The Effects of Climate Change on Financial Markets

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Abstract

There is a critical relationship between climate change and financial markets. In this study, temperature change values are used to examine the impact of climate change on agriculture, banking, investment, and insurance sectors.

The study determines the relationship between temperature changes and agriculture, banking, investment, and insurance indices in BIST by regression analysis. The results show that climate change has different impacts on different sectors. While the agricultural sector is more sensitive to temperature changes, its impact on the bankingand investment sectors may be more limited. These results suggest that temperature changes directly and significantly impact the financial performance of the agricultural sector and provide a broad understanding of the potential impacts of climate change on financial markets and the agricultural sector.

In addition, the insurance sector can be affected by climate change, and temperature increases can trigger changes in insurance indices. These results emphasize that climate change is an essential factor in financial sector performance and risk management. In this context, policies and strategies to combat climate change should focus on promoting stability and sustainability in financial markets.

Keywords: Agriculture sector; banking sector; climate change; financial markets; insurance sector; investment sector;

INTRODUCTION

Climate change, which is a global problem and a source of global concern, is not only an environmental impact problem, but also an increasingly important economic and financial problem. The consequences of a warming planet permeate our societies and affect industries outside of areas traditionally associated with environmental concerns. The financial sectors, consisting of banking, insurance, investment companies and arange of financial instruments, are not insulated from these climatic changes like the foodsector. These sectors face new risks and opportunities that require comprehensive understanding and strategic adaptation.

Within the scope of the study, more specific effects of climate change on financial instruments related to sectors are discussed. Agriculture, which is essentially dependent on climatic conditions, is particularly vulnerable to the effects of climate change. This vulnerability is then transferred to the financial instruments that support this sector. Examining a range of these instruments is essential, including crop insurance, commodity futures and options, agricultural loans, green bonds, impact investments, and government subsidies and support programs. These tools, traditionally aimed at managing the risks inherent in agriculture, now must contend with an additional layer of climate-related uncertainty.

This study also presents a review by addressing the effects of climate change on banking, insurance and investment companies, which are critical components of the financial sectors. It is a curious issue how these institutions, which are an integral part of the functioning of economies around the world, are reshaped by climate change. How risk profiles have changed, how business models have been challenged, and how strategic planning has been forced to include environmental factors are topics that need to be examined.

Understanding how financial sectors and instruments are affected by climate change is important not only for the sustainability of these sectors but also for broader economic stability.

As climate change changes the environment of risk and opportunity, financial institutions and their associated instruments play an important role in increasing or reducing these impacts. This study aims to contribute to a broader discourse on climate change, finance and their intersecting challenges by shedding light on these impacts. Within the scope of the study, a review of this complex and rapidly developing subject is presented and ideas for finance practitioners and policy makers are presented.

RESULTS

Descriptive Statistics

Before the estimations of the models were made in the study, the descriptive statistics of the variables used in the models were calculated and presented in Table 5.1. In the study, the analyzes and analyzes were made with the Eviews 12 package program.

Table 5.1. Descriptive Statistics

	temp	Δxgida	Δxbank	Δxyrt	Δxsgrt
Avg.	0.032667	1.024009	1.024512	1.021705	1.027883
Median	-0.100000	1.017728	1.015570	1.012145	1.016599
Max	6.300000	1.696204	1.883382	1.792883	1.782175
Min	-6.900000	0.652305	0.644731	0.564085	0.477830
Std. Deviat.	2.077656	0.109793	0.142414	0.133521	0.134648
Distortion	0.183548	0.485651	0.293156	0.697101	0.787100
Kurtosis	3.469000	3.509361	3.674989	2.932361	3.015249
Jarque-Bera	4.434008	5.239875	6.181497	9.305371	4.451385
p	0.108935	0.195292	0.267318	0.863831	0.100125
Observation	300	300	300	300	300

One of the key assumptions of the least squares method is that the data series should be normally distributed or that the errors should follow the normal distribution (Wooldridge, 2003).

For this reason, it was first checked whether the variables were suitable for normal distribution. The normal distribution suitability of the variables was evaluated using the Jarque-Bera test based on the kurtosis and skewness statistics. The fact that the skewness value in the data set is zero and the kurtosis value is three indicates that the data set has a normal distribution. If the skewness value is greater than zero, it indicates that the data is skewed to the right, and less than zero indicates that the data is skewed to the left. A kurtosis value greater than 3 indicates that the data is sharper than the normal distribution, and a value less than 3 indicates that it is flatter (Yalçın&Çakmak, 2016). Data sets with these values in the range of ±1 are considered to be in normal distribution (Tabachnick et al., 2007). When the skewness and kurtosis values in the data set used in this study are examined, it can be seen that all variables have a normal distribution.

Along with the skewness and kurtosis values, the Jarque-Bera test is also used to determine whether the error term is suitable for a normal distribution (Şenesen and Şenesen, 2007). If the p value obtained from the Jarque Bera test is greater than 0.05, it means that the error terms have a normal distribution (Jarque and Bera, 1987). The collected statistical values indicate that all variables follow the normal distribution.
In time series analysis, it is an important assumption that the variables used are stationary, that is, they have a fixed mean and variance. Therefore, the stationarity of the variables used in this study (whether they carry a unit root) should be checked. Regression analyzes using non-stationary variables may reveal the "false regression" problem. This reveals that the estimations reflect a non-existent (false) relationship (Greene, 2003).

In this study, the stationarity of the variables was analyzed using the Augmented Dickey-Fuller (ADF) unit root test. The number of lags used in the ADF test was determined by the Akaike Information Criteria. The stationarity test results of the variables are presented in a Table 5.2.

Table 5.2. Augmented Dickey-Fuller (ADF) Unit Root Test Results

	Level					
		temp	xgıda	xbank	xyrt	xsgrt
I	t-Statistic	-18.6728	-7.0152	-17.3764	-16.0339	-16.2520
	Prob.	0.0000	0.0000	0.0000	0.0000	0.0000
		***	***	***	***	***
T and I	t-Statistic	-18.7448	-7.0181	-17.3994	-16.0196	-16.2893
	Prob.	0.0000	0.0000	0.0000	0.0000	0.0000
		***	***	***	***	***
N	t-Statistic	-11.7504	-6.5212	-10.3090	-11.0051	-9.9950
	Prob.	0.0000	0.0000	0.0000	0.0000	0.0000
		***	***	***	***	***

*Note:*** indicates that the variables are stationary at the 1% significance level. Model with T and I trend and constant, I; the model containing only the constant and N denotes the model that does not contain the constant and the trend. The values in the table are the ADF test values and the probability values for each test are given in parentheses.*

The variables used in the model have constants and do not have a trend. For this reason, in the stationarity test results, only the part (I) in which these variables have constants has been considered. In line with the results obtained, it can be stated that the variables are stationary at the level, in other words, they do not have a unit root.

Regression Results

Regression analysis was performed within the scope of the study. The first assumption for regression analysis is that the mean of the errors is zero. The mean of the errors was assumed to be zero and the model was estimated accordingly. The estimation results obtained are shown in Table 5.3.

Table 5.3. Prediction Results

	Model 1 DependentVariable ***xgida***	Model 2 DependentVariable ***xbank***	Model 3 DependentVariable ***xyort***	Model 4 DependentVariable ***xsgrt***
fixed Q_0	1,02414 (0,000)*	1.024398 (0,000)*	1.021622 (0,000)*	1.027721 (0,000)*
temp Q_1	-0.422223 (0,000)*	0.003505 (0,377)	0.002543 (0,4948)	0.004948 (0,018)*
R^2	0,69	0,26	0,16	0,58
Durbin-Watson	2.16	2.00	1.84	1.85

Note: indicates that the coefficient is statistically significant at the 5% significance level. Values in parentheses represent p-values.*

When the estimation results obtained for Model 1 and Model 4 were evaluated, the coefficient of determination value (R2), which was expressed as the disclosure rate of the dependent variable by the independent variable, was calculated as 0.69 and 0.58, respectively. From these obtained R2 values, it can be deduced that the explanatory power of the model is sufficient. According to Model 2 and Model 3 estimation results, R2 values were calculated as 0.26 and 0.16, respectively. From these obtained R2 values, it can be deduced that the explanatory power of the models is not sufficient.

However, in models where a single independent variable is used, the undeniable effects of the effects of other variables may cause the R2 values to have lower values. In addition, Cohen (1988) states that in the fields of social sciences, however, R2 values below 0.05 indicate that the model is not good. For these reasons, the R2 values obtained can be expressed as an acceptable value.

In order to test the compatibility of the predicted models, it is necessary to provide assumptions for the error terms.

In this direction, first of all, it is necessary to check whether the errors are independent from each other. In other words, the variances of the error term should be homogeneous (no autocorrelation). Autocorrelation occurs when error terms correlate over time. This indicates that errors violate the independence assumption and may affect the reliability of the model. For this reason, the predicted models were analyzed with the Durbin-Watson test. If the Durbin-Watson statistic is close to 2, it indicates that the errors are independent of each other (no autocorrelation).

In other words, it is said that the error terms are independent of each other and there is no relationship between the errors (Tillman, 1975). The fact that the Durbin-Watson test statistics values are close to 2 indicates that the models do not have autocorrelation.

Another assumption that must be provided for the significance of the estimation results is the Constant Variance (Homoskedasticity) assumption. The variance of the errors is fixed. This means that the error of each observation has the same distribution. If the variance of errors varies between observations, this is called heteroskedasticity, and the presence of this condition means that a regression model can be misleading. This assumption was checked with the White test.

The White test is used to test whether the error terms of a regression model have a constant variance (homoskedasticity). The null hypothesis of this test is that the errors have a constant variance (homoscedastic).

The results of the White's test are usually expressed as a Chi-Square statistic and the corresponding "Probe" value. Obtained Probe. If the value is greater than 0.05 at the 95%

confidence level, the null hypothesis cannot be rejected and the errors are considered to have a constant variance (homoscedastic).

In other words, it is said that there is no systematic variation of variance between the error terms of the regression model.

Accordingly, the White test results obtained for the models are presented in Table 5.4.

Table 5.4. White Test Results

Model 1			
F-statistic	0.963494	Prob. F(2,297)	0.3827
Obs*R-squared	1.933905	Prob. Chi-Square(2)	0.3802
Scaledexplained SS	8.786754	Prob. Chi-Square(2)	0.0124
Model 2			
F-statistic	0.496912	Prob. F(2,297)	0.6089
Obs*R-squared	1.000514	Prob. Chi-Square(2)	0.6064
Scaledexplained SS	3.781238	Prob. Chi-Square(2)	0.1510
Model 3			
F-statistic	0.015604	Prob. F(1,298)	0.9007
Obs*R-squared	0.015708	Prob. Chi-Square(1)	0.9003
Scaledexplained SS	0.077398	Prob. Chi-Square(1)	0.7809
Model 4			
F-statistic	0.206195	Prob. F(2,297)	0.8138
Obs*R-squared	0.415978	Prob. Chi-Square(2)	0.8122
Scaledexplained SS	1.455760	Prob. Chi-Square(2)	0.4829

The White test offers three different statistics: “F-statistics, Obs*R-squared and Scaled explained SS”. All three statistics test the hypothesis that errors are heteroskedastic. In this case, the probe values of all three tests should be checked. It is seen that all obtained values are greater than 0.05 at the 95% confidence level. In other words, the null hypothesis that F-test errors are homoscedastic cannot be rejected.

Therefore, the errors for all models are considered homoscedastic. In other words, there is no systematic variation of variance between the error terms of the regression model, which indicates that the model is suitable.

Another assumption that must be provided in the analysis is that there is no autocorrelation of errors. This means that an error term is independent of previous or subsequent error terms. The Breusch-Godfrey Serial Correlation LM (LagrangeMultiplier) test is used to check whether there is autocorrelation (serial dependence) inthe error terms of the regression model.

The null hypothesis of this test is that there is no serial dependence of the errors. Accordingly, the Breusch-Godfrey test results obtained for the models are presented in Table 5.5.

Table 5.5. Breusch-Godfrey Serial Correlation LM Test Results

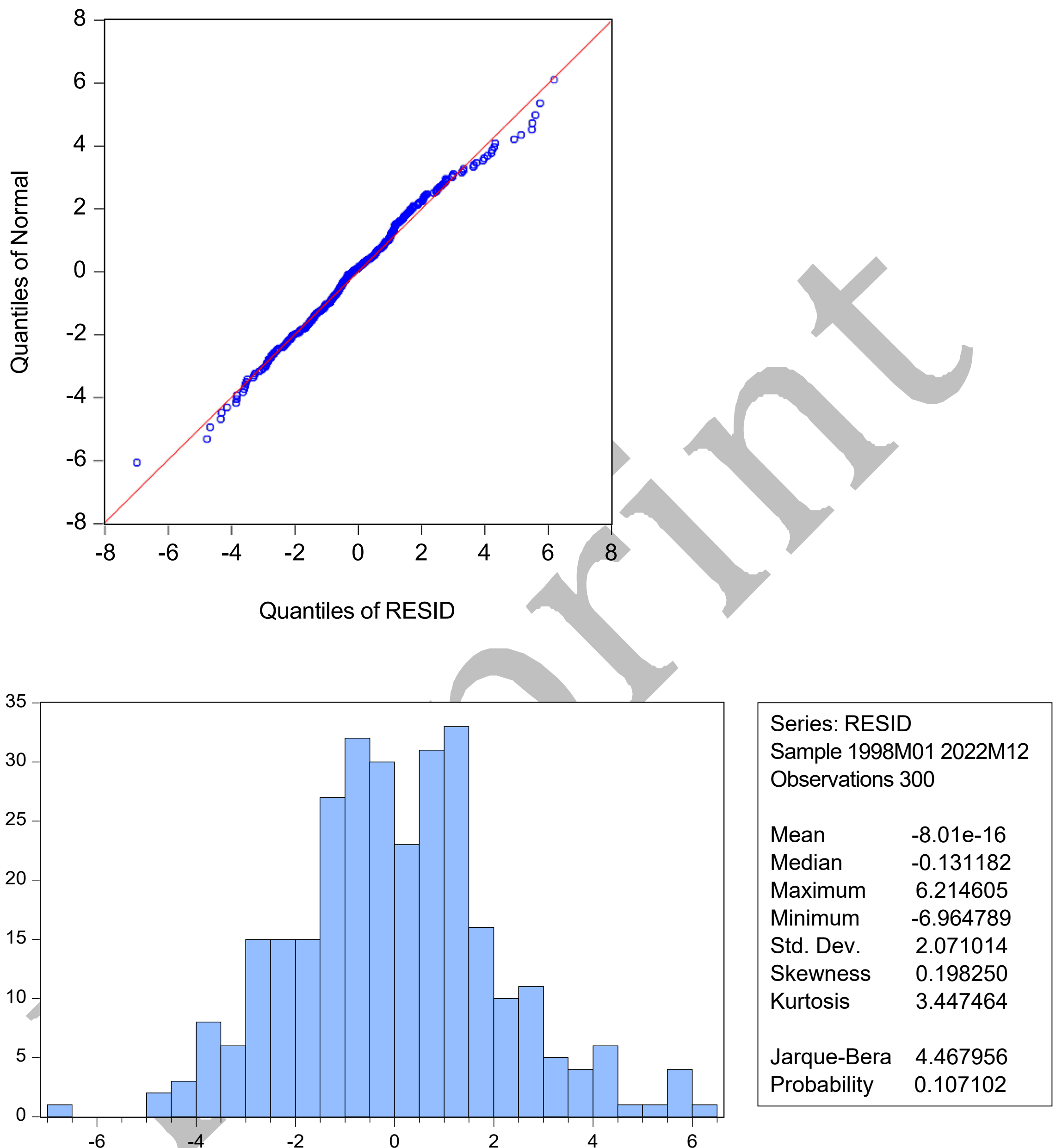
Model 1			
F-statistic	1.165477	Prob. F(2,296)	0.3132
Obs*R-squared	2.343994	Prob. Chi-Square(2)	0.3097
Model 2			
F-statistic	0.022337	Prob. F(2,296)	0.9779
Obs*R-squared	0.045271	Prob. Chi-Square(2)	0.9776
Model 3			
F-statistic	1.009632	Prob. F(2,296)	0.3656
Obs*R-squared	2.032684	Prob. Chi-Square(2)	0.3619
Model 4			
F-statistic	1.219686	Prob. F(2,296)	0.2968
Obs*R-squared	2.452129	Prob. Chi-Square(2)	0.2934

Test results are presented as a Chi-Square statistic and the corresponding probe value. If the probe value is greater than 0.05, the null hypothesis cannot be rejected and the errors are assumed to have no serial dependence. In other words, an error term is independent of other error terms and is said to be unrelated. Both Probes obtained. Since the values are greater than 0.05 at the 95% confidence level, it means that the null hypothesis that the

errors have no serial dependence cannot be rejected. These results show that there is no serial dependence (autocorrelation) in the error terms of the regression model.
That is, one error term is independent of other error terms and there is no relationship between errors. This indicates that your regression model is suitable for serial dependency.

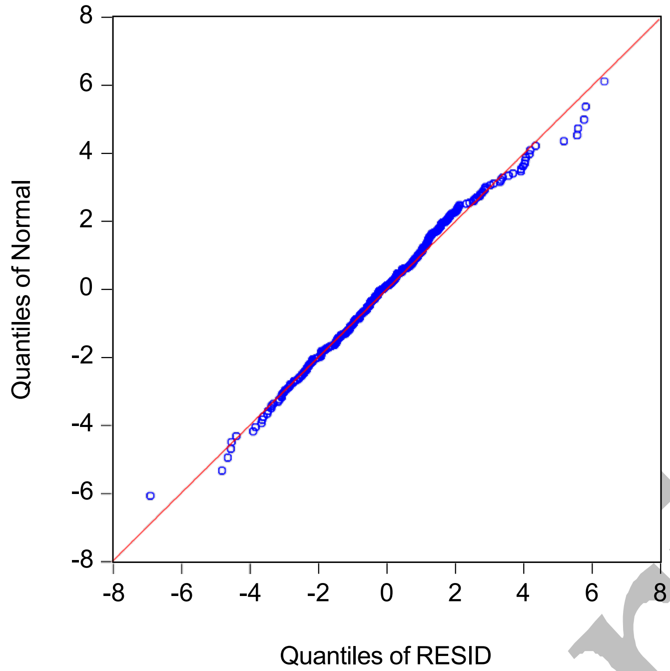
Another assumption that must be provided within the scope of the analysis is the assumption that the errors show a normal distribution. A QQ plot or histogram chart is used to test this assumption.
The QQ chart is used to visually assess whether a data set follows a particular distribution. A normal QQ plot is used to determine whether the data follow a normal distribution. If the data points fall smoothly along the line, this indicates that the data follow the chosen distribution (usually the normal distribution).
If data points deviate significantly from the line, this usually indicates that the data do not follow the chosen distribution. The fact that the points do not fall smoothly along the line may indicate the presence of extreme values or deviations. Endpoints are often a sign that data does not follow a particular distribution. QQ plot of error terms, if the points fall smoothly along the line, it is concluded that the errors fit the normal distribution (Pleil, 2016). The histogram graph of the error terms, in addition to visually evaluating whether the error terms fit the normal distribution, Jarque Bera test reveals the fit for the normal distribution with skewness and kurtosis values.
The QQ plot and histogram graph obtained for Model 1 are presented in Figure 5.12. When the results obtained are examined, it is seen that both the QQ plot and the histogram graph show a normal distribution in shape. In addition, skewness and kurtosis values and Jarque-Bera test results show that the error terms are normally distributed.

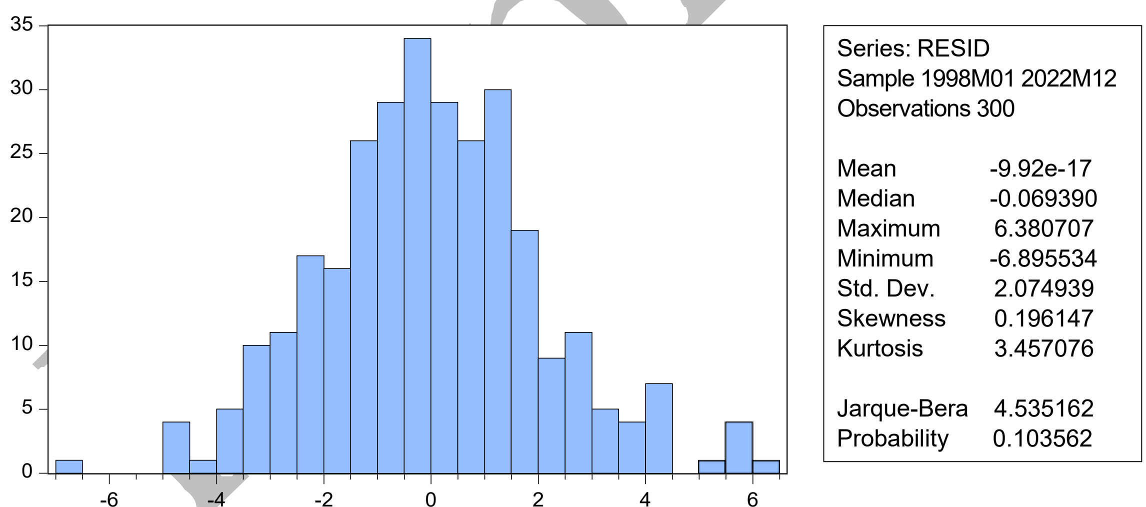
Figure 5.12. QQ Plot and Histogram Chart for Model 1



The QQ plot and histogram graph obtained for Model 2 are presented in Figure 5.13. When the results obtained are examined, it is seen that both the QQ plot and the histogram graph show a normal distribution in shape. In addition, skewness and kurtosis values and Jarque-Bera test results show that the error terms are normally distributed.

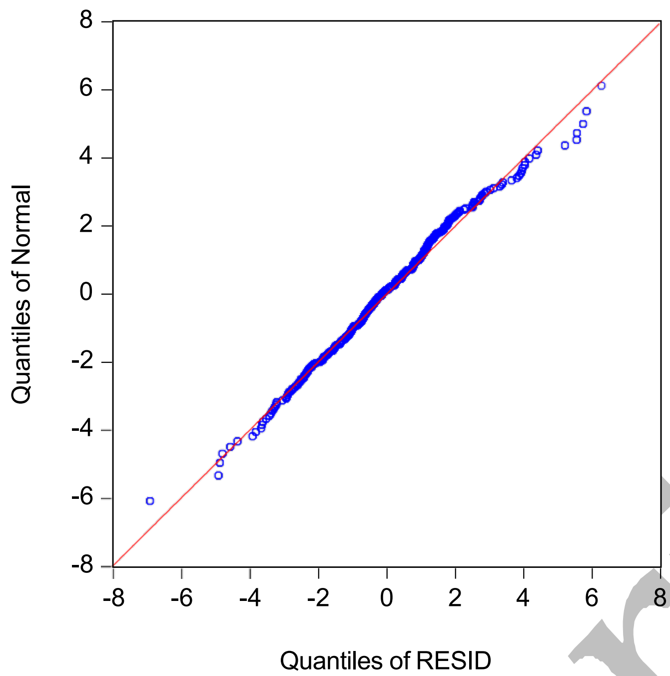
Figure 5.13. QQ Plot and Histogram Chart for Model 2

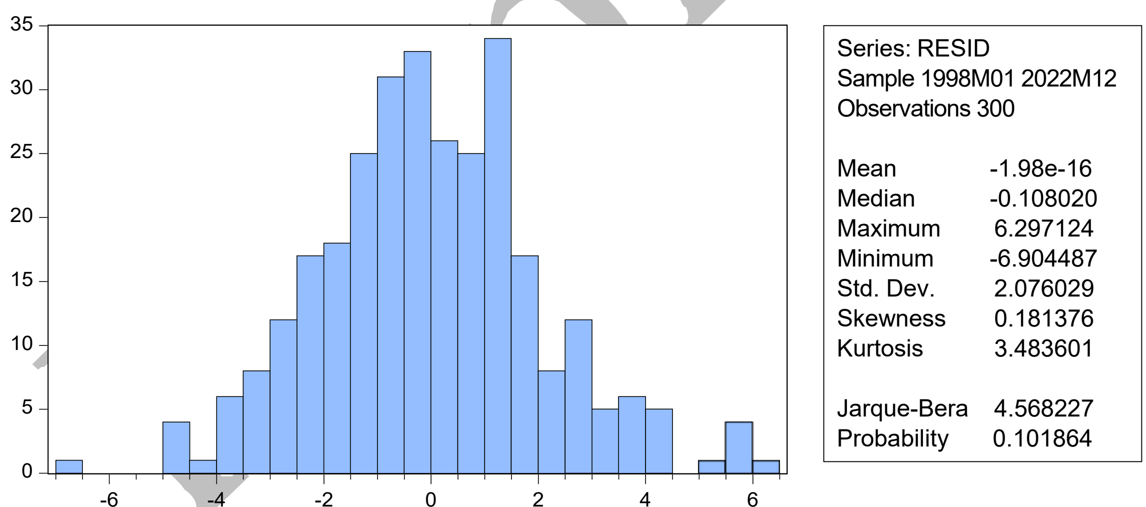




The QQ plot and histogram graph obtained for Model 3 are presented in Figure 5.14. When the results obtained are examined, it is seen that both the QQ plot and the histogram graph show a normal distribution in shape. In addition, skewness and kurtosis values and Jarque-Bera test results show that the error terms are normally distributed.

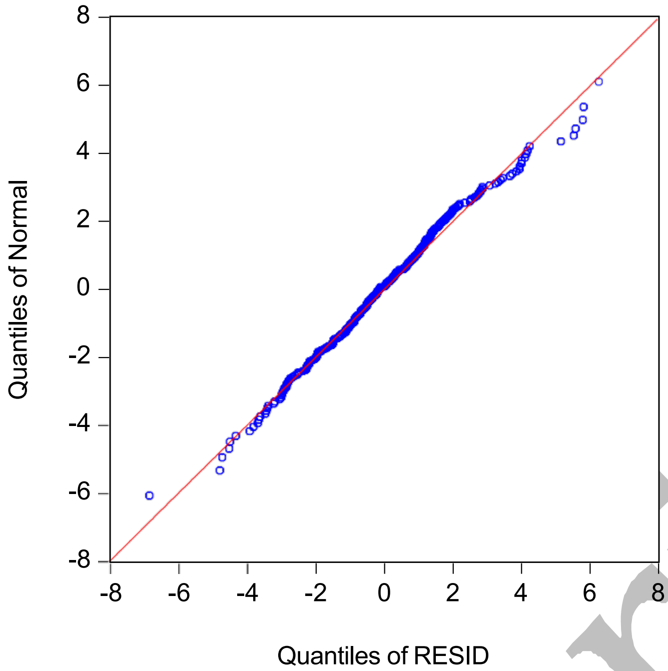
Figure 5.14. QQ Plot and Histogram Chart for Model 3

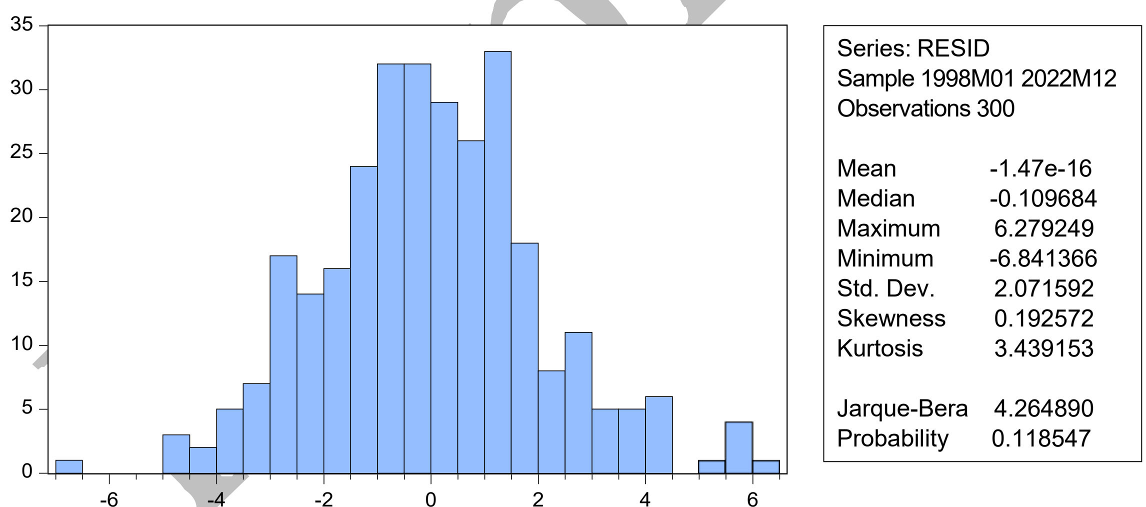




The QQ plot and histogram graph obtained for Model 4 are presented in Figure 5.15. When the results obtained are examined, it is seen that both the QQ plot and the histogram graph show a normal distribution in shape. In addition, skewness and kurtosis values and Jarque-Bera test results show that the error terms are normally distributed.

Figure 5.15. QQ Plot and Histogram Chart for Model 4





Within the scope of the study, it was determined that the assumptions were met by performing the necessary diagnostic tests. Therefore, there is no problem in interpreting the estimation results.

Accordingly, according to the estimation results obtained from Model 1, the coefficient of the "temp" variable was found to be statistically significant at the 95% confidence level. In this case, it was determined that the "temp" variable had a significant effect on the "xgida" variable.

In addition, according to the results obtained, it can be said that the rate of change of the "xfood" index causes a change of -0.42 units, despite a one-unit increase in temperature difference compared to the same month of the previous year.

According to the estimation results obtained from Model 2 and Model 3, it was determined that the coefficient of the "temp" variable was not statistically significant at the 95% confidence level. In this case, it can be concluded that the "temp" variable according to the Model does not have a significant effect on the "xbank" variable, and the"temp" variable according to the Model 3 does not have a significant effect on the "xyort"variable.

According to the estimation results obtained from Model 4, the coefficient of the "temp" variable was statistically significant at the 95% confidence level. In this case, it was determined that the "temp" variable had a significant effect on the "xsgrt" variable.

In addition, according to the results obtained, it can be said that the rate of change of the "xsgrt" index causes a change of approximately 0.005 units, despite a one-unit increase in temperature difference compared to the same month of the previous year.

DISCUSSION

The relationship between climate change and financial markets has been an issue that has attracted more and more attention in recent years. Climate change brings with it effects such as increasing temperature, extreme weather events and sea level rise throughout the world. These effects can have a significant impact on financial markets and change the nature of financial risks. First, it can be thought that climate change may increasephysical risks on financial markets. Extreme weather events, natural disasters and other climate-related factors can affect companies' assets and supply chains.

For example, a hurricane or flood can damage manufacturing facilities and infrastructure, affect agricultural crops, or disrupt energy supplies. Such events can disrupt the operations of companies, reduce their profits and cause fluctuations in financial markets. In addition, climate change can trigger transformation in financial markets through policy and regulation.

To combat climate change, governments can implement policies towards the energy transition, carbon emissions reductions and sustainable technologies.

These policies can create opportunities and risks in certain sectors such as the energy sector, renewable energy and clean technology companies. At the same time, the decrease in demand for fossil fuels can affect the value of energy companies and trigger sectoral transformation in financial markets.

Climate change can also affect long-term investment decisions in financial markets. Climate change risks and sustainability factors may cause investors to change their asset allocation strategies and turn to sustainable investments. Institutional investors can rebalance their portfolios and make investments based on environmental, social and governance criteria, considering the risks and opportunities related to climate change.

This may contribute to the evolution of financial markets towards a sustainability- oriented and long-term perspective. This transformation can encourage the support of green finance and sustainable projects.

The relationship between climate change and financial markets can also affect financial stability. Risks arising from climate change may affect the active and passive management of financial institutions. For example, the insurance sector may face higher loss payments due to increasing natural disasters, and risks related to climate change mayaffect the credit risk assessments of banks, causing an increase in risk in their loan portfolios: This triggers fluctuations and instability in financial markets.

Climate change brings risks and opportunities along with its direct and indirect effects on financial markets. Therefore, financial institutions, investors and governments should reconsider their strategies and adopt sustainability-oriented approaches, considering the risks and opportunities related to climate change. At the same time, it is important that policies and regulations support financial markets and encourage transformation to combat climate change.

In this way, financial stability can be achieved and a sustainable economic future can be built while tackling climate change.

In this study, temperature change values were used to examine the impact of climate change on agriculture, banking, investment and insurance sectors. Findings from thestudy show that climate change has different effects on different sectors.

While the agricultural sector is more sensitive to temperature changes, its impact on the banking and investment sectors may be more limited. The insurance sector, on the other hand, may be affected by climate change and temperature increases may trigger changes in insurance indices.

These results highlight that climate change is an important factor on the performance and risk management of financial sectors. In this context, policies and strategies to combat climate change need to focus on supporting stability and sustainability in financial markets.

The relationship between climate change and the agricultural sector is very important for financial markets because climate change is a factor that can directly affect agricultural production. Agricultural production is highly dependent on weather and climatic conditions. It can be said that temperature changes, precipitation amount, condition of water resources and other climatic conditions directly affect the growth and development of agricultural products. Climate changes can reduce the yield and quality of agricultural products, thus negatively affecting the economic performance and profitability of the agricultural sector. This may also affect the stock prices and other financial indicators of companies operating in the agricultural sector.

As the agricultural sector is an important part of the economy in many countries, the impact of climate changes on this sector can also have significant effects on the overall economy and financial markets.

CONCLUSION

The results obtained for the banking and investment sector within the scope of the study provide important information in terms of evaluating the impact of climate change on the banking and investment sectors.

The findings show that the banking sector does not respond independently to temperature changes. Likewise, it indicates that the investment sector is unresponsive to temperature changes. These findings show that the banking and investment sectors are less sensitive to climate change compared to other sectors.

It can be thought that the activities of these sectors are less affected by temperature changes or the effect of other factors is more pronounced.

These results emphasize that the risk of climate change in financial markets may differ according to sectors and that policy makers should consider these differences.

The results obtained in the study for the insurance sector are an important finding in terms of examining the impact of climate change on the insurance sector. The findings show that climate change has a significant impact on the insurance sector.

Thus, it shows that temperature changes affect the performance in the insurance sector. This indicates that temperature changes affect the risk and demand dynamics in the insurance industry. The insurance sector is a sector associated with natural disasters, climate events and similar risks. Therefore, the effects of factors such as climate change on the insurance sector are of great importance. These findings show that climate change has significant effects in the insurance sector in areas such as premium rates, demand levels and risk assessments. In addition, the results highlight the need for insurance companies to review their climate change risk management strategies and policy makers need to make appropriate adjustments to adapt to climate change.

This study contributes to a broader understanding of the impact of climate change on the financial sectors, while documenting its potential impacts, particularly on the agricultural sector. In addition, it sheds light on future studies to investigate these effects in a wider framework and in different sectors.

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