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Does Climate Change Affect Renewable Stock Prices?

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Abstract

The paper analyzes whether climate change affects renewable stock prices. This is important because, as climate change concerns continue to grow, if there is an effect on renewable stock prices, companies and investors can take that into consideration when making financial decisions. The paper looks at monthly average temperature and precipitation data in the United States as a measure of climate change. This data is gathered from the National Centers for Environmental Information (NCEI), which is a part of the National Oceanic and Atmospheric Administration (NOAA). It also looks at the closing stock price data of 20 renewable companies. All financial data is gathered from Yahoo Finance. The paper finds that there is no statistically significant effect of climate change on renewable stock prices. This differs from some other research, likely due to the use of temperature and precipitation as a measure of climate change, unlike other studies that examine corporate policy or major weather events when referencing climate change. The lack of statistically significant results means that investors do not look at the average temperature or precipitation levels when considering whether or not to invest in renewable stocks. Firms and investors should expect climate change to only affect renewable stock prices when there are major policy or weather events, and should not worry about renewable stock prices fluctuating due to temperature or precipitation.

1. Introduction

Awareness of the devastating impact of climate change is becoming more prevalent today (Shi *et al.*, 2015). The US National Climate Assessment determined that Earth's climate is warming at a faster rate now than it ever has previously (Jay *et al.*, 2018). Climate refers to long-term patterns of weather, which include temperature, precipitation, and storms, and climate change refers to changes in the long-term averages and the increased variation around them (Dietz *et al.*, 2020). This leads to the increased frequency, intensity, and duration of extreme weather events (National Academies of Sciences *et al.*, 2016). Earth's climate is influenced by natural variability and human activities (Stevens *et al.*, 2021). Most of the climate change we can see today can be attributed primarily to human activities, particularly the addition of carbon dioxide and other greenhouse gases to the atmosphere (Hayhoe *et al*., 2018). Recent evidence indicates that the global average temperature has increased by about 1.8°F (1°C) since 1880, and 2020 was the warmest decade on record (Stevens *et al.*, 2021). While the general consequences of climate change are well-documented, the magnitude of their impact remains uncertain, leading to volatility in financial markets (Pindyck, 2021). Financial markets are locations, physical or otherwise, where people can buy and sell stocks, bonds, etc.

A stock, also known as a share, is a share in the ownership of a company. Owning a share of the company allows a person to benefit when the company starts making profits. The more stocks a person owns in a company, the more benefits they can enjoy (Duncan, 2016). Investors purchase stocks as a means of capital appreciation and portfolio diversification. People are more concerned with ensuring their stock is eco-friendly because of climate change and the public's increasing awareness of it (El Ouadghiri *et al.*, 2021). In the stock market, this manifests as more people purchasing renewable energy stocks. Renewable energy stocks are stocks of companies that use renewable energy, such as wind, solar, and hydropower, as opposed to fossil fuels. Renewable energy is better for the environment, as the use of fossil fuels such as coal, oil, and natural gas is one of the most significant contributors to climate change. If more people show a preference for renewable energy stocks, this will indicate an increase in demand for those stocks and will drive up the price.

Previous literature is abundant in this area, and many studies have analyzed it. A seminal paper in 2024 by Duan and Li gathers climate change data from the National Oceanic and Atmospheric Administration (NOAA). They explore the effects of climate change concerns on mortgage lending by using a temperature anomaly variable and accounting for sea-level rise. This paper builds on that literature by examining the impact of climate change on the stock prices of the top renewable energy companies in the USA, as identified by Hamid in 2023, instead of mortgage lending. Another paper looks at how climate change impacts the stock market but focuses specifically on certain events, including the Paris Agreement, Climategate, and Fukushima (Antoniuk and Leirvik, 2024), whereas this paper will be utilizing temperature and precipitation levels to account for climate change instead of specific climatic events. The hypothesis is that as climate change increases, renewable company stock prices will increase as well. Another paper proves a similar and related hypothesis: as climate change awareness increases, preference for renewable stocks increases (El Ouadghiri *et al.*, 2021). This is related to the hypothesis because previous literature indicates a relationship between an increase in climate change and climate change awareness. Awareness of climate change tends to increase when there are climatic or political events. Previous literature mostly analyzes climate change through policy awareness or the public's attention to climate change. This paper will fill the research gap by analyzing average temperature and precipitation levels.

In conclusion, this research is necessary due to the ever-increasing dangers of climate change and how it could impact financial markets. This paper seeks to inform investors and companies about how climate change impacts renewable stock prices. This paper aims to examine the effects of climate change on renewable stock prices through the analysis of average temperature and precipitation levels on the closing stock prices of the chosen renewable companies. This differs from previous literature that analyzes policy awareness or the public's attention to climate change.

2. Literature review

When studying the effects of climate change on renewable stocks, some previous literature chooses to focus on the public's response to policy rather than to climate change itself. Antoniuk and Leirvik (2024) examine how unexpected political events affect climate-sensitive sectors. They specifically look at the impacts of the Paris Agreement, Climategate, Fukushima, and the 2016 US presidential election on daily price data of ETFs from clean energy and fossil fuel companies from July 2009 to December 2016. The Paris Agreement aims to reduce climate change through the agreement of nations to reduce CO2 emissions. Climategate involved the leak of employee emails from the Climatic Research Unit at the University of East Anglia, which was then used by climate change deniers. Fukushima refers to the destruction of a nuclear plant due to an earthquake and tsunami, and the resulting change to energy policies. The US presidential election is significant due to the winner, Trump, being clear in his intentions not to prioritize climate change policies. They conclude that, with the exception of the 2016 US presidential election, these events benefited the clean energy sector because they increased climate change awareness and supported policies reducing the impact of climate change. The fossil energy sector only benefited from events weakening climate change policy. This contributes to understanding the relationship between climate change and renewable stock prices because the increase in climate change awareness and its corresponding benefit to the clean energy sector means an increase in renewable stock prices.

Another example of literature that examines the public's response to policy is shown in Ziegler *et al.* (2011). In that paper, they look at the disclosed corporate responses to climate change and examine how they affect stock performance in Europe and the US. They chose to look at both Europe and the US to compare the effect of the disclosure of corporate responses to institutional pressures. They analyze the average stock performance of corporations that have different responses to climate change from 2001-2006. Ziegler *et al.* conclude that there is a positive relationship between the disclosed corporate responses to climate change for energy companies in the US and stock performance.

Other previous literature that focuses on the public's response to company policies is Aswani *et al.* (2023). In the previous literature they reference in their paper, there are shown to be correlations between carbon emissions and stock returns. Aswani *et al*. determine that previous literature looked at the correlation between unscaled emissions estimated by a data vendor and not the emissions disclosed by the firms. While significant, looking for a correlation between emission intensity—the amount of emissions produced per unit of activity or output—and stock returns would be more appropriate. Aswani *et al.* made that adjustment and found no correlation between carbon emissions and stock returns.

Alternative previous literature focuses on the investor and how their attention to climate change influences the stocks they invest in, rather than their attention to policy. Different

studies use different techniques to evaluate the public's attention to climate change. El Ouadghiri *et al.* (2021) consider US media attention to climate change and pollution, as well as the US Google Search Volume Index (GSVI) for “climate change” and “pollution.” They measure US media attention by the weekly number of articles about climate change and pollution published in The New York Times, The Wall Street Journal, The Washington Post, and USA Today from January 2004 to June 2018. They justify using both of these as their measure of public attention to climate change because not all investors do one or the other; some don’t search for information on Google, some don’t read newspaper articles. In this study, they use their measures of public attention to climate change in addition to an examination of unexpected natural disasters worldwide to determine the effect of public attention to climate change and pollution on the weekly returns on two sustainability stock indices which use ESG ratings (DJSI US and the FTSE4Good USA Index) in comparison to their parent indices: the S&P 500 Index and the FTSE USA. El Ouadghiri *et al.* conclude that public attention to climate change has significant positive effects on the sustainability stock indices, and the opposite is true for their parent indices. When investors’ awareness of climate change increases, their preference for sustainable stocks increases. Jia *et al.* (2015) also looked at internet searches related to climate change to determine if they can predict the performance of traditional energy stocks. They also use the monthly GSVI from 2004 to 2021 for terms associated with climate change, but they use it to construct a climate change attention (CCA) index to quantify concerns about climate change. They use the monthly excess returns of the MSCI ACWI/Energy Index as their dependent variable and conclude that how much investors are concerned with climate issues negatively predicts the next month's traditional energy stock returns.

Other papers look at the public attention to climate change based on temperature or weather events as opposed to media attention. Although related to mortgage lending rather than stocks, Duan and Li (2024) examine whether people’s beliefs about climate change affect their decision-making. Specifically, whether loan officers’ beliefs about climate change affect their mortgage lending decisions. They look at a temperature anomaly variable, as well as the loan approval rate and a log of the loan amount. Duan and Li conclude that high local temperatures increase public attention and concerns about climate change, and that in higher temperatures, loan officers approve fewer loan applications and smaller amounts. Separately, Cao *et al.* (2015) use event analysis to evaluate the effects of unexpected climatic events, rather than temperatures, on the Chinese stock market. They use the daily closing price of the Shenzhen Component Index as a representative of the Chinese stock market and look at a 2008 snowstorm and a 2011 tropical storm in China, and a 2006 snowstorm and a 2008 hurricane in the US. Their study determines that unexpected domestic climatic events have a larger effect than foreign climatic events, but that both significantly affect the Chinese stock market. The impact of a single climatic event can vary across industries, and different climatic events can have different impacts on a single industry.

Previous literature most similar to this paper looks at actual climate data over time to measure climate change and examines how that affects stock. Jiang and Weng (2019) do exactly that, using the Actuaries Climate Index (ACI) to investigate how climate

change affects specifically agriculture-related stocks. They use ACI trends as proxies for climate change risk and, using that, determine that agriculture-related companies in regions with higher climate change risk tend to have lower profits. They construct a risk-adjusted trading strategy and determine that the impact of ACI on stock returns can be predicted, and so there is an opportunity for profit in the stock market. Based on this, they conclude that the stock market is inefficient towards climate change risk. The most relevant conclusion they find, to this paper, is that the stock market reacts slowly to climate information.

Previous literature is centered on the public's awareness of policies—corporate and political—concerning climate change, or the public's attention to climate change based on extreme weather events or temperatures. Studies have found that when corporate or political policies that help reduce the impact of climate change are put into place, there is a positive effect on renewable energy companies and their stocks. Studies have also found that, when public attention to climate change is increased—either due to media attention, extreme unexpected weather events, or high temperatures—there are significant positive effects on renewable companies' stocks. This paper addresses the gap left by previous literature by analyzing temperature and precipitation as the measure of climate change instead of policy awareness or public attention. Overall, previous literature seems to suggest that there should be a positive relationship between climate change and renewable stock prices.

3. Data and Methodology

The climate change data was gathered from the National Centers for Environmental Information (NCEI), which is a part of the National Oceanic and Atmospheric Administration (NOAA). Specifically, the average temperature and precipitation data in the United States. This paper examines these data variables on a national scale instead of at the individual state level because of the variety of companies and how they do not just operate in one state. Some companies operate in all the states, so a national measure yields the most accurate results. Specifically, examining the average temperature and precipitation data together provides an apt measure of climate change. The average temperature data collected is from December 2019 to December 2024. This data is then used to compute the deviation from the 20-year average, which previous literature has done (Ahmad *et al.* 2017). The same is done for the precipitation data, and both are lagged to identify their effect on stock performance. The data is presented in a monthly format since annual data would produce too drastic a difference, sparse data, and would not coincide with the frequency of the finance data.

The finance data from Yahoo Finance looks at the closing stock prices of renewable companies, specifically because they are expected to be the most impacted by climate change. The 20 renewable companies chosen originated from a 2023 article on Yahoo Finance naming the top 20 renewable energy companies in the US (Hamid 2023). The closing stock price data originated from the Historical Data section of each of the

companies from December 2019 to December 2024. The market cap and trailing p/e ratio, from the Statistics section. The market cap and trailing p/e ratio account for company growth. All the finance data gathered is monthly because annual data from 2019 to 2024 would not have been enough data to analyze. This time frame is chosen to ensure the research is recent and relevant.

To effectively analyze how climate change affects renewable stock prices, a fixed-effect model is needed. The regression equation used is as follows:

$$\text{Stock price}_{it} = \beta_0 + \beta_1 \text{Temp}_{t-1} + \beta_2 \text{Precipitation}_{t-1} + \beta_3 \text{Risk}_{it} + \beta_4 \text{Growth}_{it} + \alpha_i + \varepsilon_{it}$$

Where Stock price_{it} is the closing stock price of renewable company $_i$ at time $_t$, Temp_{t-1} is the average temperature in the United States at time $_{t-1}$, $\text{Precipitation}_{t-1}$ is the precipitation at time $_{t-1}$, Risk_{it} is a risk factor associated with the stock at time $_t$, Growth_{it} is a company growth metric–in this instance, the market capitalization and trailing P/E ratio provided by Yahoo Finance–, α_i represents firm-specific fixed effects, and ε_{it} is an error term.

$\beta_1 \text{Temp}_{t-1}$ is positive; an increase in average temperatures in the United States is expected to raise investor awareness of climate change, leading to greater investment in renewable energy stocks. This should increase the stock prices of renewable companies. $\beta_2 \text{Precipitation}_{t-1}$ is expected to be positive for the same reasons. An increase in precipitation will raise awareness of climate change and cause investors to buy stocks from renewable companies. The expected sign of $\beta_3 \text{Risk}_{it}$ is ambiguous. On one hand, higher risk may necessitate higher returns. On the other hand, high risk could pose a deterrent to potential investors, which would cause stock prices to drop. $\beta_4 \text{Growth}_{it}$ will be positive because as the company grows, so will its stock prices.

4. Results and Discussion

The first regression run was between the closing stock prices and the average temperature:

$$\text{Stock price}_{it} = \beta_0 + \beta_1 \text{Temp}_{t-1} + \varepsilon_{it}$$

Table 1. Relationship between closing stock prices of a renewable company and the average temperature in the United States

Stock price	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]
Temp	0.0518348	0.0566505	0.91	0.36	-0.0593111	0.1629806
_cons	68.53427	0.8488494	80.74	0***	66.86886	70.19967

Number of obs	1193	R-squared	0.0007
F(1,1191)	0.84	Adj R-squared	-0.0001
Prob > F	0.3604	Root MSE	29.274

Note: ***p<0.001; **p<0.01; *p<0.05

This table shows that there is no statistically significant relationship between the closing stock prices of renewable companies and temperature. This is not the result anticipated, but it could be due to temperature on its own not being an apt measure of climate change.

In the second regression run, precipitation was used instead of average temperature:

$$\text{Stock price}_{it} = \beta_0 + \beta_1 \text{ Precipitation}_{t-1} + \varepsilon_{it}$$

Table 2. Relationship between closing stock prices of a renewable company and precipitation in the United States

Stock price	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]
Precipitation	-1.500167	1.597896	-0.94	0.348	-4.635172	1.634838
_cons	68.45116	0.8580954	79.77	0***	66.76761	70.1347

Number of obs	1193	R-squared	0.0007
F(1,1191)	0.88	Adj R-squared	-0.0001
Prob > F	0.348	Root MSE	29.274

Note: ***p<0.001; **p<0.01; *p<0.05

This table shows that there is no statistically significant relationship between the closing stock prices of renewable companies and precipitation. This could also be explained by precipitation on its own not being an apt measure of climate change.

The third regression included both temperature and precipitation:

$$\text{Stock price}_{it} = \beta_0 + \beta_1 \text{ Temp}_{t-1} + \beta_2 \text{ Precipitation}_{t-1} + \varepsilon_{it}$$

Table 3. Relationship between closing stock prices of a renewable company and the average temperature and precipitation in the United States

Stock price	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]
Temp	0.0770494	0.0598408	1.29	0.198	-0.0403559	0.1944547
Precipitation	-2.202094	1.687915	-1.3	0.192	-5.513714	1.109527
_cons	68.32851	0.8631304	79.16	0***	66.63508	70.02194

Number of obs	1193	R-squared	0.0021
F(2, 1190)	1.27	Adj R-squared	0.0005
Prob > F	0.2812	Root MSE	29.266

Note: ***p<0.001; **p<0.01; *p<0.05

The addition of precipitation was meant to add to the temperature to better account for climate change, but as you can see in Table 3, there is still no statistical significance. Next, additional financial variables are added to ensure that no variables added will change the lack of statistical significance.

For the fourth and fifth regressions run, the companies' p/e ratio and market capitalization were added to account for company growth:

$$\text{Stock price}_{it} = \beta_0 + \beta_1 \text{Temp}_{t-1} + \beta_2 \text{Precipitation}_{t-1} + \beta_3 \text{Risk}_{it} + \beta_4 \text{Growth}_{it} + \varepsilon_{it}$$

Table 4. Relationship between closing stock prices of a renewable company, the average temperature and precipitation in the United States, and the company's p/e ratio to account for growth

Stock price	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]
Temp	0.0480023	0.0596597	0.8	0.421	-0.0690592	0.1650637
Precipitation	-1.748101	1.776162	-0.98	0.325	-5.233201	1.737
P/e ratio	0.0023242	0.0606093	0.04	0.969	-0.1166005	0.1212489
_cons	69.59572	1.722463	40.4	0***	66.21599	72.97546

Number of obs	1089	R-squared	0.0011
F(3, 1085)	0.4	Adj R-squared	-0.0016
Prob > F	0.75	Root MSE	27.737

Note: ***p<0.001; **p<0.01; *p<0.05

Table 5. Relationship between closing stock prices of a renewable company, the average temperature and precipitation in the United States, and the company's p/e ratio and market capitalization to account for growth

Stock price	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]
Temp	0.0465639	0.0582843	0.8	0.425	-0.0677988	0.1609266
Precipitation	-1.594334	1.735332	-0.92	0.358	-4.999323	1.810655
P/e ratio	-0.1373595	0.0622524	-2.21	0.028*	-0.2595084	-0.0152105
Market cap	2.03E-10	2.79E-11	7.27	0***	1.48E-10	2.58E-10
_cons	64.70498	1.812294	35.7	0***	61.14898	68.26098

Number of obs	1089	R-squared	0.0475
F(4, 1084)	13.52	Adj R-squared	0.044
Prob > F	0	Root MSE	27.097

Note: ***p<0.001; **p<0.01; *p<0.05

The introduction of the p/e ratio does not cause the significance of the results to change in Table 4. The introduction of market capitalization is significant and causes the p/e ratio to be moderately significant, but regardless of the addition of these variables to account for company growth, the results of Table 4 and Table 5 conclude that there is still no statistical significance of temperature and precipitation on stock prices.

The final regression ran controls for company fixed effects:

$$\text{Stock price}_{it} = \beta_0 + \beta_1 \text{Temp}_{t-1} + \beta_2 \text{Precipitation}_{t-1} + \beta_3 \text{Risk}_{it} + \beta_4 \text{Growth}_{it} + \alpha_i + \varepsilon_{it}$$

Table 6. Relationship between closing stock prices of a renewable company, the average temperature and precipitation in the United States, the company's p/e ratio and market capitalization, and company fixed effects

Stock price	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]
Temp	-0.0120615	0.0161771	-0.75	0.456	-0.0438042	0.0196812
Precipitation	0.1921296	0.4812352	0.4	0.69	-0.7521472	1.136404
p/e ratio	-0.0182385	0.0189613	-0.96	0.336	-0.0554444	0.0189673
Market cap	1.32E-09	3.39E-11	38.91	0***	1.25E-09	1.39E-09
_cons	54.10492	1.227556	44.08	0***	51.69622	56.51362

company fixed effect	✓

Number of obs	1089	R-squared	0.9284
F(23, 1065)	600.39	Adj R-squared	0.9269
Prob > F	0	Root MSE	7.4954

Note: ***p<0.001; **p<0.01; *p<0.05

None of these additions changes the fact that the effects of temperature and precipitation on the stock prices are not statistically significant. These results mean that when using temperature and precipitation as a measure of climate change, there is no effect of climate change on renewable stock prices. This could be because investors do not pay attention to everyday temperatures or precipitation levels and do not consider that to be an indication of climate change. This would make sense because when other papers use bigger events to measure climate change, such as unexpected extreme storms or major policy issues, they find statistical significance.

5. Concluding Remarks

With every year that passes, climate change is becoming more and more relevant to people's everyday lives. The drastic changes in the climate will naturally also affect their financial decisions. Previous literature looks at exactly that, but uses different means. Some papers choose to focus on policy and examine how public awareness of corporate policies affects stock performance, while other papers focus on the public's attention to climate change.

This paper examines whether climate change affects renewable stock prices. To determine that, it uses monthly average temperature and precipitation data in the United States gathered from the National Centers for Environmental Information (NCEI), which is a part of the National Oceanic and Atmospheric Administration (NOAA), to account for climate change. This paper also uses monthly stock price data from the top 20 renewable companies in the US, as named by Yahoo Finance (Hamid 2023), from December 2019 to December 2024.

Through this research, this paper concludes that there is no statistically significant relationship between climate change and renewable stock prices. This is due to the use of temperature and precipitation data as a measure of climate change. Other papers used extreme weather events, company policies, or media attention to account for climate change, and that is why they draw different conclusions. This makes a difference because extreme weather events, policies, and media attention catch the public's attention and make them concerned enough about climate change to influence

which stocks they invest in. Actual monthly climate data, such as temperature and precipitation, does not affect their investing decisions. The lack of statistical significance may also be attributed to investors not believing in climate change (Baldauf *et al.* 2020) or investors prioritizing strictly financial effects and choosing not to factor climate change into their investing decisions (Faccini *et al.* 2023).

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