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IMPACT OF CLIMATE CHANGE ON BIST 30 INDEX USING VAR MODEL

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ABSTRACT

Purpose- Global warming has caused an increase in the frequency and severity of extreme weather events in many parts of the world, including Turkey, over the past several decades. This study examines the effects of weather disasters on the Borsa Istanbul stock market from 2009 to 2019 using the BIST 30 Index.
Methodology- In the study, the short–term relationship between the Borsa Istanbul Stock Exchange (BIST30) index and climate change for the period January 2009 – December 2019 was analyzed using the VAR model, and Granger causality test, effect-response test and variance Decoupling tests were applied, respectively. In climate change we take 2 variable which are temperature and precipitation.
Findings – The impact of weather-related calamities on stock market volatility and returns has been found to be insignificant. BIST30 index has no effect of climate change and vice versa. A one-way relationship found between Temperature and the precipitation, and a short-term positive effect-response was found between these variables.
Conclusion – In conclusion we can say that climate change is one of the harsh reality which starts in recent years, and we can't ignore it. It has been determined that the BIST 30 index has not been impacted by climate change in Turkey. which mean 30 best performance companies but maybe it affects small companies and big stock exchanges like Nasdaq, FTSE, and others.

Keywords: Climate change, BIST-30, VAR model, precipitation, extreme weather temperatures
JEL Codes: Q5, Q54, G1

1. INTRODUCTION

Climate change poses significant difficulties and opportunities for industry. In terms of expenses, proposed legislation will increase regulatory costs. The Congressional Budget Office, for example, estimated that a newly proposed climate package would cost businesses more than $100 billion per year. On the plus side, "green" markets may open up new earning opportunities. The magnitudes of firms' climate-related net gains, and also which companies' profit, and which ones lose, are mostly unclear. This research adds to the debate by estimating the impact of climate change on stock prices. The impact of such knowledge should be reflected in short-run stock price adjustments if markets are generally efficient.

Investors are taking high interest in learning how the transition for a greener economy affects businesses, such as, He & Liu (2018), Li et al. (2020), Alsaifi et al. (2020), Teng & He (2020), Qian et al. (2020), Sarkodie et al. (2020). Furthermore, Alsaifi et al. (2020) used an event research technique to investigate how optional carbon disclosure affects businesses in UK. The researcher discovered that companies in carbon-intensive sector have a stronger unfavorable response to voluntary carbon disclosure.

These research display the current emphasis on climate risk, which is a systematic risk, according to Nordhaus and Yang (1996), affecting the entire economy rather than simply a single enterprise. Climate risks can also be divided into two categories: transition and physical risk (Clapp et al. 2017). The first is concerned with harsh weather and its repercussions, The alternative

however, is focused on the characteristics of the shift to a low-carbon economy., such as technology transitions, policy and regulation implementation, production-level changes, and purchasing behaviors. As a result, the market must account for transition risk in the upcoming days.

The research's importance is the presentation of early evidence on the association between financial markets and climate-related environmental behavior. Because there will likely be more market uncertainty over climate change, this study is very important. Compared to earlier empirical studies linking environmental success with financial success, our research has a number of important features.

Our Hypothesis we made for the study, is that the stock market could respond negatively, positively which is our alternative hypothesis, and null have no effect. Climate change has little effect on stocks if there is no reaction. This could indicate that meteorological variables such as temperature and precipitation are irrelevant to the company or market in question, or that they do not provide fresh information that should be factored in. A price change caused by climate change, on the other hand, is considerable but may have a significant effect on price development.

2. LITERATURE REVIEW

Pahuja (2009), in his study on large-scale manufacturing enterprises in India, investigated the relationship between environmental disclosures of firms and firm characteristics. For this purpose, the environmental disclosure index was created, and the activity reports of the enterprises were examined in a three-year period environmental disclosure scores were determined. Based on the analysis's findings, business size, and activities. The sector, profitability, and environmental performance have been found to significantly interact.

Chithambo and Tauringana (2014), took 210 from 2011 manufacturing businesses listed on the London Stock Exchange Measurement of greenhouse gas disclosures in sustainability reports, annual reports and websites between business-specific factors and GHG disclosures by developing a disclosure index for examined the relationship. In the study, greenhouse gas notifications and firm size, debt level and Profitability, liquidity, and investment expenditures, with which the sector is significantly related, it has been determined that there is no effect on greenhouse gas notifications.

Luo et. al (2012) found that 291 businesses in the Global 500 volunteered to the CDP (Carbon Disclosure Project) in 2009. In their study, they examined the factors affecting the participation of voluntarily submit to CDP reporting of large-scale enterprises operating in sectors were found to be more inclined to participate. Also, in this study, climate change is the main stakeholders demanding disclosures to the public and government rather than shareholders and lenders.

Kolk et. al (2008), business statement on climate change level and the significance of these disclosures for investors, the CDP survey although they observed a significant increase in the response rates given each year, this They concluded that the disclosures have a non-significant effect on the decision-making processes of investors.

According to İlgüz, B. (2022), the temperature increases experienced and the uncontrolled fluctuations in precipitation are affected by the climate change reveals the various effects of the change on the economy. Afore mentioned natural disasters such as floods, landslides, or on the contrary, it can cause extreme drought; economically can cause adverse situations.

Dlugolecki, A., & Lafeld, S. (2005) observed that economically developed countries take intensive measures against climate change While developing countries can take these measures instead of spending It is seen that they give priority to other areas. Developing countries being poor and lack in measures to address climate change behavior can reveal their situation.

Environmental monitoring event studies, the second strand of empirical research, is weaker but generates stronger results. The majority of studies related to stock market show that stock prices fall because of negative environmental news, and it reflects inverse relation of stock prices when news are positive (Hamilton 1995; Klassen & McLaughlin 1996; Konar & Cohen 1997; Khanna et al. 1998). Although the event study method used in this research helps to reduce inverse causation and neglected variable biases, various authors, especially Konar & Cohen (2001); McWilliams et al. (2006) have observed that studies in this field often encounter empirical obstacles. Most of the time environmental data is biased, so data of firm-level may suffer from measurement error or strategic misreporting, which is one of the issues driving this study.

Climate change is influencing our time's sociological, geopolitical, and financial dynamics. Shifts in long-term weather variable patterns may have a significant impact on sociocultural issues, including food shortages and relocation, particularly in poor nations (Dell et al., 2012).

Physical and transitional dangers arise as a result of climate change (Carney, 2015). Author finds out physical risks are the mostly negative consequences of weather and climate catastrophes on society, business operations and supply chain (Tankov & Tantet, 2019). Acute and persistent bodily dangers exist. Floods, excessive drought, wildfires, storms, and heat waves all pose acute bodily dangers. Sea-level rise, temperature rise and increase in precipitation are examples of chronic climate concerns that are steadily emerging.

Transitional hazards are the other possible scenarios that are consistent with a less carbon emission and their consequences for carbon fuels on dependent industries (Curtin et al., 2019). Other transitory hazards include firm reputation and technological changes (Semieniuk et al., 2021). I explore how the dynamics of both forms of climate change threats affect asset pricing in this paper. Extreme weather events are becoming more often and severe due to global warming and climate change, particularly within last three decades (Bourdeau & Kryzanowski 2017; Francis & Vavrus 2012).

The stock market's performance is beneficial to a country's overall economic performance. Every year, a lot of policies and research studies are undertaken around the world to investigate various elements of stock market development on economic growth. This is consistent with prior studies that looked at the effect of meteorological disasters on stock returns and local economic performance. Since the weather is regarded as a critical factor in economic performance and a determining factor in day-to-day living, several research and academic studies have been done to evaluate the influence of severe weather events on the industrial and financial market returns (Feltmate et al. 2020; Worthington & Valadkhani 2004; Wang & Kutan 2013). The majority of the research looked at how weather disasters affect the economy, and a few looked at how they affect stock market performance.

Over time, the weather impact study methodology improved and was applied on data from different markets. Some studies look at how weather disasters affect the country's economic indices, while others are primarily concerned with financial markets (Cavallo & Noy 2011; Lanfear et al. 2019; Wang & Kutan 2013).

Lanfear et al. (2019) estimate the impact on stock returns by landfall hurricanes in the America from 1990-2017. Researchers employed t-stats to determine the relationship between returns during in the event time frame and normal stock returns after calculating different accounting ratios for event window durations. Short-term returns were found to be particularly susceptible to hurricanes, but long-term returns were found to be unaffected. Equities with high momentum had a substantial negative effect than other stocks. Another oddity of catastrophic weather events was abnormal illiquidity.

Our main finding that climate change is having a significant economic impact on financial market returns is consistent with a large part of theoretical literature investigating the mechanisms that link environmental and financial performance. The most basic connection is that investors have "green" preferences. According to the literature, for good environmental performance (Arora and Gangopadhyay, 1995) to distinguish attract new customers with environmentally friendly products, (Maxwell and Decker, 2006) reduced monitoring and surveillance application, in the face of future regulation. The opposite is also true: those who perform poorly in the environment may see their profits suffer. Finally, poor performance can be directly lost as a result of high compliance costs in the face of new or stricter regulations that may reduce projected profitability. Stock prices reflect expectations for the predicted profitability.

In summary of previous studies, we can conclude that climate change is one of the hot topic now a days, not much researches are done on climate change but there are various studies related to environmental changes and its effect on firms profitability, stock returns and others key variables. We may say that this is the first study in which directly test the relationship between climate change and BIST 30 index prices. According to many researches climate change affected the firms and some of them found no significant result. We are going to test the same hypothesis on Turkish stock market that do they have any affects or not?

3. METHODOLOGY OF THE STUDY

3.1. Sample and Sources of Data

In this research, it is aimed to find the interaction between Climate change and BIST 30 Price Index using data on monthly frequency. Climate Change have 2 important variable which are Temperature and Precipitation and BIST30 index closing prices between January 2009 – December 2019, a total of 11 years dataset. In the studies in the literature on the subject, it has been observed that Granger causality tests and cointegration test are generally preferred and that causality tests give better results. For this reason, the VAR model was preferred in the analysis of the relationship between Climate change variables and BIST 30 in the study with the help of the VAR regression model, the correlation between the two variables shows the effects of climate

change on the BIST 30 index were observed. In addition, the effect occurred in the market during the selected data set time interval on the relationship between these variables was also included in the analysis.

The main aim of the research is to check the effect of climate change on BIST30 stock prices and the relationship between these two variables. For this purpose, Temperature, Precipitation and BIST30 data for the period 1.1.2009 – 29.12.2019 were used. Due to the fact that the data obtained from the Thomson Reuters DataStream and climateknowledgeportal.worldbank.org were used in the study. Within the scope of the study, Vector Autoregressive (VAR) model was created and EViews 10 program was used for the analysis. The main hypotheses of the study are as follows.

H0: Climate change have no effect on the BIST30 index.

H1: Climate change have an impact on the BIST30 index.

3.2. Econometric Modelling and Estimation

In the study, the stationarity of the Temperature, Precipitation and BIST30 variables was first examined. To examine if the series was stationary, the Augmented Dickey-Fuller (ADF) unit root test was applied.

$$\Delta Yt = \mu + \beta t + \delta Yt - 1 + \sum kj = 1 \alpha t \Delta Yt - 1 + \varepsilon t \quad (1)$$

ΔYt : The coefficients, the stationarity of which determines the time series to be tested

μ and ßt: The existence of a consistent trend in the time series under consideration

εt: Indicate an accidental error

Equation (1) refers to the equality of the ADF test. When the null hypothesis (H0) is rejected in the ADF test, it is concluded that there is no unit root for the ADF test, in other words, the time series in question is stationary (Elmastaş et. al 2016). Stationarity in general; It is described as the circumstance in which a time series' mean and variance remain constant across time and the covariance value between two points solely depends on the separation or time elapsed between the two points, not on actual time (Gujarati and Porter, 2010, p. 381).

$$\Delta Yt = A1 + A2t + A3Yt - 1 + \mu t \quad (2)$$

If the unit root test applied to determine the stationarity is expressed as in equation (2); the hypothesis H0 is that the coefficient of A3 is zero, and this indicates that the time series is not stationary. In this study, Augmented Dickey-Fuller (ADF) unit root test was applied to test that A3 is zero. If the value of the calculated A3 is greater than the critical value of the 10% selected for this study, the unit root hypothesis is rejected. In other words, the time series is considered to be stationary (Gujarati and Porter, 2010, p. 382). In order to find the number of delays in the ADF test, the Akaike information criterion was used in the study (AIC).

The VAR model was established with time series that were determined to be stationary by ADF test. However, the VAR model was subjected to autocorrelation, variable variance, normality, and root graph/table tests, respectively, and was tested for stability conditions, and the effect of Temperature and Precipitation on BIST30 was examined with the VAR model, which provides all four stages. In the next step, causality, effect-response, and variance decomposition analyses were applied respectively. With the effect-response analysis, it was measured what the reactions of the variables would be if one-unit shocks were applied to the variables in question. The variance decomposition was used to test at which percentage the change in the variance of each variable in question was covered by its delay or at which percentage it was covered by the other variable.

4. FINDINGS AND DISCUSSION

Whether a time series have a unit root depends on the stationarity of the series it is decided by looking at it. In other words, the time series changes over time the fact that it does not stop shows that the series is stationary, as well as the unit root of the series it also shows that it contains (Koyuncu, 2018, p. 621).

$$Xt = pXt - 1 + Ut \quad (3)$$

In the study, the stationarity of climate change and BIST 30 variables is determined by the ADF unit root in Table 1.

Table 1: Unit Root Test for BIST30 and Climate Change

D_BIST30	-10.35419***
D_Temperature	-3.996860***
D_Precipitation	-9.965391***

MacKinnon critical values for the 1%, 5% and 10% levels, respectively ***-3.5713, **-2.9225, * -2.5992

According to the applied ADF unit root test, with the current state of these series it has been determined that it is not stationary. There is a prerequisite for the analysis, which will be included in the model this is because the series is stationary. Therefore, the differences of the considered series are taken and the ADF test was repeated. As can be seen from Table the differences imported series do not contain a unit root. Here D represents the difference, for making stationary our variables.

4.1. VAR Model Stability Conditions

In order to ensure the stability conditions of the VAR model, respectively VAR (1,2,3,4,5,6,7,8,9) models have been tried. There is VAR (9) autocorrelation for the model. The results are shown in Table 2.

Table 2: Autocorrelation Test for the VAR (9) Model

Lags	P-value
Lag 1	0.0001
Lag 2	0.0131
Lag 3	0.0742
Lag 4	0.1048
Lag 5	0.0020
Lag 6	0.1484
Lag 7	0.5010
Lag 8	0.0658
Lag 9	0.1261

As can be seen from Table 2, there is no autocorrelation problem for the VAR (9) model, where the probability value of 9th Lag is more than 10%. A variable variance test was performed at a later stage for the VAR (9) model in which there was no autocorrelation problem. The probability value for the VAR (9) model subjected to the variable variance test is given in Table 3.

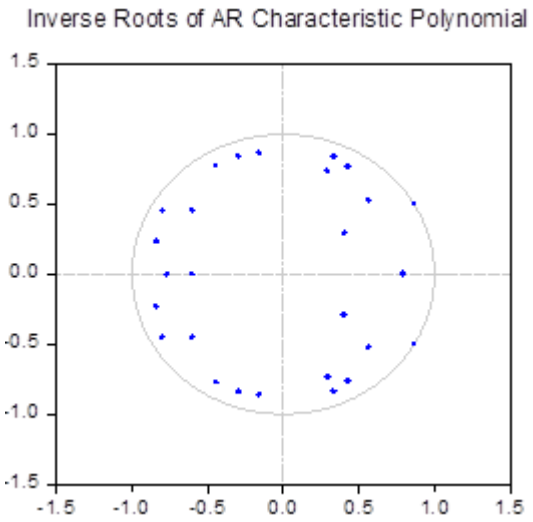
Table 3: VAR Residual Heteroskedasticity Tests Results

Chi-square	Probability
356.4932	0.1035

According to the VAR (9) model covering the BIST30 and Climate change time series, there are no problems with both autocorrelation and variable variance. For this reason, the analysis was continued with the VAR (9) model and the normality test was performed for the specified model. According to the normality test, the normality for the VAR model in question was greater than the specified confidence interval, that is 10%, and there is no normality problem.

In the VAR (9) model, there are 9*2=18 roots for this analysis, i.e., multiplying the model and the number of variables for bivariate analysis. These 18 roots must be located in the unit circle. The graph obtained for the VAR (9) model is given in Figure 1.

Figure 1: Unit Root Graph



4.2. Causality Test

In the causality test, the existence of a cause effect relationship between variables is tested and if there is a cause-and-effect relationship, the direction of this relationship is determined. The Granger causality test results applied in the study are as follows in Table 4.

Table 4: The Granger Causality Test Result

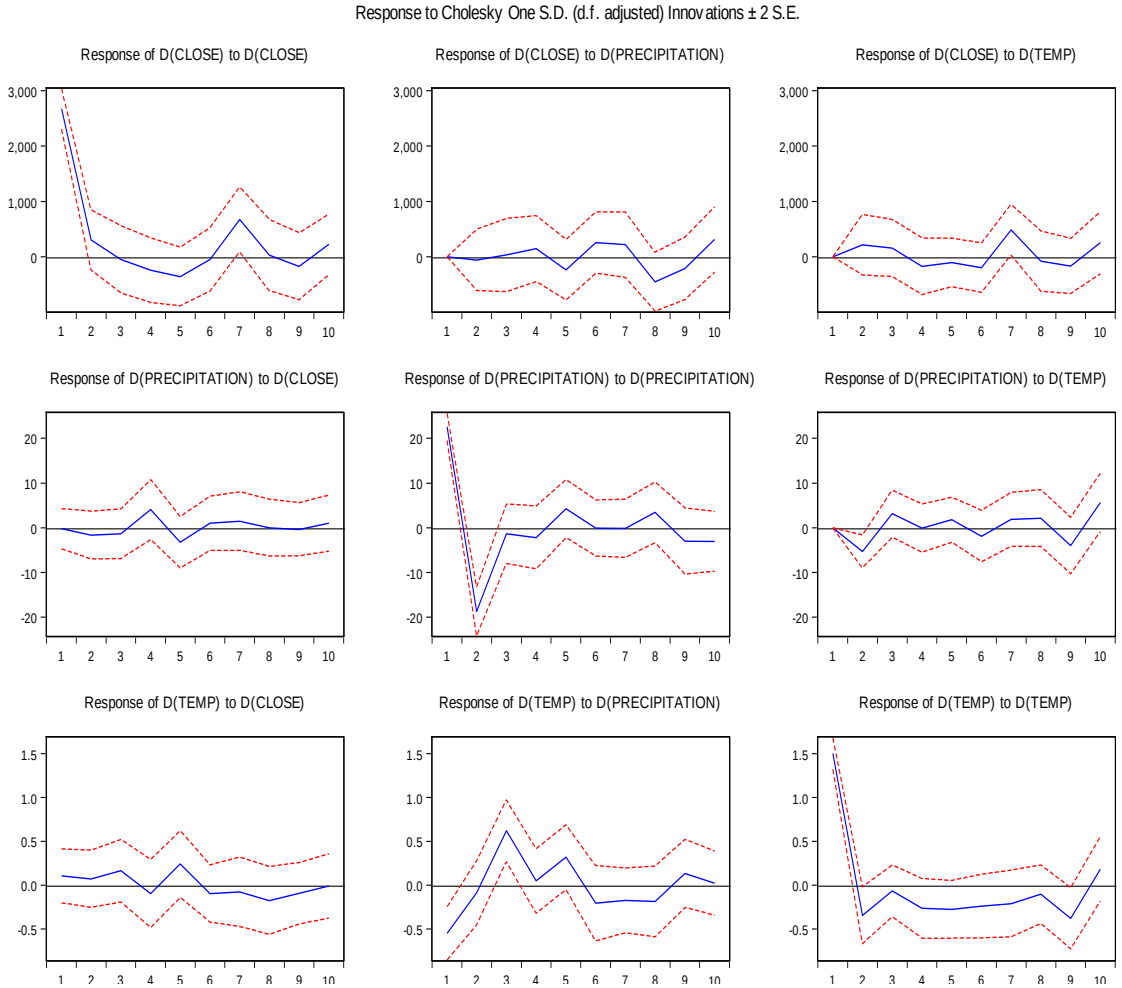
D_Temperature≠ > D_BIST30	0.3770
D_Precipitation ≠ > D_BIST30	0.2234
D_BIST30 ≠ > D_Temperature	0.5194
D_Precipitation ≠ > D_Temperature	0.0172
D_BIST30 ≠ > D_Precipitation	0.7715
D_Temperature≠ > D_Precipitation	0.0000

According to the results of the Granger causality test, Precipitation and Temperature have effect on each other. However, as can be seen from Table 4, BIST30 is not the reason for climate change and vice versa. In summary, there is no mutual causality relationship between the variables.

4.3. Effect-Response Test Results

Effect-response tests measure how a one-unit shock to a selected variable will affect the other variable or how the other variable will respond. In the study, the effect-response test was performed with the" Monte Carlo Standard Error and Generalized Effect" options. The generalized effect was chosen so that the results do not differ according to the order of variable selection.

Figure 2: Effect-Response Test Results



The first graph shows how a shock that will occur in the BIST30 will react in the BIST30. The second chart shows the reaction of Precipitation to a shock that will occur in BIST30, third chart shows the reaction of Temperature to a shock that will occur in BIST30. The fourth graph shows how a shock that will occur in the BIST30 will react in the Precipitation. The fifth chart shows the reaction of Precipitation to a shock that will occur in Precipitation, sixth chart shows the reaction of Temperature to a shock that will occur in Precipitation. The seventh graph shows how a shock that will occur in the BIST30 will react in the Temperature. The fifth chart shows the reaction of Precipitation to a shock that will occur in Temperature and the last chart shows his reaction to the shock caused by Temperature. The second, third, fourth, sixth, seventh and eight graphs are considered when interpreting these graphs. Because the first, fifth and ninth graphs measure the effect response of the variables themselves. The second, third, fourth, sixth, seventh and eight graphs are included in the interpretation since the important thing for analysis is the inter-variable effect-response.

When the effect-response graphs for BIST30 and temperature & precipitation are examined, it is seen that the other variable temperature and precipitation did not react to a shock occurring in BIST30 for a short period of time. But Precipitation and Temperatures variable have positive reaction to a shock.

4.4. Results of the Variance Decomposition Test

It measures the percentage of the change that occurs in one variable in the variance decomposition and how much other variables are affected by this change. The results of variance decomposition for an average of 10 periods are shown in Table 5.

Table 5: Variance Decomposition for BIST30 (%)

D_BIST30		
D_BIST30	D_Precipitation	D_Temperature
90.134	5.060	4.804
D_Precipitation		
D_BIST30	D_Precipitation	D_Temperature
3.455	89.692	6.8523
D_Temperature		
D_BIST30	D_Precipitation	D_Temperature
4.284	23.848	71.867

It measures the percentage of the change that occurs in one variable in the variance decomposition and how much other variables are affected by this change. The results of variance decomposition for an average of 10 periods are shown in Table 5.

As can be seen from Table 5, about 10% of the changes in the BIST30 index for an average of 9 periods are due to Temperature and Precipitation, and 90% are due to it. And almost 10% of the changes in the Precipitation for an average of 09 periods are due to Temperature and BIST30, and 90% are due to it. However, about 28% of the changes in Temperature are due to the BIST30 index and precipitation, and 72% are due to it. The results are limited by precipitation on temperature and but there is no effect of BIST30 on climate change and vice versa.

5. CONCLUSION AND RECOMMENDATION

Share prices and index values are affected by many macroeconomic variables such as inflation, interest rates, exchange rates, industrial production index, GDP, as well as precious metals such as oil and gold. In the scope of the research, it is aimed to find the interactions between the BIST30 index and climate change, which is the input of all sectors.

In the study, the short–term relationship between the BIST30 index and climate change for the period January 2009 – December 2019 was analyzed using the VAR model, and Granger causality test, effect-response test and variance Decoupling tests were applied, respectively.

The results of the causality test were obtained are that the BIST30 index is not the reason of climate change also climate change is not affected BIST30. A one-way relationship found between temperature and the precipitation, and a short-term positive effect-response was found.

When making investment decisions, carbon risk should be considered because programs to combat climate change aim to minimize carbon emissions. According to recent studies (Krueger, Sautner, and Starks 2020), investors are aware of the climate risk and seek better returns from businesses with higher emissions levels (Bolton & Kacperczyk 2021). Furthermore, the cost of borrowing is cheaper for businesses that care about the environment as compared to those that don't report their carbon footprint (Jung et al. 2018).

These findings demonstrate the need for investors to receive payment for owning climate-risky stocks. We contend that risk premiums and adjustments to expectations can account for how the sectors responded to the events. It is essential for

policymakers to comprehend how different businesses and the stock exchange as a whole respond to climate related policy in order to develop the best solution for the entire economy.

In conclusion we can say that climate change is one of the harsh reality which starts in recent years, and we can't ignore it. Our results for BIST30 are not significant but for other big index and big stock exchanges may have effects of climate change.

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