frl.2023.104695
Xu, X., Ren, X., & He, F. (2024). Climate policy uncertainty and bank liquidity creation. *Finance Research Letters*, *65*, Article 105403. https://doi.org/10.1016/j.frl.2024.105403
Yen, H. P., Yue, X., Ho, K. C., & Kong, X. (2024). FACT or FICTION?-CLIMATE CHANGE RISK and TRADE CREDIT. *Climate Change Economics*, Article 2440005. https://doi.org/10.1142/S2010007824400050
Zhang, D., Wu, Y., Ji, Q., Guo, K., & Lucey, B. (2024). Climate impacts on the loan quality of Chinese regional commercial banks. *Journal of International Money and Finance*, *140*, Article 102975. https://doi.org/10.1016/j.jimonfin.2023.102975
Zhang, L., & Kanagaretnam, K. (2024). Climate Disasters and Analysts' Earnings Forecasts: Evidence from the United States. *European Accounting Review*. https://doi.org/10.1080/09638180.2024.2364785
Zhou, P., & Ruland, W. (2006). Dividend Payout and Future Earnings Growth. *Financial Analysts Journal*, *62*(3), 58-69. https://doi.org/10.2469/faj.v62.n3.4157