The Impacts of Climate Risk on Commercial Real Estate: Evidence from REITs

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Abstract

Though climate risk has been recognized as a material risk in finance and residential real estate, there is limited research on how climate risk affects commercial real estate markets. To enrich such understanding, in this research, we construct a firm-level climate risk measure based on the county-level temperature data from National Oceanic and Atmospheric Administration (NOAA) and an extensive property-level data set of U.S. equity REITs from 1995-2020. The impacts of climate risk on commercial real estate are then examined at the firm-level. We find that REITs with higher climate risk exposures (i.e., with more properties located in counties experiencing higher abnormal temperature changes) tend to have lower cash flow and firm values. The negative impacts from climate risk are robust with various model specifications and control variables. This article contributes towards a better understanding of the economic implications of rising temperatures on commercial real estate and provides empirical support to the temperature-based long-run risk model.

JEL Classification: G32, Q54, R11, R33

Keywords: climate change, warmer climate, temperature, cash flow, firm value, risk, commercial real estate, REIT

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1. **Introduction**

Business professionals and economic policymakers have increasingly recognized climate risk as one of the most critical risks in investments and financial management (Stroebel and Wurgler, 2021). The U.S. Government Accountability Office reports (GAO-20-633R) that, according to the National Oceanic and Atmospheric Administration (NOAA, henceforth), "between January 1980 and July 2020, the United States experienced 273 climate and weather disasters causing more than $1 billion in damages each. The total cost of damages from these disasters exceeded $1.79 trillion."[1] There are extensive warnings from the commercial real estate industry that climate risk heavily affects the sector. For instance, Paul Morassutti, CBRE Vice Chairman, claims that "climate risk will manifest itself in commercial real estate in numerous ways."[2] Indeed, climate risk has become a pressing issue for the commercial real estate industry. A report from the national association of real estate investment trusts (Nareit) points out that "As the climate crisis becomes ever more urgent, assessing the potential risk it presents to REIT portfolios has become a top issue for the industry."[3,4]

Studies in economics [see, Stern (2007); Nordhaus (2008), Gollier (2012] have provided some theoretical guidance on the economic impacts of global warming and emphasized the difficulties and challenges in quantifying the costs associated with temperature risks, especially on the social cost of carbon (SCC) emissions. More recently, Bansal, Kiku, and Ochoa (2016, 2017) build a general-equilibrium temperature-based long-run risk (LRR-T) model to investigate how

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[1] GAO report retrieved from https://www.gao.gov/products/gao-20-633r on February 1, 2022.

[2] See an article from *CBRE*, titled "Preparing for Climate Change: Commercial Real Estate's Next Great Challenge."

[3] See an article from *Nareit* on April 05, 2021, titled "REITs Increasing Focus on Risks Due to Climate Crisis."

[4] Also, see a report from *CNBC* on May 28, 2019, titled "Climate change can pose big risks to real estate investments." and a 2018 industry report compiled by Four Twenty Seven and real estate technology company GeoPhy details that "Climate change is already influencing real estate markets, with properties exposed to sea level rise in the United States selling at a 7 percent discount to those with less exposure" and that "35 percent of REITs properties are exposed to climate hazards. Of these, 17 percent of properties are exposed to inland flood risk, 6 percent to sea level rise and coastal floods, and 12 percent exposed to hurricanes or typhoons."

temperature shifts affect the economy. They show that long-term temperature changes affect current asset prices and risk premiums (i.e., discounted rates).

In this research, we study the impacts of climate risk on the cash flow and market valuation of real estate investment trust (REIT) firms. Lately, a fast-growing volume of real estate and finance literature has focused on the effects of climate risk on property returns and firm financial management. However, a review by Clayton et al. (2021) indicates that an overwhelming majority of the literature in real estate focuses on residential properties. Academics and practitioners in the commercial real estate industry have limited knowledge of how climate changes affect commercial real estate markets.[5]

The REIT industry as an alternative investment sector has grown tremendously over the past decades.[6] REIT firms present a unique opportunity to examine how climate risk impacts firm performances and management as REITs are viewed as a portfolio of commercial real estate properties with specific geographic locations [Ling, Naranjo, and Scheick (2018, 2019)], with a long term holding period of their portfolios [Feng, Hardin, and Wang (2021)]. Most recently, Cvijanovic and van de Minne (2021) investigate the effects of climate change on the investment performances of commercial real estate properties using a repeated-sale model. Chiang, Feng and Harrison (2022) illustrate that commercial property performance at the core-based statistical area (CBSA) level is negatively related to abnormally high temperatures after the Paris Agreement. Distinct from their studies, our research examines the impacts of climate changes on cash flow and firm valuation at the *firm-level*, a weighted-average property portfolio level.

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[5] The board literature on the relation between climate change exposure and real estate returns devotes themselves to hurricanes [e.g., Addoum et al. (2021); Fisher and Rutledge (2021); Holtermans, Niu and Zheng (2022], flood risk [e.g., Baldauf, Garlappi, and Yannelis (2020); Giglio et al. (2021)], and sea level rise [e.g., Bernstein, Gustafson, and Lewis (2019)].

[6] See "Market capitalization of real estate investment trusts (REITs) in the United States from 1975 to 2020", in https://www.statista.com/statistics/916665/market-cap-reits-usa/

Climate change risks are highly geographically location-driven.[7] Climate risk is considered to have potential impacts on a region's income growth or investors' financial performance.[8] First, climate risk can affect the cash flow generated by the underlying assets. Early studies show that higher average temperatures are negatively correlated with income growth [see, Gallup, Sachs, and Mellinger (1999); Dell, Jones, and Olken (2009)]. Higher temperatures are also associated with lower economic productivity [see, Jones and Olken (2010); Hsiang (2010); Dell, Jones, and Olken (2012 and 2014)].[9] Schlenker and Roberts (2009) show how extreme temperature changes affect the agricultural crop yield in the U.S.[10] For the firm-level analyses, previous literature has documented a negative relation between temperatures and firms' earnings and profitability [see, Hugon and Law (2019); Addoum, Ng, and Ortiz-Bobea (2020); Sun, Xu, and You (2021)].

Second, climate risk can affect the discount rate used in financial valuation. Javadi and Masum (2021) find that climate risk exposures of a firm's headquarter are priced in the cost of borrowing in its bank loans.[11] Many recent studies have focused on residential real estate pricing risks in real estate research. For example, Bernsten, Gustafson, and Lewis (2019) show that houses exposed to sea-level rise sell for less than equivalent unexposed houses from the beach. Baldauf, Garlappi, and Yannelis (2020) find that climate risk is priced differently at homeprices based on whether neighborhoods believe in climate risk. Giglio et al. (2021) present robust evidence that

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[7] See an article from *The New York Times* on September 18, 2020, titled "Every Place Has Its Own Climate Risk. What Is It Where You Live?."

[8] Besides, the U.S. financial system may also be affected by climate-related risks. See an article from *The Center for American Progress* on November 21, 2019, titled "Climate Change Threatens the Stability of the Financial System", and a report from *The Financial Stability Board (FSB)* on November 23, 2020, titled "The Implications of Climate Change for Financial Stability"

[9] See an article from *Business Insider* on July 19, 2019, titled "This heat wave is going to make you — and the rest of America — less productive, by as much as 28%."

[10] See a report from *United States Environmental Protection Agency*, titled "Climate Impacts on Agriculture and Food Supply."

[11] See a report from *the Mortgage Bankers Association's Research Institute for Housing America*, titled "The Impact of Climate Change on Housing and Housing Finance."

climate risk is captured and discounted in housing prices.[12] Regarding commercial real estate, Cvijanovic and van de Minne (2021) are one of the first studies to show that extreme climate changes negatively impact investor returns at the property level. The negative effect is more driven by the shocks to the risk premium of commercial real estate assets rather than shocks to income returns.

Our research, inspired by previous studies, contributes to the existing literature by providing strong documented evidence on the effects of climate changes on commercial real estate markets by analyzing the impacts of abnormal climate changes on cash flow and firm value at the firm level (i.e., weighted average portfolio level). The unique setting of REITs allows us to effectively estimate the impacts of climate risk on commercial real estate performance at the firm- or portfolio level. Public REIT firms own more than 500,000 properties across the U.S. as of the year 2020.[13] Our data sample provides comprehensive information on the locations and values of geographically dispersed, individual properties held by REITs. Since REITs typically hold their property portfolios for a long time period, the aggregated measure at the firm level helps us examine the causal relationship between climate risk and commercial real estate financial performances.

We measure the geographic climate risk by calculating the abnormal temperatures of each county in the U.S. using the NOAA data. We construct an aggregated measure of firm-level climate risk for each REIT firm based on the property-value-weighted abnormal temperatures of its property locations.[14] If a REIT firm has more properties located in high abnormal temperature

[12] See an article from *Rocket Mortgage*, titled "How Does Climate Change Affect Real Estate Prices?."
[13] Please see https://www.reitsacrossamerica.com/ for more information on the property locations of REIT firms in the United States.
[14] For example, suppose there is a REIT holds properties only in two counties in 2000: 30% of its property value in county A and 70% of its property value in county B. The 2000 abnormal temperature in county A is $0.325°F$, while that in county B is -0.217°F. The firm-specific abnormal temperature of the REIT in 2000 will be $30\% \times 0.325°F\ +$

counties, its firm-specific abnormal temperature would be high compared with other REIT firms. The advantage of using firm-level temperature data is that it allows us to examine the climate risk effect in a portfolio context, which mitigates potential idiosyncratic bias and endogenous concerns from an uncontrolled confounding variable.

To our knowledge, our study is one of the first studies examining the impacts of climate change on the commercial real estate markets. The results suggest that climate risk indeed has significant impacts on commercial real estate performance and valuation at the firm-level. Our research provides layers of exciting results. Using a sample based on the county-level temperature data from NOAA and granular property-level data of U.S. equity REITs for the period of year 1995 to year 2020, we find that REIT firms with higher exposures to high abnormal climate changes tend to have lower cash flow and lower firm values. In addition, we show the heterogeneous impacts of climate risk on different property types in commercial real estate. For example, we find that property types, such as Self-Storage, Industrial, Office, and Hotel, tend to perform better in cash flow (measured by FFO/TA) in warmer climate relatively compared to other property types, such as Regional Mall, Multi-family, and Manufactured Home. These results are robust after controlling for many firm characteristics and property types.

The remaining of the article is organized as follows: Section 2 reviews related literature on climate risk in real estate and finance, Section 3 describes the data and variables, Section 4 introduces the methodology and forms hypotheses, Section 5 presents the main empirical results, Section 6 provides additional analysis, and Section 7 concludes.

$70\% \times (-0.217°F) = -0.0544°F$. In other words, we adopt a property-value-weighted average county-level abnormal temperature for each REIT each year.

2. Related Literature

2.1 Climate Risk in Real Estate

Climate changes and climate risk have garnered more attention from real estate researchers in recent years. We have observed and experienced significant losses from natural disasters and extreme weather conditions, such as floods, droughts, rising sea levels, wildfires, etc. A growing body of literature is investigating how climate changes affect real estate prices. Many previous studies focus on the residential real estate markets. Roback (1982) was the first to mention the effects of climate change on housing prices. More recently, Bernsten, Gustafson, and Lewis (2019) study the impacts of rising sea levels on housing prices. They find that houses exposed to such risk are sold at lower prices than equivalent houses without the exposure. However, Murfin and Spiegel (2020) argue that, by separating the sensitivity of housing to rising sea level from other characteristics related to land motion, the price impacts of rising sea level on housing prices are limited. Semenenko and Yoo (2019) document international evidence that the changes in daily temperature volatility are negatively correlated with real estate returns. Giglio et al. (2021) present robust evidence that climate risks are captured and discounted in housing prices.

Bunten and Kahn (2014) show the importance of recognizing population heterogeneity related to the effects of climate risk on home prices. Though climate risk is well-documented in natural science and social science literature,[15] in real estate, it shows that the real estate prices may be influenced by the belief in climate risk, rather than climate risk itself. McNamara and Keeler (2013) find that property owners who believe in climate change tend to invest more to protect against climate risk. These property owners are more likely to abandon their properties in a significant event, which causes profound price fluctuations in the local markets. Balduaf, Garlappi,

[15] See a report from *NASA's Goddard Institute for Space Studies*, "Scientific Consensus: Earth's Climate Is Warming."

and Yannelis (2020) suggest that houses exposed to higher climate risk in areas where people tend to believe in climate changes sell at a discount compared to similar houses in areas where people tend not to believe in climate changes. Bernstein, Billings, Gustafson, and Lewis (2021) explore the political affiliations of the homeowners of rising-sea-level houses. They find that coastal houses exposed to the rising sea level risk are more likely to be owned by Republicans than Democrats.

Lately, scholarly activities to examine climate risk in real estate have expanded to mortgage markets and insurance products. Issler et al. (2020) show that the number of mortgage delinquency and foreclosures increase significantly after a wildfire in California. They point out that it is highly doubtful that insurance companies could continue to absorb such significant losses.

With respect to climate risk on commercial real estate, there has been quite a void. Clayton et al. (2021) review the related literature on climate change effects on real estate prices. They acknowledge that there have been limited studies on commercial real estate compared to the volume of studies in residential real estate. Feng and Wu (2021) show that Environmental, Social, and Governance (ESG) disclosure is related to REIT debt financing and firm value. The latest work by Cvijanovic and van de Minne (2021) may be the first one to directly examine the impacts of climate change on commercial real estate properties. They use a repeated sales model to capture how extreme climate changes affect the real estate returns on the property level. They find that property returns are negatively correlated to the extreme temperature shocks. They further examine the sources of the negative correlation and suggest that the return reduction on properties exposed to extreme temperature shocks is more likely a result of higher discount rate required by such properties due to the uncertainty of the property's future cash flows.

2.2 Climate Risk in Finance

Climate finance has become a hot topic in recent years. Stroebel and Wurgler (2021) conduct a survey about climate finance. The respondents include finance academics, professionals, regulators, and policy economists. The majority of them believe that, in the current environment, asset prices underestimate climate risk even though they all recognize that climate risk is one of the top risks to businesses and investors for the next five years. Many studies focus on how climate risk affects business cash flows and performances, while others focus on how investors and the markets price climate risks.

The effects of climate risk on fundamental economic activities are not news to us. For instance, Gallup, Sachs, and Mellinger (1999) show that climate change has a negative impact on income growth of a region. Schlenker and Roberts (2009) suggest that extreme temperature changes affect the agriculture crop yield in U.S. Dell, Jones, and Olken (2012) find that higher temperatures reduce economic growth in poor countries.

Regarding corporate finance and climate risk, Hugon and Law (2019) shownegative impacts of warmer climate on firms' sales and earnings using firms headquarter locations. Sun, Addoum, Ng, and Ortiz-Bobea (2020) examine the causal effects of temperature shocks on sales and productivity. Intriguingly, they find no evidence to show that extreme temperature shocks significantly affect establishment-level sales or productivity. Similar results are presented at the firm level. Xu, Sun, and You (2021) suggest that firms with higher temperature exposures tend to have lower future profitability. They also show that firms with high climate risk exposures tend to have lower future stock returns.

In addition, several research concentrates on how climate risk is priced in the cost of capital or the discount rate. Huynh, Nguyen, and Truong (2020) find a significant correlation between drought risk and the cost of equity of a firm. They show that the length and intensity of the drought increase a firm's cost of equity furthermore. Javadi and Masum (2021) examine the cost of borrowing of firms located in areas with high climate risk exposures. Their results indicate that such firms suffer from a higher cost of borrowing on their bank loans as the lenders tend to charge a higher premium on the loans to price the climate risk.

3. **Data, Variables, and Summary Statistics**

3.1 Data Source

To empirically assess the impacts of climate change on REITs, we collect data from several sources. The climate data are obtained from the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce. The NOAA has provided county-level monthly average temperatures – reported in Fahrenheit (°*F*) [16] - for most regions since 1895.[17] The annual firm-level accounting information and property-level data are collected from the S&P Global Market Intelligence (formerly known as SNL Financial) between 1995 and 2020 (a 26-year sample period).[18]

3.2 Abnormal Temperature

Inspired by Hugon and Law (2019) and Chiang, Feng and Harrison (2022), we first compute the monthly abnormal temperature for each county by its 36-month moving average temperature minus the rolling 1,200-month (100 years) historical average temperature in that

[16] While the United States adopts the Fahrenheit (°F) temperature scale, most countries around the world adopt the Celsius(°C) temperature scale. On the Fahrenheit scale, water freezes at 32°F and boils at 212°F. On the Celsius scale, water freezes at 0°C and boils at 100°C. To convert temperatures in degrees Fahrenheit to Celsius, subtract 32 and multiply by 5/9.

[17] https://www.ncdc.noaa.gov/cdo-web/

[18] The sample starts in 1995 is because the property-level information of the individual REITs are only available in the S&P Global Market Intelligence asset database at the year.

county. Formally, the county-level abnormal temperature based on 100 years rolling average temperature is given by

$$
\begin{aligned}
&Abnormal\ Temperature - 100yrs_{c,m} \\
&\quad = Moving\ Average\ Temperature_{c,m-36\ to\ m} \\
&\quad - Average\ Temperature_{c,m-1199\ to\ m}
\end{aligned} \tag{1}
$$

where c represents each county, m represents each month.

Figure 1 illustrates the abnormal temperature based on 100 years rolling average temperature at the county level in July in each year of our sample period.[19]

[Figure 1 here]

Next, we take the average of the monthly abnormal temperature and define it as the abnormal temperature of each county each year ($Abnormal\ Temperature - 100\ yrs_{c,t}$). We sum up the net book values [Ertugrul and Giambona (2011); Demirci, Eichholtz and Yönder (2020); Feng and Wu (2022)] of a REIT's properties by county in each year.[20] Finally, the firm-specific abnormal temperature measure is defined as:

[19] The figure uses all temperature data extracted from NOAA, without winsorizing the distribution.

[20] Some studies [e.g., Milcheva, Yildirim and Zhu (2021); Wang and Zhou (2021); Ling, Naranjo and Scheick (2021)] use the adjusted cost of REIT properties to construct their property-value-weight in each region. For robustness, we also construct the firm-specific abnormal temperature measure with the adjusted cost. The results are similar to those based on net book value.

$$Abnormal\ Temperature - 100yrs_{i,t} = \sum_{i=1}^{N} W_{i,c,t} * Abnormal\ Temperature - 100yrs_{c,t} \quad (2)$$

where W represents the property-value-weight in each county. i represents a firm, t represents a year, and c represents a county.

Similarly, we also compute the firm-level abnormal temperature based on 50 years rolling average temperature and denotes $Abnormal\ Temperature - 50yrs_{c,t}$. Figure 2 depicts the distribution of two firm-level $Abnormal\ Temperature$ measures of REITs in our sample between 1995 and 2020.[21] Each bar represents a 0.2-degree Fahrenheit temperature change. The mean $Abnormal\ Temperature - 100\ yrs$ is 1.40°F. The dashed lines show that one standard deviation below and above the mean are 0.76°F and 2.04°F, respectively. The mean $Abnormal\ Temperature - 50\ yrs$ is 1.12°F, while its one standard deviation below and above are 0.57°F and 1.67°F. The figures confirm that, in recent years, U.S. metropolitan areas experienced higher temperatures than their historical averages.

[Figure 2 here]

The abnormal temperature of a REIT firm each year is then calculated as its property-value-weighted average abnormal temperature in all the counties where it has properties.[22] A positive (negative) abnormal temperature indicates that the 36-month moving average temperature is

[21] Starting from here, the numerical variables in all figures and tablkes are winsorized at the 1% and 99% levels to avoid the influence of extreme observations.

[22] To make the total of the weight equal 100%, we drop all the properties that are not in the U.S. in the calculations.

warmer (cooler) than the long-term (100 years or 50 years) average temperature. Table 1 presents the summary statistics of the $Abnormal\ Temperature$ throughout our sample period. The table shows the mean, median, standard deviation, the minimum and maximum values of the abnormal temperature in the sample. It indicates a slight increase in abnormal temperature over the sample period.

[Table 1 here]

In the empirical analysis, we construct an Abnormal Temperature (Level) variable. Operationally, we classify a firm's climate risk exposures into three levels: Abnormal Temperature $< 1°F$, Abnormal Temperature = $1 - 2°F$, and Abnormal Temperature $> 2°F$. In our analysis, the Abnormal Temperature levels are assigned as 1 for Abnormal Temperature $< 1°F$, 2 for Abnormal Temperature = $1 - 2°F$, and 3 for Abnormal Temperature $> 2°F$. That is, we create a categorical variable and apply it in portfolio sorting and regressions. The Abnormal Temperature (Level) is the key independent variable in this study.

Figure 3 depicts the number of year-firm observations of the firm-level abnormal temperature (level) measures. Specifically, 1,186 firm years are less than $1°F$, 2,360 firm years are between $1 - 2°F$, and 826 firm years are greater than $2°F$, based on $Abnormal\ Temperature - 100\ yrs$. The numbers are 1,770, 2,324, and 278 in each level, based on $Abnormal\ Temperature - 50\ yrs$.

[Figure 3 here]

3.3 Dependent Variables

The empirical analysis focuses on the impacts of climate risk on cash flows and firm valuation of REIT firms. We adopt two proxies to measure the cash flows of REITs: funds from operations scaled by total assets (FFO/TA) and net operating income scaled by total assets (NOI/TA). FFO is one of the most commonly adopted cash flow measures in the REIT industry [Ben-Shahar, Sulganik and Tsang (2011)]. NOI can be considered as property-level cash flows (PCF), which is equal to the sum of corporate-level cash flows, general and administrative expenses, and interest expenses [see, Capozza and Seguin (1999), Eichholtz and Yonder (2015)].

We adopt two proxies to measure the firm value of REITs: market-to-book equity ratio (Market-to-Book) and firm *Q*. Market-to-Book is calculated as the market capitalization of equity (i.e., the share price times common shares outstanding) divided by the book value of equity [Beracha, Feng and Hardin (2019); Cashman, Harrison and Sheng (2022)]. Firm *Q* is the ratio of the market value of equity (measured as the share price times common share outstanding plus total assets minus the book value of equity) divided by the sum of total assets and accumulated deprecation [Downs, Straska and Waller (2019); Ling, Wang and Zhou (2021)].[23]

3.4 Control Variables

Following the REIT literature, we include the following control variables in our research: firm size (the log of total assets); firm leverage (the ratio of total assets to total equity); firm age (the log of the number of years since IPO or year REIT status is established); asset growth rate (the growth rate of total assets); geographic diversification (the negative of the Herfindahl Index of REITs, calculated using their assets invested in different NCREIF Region, based on book

[23] Negative FFO/TA, NOI/TA, Market-to-Book and firm *Q* are replaced with missing values.

values); property type diversification (the negative of the Herfindahl Index of REITs, calculated using their assets invested in various property types, based on book values); gateway MSA concentration (the ratio of the firm's assets invested in the six Gateway MSAs - Boston, Chicago, Los Angeles, New York, San Francisco, and Washington, D.C. - to its total assets). Please see Appendix A for the summary of variable definitions.

3.5 Sample Characteristics

Table 2 exhibits the summary statistics of the variables for the empirical analysis. The mean and median of $Abnormal\ Temperature - 100yrs$ are 1.402°F and 1.408°F. The mean and median of $Abnormal\ Temperature - 50\ yrs$ are 1.120°F and 1.137°F. Regarding the abnormal temperature (level) measures, the primary variable of interest, A typical REIT has the mean and median abnormal temperature (level) of 1.92 and 2.00 based on $Abnormal\ Temperature - 100yrs$, and 1.66 and 2.00 based on $Abnormal\ Temperature - 50yrs$. For the cash flow measures, the average (median) FFO/TA and NOI/TA of REITs are 5.08% (5.99%) and 7.93% (7.94%), respectively. In terms of firm value measures, the mean market-to-book equity ratio is 1.86, while the median is 1.47. The mean firm Q is 1.09, while the median is 1.25.

[Table 2 here]

Table 3 illustrates the pairwise correlations of the variables for the empirical analysis. As expected, the correlations between the abnormal temperature measures are very high (ρ ranging from 0.75 to 0.95) and statistically significant at the 1% level. Of note, while the correlation between $Abnormal\ Temperature - 100yrs\ (level)$ and REIT firm value is mixed, the correlations between $Abnormal\ Temperature - 100yrs\ (level)$ and REIT cash flow (FFO/TA and NOI/TA) are negative (ρ = -0.06), and statistically significant at the 1% level.

[Table 3 here]

4. **Empirical Methodology and Hypothesis Development**

4.1 Impacts on Cash Flows

Prior literature in corporate finance indicates that warmer climate negatively affects the cash flows of a firm, such as earnings and profitability [see, Hugon and Law (2019); Addoum, Ng, and Ortiz-Bobea (2020); Sun, Xu, and You (2021)]. Thus, we hypothesize that a warmer climate hurts the cash flows of a REIT firm.

The empirical analysis starts with an essential evaluation determining the primary association between REIT cash flow and abnormal temperature. To do so, we create three portfolios sorted by REITs' Abnormal Temperature (Level), which is Abnormal Temperature <1°F, Abnormal Temperature = 1-2°F, and Abnormal Temperature >2°F. Then, we investigate the mean and median of cash flow (i.e., FFO/TA and NOI/TA) of REITs in these portfolios.

To further assess the impacts of climate change on REIT firms, we estimate the following Equation (3) to determine how climate change impacts REIT firms' cash flow condition on other firm characteristics.

$$Cashflow_{i,t} = \beta_0 + \beta_1 Abnormal\ Temperature_{i,t} + \gamma Controls_{i,t} + \delta_i + \varepsilon_{i,t} \quad (3)$$

where $Cashflow_{i,t}$ is FFO/TA or NOI/TA of REIT i at year t. $Abnormal\ Temperature_{i,t}$ is the property-value-weighted abnormal temperature (Level), which is the categorical variable of Abnormal Temperature <1°F, Abnormal Temperature = 1-2°F, and Abnormal Temperature >2°F, of REIT i at year t. δ_i represents real estate property type fixed effect. $\varepsilon_{i,t}$ is the standard error term. The control variables include firm size, firm age, leverage ratio, total asset growth, geographic and property type diversification, and gateway MSA concentrations. The control variables are defined in Appendix A.

4.2 Impacts on Firm Value

Prior studies show that asset performance is not only influenced by the cash flows generated by the assets, but also by the uncertainty of the cash flow generation. Cvijanovic and van de Minne (2021) provide strong evidence that the uncertainty in predicting cash flow for properties exposed to extreme climate risk drives the return reduction of such properties in commercial real estate market. Similar results are found in residential real estate, in which house prices are discounted by climate risk.

If climate risk matters to REIT cash flows, we should observe persistent differences in the firm valuation among REITs with different levels of abnormal temperature. We should also find a positive relationship between operational efficiency and REIT stock returns. Thus, we hypothesize that higher climate risk exposures are associated with lower firm value. A similar approach is used to examine the impacts on REIT firm value from climate risk exposures.

5. **Empirical Results**

Following the research design in the previous section, we begin the empirical analysis by providing a basic illustration of REIT cash flow conditioned on abnormal temperature. Table 4 presents the results from a high-minus-low analysis approach that compares the mean and median FFO/TA and NOI/TA of REITs sorted by their abnormal temperature levels.

The results show that the mean and median of REIT cash flow measures sorted by their abnormal temperature levels decrease from the first portfolio (Abnormal Temperature <1°*F*), the second portfolio (Abnormal Temperature =1-2°*F*), and to the third portfolio (Abnormal Temperature >2°*F*) in all cases. Based on $Abnormal\,Temperature - 100yrs\ (level)$, the spreads of the mean (median) of FFO/TA and NOI/TA between the first and third portfolios in percentage is -0.353 (-0.391) and -0.444 (-0.452), respectively. The cash flow spread of the mean (median) based on $Abnormal\,Temperature - 50yrs\ (level)$ also confirm the differences. All of these differences are statistically significant at the 1% level using the *t*-statistic from the *t*-test or the *z*-statistics from the Wilcoxon rank-sum test.

[Table 4 Here]

Next, we apply Equation (3) to our data sample to examine how climate risk affects REIT firm cash flows. Table 5 presents the results. Consistent with our expectations and in line with the literature [e.g., Hugon and Law (2019); Addoum, Ng, and Ortiz-Bobea (2020); Sun, Xu, and You (2021)], we find that REIT firms with properties exposed to warmer climate generate lower funds from operations and net operating income.

We show that the cash flow (FFOs and NOIs) of the REIT firms with properties located in the extreme hot counties suffered more than the rest after we control for REIT firm characteristics and property types. When the dependent variable is FFO/TA, as in Column (1), the estimated coefficients for Abnormal Temperature –100 yrs $1-2°F$ and Abnormal Temperature –100 yrs $> 2°F$ are -0.388 and -0.613, respectively.[24] All three coefficients display statistical significance at the 1% level. Economically, the results imply that, if a REIT firm with total assets of $1 billion is exposed to an abnormal temperature of $2.04°F$ (i.e. one standard deviation above the mean in our sample), its FFO and NOI are estimated to decrease by approximately $12.50 million and $16.24 million, respectively compared to the base case of abnormal temperature of less than $1°F$. The negative and statistically significant coefficients of the categorical variable based on $Abnormal\ Temperature - 50yrs$ in Column (2) provide further confirmation that FFO/TA of REIT firms with a higher concentration of properties in highly heated areas is lower than those observed in less heated areas.

NOI/TA is used as an alternative proxy for the cash flows. Results from Columns (3) and (4) indicate that REITs with higher abnormal temperature levels generally collect less cash flow from their assets. Specifically, the coefficients (*t*-statistics) of Abnormal Temperature –100 yrs $= 1-2°F$ and Abnormal Temperature –100 yrs $> 2°F$ are -0.300 (-3.17) and -0.796(-3.92) of Abnormal Temperature –50 yrs $1-2°F$ and Abnormal Temperature –50 yrs $> 2°F$ are -0.260 (-3.23), respectively. The baseline results suggest that the cash flow of REITs is lower when they have higher levels of abnormal temperature.

[24] That is, compared to the FFO/TA in Group 1 (Abnormal Temperature –100 yrs <1°F), we would expect the FFO/TA in Group 3 (Abnormal Temperature –100 yrs >2°F) to be 0.613% higher, on average.

In addition to the coefficients of interest, the results presented in Table 5 also show that REITs that are smaller, older, lower leveraged, slowly grown, less diversified in property locations, and more concentrated in gateway regions are associated with higher cash flow related to their assets. These findings align with expectations and are consistent with the existing literature.

[Table 5 here]

After studying the impacts of climate risk on REIT firm cash flows, we focus on the market values of REIT firms. We now know that climate risk negatively affects REIT cash flows, so we employ the same portfolio sorting approach and regression analysis. We find that REIT firms with more properties in warmer counties tend to have lower market-to-book ratios and lower Firm Q, which indicates that such firms have lower firm values than REIT firms with lower climate risk exposures.

Table 6 presents the differentials of firm value between REITs with different abnormal temperatures. The portfolio sorting results seem to point in the direction that REITs with fewer climate risk exposures may be valued higher by investors than REITs with more climate risk exposures. The spreads of the mean (median) of market-to-book and firm Q between the third portfolio (Abnormal Temperature $>2°F$) and the first portfolio (Abnormal Temperature $<1°F$) are negative in seven of eight specifications. However, most of them are statistically insignificant.

[Table 6 here]

Table 7 reports the results that explore the correlation between REITs' firm value and their climate risk exposures level, using Equation (3) with firm value measures as the independent variables. When the market-to-book equity ratio is used as the dependent variable, the estimated coefficient of Abnormal Temperature –100 yrs $= 1 - 2°F$ is –0.119 with a *t*-statistic of -2.45, while the estimated coefficient of Abnormal Temperature –100 yrs $> 2°F$ is -0.176 with a *t*-statistic of -2.38. Regarding the other climate risk exposures categorical variables, their estimated coefficients are all negative and statistically significant. This result, with firm Q being the dependent variable, also suggests that REITs' market valuations are lower when they have higher levels of climate risk exposures.

We show that REIT firms with a higher concentration of properties in extremely heated areas tend to have lower market-to-book ratios and Q than the rest of the REIT firms in the sample. Our results are consistent with our expectations based on the findings from previous regression analyses. As REIT firms with higher climate risk exposures tend to have lower cash flows, their firm values are decreased the most by the impacts of climate risk.

[Table 7 here]

Collectively, the results presented thus far provide evidence that REITs' firm value, measured by market-to-book equity ratio and firm Q, is negatively related to their climate risk exposures with statistical and economic significance.

6. **Additional Analysis**

To further establish how extreme warm climate impacts the REIT cash flow and firm value, Table 8 presents the propensity score matching results.[25] Panel A reports the logit regression results that the probability (i.e., the propensity score) is the predicted value. In the pre-match sample, the results show that high climate risk exposures REITs, which have an Abnormal Temperature –100 yrs greater than 2°F, are larger, older, with lower asset growth, less geographic diversification, and more gateway cities concentration. The pseudo R-square for the regression is 0.076. In the post-match sample, all estimated coefficients are statistically insignificant, suggesting that there are no distinguishable trends in the climate risk exposures between the two groups. The pseudo R-square is 0.006 for the post-match sample. The results indicate that the propensity score matching removes all observable differences among the sample other than the difference in the climate risk exposures level. Panel B illustrates that none of the differences in firm characteristics between the treated and the control groups are statistically significant, confirming that the propensity score matching analysis removes all the other observable differences. Thus, the difference in cash flow and market value of REITs between the two groups is likely due to their climate risk exposure levels.

Panel C reports the propensity score matching estimates. The average treatment effect on the treated (ATT) indicates that there are significant differences in FFO/TA (4.978% vs. 5.213%, *t*-stat = -1.98), NOI/TA (7.772% vs. 8.216%, *t*-stat = -3.40), the market to book equity ratio (1.973 vs. 2.074, *t*-stat = -1.08), and firm Q (1.092 vs. 1.118, *t*-stat = -1.78) between REITs with Abnormal Temperature –100 yrs $> 2°F$ and those matched REITs. The results show that the high-climate

[25] In Panels A and B, the results are based on FFO/TA as the variable of interests. The results are quantitatively and qualitative similar when NOI/TA, market-to-book equity ratio, and firm *Q* are used as the variable of interests. These results are not reported in the paper for brevity.

risk exposures REITs have a lower cash flow and market value than the otherwise indistinguishable REITs. The propensity score matching analysis provides supporting evidence for the main results.

[Table 8 here]

Table 9 reports the impact of abnormal temperature on REIT cash flow and firm value, using the *linear* abnormal temperature measures ($Abnormal\ Temperature - 100\ yrs$ and $Abnormal\ Temperature - 50\ yrs$). The results are based on Equation (3), with the outcome variables being FFO/TA, NOI/TA, market-to-book equity ratio, and firm Q, respectively. The Abnormal Temperature variables are the property-value-weighted average abnormal temperature, based on 100 and 50 years rolling average temperature, in all the counties where a REIT has properties.

Results from Columns (1) to (4) affirm that REITs with higher abnormal temperature levels generally collect less cash flow from their assets. Specifically, the estimated coefficients of $Abnormal\ Temperature - 100yrs$ are -0.390 for FFO/TA and -0.497 for NOI/TA. Both are statistically significant at the 1% level. Economically, the results indicate that, if a REIT firm with total assets of $1 billion experiences an increase of 1.40°F (i.e., the mean $Abnormal\ Temperature - 100yrs$ of our sample) in abnormal temperature, on average, its FFO and NOI are estimated to decrease by approximately$5.46 million and $6.96 million, respectively. Moreover, the estimated coefficients of $Abnormal\ Temperature - 50yrs$ are -0.406 for FFO/TA and -0.455 for NOI/TA, and statistically significant at the 1% level. The estimated coefficients of $Abnormal\ Temperature - 10yrs$ are negative but lose its statistical significance.

Results from Columns (5) to (8) attest that REIT firms with more properties in warmer counties tend to lower firm values than REIT firms with lower climate risk exposures. The coefficients of $Abnormal\ Temperature$ are all negative and statistically significant. For instance, the estimated coefficients (t-statistics) of $Abnormal\ Temperature - 100yrs$ is -0.111 (-3.00) for market-to-book in Model (5) and -0.031 (-4.19) for firm Q in Model (7). We find similar results when examining the impacts of abnormal temperatures with the $Abnormal\ Temperature - 50yrs$ and $Abnormal\ Temperature - 10yrs$ variables.

[Table 9 here]

In addition, we further examine the impacts of climate risk on different property types. Our previous analysis used property types as control variables for fixed effects. Now we want to know how climate risk influences the cash flow and firm values across different property types. Table 10 present the results. We evaluate the proportion of REITs that are climate "winners" and "losers" by property types. Winners are determined based on firm-level univariate time-series regressions of a dependent variable (funds from operations on total assets (FFO/TA) or market-to-book equity ratio) on the *Abnormal Temperature –100 yrs* $> 2°F$ variable. A firm is defined as a winner (loser) with respect to FFO/TA and market-to-book equity ratio if the respective time-series beta estimate is positive (negative).

Our results imply that property types, such as Industrial, Self-Storage, Office, and Hotel, tend to perform better in cash flow (measured by FFO/TA) in a warmer climate. Property types, such as Regional Mall, Multi-family, and Manufactured Home, tend to perform worse in cash flow in warmer temperatures. With regard to firm values measured by the Market-to-Book ratio, property types, such as Industrial, and Multi-family, tend to fare better in warmer climates compared to other property types. Our findings shed light on the heterogeneity of climate risk impacts in commercial real estate across property types.

[Table 10 here]

7. **Conclusion**

In this research, we examine how climate risk impacts firm performances and risks using real estate investment trusts. We take advantage of the uniqueness of REIT firms by studying the climate risk exposures of the firms' asset locations instead of firm headquarter locations as in prior literature in corporate finance. We find that REITs with higher climate risk exposures (i.e., with more properties located in counties experiencing higher abnormal temperature changes) tend to generate lower cash flows and have lower firm values. Moreover, we establish evidence that climate risk exposures are heterogeneous across different real property types.

We believe that our research findings can help fill a gap in our knowledge of how firm performances are impacted by climate risk at a more granular geographic location level as REIT firms are considered as a portfolio of commercial real estate properties with specific locations. Our empirical evidence supports the temperature-based long-run risk model and provides a clearer insight into the rising temperature's economic implications. We hope that our results could inspire more research into climate finance on firm-specific asset location level. Additionally, we would like to movitate more studies in commercial real estate to understand the critical nature of climate risk.

References

Addoum, J. M., Eichholtz, P., Steiner, E., & Yönder, E. (2021). Climate change and commercial real estate: Evidence from Hurricane Sandy. Available at SSRN 3206257. *Working Paper*.

Addoum, J. M., Ng, D. T., & Ortiz-Bobea, A. (2020). Temperature shocks and establishment sales. *The Review of Financial Studies*, *33*(3), 1331-1366.

Baldauf, M., Garlappi, L., & Yannelis, C. (2020). Does climate change affect real estate prices? Only if you believe in it. *The Review of Financial Studies*, *33*(3), 1256-1295.

Bansal, R., Kiku, D., & Ochoa, M. (2016). Price of long-run temperature shifts in capital markets (No. w22529). National Bureau of Economic Research. *Working Paper*.

Bansal, R., Ochoa, M., & Kiku, D. (2017). Climate change and growth risks (No. w23009). National Bureau of Economic Research *Working Paper*.

Ben-Shahar, D., Sulganik, E., & Tsang, D. (2011). Funds from operations versus net income: Examining the dividend relevance of REIT performance measures. *Journal of Real Estate Research*, 33(3), 415-442.

Beracha, E., Feng, Z., & Hardin III, W. G. (2019). REIT operational efficiency and shareholder value. *Journal of Real Estate Research*, *41*(4), 513-554.

Bernstein, A., Gustafson, M. T., & Lewis, R. (2019). Disaster on the horizon: The price effect of sea level rise. *Journal of Financial Economics*, *134*(2), 253-272.

Cashman, G. D., Harrison, D. M., & Sheng, H. (2022). Does options trading activity benefit REITs?. *Journal of Real Estate Research*, 1-35.

Capozza, D. R., & Seguin, P. J. (1999). Focus, transparency and value: the REIT evidence. *Real Estate Economics*, *27*(4), 587-619.

Chiang, C. C., Feng, Z, & Harrison, D. (2022). Heat stress and commercial real estate returns. Available at SSRN 4150066. *Working Paper*.

Clayton, J., Devaney, S., Sayce, S., & Van de Wetering, J. (2021). Climate risk and real estate prices: what do we know?. *The Journal of Portfolio Management*, *47*(10), 75-90.

Cvijanovic, D., & Van de Minne, A. (2021). Does climate change affect investment performance? Evidence from commercial real estate. *MIT Center for Real Estate Research Paper*, (21/15).

Dell, M., Jones, B. F., & Olken, B. A. (2009). Temperature and income: Reconciling new cross-sectional and panel estimates. *American Economic Review*, *99*(2), 198-204.

Dell, M., Jones, B. F., & Olken, B. A. (2012). Temperature shocks and economic growth: Evidence from the last half century. *American Economic Journal: Macroeconomics*, *4*(3), 66-95.

Dell, M., Jones, B. F., & Olken, B. A. (2014). What do we learn from the weather? The new climate-economy literature. *Journal of Economic Literature*, *52*(3), 740-98.

Demirci, I., Eichholtz, P., & Yönder, E. (2020). Corporate diversification and the cost of debt. *The Journal of Real Estate Finance and Economics*, 61(3), 316-368.

Downs, D. H., Straska, M., & Waller, H. G. (2019). Shareholder activism in REITs. *Real Estate Economics*, 47(1), 66-103.

Eichholtz, P., & Yönder, E. (2015). CEO overconfidence, REIT investment activity and performance. *Real Estate Economics*, *43*(1), 139-162.

Ertugrul, M., & Giambona, E. (2011). Property segment and REIT capital structure. *The Journal of Real Estate Finance and Economics*, 43(4), 505-526.

Feng, Z., Hardin III, W. G., & Wang, C. (2022). Rewarding a long-term investment strategy: REITs. *Journal of Real Estate Research*, *44*(1), 56-79.

Feng, Z., & Wu, Z. (2021). ESG disclosure, REIT debt financing and firm value. *The Journal of Real Estate Finance and Economics*, 1-35.

Feng, Z., & Wu, Z. (2022). Local economy, asset location and REIT firm growth. *The Journal of Real Estate Finance and Economics*, 65(1), 75-102.

Fisher, J. D., & Rutledge, S. R. (2021). The impact of Hurricanes on the value of commercial real estate. *Business Economics*, 56(3), 129-145.

Gallup, J. L., Sachs, J. D., & Mellinger, A. D. (1999). Geography and economic development. *International regional science review*, *22*(2), 179-232.

Giglio, S., Maggiori, M., Rao, K., Stroebel, J., & Weber, A. (2021). Climate change and long-run discount rates: Evidence from real estate. *The Review of Financial Studies*, *34*(8), 3527-3571.

Gollier, C. (2013). *Pricing the planet's future: the economics of discounting in an uncertain world*. Princeton University Press.

Howe, P. D., Mildenberger, M., Marlon, J. R., & Leiserowitz, A. (2015). Geographic variation in opinions on climate change at state and local scales in the USA. *Nature climate change*, *5*(6), 596-603.

Hugon, A., & Law, K. (2019). Impact of climate change on firm earnings: evidence from temperature anomalies. *Available at SSRN 3271386*.

Huynh, T. D., Nguyen, T. H., & Truong, C. (2020). Climate risk: The price of drought. *Journal of Corporate Finance*, *65*, 101750.

Holtermans, R., Niu, D., & Zheng, S. (2022). Quantifying the impacts of climate shocks in commercial real estate market. Available at SSRN 4276452. *Working Paper*.

Hsiang, S. M. (2010). Temperatures and cyclones strongly associated with economic production in the Caribbean and Central America. *Proceedings of the National Academy of sciences*, *107*(35), 15367-15372.

Ilhan, E., Krueger, P., Sautner, Z., & Starks, L. T. (2021). Climate risk disclosure and institutional investors. *Swiss Finance Institute Research Paper*, (19-66).

Issler, P., Stanton, R., Vergara-Alert, C., & Wallace, N. (2020). Mortgage markets with climate-change risk: Evidence from wildfires in california. Available at SSRN 3511843. *Working Paper*.

Javadi, S., & Masum, A. A. (2021). The impact of climate change on the cost of bank loans. *Journal of Corporate Finance*, *69*, 102019.

Jones, B. F., & Olken, B. A. (2010). Climate shocks and exports. *American Economic Review*, *100*(2), 454-59.

Krueger, P., Sautner, Z., & Starks, L. T. (2020). The importance of climate risks for institutional investors. *The Review of Financial Studies*, *33*(3), 1067-1111.

Ling, D. C., Naranjo, A., & Scheick, B. (2018). Geographic portfolio allocations, property selection and performance attribution in public and private real estate markets. *Real Estate Economics*, *46*(2), 404-448.

Ling, D. C., Naranjo, A., & Scheick, B. (2019). Asset location, timing ability and the cross-section of commercial real estate returns. *Real Estate Economics*, *47*(1), 263-313.

Ling, D. C., Naranjo, A., & Scheick, B. (2021). There is no place like home: Information asymmetries, local asset concentration, and portfolio returns. *Real Estate Economics*, 49(1), 36-74.

Ling, D. C., Wang, C., & Zhou, T. (2021). Institutional common ownership and firm value: Evidence from real estate investment trusts. *Real Estate Economics*, 49(1), 187-223.
McKenzie, R., & Levendis, J. (2010). Flood hazards and urban housing markets: The effects of Katrina on New Orleans. *The Journal of Real Estate Finance and Economics*, *40*(1), 62-76.
McNamara, D. E., & Keeler, A. (2013). A coupled physical and economic model of the response of coastal real estate to climate risk. *Nature Climate Change*, *3*(6), 559-562.
Milcheva, S., Yildirim, Y., & Zhu, B. (2021). Distance to headquarter and real estate equity performance. *The Journal of Real Estate Finance and Economics*, 63(3), 327-353.
Murfin, J., & Spiegel, M. (2020). Is the risk of sea level rise capitalized in residential real estate?. *The Review of Financial Studies*, *33*(3), 1217-1255.
Nordhaus, W. D. (2010). Economic aspects of global warming in a post-Copenhagen environment. *Proceedings of the National Academy of Sciences*, *107*(26), 11721-11726.
Ortega, F., & Taşpınar, S. (2018). Rising sea levels and sinking property values: Hurricane Sandy and New York's housing market. *Journal of Urban Economics*, *106*, 81-100.
Roback, J. (1982). Wages, rents, and the quality of life. *Journal of Political Economy*, *90*(6), 1257-1278.
Schlenker, W., & Roberts, M. J. (2009). Nonlinear temperature effects indicate severe damages to U.S. crop yields under climate change. *Proceedings of the National Academy of sciences*, *106*(37), 15594-15598.
Semenenko[1], I., & Yoo, J. (2019). Climate change and real estate prices. *International Journal of Economics and Finance*, *11*(11).
Stern, N., & Stern, N. H. (2007). *The economics of climate change: the Stern review*. cambridge University press.
Stroebel, J., & Wurgler, J. (2021). What do you think about climate finance?. *Journal of Financial Economics*, *142*(2), 487-498.
Wang, C., & Zhou, T. (2021). Trade-offs between asset location and proximity to home: Evidence from REIT property sell-offs. *The Journal of Real Estate Finance and Economics*, 63(1), 82-121.
Xu, J., Sun, C., & You, Y. (2021). Climate change exposure and stock return predictability. Available at SSRN 3777060. *Working Paper*.

Appendix A: Definition of Variables

Variable Name	Definition and Construction
FFO/TA	Funds from operations scaled by total assets
NOI/TA	Net operating income scaled by total assets
Market-to-Book	The market capitalization of equity (i.e., the share price times common shares outstanding) divided by the book value of equity
Firm *Q*	The ratio of the market value of equity (measured as the share price times common share outstanding plus total assets minus the book value of equity) divided by the sum of total assets and accumulated depreciaton
Firm size	The natural logarithms of total assets
Leverage	The ratio of the book value of assets to the book value of equity
Firm age	The natural logarithm of one plus the number of years since the IPO (*Year Listed*) or REIT status established if the IPO year is missing
Asset growth rate	The growth rate of total assets
Geographic diversification	The negative of the Herfindahl Index based on a REIT's assets invested in different NCREIF regions
Property type diversification	The negative of the Herfindahl Index based on a REIT's assets invested in different real estate property types
Gateway MSA concentration	The ratio of assets invested in the six Gateway MSAs (Boston, Chicago, Los Angeles, New York, San Francisco, and Washington, DC.) to the total assets of a REIT firm
Abnormal Temperature	The property-value-weighted average abnormal temperature in all the counties that a REIT has properties, where the abnormal temperature for each county by its 36-month moving average temperature minus its long-term average temperature (i.e., the rolling average temperature for 100 or 50 years, respectively).
Abnormal Temperature (Level)	A categorical variable for the abnormal temperature level [i.e., Abnormal Temperature (Level) = 1 if Abnormal Temperature $< 1°F$, Abnormal Temperature (Level) = 2 if Abnormal Temperature = $1 - 2°F$, and Abnormal Temperature (Level) = 3 if Abnormal Temperature $>$ $2°F$.]

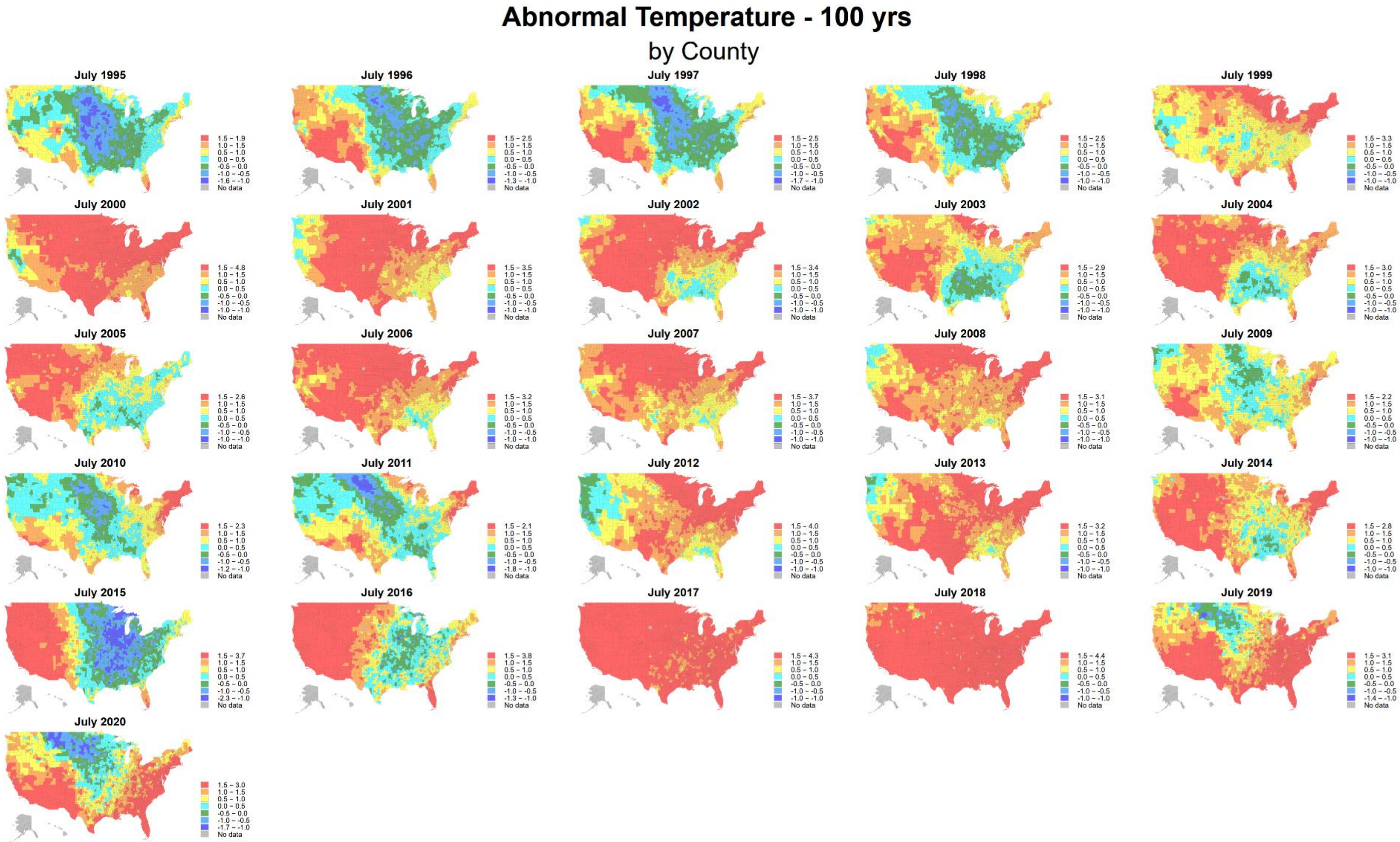

Figure 1. Abnormal Temperature by County

This figure illustrates the abnormal temperature based on 100 years rolling average temperature at the county level in July in each year of our sample period.

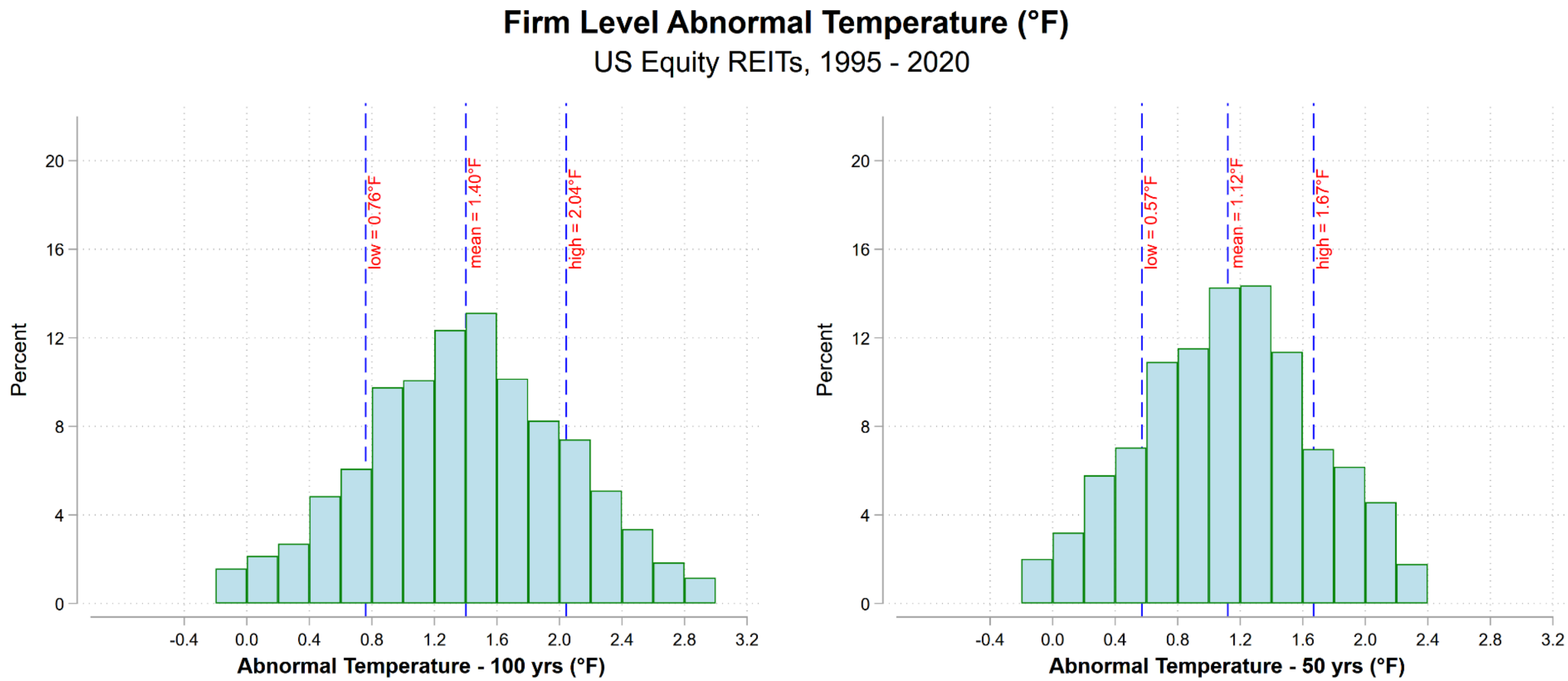

Figure 2. REIT Abnormal Temperature

This figure presents the distribution of the firm-level abnormal temperature measures, based on 100 and 50 years rolling average temperature, of REITs in the sample from 1995 to 2020. High (low) means one standard deviation above (below) the mean abnormal temperature. Numerical variables are winsorized at the 1% and 99% levels to avoid the influence of extreme observations.

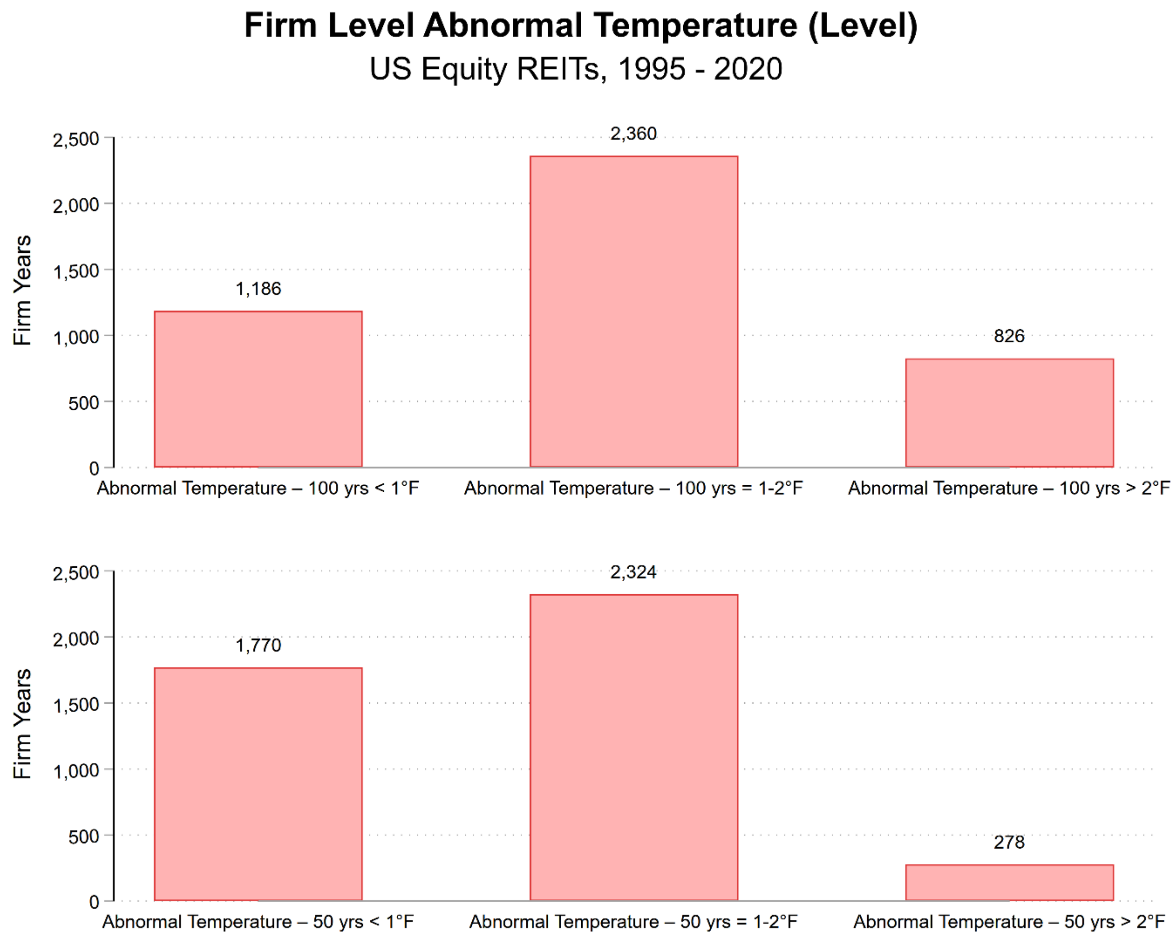

Figure 3. REIT Abnormal Temperature (Level)

This figure presents the number of year-firm observations of the firm-level abnormal temperature (level) measures, based on 100 and 50 years rolling average temperature, of REITs in the sample from 1995 to 2020. Numerical variables are winsorized at the 1% and 99% levels to avoid the influence of extreme observations.

Table 1. Summary Statistics – Abnormal Temperature

This table reports the descriptive statistics of the abnormal temperature variable used in the empirical analysis. Numerical variables are winsorized at the 1% and 99% levels to avoid the influence of extreme observations.

	Abnormal Temperature – 100 yrs					**Abnormal Temperature – 50 yrs**					
	Mean	**Median**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Median**	**Std. Dev.**	**Min**	**Max**	**Obs.**
1995	0.498	0.447	0.420	-0.074	1.685	0.322	0.308	0.271	-0.122	1.107	119
1996	0.580	0.460	0.541	-0.074	2.051	0.399	0.279	0.394	-0.122	1.401	125
1997	0.674	0.538	0.570	-0.074	2.288	0.503	0.417	0.425	-0.122	1.719	135
1998	0.781	0.706	0.518	-0.074	2.284	0.572	0.514	0.366	-0.089	1.752	148
1999	1.367	1.350	0.286	0.764	2.105	1.164	1.176	0.214	0.551	1.588	149
2000	1.790	1.762	0.433	0.688	2.862	1.570	1.644	0.434	0.287	2.302	143
2001	1.417	1.405	0.302	0.253	2.225	1.201	1.238	0.307	0.154	1.872	145
2002	1.427	1.427	0.331	0.670	2.177	1.205	1.217	0.242	0.661	1.831	138
2003	0.983	0.998	0.290	0.036	1.732	0.781	0.783	0.125	0.294	1.019	141
2004	1.230	1.237	0.286	0.294	1.954	1.035	1.045	0.126	0.533	1.334	154
2005	0.959	0.935	0.271	0.449	1.802	0.767	0.760	0.163	0.253	1.271	158
2006	1.428	1.439	0.211	0.900	2.169	1.231	1.231	0.167	0.606	1.896	136
2007	1.628	1.608	0.266	1.105	2.862	1.407	1.431	0.254	0.660	2.302	123
2008	1.666	1.627	0.286	1.093	2.394	1.420	1.407	0.248	0.424	1.930	136
2009	1.244	1.186	0.313	0.475	2.268	0.989	0.978	0.196	0.369	1.482	147
2010	0.993	0.940	0.379	-0.074	1.840	0.734	0.702	0.263	-0.122	1.301	162
2011	0.906	0.862	0.343	-0.062	1.835	0.650	0.624	0.266	-0.122	1.301	189
2012	1.635	1.560	0.495	0.435	2.862	1.353	1.364	0.490	-0.047	2.302	199
2013	1.833	1.797	0.416	0.621	2.862	1.524	1.549	0.411	0.105	2.302	205
2014	1.488	1.452	0.360	0.580	2.634	1.171	1.157	0.207	0.591	1.817	224
2015	0.818	0.693	0.651	-0.074	2.862	0.502	0.364	0.515	-0.122	2.302	227
2016	1.328	1.252	0.596	0.054	2.862	0.961	0.887	0.475	-0.122	2.302	233
2017	2.247	2.205	0.271	1.379	2.862	1.855	1.831	0.149	1.294	2.302	224
2018	2.482	2.458	0.175	2.044	2.862	2.081	2.085	0.118	1.655	2.302	214
2019	2.013	2.039	0.245	0.771	2.578	1.566	1.571	0.206	0.291	2.110	204
2020	1.741	1.785	0.339	-0.074	2.336	1.267	1.260	0.251	-0.122	1.846	194
Total	1.402	1.408	0.642	-0.074	2.862	1.120	1.137	0.549	-0.122	2.302	4,372

Table 2. Summary Statistics – Regression Variables

This table reports the summary statistics of the variables used in the empirical analysis. The sample period is from 1995 to 2020. Numerical variables are winsorized at the 1% and 99% levels to avoid the influence of extreme observations.

Variables	**Mean**	**Median**	**Std. Dev.**	**Min**	**Max**	**Obs.**
Total Assets ($B)	2.990	1.506	4.271	0.017	23.966	4,372
Year Listed	12.872	9.000	12.616	0.000	55.000	4,175
Leverage Ratio	1.524	1.132	2.269	-9.109	14.365	4,372
Asset Growth (%)	24.618	6.319	57.839	-31.598	370.667	4,157
Geographic Diversification	-0.407	-0.291	0.280	-1.000	-0.141	4,349
Property Type Diversification	-0.797	-0.942	0.244	-1.000	-0.224	4,349
Gateway MSA Concentration	0.231	0.130	0.266	0.000	1.000	4,349
FFO/TA (%)	5.077	4.987	2.470	0.231	13.121	3,987
NOI/TA (%)	7.933	7.938	2.969	0.809	17.373	4,331
Market-to-Book Equity Ratio	1.859	1.466	1.568	0.239	11.524	3,424
Firm Q	1.086	1.051	0.267	0.542	1.997	3,468
Abnormal Temperature –100 yrs ($Level$)	1.918	2.000	0.673	1.000	3.000	4,372
Abnormal Temperature –50 yrs ($Level$)	1.659	2.000	0.593	1.000	3.000	4,372
Abnormal Temperature –100 yrs ($°F$)	1.402	1.408	0.642	-0.074	2.862	4,372
Abnormal Temperature –50 yrs ($°F$)	1.120	1.137	0.549	-0.122	2.302	4,372

Table 3. Pairwise Correlations

This table reports the pairwise correlation coefficients of the variables used in the empirical analysis. The sample period is from 1995 to 2020. Numerical variables are winsorized at the 1% and 99% levels to avoid the influence of extreme observations. Significance at the 1%, 5%, or 10% level is shown with 3, 2, or 1 asterisk, respectively.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) Total Assets	1.00														
(2) Year Listed	0.24***	1.00													
(3) Leverage Ratio	0.04**	0.04***	1.00												
(4) Asset Growth	-0.11***	-0.23***	-0.05***	1.00											
(5) Geographic Diversification	0.15***	-0.06***	-0.03**	0.02	1.00										
(6) Property Type Diversification	0.02	0.13***	0.02	-0.04**	-0.08***	1.00									
(7) Gateway MSA Concentration	0.23***	0.17***	0.05***	-0.07***	-0.28***	0.07***	1.00								
(8) FFO/TA	0.02	0.18***	-0.11***	-0.22***	0.01	-0.07***	0.05***	1.00							
(9) NOI/TA	-0.03*	0.19***	0.06***	-0.38***	-0.02	-0.06***	0.04***	0.69***	1.00						
(10) Market-to-Book Equity Ratio	0.13***	0.13***	0.57***	-0.03	-0.05***	0.01	0.16***	0.28***	0.31***	1.00					
(11) Firm Q	0.14***	0.15***	0.00	0.12***	-0.03*	-0.02	0.14***	0.34***	0.19***	0.65***	1.00				
(12) Abnormal Temperature –100 yrs ($Level$)	0.18***	0.13***	0.05***	-0.11***	-0.06***	-0.01	0.21***	-0.05***	-0.05***	0.04**	-0.01	1.00			
(13) Abnormal Temperature –50 yrs ($Level$)	0.13***	0.10***	0.03**	-0.09***	-0.02	0.01	0.11***	-0.04**	-0.03**	0.01	-0.04**	0.75***	1.00		
(14) Abnormal Temperature –100 yrs ($°F$)	0.21***	0.14***	0.05***	-0.11***	-0.07***	0.00	0.25***	-0.06***	-0.06***	0.05***	-0.00	0.90***	0.83***	1.00	
(15) Abnormal Temperature –50 yrs ($°F$)	0.15***	0.11***	0.05***	-0.09***	0.00	0.01	0.12***	-0.07***	-0.06***	0.01	-0.05***	0.87***	0.87***	0.95***	1.00

Table 4. Cash Flow of Portfolios Sorted on Abnormal Temperature

This table shows the mean and median of REIT cash flow (measured as funds from operations on total assets (FFO/TA) and net operating income on total assets (NOI/TA) across portfolios sorted by Abnormal Temperature ($Level$), which is a categorical variable [i.e., Abnormal Temperature <1°F, Abnormal Temperature = 1-2°F, and Abnormal Temperature >2°F] of the property-value-weighted average abnormal temperature, based on 100 and 50 years rolling average temperature, in all the counties that a REIT has properties. t-statistics from the t-test and the z-statistics from the Wilcoxon rank-sum test are reported. Significance at the 1%, 5%, or 10% level is shown with 3, 2, or 1 asterisk, respectively.

Sort By	**Portfolio**		**1 (Abnormal Temperature <1°F)**	**2 (Abnormal Temperature =1-2°F)**	**3 (Abnormal Temperature >2°F)**	**3-1 Spread**	***t*-test**	**rank-sum test**
Abnormal Temperature –100 yrs ($Level$)	**FFO/TA**	Mean	5.259	5.048	4.906	-0.353***	-2.959	
		Median	5.205	4.961	4.814	-0.391***		-2.685
	NOI/TA	Mean	8.067	7.975	7.622	-0.444***	-3.215	
		Median	8.107	7.971	7.655	-0.452***		-3.741
Abnormal Temperature –50 yrs ($Level$)	**FFO/TA**	Mean	5.168	5.042	4.798	-0.371**	-2.227	
		Median	5.099	4.931	4.792	-0.307*		-1.791
	NOI/TA	Mean	8.011	7.920	7.557	-0.453**	-2.328	
		Median	8.057	7.904	7.583	-0.474***		-2.733

Table 5. Cash Flows and Abnormal Temperature

This table reports the impact of abnormal temperature on REIT cash flows. The dependent variables are funds from operations on total assets (FFO/TA) and net operating income on total assets (NOI/TA). Abnormal Temperature ($Level$) is a categorical variable [i.e., Abnormal Temperature $< 1°F$, Abnormal Temperature $= 1 - 2°F$, and Abnormal Temperature $> 2°F$] of the property-value-weighted average abnormal temperature, based on 100 and 50 years rolling average temperature, in all the counties that a REIT has properties. Abnormal Temperature $< 1°F$ is set as the base level and omitted in the regression. The coefficients of real estate property types are suppressed from reporting. t-statistics based on robust standard errors are reported. Significance at the 1%, 5%, or 10% level is shown with 3, 2, or 1 asterisk, respectively.

	(1)	(2)	(3)	(4)
Variables	**FFO/TA**	**FFO/TA**	**NOI /TA**	**NOI/TA**
Abnormal Temperature –100 yrs $= 1 - 2°F$	-0.388***		-0.300***	
	(-4.17)		(-3.17)	
Abnormal Temperature –100 yrs $> 2°F$	-0.613***		-0.796***	
	(-5.08)		(-6.45)	
Abnormal Temperature –50 yrs $= 1 - 2°F$		-0.263***		-0.260***
		(-3.32)		(-3.23)
Abnormal Temperature –50 yrs $> 2°F$		-0.550***		-0.645***
		(-3.95)		(-4.25)
Log Firm Size	-0.145***	-0.161***	-0.377***	-0.398***
	(-3.79)	(-4.27)	(-9.53)	(-10.15)
Log Firm Age	0.417***	0.412***	0.379***	0.373***
	(8.45)	(8.37)	(7.31)	(7.16)
Firm Leverage	-0.170***	-0.173***	0.019	0.018
	(-7.01)	(-7.08)	(0.71)	(0.65)
Total Asset Growth	-0.009***	-0.009***	-0.017***	-0.017***
	(-12.68)	(-12.36)	(-24.91)	(-24.63)
Geographic Diversification	-0.330**	-0.305*	-0.571***	-0.493***
	(-2.04)	(-1.91)	(-3.53)	(-3.06)
Property Type Diversification	-0.136	-0.094	-0.035	0.001
	(-0.64)	(-0.44)	(-0.16)	(0.00)
Gateway MSA Concentration	0.931***	0.868***	0.838***	0.750***
	(5.96)	(5.55)	(4.61)	(4.14)
Constant	7.246***	7.380***	14.390***	14.617***
	(10.70)	(11.02)	(20.31)	(20.71)
Observations	3,703	3,703	3,943	3,943
R-squared	0.169	0.166	0.267	0.263
Property Type FE	YES	YES	YES	YES

Table 6. Firm Value of Portfolios Sorted on Abnormal Temperature

This table shows the mean and median of REIT firm value (measured as market-to-book equity ratio and firm Q) across portfolios sorted by Abnormal Temperature ($Level$), which is a categorical variable [i.e., Abnormal Temperature <1°F, Abnormal Temperature = 1-2°F, and Abnormal Temperature >2°F] of the property-value-weighted average abnormal temperature, based on 100 and 50 years rolling average temperature, in all the counties that a REIT has properties. t-statistics from the t-test and the z-statistics from the Wilcoxon rank-sum test are reported. Significance at the 1%, 5%, or 10% level is shown with 3, 2, or 1 asterisk, respectively.

Sort By	**Portfolio**		**1 (Abnormal Temperature <1°F)**	**2 (Abnormal Temperature =1-2°F)**	**3 (Abnormal Temperature >2°F)**	**3-1 Spread**	***t*-test**	**rank-sum test**
Abnormal Temperature –100 yrs ($Level$)	**Market-to-Book**	Mean	1.750	1.882	1.944	0.194**	2.569	
		Median	1.467	1.467	1.445	-0.023		2.233
	Firm *Q*	Mean	1.095	1.081	1.087	-0.008	-0.605	
		Median	1.065	1.046	1.036	-0.029**		-1.991
Abnormal Temperature –50 yrs ($Level$)	**Market-to-Book**	Mean	1.827	1.889	1.801	-0.026	-0.247	
		Median	1.490	1.445	1.451	-0.039		-0.984
	Firm *Q*	Mean	1.098	1.079	1.068	-0.030	-1.621	
		Median	1.069	1.036	1.037	-0.032*		-1.851

Table 7. Firm Value and Abnormal Temperature

This table reports the impact of abnormal temperature on REIT REIT cash flow and firm values, using non-linear abnormal temperature measures. The dependent variables are market-to-book equity ratio and firm Q. Abnormal Temperature ($Level$) is a categorical variable [i.e., Abnormal Temperature $< 1°F$, Abnormal Temperature $= 1 - 2°F$, and Abnormal Temperature $> 2°F$] of the property-value-weighted average abnormal temperature, based on 100 and 50 years rolling average temperature, in all the counties that a REIT has properties. Abnormal Temperature $< 1°F$ is set as the base level and omitted in the regression. The coefficients of real estate property types are suppressed from reporting. t-statistics based on robust standard errors are reported. Significance at the 1%, 5%, or 10% level is shown with 3, 2, or 1 asterisk, respectively.

Variables	(1) **Market-to-Book**	(2) **Market-to-Book**	(3) **Firm *Q***	(4) **Firm *Q***
Abnormal Temperature –100 yrs $= 1 - 2°F$	-0.119**		-0.032***	
	(-2.45)		(-3.25)	
Abnormal Temperature –100 yrs $> 2°F$	-0.176**		-0.051***	
	(-2.38)		(-3.58)	
Abnormal Temperature –50 yrs $= 1 - 2°F$		-0.161***		-0.036***
		(-3.61)		(-4.11)
Abnormal Temperature –50 yrs $> 2°F$		-0.217**		-0.056***
		(-2.38)		(-3.16)
Log Firm Size				
	0.118***	0.116***	0.021***	0.020***
Log Firm Age	(6.16)	(6.24)	(5.54)	(5.39)
	0.170***	0.171***	0.041***	0.041***
Firm Leverage	(6.85)	(6.85)	(7.57)	(7.55)
	0.426***	0.427***	-0.001	-0.001
Total Asset Growth	(12.36)	(12.44)	(-0.31)	(-0.31)
	0.002***	0.002***	0.001***	0.001***
Geographic Diversification	(3.62)	(3.52)	(9.61)	(9.61)
	-0.153*	-0.140*	-0.085***	-0.081***
Property Type Diversification	(-1.94)	(-1.82)	(-4.42)	(-4.30)
	-0.003	0.005	-0.046*	-0.043*
Gateway MSA Concentration	(-0.03)	(0.05)	(-1.87)	(-1.74)
	1.037***	1.026***	0.197***	0.193***
Constant	(11.72)	(11.69)	(10.47)	(10.29)
	-0.605*	-0.574*	0.724***	0.737***
	(-1.90)	(-1.83)	(10.71)	(10.99)
Observations				
R-squared	3,227	3,227	3,268	3,268
Property Type FE	0.423	0.424	0.193	0.194

Table 8. Propensity Score Matching Results

This table reports the propensity score matching results. Panel A reports the parameter estimates from the logit model (i.e., pre-match propensity score regression and post-match diagnostic regression) used to estimate the propensity scores. The dependent variable is an indicator variable set to one if a REIT's Abnormal Temperature –100 yrs is greater than 2°F and zero otherwise. The control variables include log firm size, log firm age, leverage, total asset growth, geographic and property type diversification, and gateway city concentration. The coefficients of property types are suppressed from reporting. Panel B reports the univariate comparison of firm characteristics between the treated and the control groups and the corresponding *t*-statistics. The treated group consists of REIT years Abnormal Temperature –100 yrs >2°F. Panels A and B results are based on funds from operations on total assets as the variable of interest. Panel C reports estimates of the average treatment effects. The dependent variables are funds from operations on total assets (FFO/TA), net operating income on total assets (NOI/TA), market-to-book equity ratio, and firm *Q*, respectively. The matching variables include log firm size, log firm age, leverage, total asset growth, geographic and property type diversification, and gateway city concentration. Significance at the 1%, 5%, or 10% level is presented as 3, 2, or 1 asterisk, respectively.

Panel A. Pre-match Propensity Score Regression and Post-match Diagnostic Regression

	Dependent Variable: Abnormal Temperature –100 yrs >2°F	
	(1)	(2)
Variable	**Pre-match**	**Post-match**
Log Firm Size	0.307***	0.011
	(8.16)	(0.23)
Log Firm Age	0.178***	-0.071
	(3.29)	(-1.03)
Firm Leverage	0.015	0.004
	(0.79)	(0.14)
Total Asset Growth	-0.002**	-0.002
	(-2.02)	(-1.33)
Geographic Diversification	-1.388***	0.153
	(-8.02)	(0.74)
Property Type Diversification	-0.342	0.127
	(-1.47)	(0.43)
Gateway MSA Concentration	0.708***	-0.047
	(4.30)	(-0.24)
Constant	-6.975***	0.205
	(-10.58)	(0.25)
Observations	3,975	1,476
Pseudo R-squared	0.076	0.006
Property Type FE	YES	YES

Panel B. Propensity Score Matching Difference in Firm Characteristics

Variables	**Treated (N= 738)**	**Controls (N= 738)**	**Difference**	***t*-Statistic**
Log Firm Size	14.630	14.629	0.001	0
Log Firm Age	2.520	2.531	-0.011	-0.24
Firm Leverage	1.691	1.651	0.040	0.35
Total Asset Growth	13.542	16.044	-2.502	-1.23
Geographic Diversification	-0.469	-0.472	0.003	0.17
Property Type Diversification	-0.783	-0.794	0.012	0.91
Gateway MSA Concentration	0.348	0.350	-0.002	-0.13

Panel C. Propensity Score Matching Estimator

	Treated		**Controls**			
Variables	**Mean**	**No. of Obs.**	**Mean**	**No. of Obs.**	**Difference**	***t*-Statistic**
FFO/TA	4.978	738	5.213	738	-0.235	-1.98
NOI/TA	7.772	764	8.216	764	-0.444	-3.40
Market-to-Book	1.973	627	2.074	627	-0.101	-1.08
Firm *Q*	1.092	636	1.118	636	-0.026	-1.78

Table 9. The Linear Abnormal Temperature Measures

This table reports the impact of abnormal temperature on REIT cash flow and firm value, using the linear abnormal temperature measures. The dependent variables are funds from operations on total assets (FFO/TA), net operating income on total assets (NOI/TA), market-to-book equity ratio, and firm *Q*. Abnormal Temperature is the property-value-weighted average abnormal temperature, based on 100 and 50 years rolling average temperature, in all the counties that a REIT has properties. The coefficients of real estate property types are suppressed from reporting. *t*-statistics based on robust standard errors are reported. Significance at the 1%, 5%, or 10% level is shown with 3, 2, or 1 asterisk, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables	**FFO/TA**	**FFO/TA**	**NOI /TA**	**NOI/TA**	**Market-to-Book**	**Market-to-Book**	**Firm *Q***	**Firm *Q***
Abnormal Temperature –100 yrs	-0.390***		-0.497***		-0.111***		-0.031***	
	(-6.04)		(-7.49)		(-3.00)		(-4.19)	
Abnormal Temperature –50 yrs		-0.406***		-0.455***		-0.190***		-0.045***
		(-5.74)		(-6.21)		(-4.74)		(-5.50)
Log Firm Size	-0.130***	-0.148***	-0.356***	-0.383***	0.122***	0.123***	0.022***	0.022***
	(-3.40)	(-3.93)	(-8.99)	(-9.78)	(6.27)	(6.54)	(5.83)	(5.80)
Log Firm Age	0.425***	0.421***	0.390***	0.382***	0.173***	0.176***	0.041***	0.042***
	(8.59)	(8.53)	(7.52)	(7.39)	(6.94)	(7.05)	(7.67)	(7.76)
Firm Leverage	-0.169***	-0.169***	0.022	0.021	0.427***	0.428***	-0.001	-0.000
	(-6.95)	(-6.96)	(0.81)	(0.78)	(12.42)	(12.49)	(-0.28)	(-0.22)
Total Asset Growth	-0.009***	-0.009***	-0.017***	-0.017***	0.002***	0.002***	0.001***	0.001***
	(-12.67)	(-12.58)	(-24.73)	(-24.68)	(3.66)	(3.45)	(9.73)	(9.65)
Geographic Diversification	-0.375**	-0.297*	-0.586***	-0.479***	-0.167**	-0.147*	-0.088***	-0.082***
	(-2.34)	(-1.87)	(-3.64)	(-3.01)	(-2.15)	(-1.93)	(-4.60)	(-4.34)
Property Type Diversification	-0.158	-0.111	-0.087	-0.019	-0.010	-0.003	-0.048*	-0.045*
	(-0.75)	(-0.53)	(-0.40)	(-0.09)	(-0.09)	(-0.03)	(-1.96)	(-1.83)
Gateway MSA Concentration	0.964***	0.879***	0.876***	0.763***	1.045***	1.027***	0.199***	0.193***
	(6.18)	(5.64)	(4.81)	(4.22)	(11.76)	(11.69)	(10.52)	(10.29)
Constant	7.928***	8.144***	14.280***	14.602***	0.311	0.354	0.743***	0.761***
	(10.15)	(10.33)	(20.19)	(20.66)	(0.79)	(0.91)	(11.02)	(11.40)
Observations	3,703	3,703	3,943	3,943	3,227	3,227	3,268	3,268
R-squared	0.171	0.170	0.270	0.267	0.423	0.426	0.194	0.197
Property Type FE	YES	YES	YES	YES	YES	YES	YES	YES

Table 10. The Proportion of Climate "Winners" and "Losers" by Property Types

This table evaluates the proportion of REITs that are climate "winners" and "losers" by property types. Winners are determined based on firm-level univariate time-series regressions of a dependent variable (funds from operations on total assets (FFO/TA) or market-to-book equity ratio) on the Abnormal Temperature variable. Abnormal Temperature is the property-value-weighted average abnormal temperature in all the counties that a REIT has properties. A firm is defined as a winner (loser) with respect to FFO/TA and market-to-book equity ratio if the respective time-series beta estimate is positive (negative). To establish reasonable parameter estimates, we require that a REIT is associated with at least five annual observations and that the climate beta is significant at a minimum conventional level [that is, the *t*-statistics for the estimated coefficients of Abnormal Temperature are greater than 1.645 (less than -1.645)].

Property Types	By FFO/TA			By Market-to-Book		
	Winner	Loser	# of REITs	Winner	Loser	# of REITs
Industrial	31.3%	6.3%	16	28.6%	7.1%	14
Shopping Center	26.5%	20.6%	34	12.1%	21.2%	33
Self-Storage	25.0%	0.0%	8	12.5%	0.0%	8
Hotel	23.5%	5.9%	34	7.7%	19.2%	26
Office	22.9%	8.3%	48	2.5%	27.5%	40
Specialty	21.4%	7.1%	14	6.7%	33.3%	15
Manufactured Home	20.0%	40.0%	5	0.0%	60.0%	5
Regional Mall	20.0%	20.0%	10	10.0%	30.0%	10
Diversified	18.0%	12.0%	50	10.3%	24.1%	29
Health Care	17.4%	21.7%	23	11.1%	16.7%	18
Multifamily	16.0%	20.0%	25	29.2%	8.3%	24
Other Retail	11.8%	23.5%	17	0.0%	25.0%	12
Casino	0.0%	0.0%	1	0.0%	0.0%	2
Mean	19.5%	14.3%		10.1%	21.0%	
Total			285			236