

THE EFFECTS OF CLIMATE CHANGE
ON FINANCIAL MARKETS

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PLAGIARISM

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ÖZET

İklim değışiklięi ve finansal piyasalar arasında kritik bir iliřki bulunmaktadır. Bu alıřmada, iklim değışiklięinin tarım, bankacılık, yatırım ve sigorta sektörleri üzerindeki etkisini incelemek amacıyla sıcaklık değışim değeri kullanılmıřtır.

alıřmada, BIST'te yer alan tarım, bankacılık, yatırım ve sigorta endeksi ve sıcaklık değışimleri arasındaki iliřki regresyon analizi ile belirlenmiřtir. Elde edilen sonuçlar iklim değışiklięinin farklı sektörler üzerinde farklı etkilere sahip olduęunu göstermektedir. Tarım sektörü sıcaklık değışimlerine daha duyarlı olurken, bankacılık ve yatırım sektörleri üzerindeki etkisi daha sınırlı olabilmektedir. Bu sonuçlar özellikle sıcaklık değışimlerinin tarım sektörünün finansal performansı üzerinde doğrudan ve önemli bir etkisi olduęunu ve iklim değışiklięinin finansal piyasalar ve özellikle tarım sektörü üzerindeki potansiyel etkilerine dair geniş bir anlayıř saęladığını göstermektedir.

Sigorta sektörü ise iklim değışiklięinden etkilenebilmekte ve sıcaklık artıřları sigorta endekslerindeki değışimleri tetikleyebilmektedir. Bu sonuçlar, iklim değışiklięinin finansal sektörlerin performansı ve risk yönetimi üzerinde önemli bir faktör olduęunu vurgulamaktadır. Bu bağlamda, iklim değışiklięiyle mücadele eden politika ve stratejilerin, finansal piyasalarda istikrarı ve sürdürülebilirlięi desteklemeye odaklanması gerektięi ifade edilebilir.

Anahtar Kelimeler: İklim değışiklięi, finansal piyasalar, tarım sektörü, sigorta sektörü, yatırım sektörü, bankacılık sektörü

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 banking and 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: Climate change, financial markets, agriculture sector, insurance sector, investment sector, banking sector

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1. 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 a range of financial instruments, are not insulated from these climatic changes like the food sector. 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.

2. Climate Change and Its Effects on Financial Markets

In this section, the definition of climate change, its causes, effects and consequences are explained and the financial effects it causes are explained. Then, global solution studies for climate change are shared.

2.1 Definition and Causes of Climate Change

In order to understand the phenomena and events of climate change, it is considered appropriate to define the greenhouse effect and global warming concepts first. In this context, firstly, the relevant definitions are given briefly.

Generally, places that benefit from the sun's radiation in a controlled manner as an auxiliary or basic source to perform photosynthesis activities and provide heating are called greenhouses. Greenhouses are structures that allow plant growth, enable the conversion of sun rays into energy forms such as heat, and prevent energy from escaping (Sevim, 2009). Because of these features, it is similar to the earth's atmosphere (Müezzinoğlu, 2003). Therefore, the natural process that provides more warming than the expected warming level and regulates the thermal balance is called the greenhouse effect, since the gases contained in the atmosphere are permeable to the sun's rays and much less permeable to the long-waved ground radiation that is re-emitted. The reason for the increase in the average air temperature is the average kinetic energy of the rising air due to the collision of the increased kinetic energy as a result of the radiation absorbed by the greenhouse gases with the other gases in the environment (Figure 1). Atmospheric greenhouse gases, especially concentrated due to anthropogenic effects, cause global warming (Türkeş, 2012).

As a natural process, the natural epilepsy effect, which is necessary to maintain the thermal balance of the world and to ensure the continuity of life, lost its quality especially after the industrial revolution. Contrary to the natural greenhouse effect, the main reason for the concentration experienced today is the anthropogenic greenhouse effect. For this reason, rather than the sun's rays coming to the world, there is heating by the sun rays reflected from the ground. The temperature of the troposphere rises as some of the rays that are re-emitted from the earth to the atmosphere are absorbed by the harmful gases and reflected back to the atmosphere. The most absorbed gases are carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), ozone (O₃), chlorofluorocarbons (CFCs) and water vapor (H₂O).

When the emission sources and contribution rates of these entities, which also express anthropogenic greenhouse gases, are examined, the human effect is revealed (Karaca, 2006). CO₂, which is responsible for 50% of greenhouse gas emissions, is generated by the use of fossil energy sources and the destruction of tropical forests. CFCs, which are responsible for 22%, originate from the production of soft and hard foam, air conditioning systems, cleaning agents especially used in the electronics industries, refrigerants used in refrigerators and aerosols in spray cans. The main sources of CH₄, which is held responsible for 14%, are coal mines, leaks from the natural gas pipeline, and garbage collection areas. O₃ responsible for 7% originates from destroyed tropical forests, thermal power plants where combustion activities are carried out and traffic, while N₂O, which is responsible for 4%, originates from artificial fertilizers used in agriculture (Meke, 2022; Kabalu, 2019; Barın, 2019).

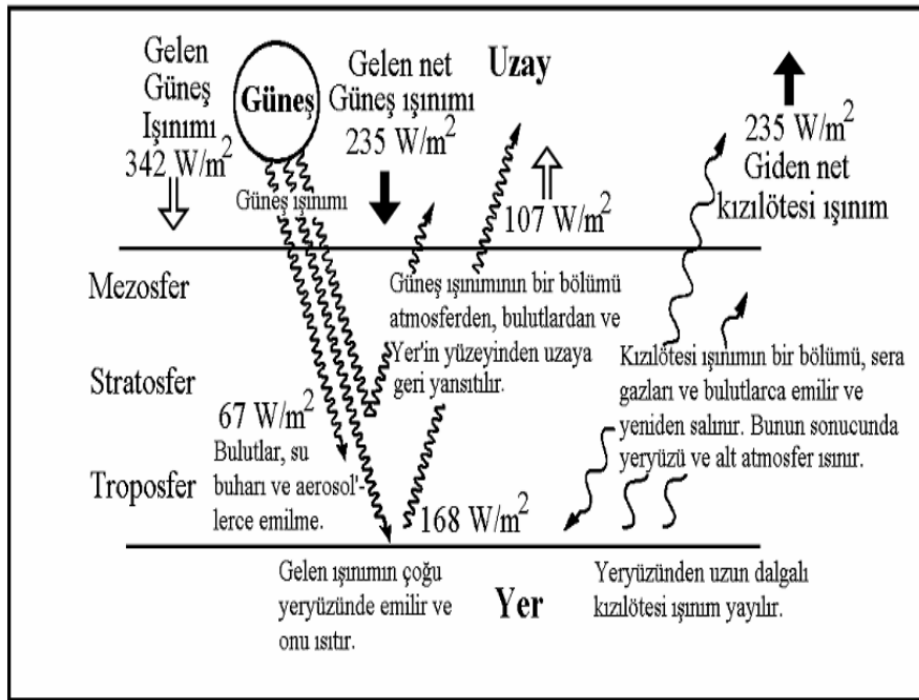


Figure 1. Greenhouse Effect of Atmosphere

Source: (Sevim, 2009)

Greenhouse gases, which continue to accumulate rapidly in the atmosphere depending on the reasons explained, increase the temperature in the lower layers of the atmosphere and on the earth with the contribution of urbanization; causes global warming (Türkeş, 2007). Anthropogenic annual net carbon emissions are 3.2 Mt, with the largest share coming from industrial production and fossil fuel use. In Table 1, the global carbon balance adjusted according to industries and ecosystems is shared.

Table 1. Annual Global Carbon Balance (Mt)

Ecosystem and industry	Release to the atmosphere	Atmospheric Uptake
Terrestrial ecosystems (Agricultural fields, pastures, wetlands, swamps, soil, vegetation, etc.)	60.0	61.4
Change in land use (Settlement and urbanization, tourism, agriculture, deforestation, etc.)	1.6	0.5
Oceans	90.0	92.0
Use of fossil fuels and energy sources, industrial processes, transportation and construction	5.5	0.0
Total	157.1	153.9
Difference (anthropogenic net carbon amount)	3.2	

Source: (Sevim, 2009)

As can be seen, anthropogenic sequence gases released into the atmosphere disrupt the global carbon balance and cycle. Global warming, which started in the 19th century and became evident in the 1980s, shows record increases in recorded temperature values. Depending on this situation, there is an increase in forest fires, increase in the water level of the seas, shrinkage and stretching of glaciers, whitening of corals, melting in the tundra, increase in rain and evaporation levels, increase in precipitation in the form of torrential rain, and increase in flood

and storm disasters (Kadıoğlu, 2008). In addition, the transition between dry and rainy periods is differentiated, paving the way for some regions to receive heavy rains and some regions to suffer drought (Demir, 2009). In its simplest form, it is understood that the entire ecological system that makes up the food chain is in danger, considering that while the adaptation of humans to the changes is rapid, animals and plants adapt late (Kadıoğlu, 2008). One of the vital consequences of global warming is climate change.

All of the atmospheric events observed and experienced in any location in a certain period are called weather, and all of the atmospheric events observed during a much longer sequence are called climate (Türkeş, 2007). Reasons such as fluctuations in solar energy, volcanic movements, variations in the orbital motion of the earth, the variability of nature, sulfate particles and carbon dioxide gas concentrated in the atmosphere make the climate dynamic and open to change (Akyel, 2009). The climatic conditions that have changed since the first moment of the world's existence have encountered anthropogenic contributions since the middle of the 19th century. Therefore, today, climate change is defined by considering the anthropogenic activities that increase the accumulation of row gases contained in the atmosphere. In this context, it is explained by the UNFCCC as the change in climate as a result of anthropogenic activities that indirectly or directly disrupt the global atmosphere in addition to the natural climate changes that can be observed in a comparable period (Öztürk & Öztürk, 2019; UNFCCC, 1992).

2.2 Financial Impacts of Climate Change

Financial institutions are organizations that can collect funds from individuals, institutions or governments and give the collected funds as loans to those in need. Banks, investment companies, insurance companies, etc., which are active in the flow of money and credit from the surplus units of the economy to the deficit units. can also be defined as Severe climate change can damage the financial system created by financial institutions.

Since the 19th century, financial institutions that can cope with natural events such as floods, landslides, earthquakes, droughts and storms have become complex and global, contractual cross-border financial obligations and receivables, and the number of branches of financial institutions has increased especially in tropical regions where extreme weather conditions are experienced. reasons such as the increased risk of physical damage to fixed assets cause financial institutions to feel physically threatened rather than a disrupted presentation

(Campiglio et al., 2018). As a matter of fact, natural disasters can be considered as external shocks (Skidmore, & Taya, 2002; Ramcharan, 2007). It even has direct effects on some macroeconomic indicators and local financial markets (Yang, 2008). Financial systems, which are interconnected due to globalization, can also affect the financial markets of different countries when affected at any point (Mahajan & Yang, 2020; Liu et al., 2007). In addition, fragility and scale invariance are the main factors affected (Morales et al., 2013; Buonocore et al., 2016). For this reason, the level of being affected by the events arising from climate change in financial markets and economic systems is investigated. In order to determine this level, the relationship between climate change and finance (Nehrebecka, 2021), emerging risk (Dietz et al., 2016; Stolbova et al., 2018; Dafermos et al., 2018) and climate finance (Giglio et al., 2021) have been studied extensively.

Researching the effects of climate change on financial actors and markets has gained weight since the 2015 Paris Agreement. Numerous incentive initiatives have been initiated, especially to explain climate change, which is recognized as a new source of financial risk by financial auditors (NGFS, 2019; Alogoskoufis et al., 2021).

The G20 Financial Stability Board (FSB) created the Task Force on Climate-related Financial Disclosures (TCFD) in 2017, which aims to provide advice and incentives for investors to disclose climate change risks in their portfolio. In the same period, the Greening the Financial System Network (NGFS) was established by a group of financial supervisors and central banks (Battiston et al., 2021). NGFS (2019), which recommended the use of climate stress tests to assess impacts on stability for its purpose in 2019, has created a series of climate scenarios to be considered in assessments in 2020 (NGFS, 2020). Therefore, climate change has become one of the risk assessment elements of financial institutions (Grippa & Mann, 2020). On the other hand, the Sustainable Finance Senior Expert Group (HLEG) was established in 2016 by the European Commission, which recommends developing standards for the completion of sustainable investments. The recommendations included in the European Commission's Sustainable Financial Action Plan published in 2018 guided the work of the European Commission's Technical Expert Group on Sustainable Finance (TEG) in 2020. As a result of these unique international initiatives, it is understood that climate change events have gained importance for the powers of financial auditors and the stability of the financial system. There are two risk areas identified in this process between climate change and financial stability: physical risks and transition risks (Battiston et al., 2021).

The possibility that climate change events may damage the production capacity and physical assets of the enterprises may increase the credit risks, create financial losses and deteriorate the financial position of the central administration refers to the physical risks. In transition risks, it is thought that it may create a financial shock for the bank, institutional investors and asset managers due to sudden and unexpected, positive or negative default changes in asset prices (Battiston et al., 2021; Skidmore, & Toya, 2002).

Within the scope of transition risks, the main threat that can disrupt financial stability is the irregular transition to a low-carbon economy (NGFS, 2019). The source of this situation is that investors who can implement climate policies cannot fully predict the effects on the business model (Monasterolo & Battiston, 2020). In particular, job and income losses within the scope of fossil fuel production and consumption (Van der Ploeg & Rezai, 2020) can adversely affect the value of financial portfolios in which assets such as financial contracts, loan or pension funds, stocks or bonds are available after a while (Battiston et al., 2017; Stolbova et al., 2018). In addition, similar to the global financial crises, an increase can be observed in the individual or global losses of the sector and financial actors (Haldane & May, 2011; Billio et al., 2012; Battiston et al., 2016). As a matter of fact, as will be discussed in the next section, achieving the goals of the Paris Agreement depends on the transition to low-carbon technologies. Therefore, the social technological changes that have taken place, although aimed at increasing welfare, will also have devastating effects. In this respect, the creative destruction process that will occur will lead to a potential difference on financial stability and economic dynamics. Even this situation alone makes it necessary to determine the effects of climate change in order to stabilize financial systems and prevent excessive economic losses (Campiglio et al., 2018). Otherwise, financial institutions will not be harmed by climate change, which has long and short-term risks and affects every sector at different levels. As a result of the researches, it is observed that climate change concentrates on two different impact areas, the financial sector and the financial system.

The effect on the financial sector is to damage physical collateral, disrupt the activities of financial institutions, disrupt the business of financial institution customers, increase insurance liabilities, narrow the coverage of insurance and increase insurance premiums, create branch losses and more challenging working conditions, and in regulations and regulations. It can be summarized as causing an increase in the explanations and requirements included (Ozili, 2020).

– While granting loans to real or legal persons whose repayment ability is doubtful, especially banks, physical collateral with a higher value than the loan amount is requested. Physical collateral such as land, housing, equipment, fleet of aircraft or automobiles, commercial property can be completely or partially damaged by extreme weather events and climate change events. This damage in the collateral value is reflected as a loss in the profit-loss statement of the financial institution and may adversely affect the profitability. This is the most common form of potential damage to physical collateral.

– Communication systems, which are made reliable by means of information technology infrastructure, can be damaged in extreme weather events and events related to climate change. This situation prevents financial institutions from doing business until the problems are resolved. Therefore, the activities of financial institutions are interrupted. As a matter of fact, the damage to the information technology systems, internet and electrical energy related infrastructures used in communication even within the enterprise prevents internal communication and makes it impossible for the activities to take place for a significant period of time. Thus, the business of customers who expect service from the financial institution is interrupted. Significant damage is also seen in the agriculture and manufacturing industry in extreme weather events and events related to climate change.

Low profit margins await financial institutions that predominantly work with these industries. This situation, which is caused by customers' inability to maintain their business relationship with financial institutions during the recovery process, affects financial institutions as well as customers, even if indirectly.

– An increase in insurance liabilities means an increase in costs for businesses in the insurance sector (Dlugolecki, 2008). In particular, natural or legal persons with comprehensive insurance policies suffer significant damage from climate change events that affect the insured object. Due to the increase in the number of customers requesting policies in case of potential problems, insurance companies do not have sufficient funds to pay policyholders. As can be understood, this situation indicates financial difficulties for financial institutions. As a matter of fact, financial institutions are the main institutions that offer loans to insurance companies that have started to experience financial difficulties due to customers who have been adversely affected by rising insurance payments or policy demands. Therefore, there is a significant effect, albeit an indirect one.

- Climate change events with a high realization potential are foreseen in the insurance sector as well as in many other sectors. Thus, insurance companies find it appropriate to increase exemptions and premiums, and to reduce insurance coverage. In addition, it can reduce insurance coverage and even refuse to provide coverage in cases where it is difficult to measure the frequency, severity and probability of climate events.
- Various efforts are followed to reduce the carbon footprint in the sustainability steps of financial institutions. Efforts with high economic costs such as using solar panels are not included in the equipment of small branches.

Despite this, some branches may be lost and financial institutions may suffer losses due to extreme weather events and climate change events. This situation may also cause disruption of transactions in the location where the branch is located.

- The probability of transactions to take place and to be productive decreases in climate change events such as the record-breaking temperatures experienced in recent times. When combined with thirst, extremely hot weather, long hours and fast-paced working conditions, it can cause workers to collapse physically and mentally. As a matter of fact, the state of being hotter or colder today can last for a long time.

- It is important to make appropriate explanations for the risks and exposures of climate change. For this reason, new regulations and legislation are being created. On the other hand, the amount of risk capital allocated to reduce the risks that may be caused by climate change is increased and this amount needs to be disclosed. In addition, the strategy of the enterprise and the impact of operational performance should be determined and subject to relevant regulations. It is important to plan and explain risk management, especially in publicly traded businesses. The disclosure made by the capital market or bank regulators creates costs. The reason for this is that experts work in estimating the risks and exposures of climate change, mitigation measures and the required risk capital.

The impact of climate change on the financial system primarily deepens on system stability (Giuzio et al., 2019). Financial systems that enable the exchange of funds between investors, borrowers and lenders are affected by climate change as a result of the difference in financial institutions. In this context, due to climate change, a problem may occur in the payment system infrastructure, causing capital flight, destabilization, and pressure and confusion on regulators (Ozili, 2020).

– The financial system, which relies heavily on payment systems for fulfilling financial obligations and receiving financial demands from counterparties in commercial transactions, is quite complex. As a matter of fact, the reconciliation system, which makes it possible for each nation to fulfill its financial demands and obligations for the transactions carried out in its jurisdiction, is also important. In particular, it is known that the reconciliation infrastructure in banks is available in a physical warehouse. Due to the damages that may occur in the payment infrastructure due to extreme weather conditions and climate change events, the required payments are not realized even though they are due. This situation disrupts the stability of the system by interrupting the financial intermediation process.

– It is also possible for countries and cities to become unstable due to climate change. As a matter of fact, the source of this situation is the withdrawal of large capital owners from locations that are prone to climate change events, and the location has very few resources even to get rid of climate change events. On the other hand, financial institutions may be left with low capital to carry out business due to the withdrawal of investments with high net worth from investment enterprises or banks located in the location by their owners. In this case, financial institutions have insufficient capital and the level of financial intermediation decreases and the financial system becomes unstable.

– There is uncertainty about the type, severity and time of occurrence of the event that will take place in regions with high risk in climate change events. This uncertainty destabilizes financial markets and makes them volatile. It may be possible for investors to accumulate capital due to uncertainty and fear, or to provide capital with a high level of premium that cannot be met by businesses.

In addition, financial institutions that do not have the ability to reduce the risks of climate change can withdraw liquidity from the money markets by recalling the financial instruments they exported to the money market. This situation may adversely affect the stability of the financial system by creating a “liquidity squeeze” or a “liquidity rush” in financial markets.

– The fact that financial system regulators, who are generally economists, cannot predict the probability of climate change events in macroeconomic models, prevents the determination of expectations, measures and steps of struggle. In this case, it becomes impossible for financial institutions that are exposed to climate change events to receive assistance from the regulators. Therefore, it seeks help from the central government. However, there is no guarantee that the central government has a specific solution that can stabilize the financial system.

As can be seen, it is known that climate risks, which are primarily endogenous, non-linear and have a deep uncertainty, pose a challenge for financial and macroeconomic analysis methods due to their unique characteristics (Battiston et al., 2017). Therefore, the creation of a “climate change” or “green” label should be avoided and the main problems caused/will be caused by climate change risks should be addressed (Monasterolo & Battiston, 2020). Thus, it is seen that climate change reveals new sources of financial risk (IPCC, 2014). It should be understood that if the risks are reduced and adaptation activities are not intensified, any climate change event that takes place poses a potential threat even in socioeconomic terms (Howarth & Monasterolo, 2016). Sustainability should be ensured in developed economies that have developed successful policies and strategies to avoid climate change that may hinder the destructive and low-carbon transition process.

A large-scale and rapid transformation is deemed appropriate within the scope of systems such as production, consumption and energy in industrializing and developing economies. In the transformation process, various industries and economic activities may be negatively affected or create new opportunities for different industries. This situation, which can be called transition risks, can create significant interruptions in financial transactions (Battiston et al., 2021). In this period when economic effects are experienced, adjustments can be made in the value of financial assets owned or exported by enterprises subject to the public and private sectors. In particular, the default rate of liabilities in insurance companies and loans provided by financial institutions may be adversely affected. Financial transmission channels assigned to act in line with climate change may not find sufficient room for action due to globalization, as stated before. Thus, the real economy can be deeply affected (Battiston et al., 2016).

Regardless of the effect of the process, it is a fact that it makes a difference on national and global financial stability. This difference, which is due to the interconnectedness of economies and institutions and the correlation of effects, poses significant challenges for central banks (Campiglio et al., 2018). First of all, in 2015, the situations that characterize financial and monetary stability policies and the long-term perspectives needed to deal with climate change risks were discussed by Carney, Chairman of the Bank of England and the Financial Stability Board (Carney, 2015), then some financial regulators and central banks made various statements. The dynamic links between financial systems, central banks and the low-carbon transition process have been explored by NGOs, international institutions and the academic community, especially by the research conducted by NGFS (Campiglio et al., 2018).

As a public institution equipped with specific objectives by governments and legislators, the central bank is responsible for monetary policy affecting the money and credit, supply and demand in the economy, in the most general terms. Monetary policy aims to achieve price stability, which is usually defined in terms of an explicit inflation rate target. In other words, price stability, which expresses the low and stable inflation rate that cannot affect the decision processes of economic units, aimed at employment and growth, which is the long-term main objective of monetary policy, is the main objective of the Central Bank (CBRT, 2023). In addition, many central banks have the authority to regulate and supervise financial institutions as well as to maintain the stability of the financial system. Therefore, additional targets can include exchange rate stability, job creation and economic growth (Monnin & Barkawi, 2015). In this context, some central banks, which have begun to examine the effects of climate change and low-carbon transition on the financial sector, explain that the stability of the financial system will be affected and that large and physical economic losses may occur (Dietz et al., 2016). The increase in climate-related physical risks such as storms, floods, and extreme heat waves are characterized as direct impact provinces, especially in the insurance sector. Therefore, uninsured risks can cause the balance sheets of businesses or households to be adversely affected, and even cause loss for lending banks. For example, if the 2°C temperature threshold is exceeded, it is likely that most of the coal, natural gas and oil reserves will remain underground, so these physical assets will be erased from the balance sheet of the businesses that own the losses (Meinshausen et al., 2009; McGlade & Ekins, 2015). In addition, carbon-intensive industrial technology, transportation infrastructure, real estate sector, and a significant portion of electricity generation capacity are among the physical assets that may lose value (Pfeifer et al., 2016).

The loss of these assets will cause economic and employment problems, as well as adversely affect the market value of the businesses that own the assets. this may trigger negative effects on all levels of the financial system that are potentially interdependent, especially investors (Battiston et al., 2017). In order to avoid the financial instability environment that develops due to these exemplary situations, the ultimate requirement is the transition to a carbon-free economy.

Although the transition process will create some inevitable setbacks at the sectoral level, it will be sustainable in the holistic sense and provide an opportunity for economic prosperity (Campiglio et al., 2018). However, this possibility seems possible in the presence of a comprehensive and coherent set of policies that support the transition and aim to manage complex dynamics.

The primary responsibility for strategic planning lies with the governments that hold the power to establish and implement policy (Howarth & Monasterolo, 2016). The introduction of environmental regulations such as fuel efficiency standards, the implementation of climate-friendly infrastructure investments such as smart electricity grids, and the development of policies to encourage businesses and households to continue low-carbon activities are some of the steps that should be taken by governments.

The main proposed policy tool is the taxation of goods and services for their carbon content, the implementation of carbon pricing by establishing a cap and trading system for emissions allowances (Edenhofer et al., 2017). Other market-based instruments likely to have a similar effect are the introduction of subsidies for clean technologies and the phasing out of fossil fuel subsidies. It is also stated that green supportive fiscal policies will be stronger if combined with carbon taxes and subsidies (Battiston et al., 2021).

On the other hand, the ability of a set of financial and environmental policies well designed by the central government to meet the Paris Climate Goals is also discussed.

In particular, market failures in financial systems may not be properly regulated by pricing mechanisms. Thus, insufficient incentives may occur for investments to take action at the required speed and scale (Campiglio, 2016). In addition, although the necessary measures are not taken due to the government, which is not sufficient to prevent financial instability in the transition process, the policies implemented suddenly may worsen the risks of transition to a low carbon economy. With a different perspective, it is possible to act with forces that are not politically supported due to the perception of carbon pricing that can harm consumers and businesses (Campiglio et al., 2018). In fact, it is appropriate to accompany carbon tax policies with "carbon tax revenue recycling" (reassessment of carbon tax revenues) policies to minimize the negative distributional and financial effects of carbon pricing (Dafermos & Nikolaidi, 2021; Dunz et al., 2021). The transition process, which has become quite complex due to these possibilities, is gaining research weight by financial regulators and central banks in order to undergo a regular and rapid structural change. Four broad intervention types identified in this context are adopted (Campiglio et al., 2018).

- Developing tools and methodologies that can encourage the understanding of risks and the financial and economic consequences that will arise due to risks,
- Encouraging or obliging investors to disclose their exposure to climate change risks,
- Considering the identified risks in financial regulations,
- Considering the risks of climate change in policy instruments, primarily monetary policy, by central banks.

In this context, two studies conducted by De Nederlandsche Bank (DNB) for the Dutch financial system set an example.

Studies indicating that the risks for fossil fuel producers are relatively low, indicate that carbon-intensive sectors may be exposed to quite wide risks, and there are events that even occur in the direction of some systemic risks. Institutions such as the Banque de France, the Swedish Finansinspektionen and the European Systemic Risk Board are also examining the risks of climate change and the potential impact of the low-carbon transition on financial stability (Campiglio et al., 2018).

In addition, Climate Stress Test methods are being developed that can develop scenarios for worsening potential effects. However, due to the difficulties mentioned earlier, it is not possible to evaluate the financial risks related to the climate. In order to perform a comprehensive climate stress test, the necessary data cannot be reached or the data obtained are not of sufficient quality (Battiston et al., 2017). In addition, since an integrated assessment cannot rely solely on snapshots, it requires modeling the dynamic interactions between environmental policies, financial systems, macroeconomics and climate change (Monasterolo, 2020; Farmer et al., 2015). In this sense, it is a problem that the Integrated Assessment Models (IAM), which are used to analyze the economy and climate interactions, lack the financial system representation, and that the Dynamic Stochastic General Equilibrium Models (DSGD), which are also used by central banks in monetary policy and macroeconomic analyzes, are isolated from climate change and environmental policies (Annicchiarico & Di Dio, 2016). In addition, comparative DSGD models, which provide rapid equilibrium transformation for representations, rational expectations and shocks, are insufficient to evaluate the dynamic and complex effects of a high-scale structural change (Dafermos et al., 2017).

In particular, macroeconomic models such as the Computable General Equilibrium (CGE) and DSGD assume that these elements have rational expectations, and that the dynamic evolution of the economy is mainly driven by external shocks. This contrasts with the profound uncertainty, endogenous and dependency that characterizes climate risk. Despite the existence of the financial system included in many DSGD models after the global financial crisis, financial fragility, interaction between heterogeneous actors, the internality of money, financial complexity and dependency are not considered (Battiston et al., 2021).

However, all effects must be analyzed in order to accurately define the financial and real interactions between heterogeneous elements and to overcome the uncertainty experienced in the decision-making processes.

As a matter of fact, these models can give a false sense of control for the ability to take quick action and manage climate-related financial risks during the transition period. This situation may lead investors and policy makers to make non-optimal decisions at the individual and collective level. This could potentially have a serious impact on financial stability. However, stock flow consistent (SFC) and agent-based models contain dynamics such as nonlinearity, interdependence, and internality; can formulate the internal money creation process, which plays a key role in the emergence of financial cycles. They are considered suitable for analyzing the macroeconomic and financial effects of climate risk (Lamperti et al., 2019). In fact, similar models that analyze macroeconomics as a nonlinear and complex adaptive system in which unbalanced phenomena play a key role are suggested as alternatives (Dafermos et al., 2017). The models that are planned to be developed need to be included in the interaction between the actors and the representation of the internal money creation process of commercial banks through loans.

Although there is no environmental focus, these models, which have been started to be developed by some central banks, are still relatively new methodological approaches and still have not shown a successful and sufficient effect (Campiglio et al., 2018). Therefore, it is important to increase research and studies in the field.

In addition, as a result of what has been conveyed, it is understood that climate change may have serious consequences for the stability of financial institutions by having an impact on financial institutions, parties and customers. Many financial institutions do not feel the need to manage climate change risk, with uncertainty being the primary reason. Another reason for this situation is the belief that the effect that may occur is not direct but indirect. Similarly, many central banks and supervisory institutions do not publish any studies in order to evaluate the readiness of financial institutions for events arising from climate change. In fact, it is seen that financial system regulators do not even express an opinion on the field. Therefore, the efforts of governments towards climate change are not transformative enough to achieve sufficient success. However, the reflection of even the effects on the non-financial sectors on the financial sector should be investigated.

2.3 Global Solutions for Climate Change

It is known that scientific concerns about climate change have increased since the 19th century. It is seen that many scientists have carried out researches in this process to understand the causes of climate change and the effects of climate change.

One of the first to express the greenhouse effect in the atmosphere was the French scientist Fourier, who argued in 1827 that the gases in the atmosphere could create a warming effect (Alfsen & Skodvin, 1998).

British scientist Tyndall, on the other hand, argued that in the 1860s, infrared radiation was blocked due to the densities of various atmospheric contents, especially carbon dioxide gas, and eventually caused climate change (Bardak, 2022). In 1896, Swedish scientist Arrhenius carried out a study to measure the effects of increasing greenhouse gases. As a result of this study, which reflects a concrete step, it is stated that the global average temperature will increase by 6°C when the carbon dioxide concentration in the atmosphere doubles compared to the level before the industrial revolution. Subsequently, Callendar's studies shed light on the relationship between the increase in carbon dioxide concentration and global warming. As a matter of fact, in these studies, it was determined that the level of carbon dioxide increased by 10% in the 19th century compared to the past (Tüzer & Doğan, 2021).

Global warming, which became a globally popular study topic in the 1930s, turned into a scientific concern in the 1950s as a result of the data revealed by researchers such as Suess, Revelle and Plass (Aktaş, 2020). In 1956, it was reported that anthropogenic activities and industrial activities would increase the global average temperature, and in 1958, an important milestone was experienced in the science of climate change, by starting the routine and systematic measurement and recording of the carbon dioxide concentration contained in the atmosphere (Fraser et al., 1986). Measurements, which have turned into a curve known as the Keeling Curve, have become the standard symbol for anthropogenic effects on the planet (Onan, 2018). Concern and awareness, which have increased scientifically and intellectually since the 1960s, have begun to carry the environmental awareness that started at the local level to the national and international level.

As stated in the work *Silent Spring* written by Carson in 1962, it was realized that the environment had lost its purity, that pollution could cross borders and that invisible dangers should be especially feared (Evans & Steven, 2007). A book was prepared by Udall in 1963, and a government document was published on the subject for the first time in 1965. Atmospheric carbon dioxide emissions were discussed in the report prepared by the Science Advisory Committee in the USA. Then, books were written in France (1965), Sweden (1966), and the United Kingdom (1970) to increase public awareness of the environment (Sanderson & Islam, 2007).

In 1968, a biosphere conference was held in Paris with the participation of 60 countries. Considered the biggest step towards the development of international environmental and climate change policies, this conference was the first intergovernmental meeting to include a series of recommendations adopted by the participants in the direction of environmental protection (UNESCO, 1993). In 1970, the environment was determined as the primary subject of the new decade, and the sales of books on environmental problems increased. In particular, the report titled *The Limits of Growth*, published by the Club of Rome in 1972, attracted great attention, and it became widely known that rapid industrialization, increasing population and consumption level brought national resources to the limit of depletion and the carrying capacity of the earth was approaching the end. This emphasis, which had a great impact especially in developed countries, has started to receive broad public support. As a matter of fact, scientific researches and reports prepared in the 1970s enabled environmental issues to be discussed at the international policy level (Yalçın, 2022).

A special and important role in the development of international environmental policy, law and, indirectly, cooperation against climate change, took place in 1972, the premier Stockholm Conference. A significant number of organizations among 113 countries participated in the conference, which was proposed by Sweden in 1968 and held by the United Nations (UN) in 1973. This conference, which took place, has various purposes other than to draw the attention of governments and the public to the importance and urgency of environmental problems (Aktaş, 2020).

Accordingly (TCDB, 2022).

- Recognizing that global temperature may rise as a result of the CO₂ content in the atmosphere due to fossil fuel consumption in the future.
- Adopting the Action Plan, alerting governments to activities that have a significant risk of impacts on the climate, ensuring that these impacts are evaluated by considering their magnitude and probability of occurrence, and recommending consultation with relevant governments.
- To ensure that 5 June is recognized as the Stockholm Declaration on the Human Environment and World Environment Day.
- To lay the groundwork for the establishment of the UN Environment Program (UNEP), thereby ensuring that member states and the UN are involved in an institutional and continuous manner in global environmental problems.

The 1972 Stockholm Conference, which is described as the area where international environmental law comes out of its cocoon, is also seen as the event that started international cooperation and discussions on environmental issues (Gavouneli, 2007).

In addition, in the UNEP report prepared on the impact of the conference in 1982, it was described as an important force in the initiation of international, regional and national environmental programs, apart from the increase in environmental awareness and accelerated programs (UNEP, 1982).

In 1979, the "First World Climate Conference" was held in Geneva by the World Meteorological Organization (WMO) in order to determine the information on climate change, the predicted atmospheric changes and the effect of anthropogenic activities on these changes. In the published declaration, it was stated that there is a need to learn more about climate change and to examine anthropogenic changes that may pose a threat to the environment (WMO, 1979). This conference is also important in the development of climate change policies, as it promotes scientific research on the subject at the international level.

The meetings held in the city of Villach (Austria) in 1985 and 1987 focused on the development of political preferences for the first time (Hekimoğlu & Altındeger, 2008). As a result of the conference held by UNEP, WMO and the International Council of Scientific Unions in 1985, the extraordinary increase in global average temperature was emphasized and it was stated that government policies would shape the degree and speed of warming in the future. Following this conference, which made the issue of climate change known to the public, a report was prepared by the World Commission on Environment and Development in 1987. The link between environment and development has been revealed in the report named Brundtland Report (Erendor & Sunguray, 2019).

The term sustainable development, which brings holistic approaches, especially climate change, and environmental problems into the agenda, has been introduced to the literature (Connelly & Smith, 1999). The place of the environment in international politics has been strengthened and the negative effects on coastal areas, agriculture sector and economy have been revealed.

Many NGOs, international organizations, policy makers and scientists from 46 countries participated in the Changing Atmosphere Conference held in Toronto in 1988.

It was proposed to reduce global carbon dioxide emissions by 20% until 2005 and it was decided to prepare a framework climate agreement through protocols. In the same year, as a result of an initiative made by Malta, a resolution on Global Climate Protection for Present and Future Generations of Humankind was adopted by the UN General Assembly, and global climate was described as the common problem and heritage of humanity (Hekimoğlu & Altındeger, 2008, p. 12). The Intergovernmental Panel on Climate Change (IPCC) was established by the World Meteorological Organization (WMO) and the UN Environment Program to assess the risks of climate change created by anthropogenic activities. In addition, the Balkans conference, the Ottawa Conference, the Tata Conference, the Hague Conference and Declaration, the Noordwijk Ministerial Conference and the Cairo Consensus were held in 1989 (Şaylan, 2009). The Second World Climate Conference, which succeeded in building a bridge between climate change science and politics in 1990, was held in Geneva under the sponsorship of WMO and UNEP.

The Balkans Declaration, which was approved by 137 countries, including the Republic of Turkey, constituted the last and most important step before a global agreement (Hekimoğlu & Altındeger, 2008, p. 12). Despite this, the target for reducing greenhouse gas emissions was not set, but at the Rio Conference planned to be held in 1992, it was stated that the framework agreement and related protocols should be prepared and intervention measures should be taken immediately (Aktaş, 2020).

In 1992, the most important and the last of the scientific and intergovernmental meetings on climate change, the agreements on the attitude of greenhouse gases at the determined level or the reduction initiatives were held: Earth Summit (Sezer, 2007). It was reported that the participation of governments, intergovernmental organizations, NGOs and the media to the conference, which was held with the participation of 172 countries, 108 of which were represented at the level of heads of state and government, exceeded 20 thousand. At the Rio Conference with this scope, the UN Framework Convention on Climate Change was signed. The agreement, which entered into force in 1994 following the approval of 50 countries, has now been signed by the European Community and 180 countries (Şaylan, 2009). Therefore, it can be said that the participation of NGOs has been increased in a 20-year period, public awareness and scientific knowledge have been brought to a large volume, and therefore experts in the field have developed.

During the conference, which coincided with the increasing population and consumption, the governments' acceptance of taking measures to balance environmental protection and development needs is seen as a very important moment in human history.

Sustainable development, which set the agenda in the Brundtland Report at the Rio Conference, has become one of the determining principles of international environmental policy.

During the conference, the parties that agreed on the environment and development declaration, the UNFCCC and Forestry Principles Statement, the UN Convention on Biological Diversity, and the adoption of Agenda 21, established various follow-up mechanisms, especially the Sustainable Development Commission (Aktaş, 2020). There have been significant discussions about providing technical and financial assistance to developing countries in the fight against environmental problems. It has been argued that environmental problems, primarily climate change, create a heavy economic burden and require external financing. In this context, it was decided to support global environmental projects and encourage environmentally sustainable development by creating a pilot program (Şaylan, 2009). In this direction, the Global Environment Facility (GEF) was established in 1991 (Duru, 2003). Initially created by UNEP, UNDP and the International Bank for Reconstruction and Development, the fund has over time gained partners such as the International Fund for Agricultural Development, European Bank for Reconstruction and Development, African Development Bank, Asian Development Bank, UN Industrial Development Organization, Food and Agriculture Organization (FAO). . The funding provided mainly focuses on 6 areas: climate change, land degradation, international waters, ozone depletion, biodiversity, persistent organic pollutants (GEF, 2023).

At the international conference held in Kyoto (Japan) in 1997 with approximately 10 thousand government officials, scientists and experts from 160 countries, all issues related to climate change were clearly revealed and the agreement called the Kyoto Protocol was signed as a result of the conference.

Accordingly, all greenhouse gas productions of developed countries, primarily carbon dioxide and methane, will be reduced by 5% until 2012. For the USA and Japan, which are responsible for $\frac{1}{4}$ of the global greenhouse gas production, this rate was determined as 8% and 6%, respectively. The agreement, which had to be accepted by 55 countries in order to enter into force, only reached sufficient acceptance in 2005.

Today, the basic principles of the protocol, which covers 160 countries with more than 55% of global greenhouse gas emissions, are determined by the UN, the developed countries are named as Annex 1, the developing countries as Annex 2, the countries included in Annex 1 are defined as Transition countries and their greenhouse gas emissions are determined. The countries included in Annex 2 submit annual greenhouse gas reports but do not have responsibilities. Annex 1 countries not complying with the target will have a 30% reduction in the penalty reduction target for the next period. In this context, the 2008-2012 period has been completed. The main purpose of the protocol is to ensure that the greenhouse gas concentrations contained in the atmosphere are at a level and in balance that will not pose a threat to the climate.

Accordingly, the reorganization of the legislation to reduce the amount of greenhouse gas originating from heating, motor vehicles and industry, the realization of heating and transportation with less energy, the installation of technological systems that enable lower energy consumption, the observance of environmentalism as the basic principle in the storage of garbage, the use of carbon dioxide and methane gas. Turning to alternative energy sources in order to reduce emissions, regulating waste management in production processes such as lime, iron steel, cement, commissioning technologies that monitor and reduce carbon emissions in thermal power plants, and global use of energy types that make zero carbon emissions possible, such as solar energy and nuclear energy.

It has been decided to encourage more taxation from countries that produce more carbon than planned and consume fuel (Güneş, 2010).

The Intergovernmental Negotiation Committee (INC) was established to prepare international agreements in line with the negotiation process initiated by the UN General Assembly with the decisions taken at the end of the 1980s and the decisions taken in 1992 (Arıkan, 2006). As an active and universal organization in global cooperation on climate change, the UN attaches importance to following a holistic approach by bringing together different perspectives and expertise. In this context, three special envoys were appointed in 2007 to facilitate international cooperation. In the high-level event, which was held in the same year to ensure the exchange of views of world leaders, it was aimed to express the political will to solve the climate change problem by accepting joint action at the highest level (Şaylan, 2009).

Following the letter delivered to the UN council president by the UK's permanent representative in 2007, the first open discussion focused on the relationship between climate, security and energy took place.

In the meeting, the participants discussed the potential effects of climate change in terms of security in the context of conflicts over access to energy, water, food and other scarce resources, population movements and border disputes (Parry, 2007). In addition, a thematic discussion on climate change aimed to identify the best policies aimed at researching cooperation between UN member states, the private sector and NGOs.

Apart from the ongoing studies, it can be said that the activities of the IPCC have a vital importance in the development of political cooperation on climate change and environmental problems. It carries out comprehensive and complex, reliable and scientific research in the fight against climate change, which is a versatile technical issue, and creates a good interaction between science and politics, apart from scientific conferences and meetings (Aktaş, 2020). Established at the 40th Session of the WMO Executive Council, the IPCC is open to UNEP and WMO members and offers politically objective and impartial assessments. From the UN General Assembly, WMO and UNEP through the IPCC titled Protection of the global climate for present and future generations of humanity, approved by resolution 43/53, on the science of climate change, its status, socio-economic effects of the problem, response strategies, measures and tools that can be included in the international convention. requested action to be taken to evaluate the recommendations (Çerçi, 2022). In this context, three working groups were formed in the first plenary session.

Working groups revised and reorganized in 1992; physical part fundamentals of climate change (Working Group 1); the impact, adaptation and vulnerability of climate change (Working Group 2); tasked with assessing the mitigation aspect of climate change (Working Group 3) (IPCC, 2022). The IPCC General Assembly is the highest decision-making body, and a team of 30 members meets once a year at the government level; It formulates methodologies for coordinating activities, calculating and reporting national greenhouse gas emissions and removals.

Producing technical documents and supporting materials, methodology guides, special reports and evaluation reports on a regular basis, the IPCC has the opportunity to set the agenda, draw public attention to the issue, and promote climate change as a stand-alone issue (TOB, 2018). The IPCC, which has prepared 6 evaluation reports to date, including 1990 (FAR), 1995 (SAR), 2001 (TAR), 2007 (AR4), 2014 (AR5), 2022 (AR6), cooperates with the international community in areas of common concern, such as the environment. and the possibility of solving even such a big challenge as climate change (IPCC, 2023).

According to the decision taken at the thirteenth session of the Conference of the Parties (COP-13), the 2007 IPCC Evaluation Report was determined as “the most comprehensive and authoritative assessment of climate change”, and a call was made for the parties to benefit from the report findings in national policy development and negotiations. The IPCC, which was awarded the 2007 Nobel Peace Prize for its contribution and efforts and its global cooperation, has been recognized by prestigious mechanisms in the development of climate change science and policy (TOB, 2018).

Finally, the Paris Climate Agreement, which was prepared for the mitigation, adaptation and financing of climate change, was signed in 2015 within the scope of UNFCCC. The agreement, which entered into force in 2016 and to which the Republic of Turkey as a developing country joined, has 191 members today (TCDB, 2022). A distinctive feature of the agreement, which aims to keep the global temperature rise to less than 2oC as a result of the contributions of all parties, is the disregard for the basis of common but differentiated responsibilities and relevant capabilities as declared by the UNFCCC.

For this reason, it can be said that the developed countries consider it appropriate to provide the necessary technology transfer and financing to the developing and least developed countries in order to increase their capacity to reduce greenhouse gas emissions. In addition, the Republic of Turkey states in its Nationally Determined Contributory Statement that it will reduce greenhouse gas emissions by 21% until 2030 (Çerçi, 2022).

3. Effects of Climate Change in Financial Sectors

The importance of addressing the effects of climate change in the financial sector, which plays a critical role in the global economy and has the potential to significantly affect the transition to a low-carbon and climate-resilient future, cannot be denied. Recognizing and addressing the impacts of climate change on financial institutions, including banks, insurance companies and investment firms, is crucial for several reasons (Bain et al., 2016: 154).

Climate change brings with it a wide range of risks, including physical risks from extreme weather events and transition risks from changes in policies, technologies and market preferences. These risks can have direct and indirect consequences on the stability and performance of financial institutions.

Identifying and managing these risks is vital to maintaining the long-term stability of the financial sector and ensuring its ability to withstand climate-related disruptions (Bolton and Kacperczyk, 2021: 14).

Financial institutions have a fiduciary duty to protect the interests of their customers and shareholders. Understanding the impacts of climate change is essential to making informed investment decisions, effectively managing portfolios and protecting clients' assets. By addressing climate-related risks and opportunities, financial institutions can fulfill their fiduciary obligations and maintain the trust of their stakeholders (Grais and Pellegrini, 2006: 317).

Governments and regulators around the world are increasingly demanding that financial institutions disclose their exposure to climate-related risks and demonstrate their commitment to climate action. Identifying and addressing the impacts of climate change on financial sector activities is crucial to complying with these regulatory requirements and avoiding possible penalties or reputational damage (Park and Kim, 2020: 11).

As awareness of climate change increases, stakeholders, including customers, investors and the wider society, are demanding greater transparency and accountability from financial institutions regarding their environmental, social and governance performance. By recognizing and addressing the impacts of climate change, financial institutions can meet these expectations, improve their reputation and attract new customers and capital (Dye et al., 2021: 144).

The financial sector plays a crucial role in financing the transition to a low-carbon and climate-resilient economy. By understanding the impacts of climate change, financial institutions can better identify opportunities for sustainable investments, develop innovative financial products and services, and support climate adaptation and mitigation efforts. This not only contributes to global climate action, but also creates new job opportunities and fosters long-term growth (Boissinot, 2016: 20).

3.1 Effects of Climate Change on the Banking Sector

Climate change has various effects on the banking sector. These effects; Credit Risk Exposure (Capasso et al., 2020), Devaluation (Johnson, 2015), Physical Risks to infrastructure and Collateral (Baker, 2012), Transition Risks (Linnenluecke et al., 2013), Liability Risks (Scott et al., 2017), Reputation Risks (Saeudy et al., 2021), Regulatory and Political Risks (Campiglio et al., 2018), Market and Investment Risks (Javadi and Innocent, 2021), Rising Operational

Costs (Lamperti, 2019), Changing Customer Expectations (Ameme and Wireko) , 2016), Climate Disclosures and Reporting Requirements (Santos and Rodrigues, 2021), Integration of Climate Risk Management (Weber et al., 2008), Changes in Geopolitical Dynamics and Trade Models (Gomez-Echeverri, 2013).

Credit risk is the potential loss that banks or financial institutions may incur if borrowers fail to meet their debt obligations. Climate change can exacerbate exposure to credit risk in several ways, affecting both the financial health of borrowers and the value of collateral used to secure loans.

Climate change could potentially affect borrowers' capacity to repay loans, leading to increased credit risk in the banking sector. Therefore, the banking sector is exposed to credit risk due to climate change. Businesses operating in climate-sensitive sectors such as agriculture, real estate and tourism may experience a decrease in income or an increase in costs due to climate change, and as a result, default rates may increase (Capasso et al., 2020: 27).

For example, climate change can have a detrimental effect on the financial performance of borrowers operating in climate-sensitive sectors such as agriculture, tourism and real estate. Extreme weather events, changing precipitation patterns or rising sea levels can cause reduced revenues, disrupted supply chains and increased costs for these businesses. This may adversely affect the loan repayment ability of these businesses and increase their likelihood of default. At the same time, climate change may affect the value of collateral used to secure loans; For example, properties in flood-prone or coastal areas may suffer from climate-related damage. Decreased collateral values make it more difficult for banks to get their funds back if the borrower defaults.

In addition, banks with high credit concentrations in sectors or regions particularly sensitive to climate change are exposed to greater credit risk. Exposure of a significant portion of a bank's loan portfolio to sectors or regions that are severely affected by climate change can result in higher default rates and significant losses.

Moreover, climate change may indirectly affect exposure to credit risk through its effects on broader economic conditions such as inflation, unemployment and market volatility, which in turn may affect borrowers' ability to pay their debts and increase the probability of default (Birendelli, 2022: 1644).

To manage and mitigate climate-related credit risk, banks need to integrate climate risk considerations into their credit risk assessment processes. This includes analyzing the potential impact of climate change on individual borrowers, sectors and regions. Banks should also diversify their loan portfolios and spread the risk they are exposed to different sectors and geographical regions in order to reduce the concentration risk. Regular monitoring and reassessment of collateral value is necessary to account for potential climate-related effects on asset values. In addition, banks should apply stress testing and scenario analysis to assess the resilience of their loan portfolios under different climate-related risk scenarios.

Finally, communicating with borrowers to increase climate risk awareness and encourage the adoption of sustainable practices can help increase borrowers' resilience to climate change and reduce their credit risk exposure (Capasso et al., 2020: 29).

Devaluation is the deliberate downward adjustment of the value of one country's currency relative to another currency or a basket of currencies. It is usually carried out by a country's central bank or monetary authority. Just as devaluation can have various effects on an economy, there can also be various reasons why a government chooses to devalue its currency. Financial institutions may be exposed to stranded assets (eg fossil fuel reserves, carbon-intensive infrastructure) that could lose value as a result of climate policy or market shifts towards low-carbon technologies. Thus, the resulting devaluation poses a risk for the banking sector. This depreciation creates a risk for banks' balance sheets and profitability (Johnson, 2015: 2514).

In the context of climate change, devaluation has intertwined effects on the banking sector. As climate change affects global economic conditions, central banks respond by adjusting their monetary policies, including devaluation. Banks that have significant exposure to foreign currency through loans or investments face increased risks due to exchange rate fluctuations, affecting their balance sheets and profitability. Devaluation also leads to higher inflation, resulting in higher production costs, especially for businesses that depend on imported inputs. Climate change can exacerbate these cost pressures by disrupting supply chains and causing resource shortages. In addition, devaluation can affect the value of the collateral used to secure loans, especially if the collateral is linked to currency fluctuations or climate change sensitive assets. A decrease in the value of the collateral may increase the banks' risk of loss if the borrower defaults.

Climate change can contribute to macroeconomic instability, including fluctuations in exchange rates and economic growth. Devaluation further complicates the macroeconomic environment, making it more difficult for banks to manage climate change-related risks and maintain financial stability (Johnson, 2015: 2517).

Climate change poses physical risks to infrastructure and collateral in the banking sector. Rising sea levels, extreme weather events, and other climate-related events threaten physical infrastructure, potentially damaging banks' collateral and affecting the ability of the borrower to recover funds in the event of default (Baker, 2012: 5).

Transition Risks are among the risks that arise due to climate change in the banking sector. Changes in policy, technology or market preferences in response to climate change can affect banks' investments and borrowers. Transition risks may arise as regulatory changes, technological innovations, or changes in consumer preferences, thereby affecting banks' business models and financial performance (Linnenluecke et al., 2013: 416).

Banks may face legal liability for financing projects or companies that have significant adverse environmental impacts or contribute to climate change, resulting in financial losses and reputational damage. (Scott et al., 2017: 7).

In addition, public and stakeholder pressure on banks to adopt sustainable practices and mitigate the effects of climate change may lead to reputational risks if banks fail to meet expectations (Saeudy et al., 2021: 177).

As a result of climate change, regulatory and policy risks occur on the banking sector. Regulatory authorities may impose new regulations or standards on banks regarding climate, which may require adaptation and potentially increase compliance costs (Campiglio et al., 2018: 465).

In addition, market and investment risks are among the risks of climate change on banking. Climate change may affect the market conditions, asset prices and investment returns and pose a risk on the investment portfolios and financial performances of banks (Javadi and Masum, 2021: 13).

In the context of climate change, market and investment risks significantly affect the banking sector. Climate change can lead to increased uncertainty and volatility in financial markets, affecting asset prices, interest rates and exchange rates. This creates difficulties for banks when managing their investment portfolios, potentially resulting in lower returns and higher risks.

Banks that invest in sectors or assets that are particularly sensitive to climate change, such as fossil fuels or real estate in regions prone to extreme weather events, may face higher risk of devaluation and loss. In addition, climate change may alter market preferences, causing investment trends to shift towards more sustainable and environmentally friendly assets, potentially making traditional investments less attractive. As climate-related risks become more prominent, banks also face regulatory pressures to assess and disclose their exposure to such risks, resulting in changes in investment strategies and risk management practices.

This situation causes banks to have to reassess and reallocate their investments, potentially incurring costs and experiencing short-term disruptions in their financial performance (Javadi and Masum, 2021: 15).

Increasing operational costs are among the effects of climate change on behalf of banks. Climate change may increase operating costs for banks, such as insurance premiums, facility maintenance and disaster recovery expenses (Lamperti, 2019: 831).

One of the long-term consequences of climate change is changing customer expectations and demand. Consumers increasingly demand sustainable banking services and products, which forces banks to adapt their services to meet these expectations (Ameme and Wireko, 2016: 388).

With the climate change, the climatic disclosure and reporting requirements of banks have emerged. Financial institutions face increasing pressure to disclose climate-related risks and opportunities, requiring the development of robust reporting frameworks and risk management strategies (Santos and Rodrigues, 2021: 124).

The integration of climate risk and bank management into this situation is a very important issue. Banks should integrate climate risk management into their overall risk management framework, consider both physical and transitional risks, and implement appropriate mitigation strategies (Weber et al., 2008: 151).

Climate change has brought about changes in geopolitical dynamics and trade models. Climate change can affect global trade patterns by contributing to geopolitical instability and create uncertainty for banks operating in international markets (Gomez-Echeverri, 2013: 638).

3.2 Impacts of Climate Change on Insurance Sector

Climate change poses significant challenges for the insurance industry as it exacerbates existing risks and introduces new uncertainties. Insurers face numerous impacts from climate change that may affect the long-term sustainability of their business models as well as their underwriting, pricing and risk management practices (Winn et al., 2011: 159).

The increasing frequency and severity of extreme weather events such as hurricanes, floods, droughts and wildfires are a major concern for insurers. These events can result in significant losses for both property and casualty insurers as compensation payments increase due to damage and disruption. As a result, the accurate assessment and pricing of these risks becomes increasingly complex and requires advanced modeling and forecasting techniques to capture the potential impacts of climate change on insured assets (Berz, 1999: 289).

In addition to the increased physical risks, the insurance industry has to deal with the transition risks associated with the transition to a low carbon economy. Changes in regulations, technology and consumer preferences can cause carbon-intensive assets to depreciate or become obsolete and present challenges for insurers that provide coverage to industries that rely on fossil fuels or other emissions-intensive activities. As a result, insurers must adapt their underwriting practices to account for these evolving risks and ensure the adequacy of their pricing. In addition, climate change may expose the insurance industry to liability risks, as companies or individuals can claim compensation for damages attributed to climate-related factors. This may lead to increased claims for insurers, particularly in sectors such as managers' and officers' liability, environmental liability and professional indemnity insurance (Golnaraghi, 2023: 145).

The repercussions of climate change also extend to the investment side of insurance companies that manage large portfolios of financial assets to meet their liabilities. Climate-related risks can affect the value and performance of these investments and have potential consequences on insurers' solvency and capital requirements (Keskitalo et al., 2014: 319).

Given the complex interplay of risks posed by climate change, the insurance industry faces increasing pressure from regulators and stakeholders to increase transparency and incorporate climate-related considerations into its operations.

This includes adopting climate risk assessment frameworks, integrating environmental, social and governance criteria into investment decisions, and developing innovative insurance products to address emerging climate-related risks (Mills, 2009: 329).

The insurance industry is vulnerable to the effects of climate change, as natural disasters cause great losses and compensation claims. Insurance premiums are based on the costs that the insurer foresees to cover a risk, and this function of insurance promotes the reduction of losses of private individuals (Molk, 2016: 412).

As natural disasters become more frequent and more costly, insurance companies face major challenges. It is clear that climate change will have a significant impact on the financial services sector, including insurance. It is also unclear what the specific impacts will be and how well the industry is prepared to respond to them. However, insurers need to make some changes to mitigate the loss. Due to the lack of sufficient data on the extent to which insurance companies are exposed to risks related to climate change, it is difficult to fully understand the extent and severity of the problem (Fredman, 2022: 1).

Climate change causes unpredictable changes in the frequency, intensity, scope and duration of extreme weather events and this affects the probability distributions used by the reinsurance industry (Matteotti and Nartova, 2012: 111). According to the IPCC, human activities are believed to have an impact on extreme weather events, including greenhouse gas levels. Linking human activities to changes in tropical cyclones is difficult because records are unreliable, there is a high degree of variability, and scientists do not fully understand the effects of climate change on tropical cyclones. Some extreme weather events are caused by natural variability, while others are caused by a combination of natural events unrelated to human activities (Field et al., 2012: 1-19).

The insurance industry, by its nature, tries to cope with uncertainty by incorporating risk assessments into premiums. Climate change adds to this complexity and creates additional challenges, but it also offers potential new opportunities for (re)insurers and governments (Matteotti and Nartova, 2012: 111). Insurance companies often take on significant risks, but they often manage them through underwriting and diversification in their investments, as well as reinsurance. This is a type of insurance for insurance companies and helps prevent any company from taking too many risks that could jeopardize its financial stability (Fredman, 2022: 1).

Impacts of climate change, such as more severe hurricanes and more frequent forest fires after droughts, may affect the legal framework (Lang, 2008: 675). Climate change may significantly increase the risks that the insurance sector is exposed to, and the insurance sector may need to develop new policies in this direction. An important challenge is to prevent insurers from assuming new risks by using premiums from new policies to offset old risks (Matteotti and Nartova, 2012: 112).

Reinsurance companies that provide insurance for insurance companies are also affected by climate change. As natural disasters become more frequent and severe, reinsurers may have to pay more claims, resulting in higher premiums for insurers. These are similar sectors operating using similar mechanisms such as underwriting, investment, claims, expense management and reinsurance that affect each other and the policyholders involved. Government regulation at all levels covers the right to start a business, types of risks, consumer protection and specific contracts, including reinsurance. Therefore, it makes sense to have a unified regulatory system for both types of insurance within a jurisdiction, although some differences exist due to the fact that direct insurers are more heavily regulated than reinsurers. The main reason for this is that the reinsurance sector is considered a more specialized sector and does not involve direct interaction with consumers (Matteotti and Nartova, 2012: 114).

In conclusion, the impacts of climate change on the insurance industry are multifaceted and far-reaching, requiring a comprehensive response from industry players. By proactively addressing the challenges posed by climate change, insurers not only maintain their financial stability, but also play a critical role in fostering resilience and adaptation in the face of a changing climate.

3.3 Impacts of Climate Change on Investment Companies

Climate change has emerged as a defining global problem of the 21st century, with profound effects on economies, societies and ecosystems around the world. As the consequences of a warming planet become increasingly evident, investment companies are forced to contend with a complex environment of risk and opportunity that can significantly affect the performance and stability of their portfolios (Bulkeley and Betsill, 2005: 33).

Determining the effects of climate change on investment companies is vital for various reasons. As the impacts of climate change become more pronounced, understanding and addressing these impacts is crucial to ensure the long-term resilience and stability of the financial sector, as well as contribute to global efforts to combat climate change and promote sustainable development (Seddon et al., 2021: 1533).

Understanding the impacts of climate change enables investment companies to make informed decisions and effectively manage the risks associated with their investment portfolios. Climate change poses both physical and transitional risks that can affect asset values, returns and overall portfolio performance. By identifying these risks, investment companies can adapt their strategies, reallocate their investments and protect against potential losses, thereby increasing their financial stability and protecting the interests of their clients and shareholders (Heltberg, 2009: 91).

Recognizing the impacts of climate change on investment companies is crucial to meeting the growing expectations of stakeholders, including customers, regulators and the wider society. With increasing awareness of the need for sustainability and climate action, investors are demanding greater transparency and accountability from investment companies regarding their environmental, social and governance performance. Identifying and addressing climate-related risks can help investment companies meet these expectations, improve their reputations, and attract new customers and capital (Agarwal et al., 2017: 37).

Identifying climate change impacts is essential for investment companies to comply with evolving regulatory requirements. Governments and regulators around the world increasingly require financial institutions, including investment companies, to disclose their exposure to climate-related risks and demonstrate their commitment to climate action. By understanding the effects of climate change on their activities, investment companies can ensure compliance and avoid possible penalties or loss of reputation (Abhayawansa and Adams, 2022: 719).

Identifying the impacts of climate change on investment companies plays an important role in promoting collaboration and innovation across the industry. As investment firms share their experiences and insights, they can collectively develop best practices, industry standards and innovative financial products that support the transition to a low-carbon and climate-resilient economy. This not only enhances the competitiveness and adaptability of the financial sector, but also contributes to broader societal efforts to mitigate and adapt to climate change (Fang et al., 2016: 321).

As a result, determining the effects of climate change on investment companies is of great importance in terms of risk management, stakeholder expectations, compliance with legislation and sectoral cooperation. By recognizing and addressing these impacts, investment companies can increase their financial resilience, support the transition to a sustainable economy and play a vital role in tackling the global climate challenge.

3.3.1 Securities Investment Trusts

Securities Investment Trusts (MKYO) are pooled investment instruments that provide investors exposure to a diversified portfolio of securities such as stocks, bonds or other financial instruments. MKYOs collect funds from multiple investors and are managed by professional investment managers who allocate assets according to a predetermined investment strategy. Individual investors can benefit from diversification, professional management, and economies of scale by investing in MSCs, while potentially reducing the risks and costs associated with investing directly in individual securities (Han and Liang, 1995: 241).

Climate change presents multiple challenges and opportunities for securities investment trusts as they navigate an increasingly complex environment of risks, regulations and stakeholder expectations. By examining the impacts of climate change on securities investment trusts, this analysis aims to shed light on how these organizations adapt their strategies and practices to address emerging climate-related concerns (Cole, 2020: 377).

A major concern for securities investment trusts is the integration of climate-related risks into their investment processes. Climate change can pose both physical risks from extreme weather events and environmental disruptions, and transition risks from shifts in policies, technologies and market preferences towards a low-carbon economy. These risks can significantly affect the valuation and performance of assets held by investment trusts and require a more comprehensive approach to risk assessment and portfolio management (Folqué et al., 2021: 879).

Climate change may also pose regulatory and legal risks for securities investment trusts. As governments and regulators increasingly stress the need for financial institutions to disclose their exposure to climate-related risks and demonstrate their commitment to climate action, investment trusts must tailor their operations to adapt to these evolving requirements. Failure to do so can lead to penalties, loss of reputation and potential lawsuits (Richardson, 2017: 328). In addition to risk management, climate change has implications for the fiduciary duties and stakeholder relations of securities investment trusts. Investors and clients are increasingly demanding transparency and accountability regarding the environmental, social and governance (ESG) performance of investment trusts. Consequently, these organizations should incorporate climate-related considerations into their investment decisions and reporting practices to meet these rising expectations and maintain their credibility in the market (Folqué et al, 2021: 880).

The transition to a low-carbon economy presents new investment opportunities for securities investment trusts seeking to capitalize on emerging trends and technologies. By identifying and investing in climate-resilient and sustainable assets, investment trusts can both reduce climate-related risks and create long-term value for their clients and shareholders (Cole, 2020: 380).

As a result, the impacts of climate change on securities investment trusts are multifaceted and encompass various dimensions of risk management, fiduciary responsibilities, regulatory compliance, stakeholder relations and investment opportunities. By recognizing and addressing these impacts, securities investment trusts can increase their financial resilience, contribute to global climate action, and play an important role in promoting a sustainable and prosperous future (Richardson, 2017: 330).

3.3.2 Venture Capital Investment Trusts (GSYO)

Venture Capital Investment Trusts (VCITs) are private investment vehicles that raise funds from multiple investors to invest in early-stage, high-growth companies, typically in innovative industries such as technology, biotechnology or clean energy. REITs are led by professional venture capital managers who identify promising startups, provide them with capital, and provide strategic guidance and resources to help these companies grow and succeed. By investing in REITs, individual investors are exposed to the high-risk, high-reward nature of venture capital investments while benefiting from diversification, professional management, and access to opportunities that might otherwise be difficult to invest directly in (Bottazzi et al., 2016: 2284).

Climate change has become a critical factor affecting Venture Capital Investment Trusts. When allocating capital to innovative ventures, REITs should consider the potential consequences of climate change on their investment strategies and portfolios. The effects of climate change on REITs can be addressed in eight main areas: investment opportunities, risk assessment, regulatory compliance, reputation and stakeholder expectations, portfolio diversification, adaptation and resilience, cooperation and partnerships, and monitoring and reporting (Owen, 2021: 341).

3.3.2.1. Investment Opportunities

Climate change presents multiple opportunities for venture capitalists to invest in innovative and sustainable solutions such as clean energy, carbon capture technologies and climate resilient infrastructure.

By supporting initiatives that directly or indirectly combat climate change, venture capitalists contribute to global efforts to mitigate climate change, while generating potentially significant financial returns from successful initiatives (Seitchik, 2009: 39).

3.3.2.2. Risk assessment

Venture capitalists should incorporate climate risk assessment into their due diligence processes, as climate change can create both direct and indirect risks to their investments.

Physical risks such as extreme weather events or rising sea levels can affect the operations and assets of invested companies.

Transition risks arising from the transition to a low-carbon economy can render certain industries or technologies obsolete, reducing the value of investments in these sectors. REITs should comprehensively evaluate these risks when choosing investments, as they may affect the long-term performance of their portfolios (Kay and Smith, 2016: 61).

3.3.2.3. Legislation Compliance

As governments and regulators implement stricter policies and guidelines regarding climate change, REITs must ensure their investments comply with these regulations. Failure to do so may expose investee companies and REITs to potential fines, legal liability and reputational damage. In addition, compliance with environmental, social and governance (ESG) standards is becoming increasingly important for investors who may prioritize REITs that comply with these principles when allocating capital (Huang, 2012: 474).

3.3.2.4. Reputation and Stakeholder Expectations

REITs are subject to increased stakeholder expectations regarding their commitment to addressing climate change.

Venture Capital Investment Companies can improve their reputation and demonstrate their determination to mitigate climate change by investing in environmentally responsible and sustainable ventures. As socially responsible and impact investing gain momentum among investors seeking not only financial returns but also positive social and environmental outcomes, this may help attract more investment (Paseda and Okanya, 2020: 664).

3.3.2.5. Portfolio Diversification

In the context of climate change, REITs should consider diversifying their investment portfolios across various sectors and geographies to mitigate potential risks. By allocating their capital to different sectors such as renewable energy, sustainable agriculture and green transport, REITs can reduce their exposure to sectors that are more sensitive to climate risks. Also, investing in ventures in different regions can help minimize the impact of regional climate events on the overall performance of the portfolio (Owen, 2021: 349).

3.3.2.6. Adaptation and Stamina

Venture capitalists should prioritize investing in companies that demonstrate a strong commitment to climate adaptation and resilience. These companies are likely to have strategies to minimize the impact of climate change on their operations and supply chains, which may include diversifying suppliers, relocating facilities to less sensitive areas, or implementing more energy efficient processes. By investing in such companies, REITs can reduce the probability of experiencing climate-related losses in their portfolios (Paseda and Okanya, 2020: 664).

3.3.2.7. Cooperation and Partnerships

REITs can benefit from collaborating with other stakeholders such as governments, non-governmental organizations and industry experts to better understand the impacts of climate change on their investments. For example, by participating in public-private partnerships, venture capitalists can access valuable resources, information and networks to support the growth and success of their portfolio companies in addressing climate change challenges. Moreover, such collaborations can help shape public policies that encourage investment in climate-friendly technologies and industries (Huang, 2012: 479).

3.3.2.8. Monitoring and Reporting

REITs should establish robust monitoring and reporting mechanisms to monitor the progress and performance of their climate change mitigation and adaptation investments. This includes measuring the environmental impact and carbon footprint of invested companies, as well as evaluating their progress in achieving climate-related goals and targets. Transparent reporting on these metrics can help REITs demonstrate their commitment to addressing climate change and attract investors who prioritize environmental, social and governance factors in their investment decisions (Owen, 2021: 350).

3.3.3 Real Estate Investment Trusts

Climate change has emerged as a critical factor affecting the performance and decision-making processes of Real Estate Investment Trusts (REITs). As the frequency and intensity of climate-related events increase, REITs must manage the challenges and opportunities presented by climate change to ensure the long-term resilience and sustainability of their portfolios. The impact of climate change on REITs; physical risks, transition risks, liability risks, adaptation and resilience, investment opportunities, Climate risk assessment, tenant participation and satisfaction, climate-related financial disclosures, access to capital and finance, and cooperation and partnerships (Fuerst, 2015: 2).

i. Physical risks: Climate change exposes REITs to various physical risks that may directly affect their real estate assets. For example, extreme weather events such as floods, hurricanes and wildfires can cause significant damage to properties, leading to repair and rebuilding costs, reduced rental income and potential loss of asset value. In addition, chronic climate stressors such as sea level rise and temperature increases can affect the long-term desirability and livability of certain places, leading to potential depreciation and reduced occupancy rates (Kerscher, 2015: 147).

ii. Transition risks: As economies shift towards low-carbon and sustainable models, REITs must contend with transition risks arising from regulatory, technological and market changes. For example, new building codes, energy efficiency standards and carbon pricing mechanisms require costly renovations and retrofits to comply with these regulations.

In addition, tenants and investors increasingly prefer properties with strong environmental, social and governance performance, potentially affecting the demand and value of less sustainable assets (Pivo and McNamara, 2005: 133).

iii. Liability risks: Climate change may also expose REITs to liability risks, as organizations that do not adequately address climate change risks or comply with relevant regulations face legal action and loss of reputation. Shareholders, tenants and other stakeholders hold REITs responsible for climate-related losses or failures to meet standards, leading to potential financial and reputational consequences (Westermann et al., 2018: 99-100).

iv. Adaptation and resilience: To mitigate the effects of climate change, REITs should invest in adaptation and resilience measures for their portfolios. This may include incorporating climate-resilient design features such as flood-resistant infrastructure, green roofs, and efficient water management systems. In addition, REITs should consider long-term climate risks when selecting and developing new properties, prefer locations that are less vulnerable to climate-related hazards, and comply with evolving sustainability standards (Zietz et al., 2003: 144).

v. Investment opportunities: Climate change offers REITs opportunities to invest in sustainable and resilient real estate assets that meet emerging market demands and regulatory requirements. For example, REITs may explore investing in green buildings, renewable energy infrastructure, or properties located in areas with a lower climate risk profile. In this way, REITs can take advantage of the growing market for sustainable real estate while minimizing their exposure to climate-related risks (Fuerst, 2015: 5).

vi. Climate risk assessment: To better understand the potential impacts of climate change on their assets, REITs should integrate climate risk assessment into their due diligence and investment analysis processes. This includes assessing the vulnerability of properties to climate-related hazards such as floods, extreme temperatures or storms and estimating the potential costs associated with these risks. By incorporating climate risk assessment, REITs can make more informed investment decisions and prioritize assets that offer lower climate-related risks (Fuerst, 2015: 7-9).

vii. Tenant engagement and satisfaction: As awareness of climate change increases, tenants may increasingly prioritize environmentally sound and climate resilient properties when choosing rental space.

REITs should consider implementing sustainable practices such as energy efficiency improvements, waste reduction programs and renewable energy sources to increase tenant satisfaction and loyalty. In addition, REITs can work with tenants to develop collaborative solutions to address climate change issues, such as joint ventures to reduce energy consumption or improve waste management (Pivo and McNamara, 2005: 135-136).

viii. Climate-related financial disclosures: Transparent reporting of climate-related risks and opportunities is becoming increasingly important to investors and stakeholders. REITs should consider adopting frameworks such as the Climate-Related Financial Disclosures Task Force (TCFD) to report on their exposure to climate-related risks and the measures they are taking to address these challenges. REITs can improve their reputation by making transparent financial disclosures about climate and potentially attract additional investment by demonstrating their commitment to addressing climate change (Westermann et al., 2018: 103).

ix. Access to capital and finance: As financial institutions and investors increasingly prioritize climate change considerations in their lending and investment decisions, REITs with strong climate risk management practices can benefit from better access to capital and more favorable financing terms. In contrast, REITs that are highly exposed to climate-related risks or underperforming may face difficulties in raising capital or incur higher borrowing costs. Therefore, addressing climate change risks and adopting sustainable practices can increase the financial performance and competitiveness of REITs (Westermann et al., 2018: 104).

x. Collaboration and partnerships: REITs can benefit from engaging with a variety of stakeholders, including governments, nonprofits, industry associations and local communities, to better understand and address climate change issues. Through these collaborations, REITs can access valuable resources, information and networks to support the implementation of climate-resilient measures and contribute to the development of public policies that promote sustainable real estate practices (Zietz et al., 2003: 144).

4. Effects of Climate Change on Financial Instruments Related to the Agricultural Sector

Climate change has far-reaching consequences for the financial instruments available to the agricultural sector. As extreme weather events, temperature fluctuations and changes in precipitation patterns become more frequent and severe, farmers and other industry stakeholders must adapt to these new realities. The following sections detail the effects of climate change on various financial instruments for the agricultural sector.

4.1. Crop insurance

Climate change increases the risks faced by farmers as unpredictable weather events can lead to low yields or crop failures. As a result, demand for crop insurance may increase as farmers seek protection against these risks. However, insurance companies may face difficulties in pricing policies correctly due to increased uncertainty regarding future climate conditions. Premiums may increase, potentially making insurance less affordable for some farmers, while insurers may be more selective in offering coverage to minimize their exposure to climate-related risks (Steiner et al., 2018: 205).

a. Parametric insurance: Interest in parametric insurance products may increase as traditional compensation-based product insurance faces difficulties in pricing and coverage due to climate change. These insurance policies pay when a predefined weather event or index threshold is reached, rather than basing the payment on actual product losses. This approach can simplify the claims process, reduce moral hazard, and get farmers paid faster. However, parametric insurance may not fully cover all losses incurred by farmers and may reveal a potential underlying risk (Steiner et al., 2018: 217).

b. Public-private partnerships: Governments and insurance companies can collaborate to develop innovative insurance plans that more effectively address climate-related risks. Public-private partnerships can help expand the reach of insurance products to underserved communities, share risks between public and private entities, and leverage the expertise and resources of both sectors to develop more resilient insurance products (Steiner et al., 2018: 222).

4.2. Commodity futures and options

Climate change can lead to greater price volatility in agricultural commodity markets due to fluctuations in supply and demand caused by extreme weather events, pest infestations or changes in growing conditions. As a result, farmers may increasingly rely on futures and options contracts to hedge against price risks. However, increased uncertainty regarding future crop yields and market conditions may cause the prices of these financial instruments to become more volatile, making it difficult for farmers to manage their risks effectively (Linnerooth-Bayer and Hochrainer-Stigler, 2015: 89-91).

a. Weather derivatives: As an alternative to traditional futures and options contracts, farmers may consider using weather derivatives to hedge against climate risks. Weather derivatives are financial instruments that pay depending on the occurrence of certain weather events or the achievement of certain weather indexes such as temperature or precipitation levels. These tools can help farmers manage weather-related risks that are not directly reflected in commodity prices (Burke and Lobell, 2010: 139).

b. Price forecasting tools: Advanced data analytics and modeling techniques can improve the accuracy of price forecasting for agricultural commodities and help farmers make more informed decisions about when to enter futures and options contracts. These tools can bring together climate data, satellite imagery and other relevant information to provide a more comprehensive view of the factors affecting agricultural commodity prices (Iglesias and Garrote, 2015: 119).

4.3. Agricultural loans

Climate change can affect farmers' credibility, as increased climate-related risks can lead to reduced crop yields and reduced incomes. Financial institutions may perceive lending to farmers as riskier, potentially leading to higher interest rates, stricter credit criteria, or reduced access for some farmers to credit. This may exacerbate the difficulties faced by farmers in adapting to climate change, as they may have limited financial resources to invest in new technologies or practices that can help reduce climate-related risks (Nnadi et al., 2013: 5).

a. Climate-smart lending: Financial institutions can develop tailored loan products for farmers that promote climate-smart farming practices. These products may offer lower interest rates or more flexible repayment terms for borrowers investing in climate-resilient infrastructure, sustainable farming methods or innovative farming technologies.

b. Credit guarantees and risk-sharing mechanisms: Governments and international institutions can support climate-resilient lending by providing credit guarantees or risk-sharing mechanisms that reduce perceived risk for financial institutions. This can help farmers expand their access to credit, enabling them to invest in climate change adaptation and mitigation measures (Nnadi et al., 2013: 14).

4.4. Green bonds and impact investing

As awareness of climate change and its impacts increases, so does the interest in financial instruments that promote sustainability and environmentally friendly practices. Green bonds and impact investments can provide additional sources of finance for farmers and agribusinesses looking to invest in climate-resilient infrastructure, sustainable farming practices or the development of innovative farming technologies. These financial instruments can help close the financing gap for climate change adaptation and mitigation efforts in the agricultural sector and can attract investors seeking positive environmental and social outcomes as well as financial returns (Falco et al., 2014: 489-490).

a. Certification and standards: As the green bond and impact investing market grows, the development of certification programs and standards can help ensure the credibility and transparency of these financial instruments. These standards can provide guidance on the types of projects eligible for financing, as well as reporting and disclosure requirements for issuers and investors (Falco et al., 2014: 491).

b. Mixed financing: Mixed financing models that bring together public and private capital to support climate-resilient investments in the agriculture sector can help secure additional financing and reduce risks for private investors. By pooling resources and allocating risks among multiple investors, hybrid financing can catalyze larger-scale investments in sustainable agriculture and climate-resilient infrastructure (Falco et al., 2014: 491-492).

4.5. State subsidies and support programs

Governments play a crucial role in supporting the agricultural sector that adapts to climate change. They can introduce new financial instruments or modify existing ones to provide targeted support to climate change adaptation and mitigation efforts. These may include subsidies for the adoption of sustainable farming practices, grants for investment in climate-resilient infrastructure, or tax incentives for investment in the research and development of innovative agricultural technologies. However, the effectiveness of these tools depends on governments' ability to design, implement and monitor them to respond to the changing effects of climate change (Lesnikowski, 2015: 279).

a. Capacity building and technical assistance: In addition to direct financial support, governments provide capacity building and technical assistance programs to help farmers and agribusinesses adopt climate-smart practices. These programs include education, extension services and knowledge sharing platforms for the dissemination of best practices and innovations throughout the agricultural sector (Lesnikowski, 2015: 279).

b. Monitoring and evaluation: It is essential to establish robust monitoring and evaluation frameworks to ensure the effectiveness of government subsidies and support programs. These frameworks can help monitor progress, measure the impact of interventions, and identify areas for improvement, enabling governments to improve and optimize their policies in response to the changing challenges of climate (Lesnikowski, 2015: 285).

5. Methodology

Within the scope of the study, econometric analysis was carried out in order to determine the effect of climate change on financial markets in Turkey in line with the main purpose. In this direction, in this section, the data set used in the study has been handled and the reasons for the econometric model to be used for analysis have been established. Then, the model and analysis findings were presented respectively in line with the existing data set.

5.1. Data set

The relationship between financial markets and climate change is an emerging field of study that requires empirical research. In this study, the XGIDA index data is used to represent the financial markets in the field of agriculture, while the XSGRT index is used to represent the financial markets in the insurance sector, the financial markets in the XBANK banking sector and the financial markets in the XGMYO Investment field. Average temperature values were used as an indicator of climate change, which is the main element of the study. The decision to use these specific variables is based on both their representative capacity and data availability.

XGIDA, XSGRT, XBANK and XGMYO index data from the variables used in the study were obtained from the Bloomberg data terminal, while the average air temperature data was compiled from the official website of the Ministry of Environment, Urbanization and Climate Change, General Directorate of Meteorology. The data used in the study consist of monthly data between February-1997/December-2022.

It is very important to examine the distribution of the data set before the working model is formed. In this direction, the temperature values used in the study are in Figure 5.1. presented.

5.1.1 Average Monthly Temperature Values

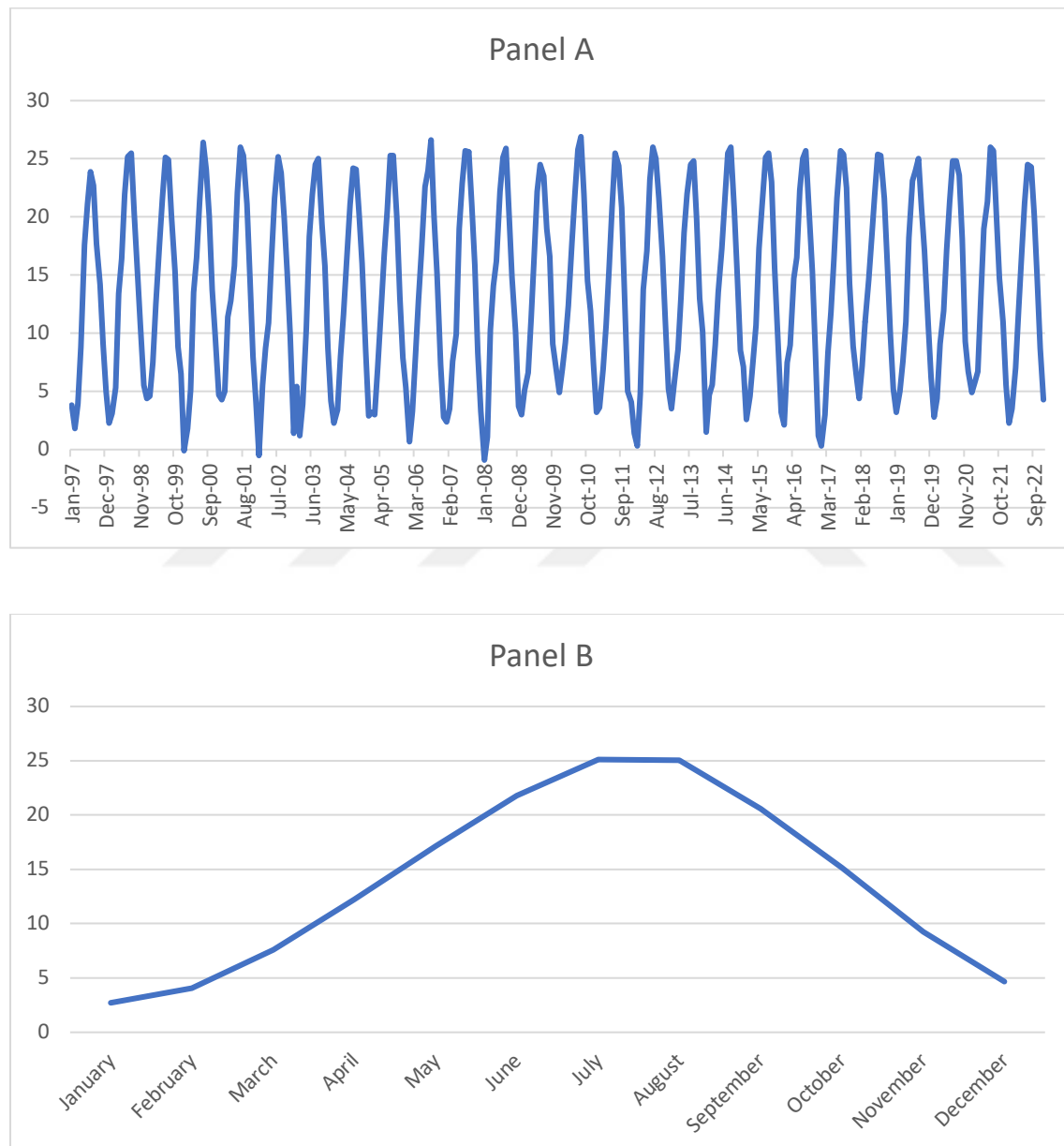
In the study, average temperature values were used as an indicator of climate change. Average temperature values can be accepted as a direct and concrete indicator of climate change. It is one of the most common and accessible climate change variables, effectively capturing the long-term warming trend on the Earth's surface. The rise in global average temperature is the main symptom of climate change, and its implications are huge, affecting everything from agriculture to water resources and therefore indirectly the financial markets. It is also a variable where robust, reliable and global data from various meteorological stations and satellite observations are available, allowing for robust statistical analysis.

Turkey's average monthly temperature values for the period of January 1997 and December 2022 (Panel A) and the average temperature of 26 years (Panel B) for each month in the years 1997-2022 are shown. When Panel A and Panel B are examined together, it is clear that Turkey shows seasonal temperature changes.

Temperatures are usually highest in summer (June, July, August) and lowest in winter (December, January, February).

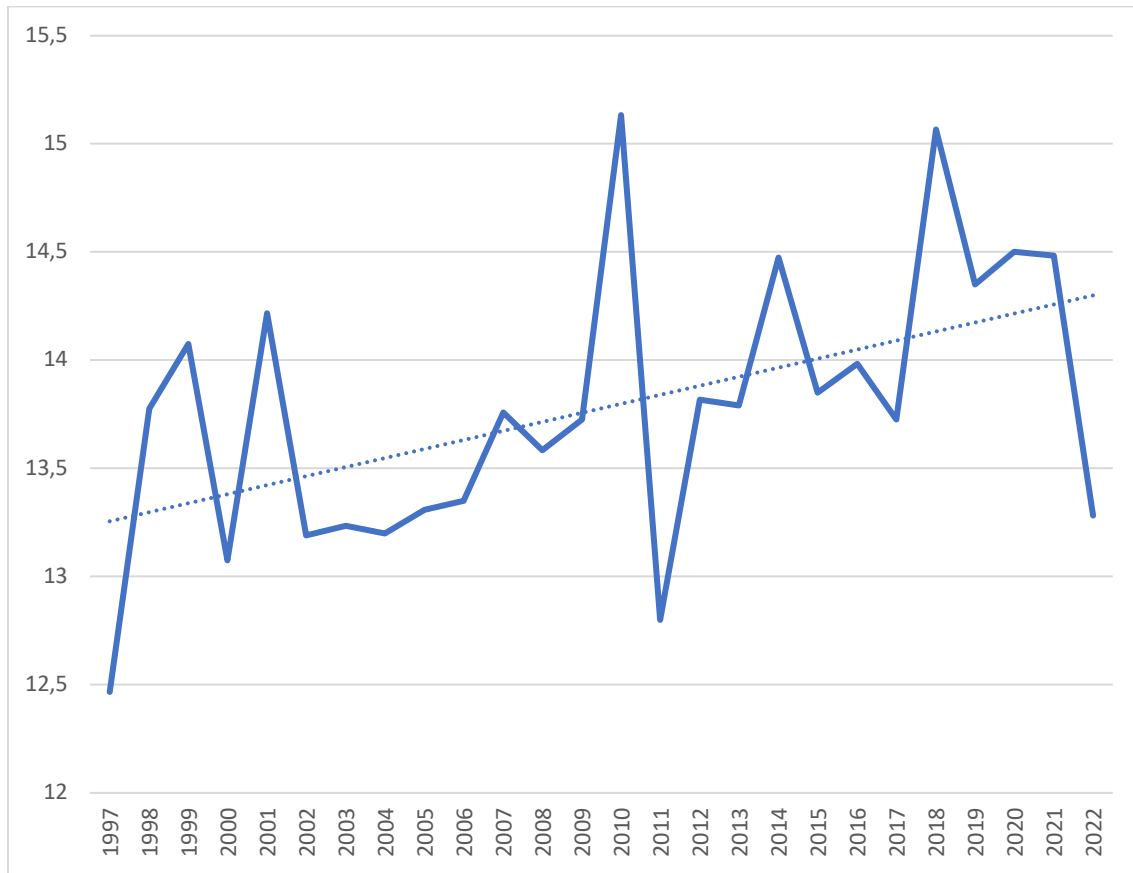
This indicates that Turkey has a mix of continental and Mediterranean climate. In some years, especially in winter, average temperatures seem lower or higher than expected. This may be due to extreme weather events or other environmental factors.

Figure 5.1 Monthly Average Temperatures in Türkiye (1997-2022)



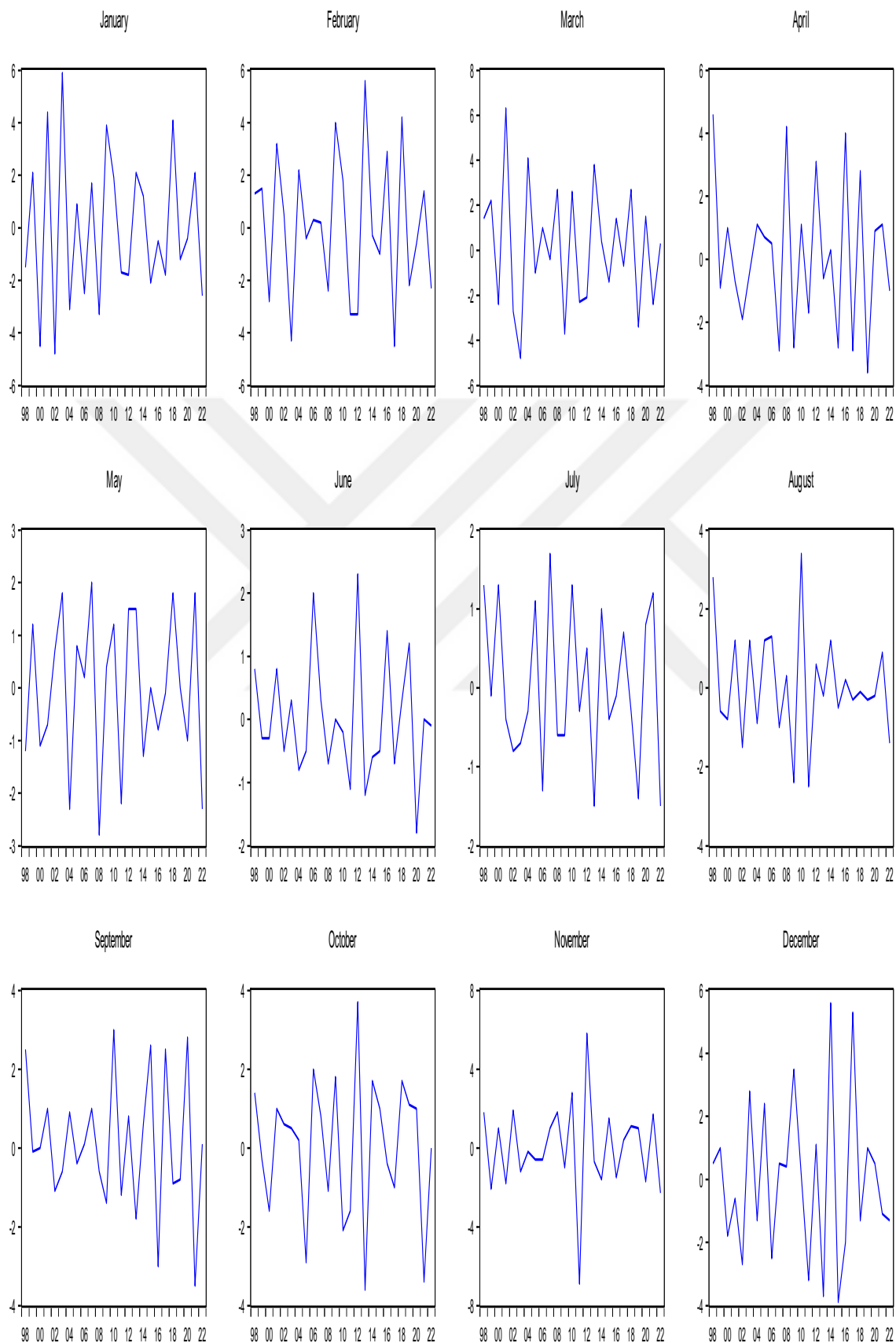
Average annual temperature values for Turkey between 1997-2022 are presented in Figure 5.2. When the values are examined, it is seen that there is a general temperature increase trend. This situation can be considered as a result of global warming.

Figure 5.2 Annual Average Temperatures in Türkiye (1997-2022)



In this case, instead of using monthly data due to the seasonality effect, the difference between the average temperature of each month between 1998 and 2022 compared to the same month of the previous year was used in the analysis. Thus, the seasonal effect was tried to be eliminated. The temperature change values of each month value according to the same month of the previous year are shown in Figure 5.3. As can be seen from the figure, although there is no general trend in temperature differences, it can be stated that there is an upward trend in January, December and February temperatures, while there is a downward trend in March and April, while the other months have a stable course.

Figure 5.3 The value of each month compared to the same month of the previous year (1997-2022)



5.1.2 XGIDA index

The XGIDA index is a comprehensive economic indicator that covers a wide range of market data. It integrates information from various sectors and thus provides a holistic view of financial markets. Using a broad-based index such as XGIDA allows for a more robust and comprehensive assessment of financial markets as it captures the performance of different sectors that may be variably affected by climate change. Considering the heterogeneous nature of the effects of climate change on different sectors, this broad-based perspective is very important.

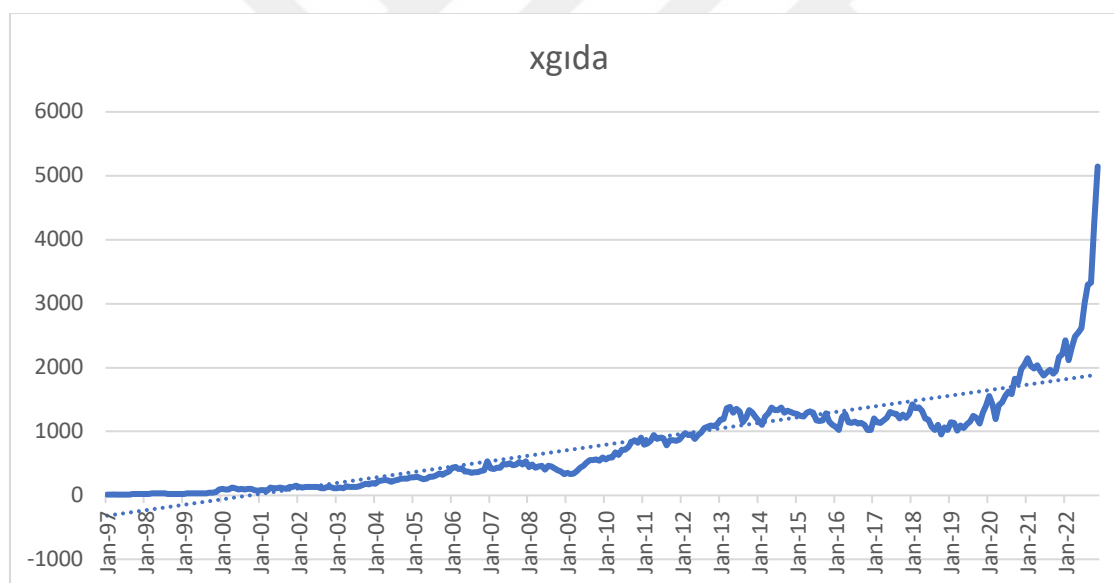
Within the scope of the study, in the context of Turkey, the XGIDA index in BIST (Borsa Istanbul) was used as an indicator of agricultural activities. The XGIDA index is a broad market index that includes many different sectors, and its composition includes companies from the agricultural sector as well as companies indirectly related to agriculture such as food processing and distribution companies (BIST, 2023). Thus, it can be said that the XGIDA index shows the performance of the agricultural sector within the wider Turkish economy. In addition, the performance of the agricultural sector can significantly affect other sectors. For example, fluctuations in agricultural production can affect the food processing industry, wholesale and retail trade, transportation, and even the financial sector through changes in credit demand and credit risk. Therefore, the XGIDA index, as a broad market index, indirectly reflects the impact of agricultural sector performance on other sectors of the economy.

Both the XGIDA index and mean temperature values are time series data, allowing us to explore the temporal relationship between financial markets and climate change. This is critical as the effects of climate change on financial markets are likely to be complex and potentially lagging. Therefore, using these two variables, we can investigate not only the existence of a relationship between climate change and financial markets, but also the nature and strength of this relationship over time.

Both the XGIDA index and mean temperature values are time series data, allowing us to explore the temporal relationship between financial markets and climate change. This is critical as the effects of climate change on financial markets are likely to be complex and potentially lagging. Therefore, using these two variables, we can investigate not only the existence of a relationship between climate change and financial markets, but also the nature and strength of this relationship over time.

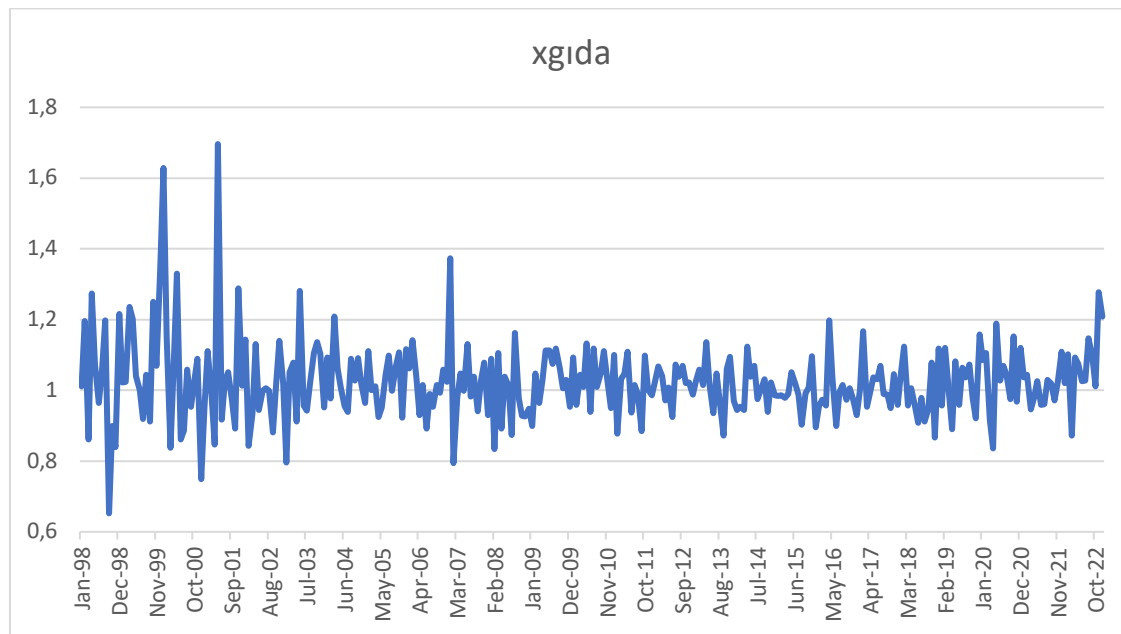
Borsa İstanbul (BIST), one of Turkey's most important financial markets, hosts various sector indices. One of these indices is the BIST Food Index (XGIDA), and the values of the XGIDA index, which is used to represent the agricultural sector in the study, are in Figure 5.4. presented. It can be said that the XGIDA index measures the performance of companies in the food sector in Turkey. When the data set is analyzed, it can be said that the XGIDA index shows a general upward trend during the period from February 1997 to December 2022. This indicates steady growth in the food industry. This is usually due to factors such as population growth and changes in consumption habits. However, there are also periods when the index experiences significant decreases and increases during this period. It can be said that such fluctuations are affected by general economic conditions, especially global and local economic crises. In addition, changes in food prices and production costs can also affect the index.

Figure 5.4 XGIDA Index Monthly Change (1997-2022)



As seen above, there is a trend in XGIDA index values. For this reason, instead of using the XGIDA index values directly in the analysis, the increase rates compared to the previous month were used. These increase rate values are shown in Figure 5.5. As seen in the figure, the series is trend-free.

Figure 5.5 XGIDA Index Monthly Proportional Change (1997-2022)



When the data set is analyzed, it can be said that the BIST XGIDA index showed a general upward trend during the period from February 1997 to December 2022. This indicates steady growth in the food industry. This is usually due to factors such as population growth and changes in consumption habits. However, there are also periods when the index experiences significant decreases and increases during this period. It can be said that such fluctuations are affected by general economic conditions, especially global and local economic crises. In addition, changes in food prices and production costs can also affect the index.

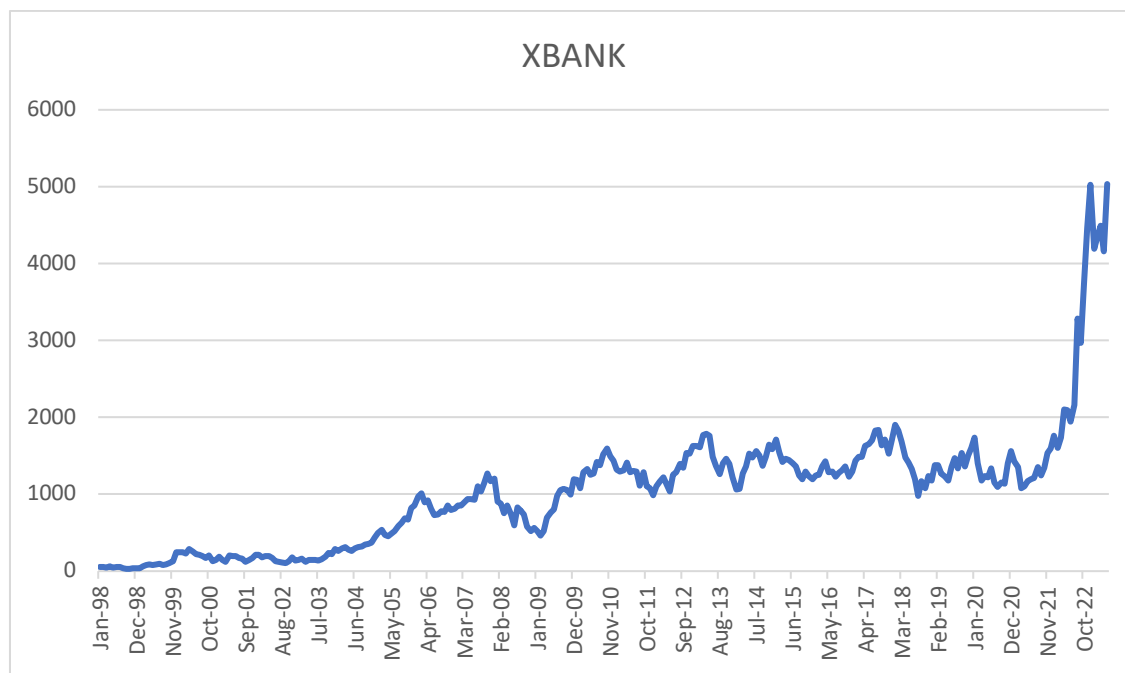
5.1.3 XBANK index

One of the indices in the BIST is the BIST Banking Index (XBANK). XBANK index calculated by BIST (Borsa Istanbul) represents the banking sector in Turkey. This index is calculated based on the market values and trading volumes of bank shares in BIST.

The index measures the overall performance of the Turkish banking sector and reflects the trends in this sector. The performance of the shares of the banks in the XBANK index is accepted as an indicator of the financial health of the banks and the general economic conditions. In addition, this index also shows the trust and interest of domestic and foreign investors in the Turkish banking sector.

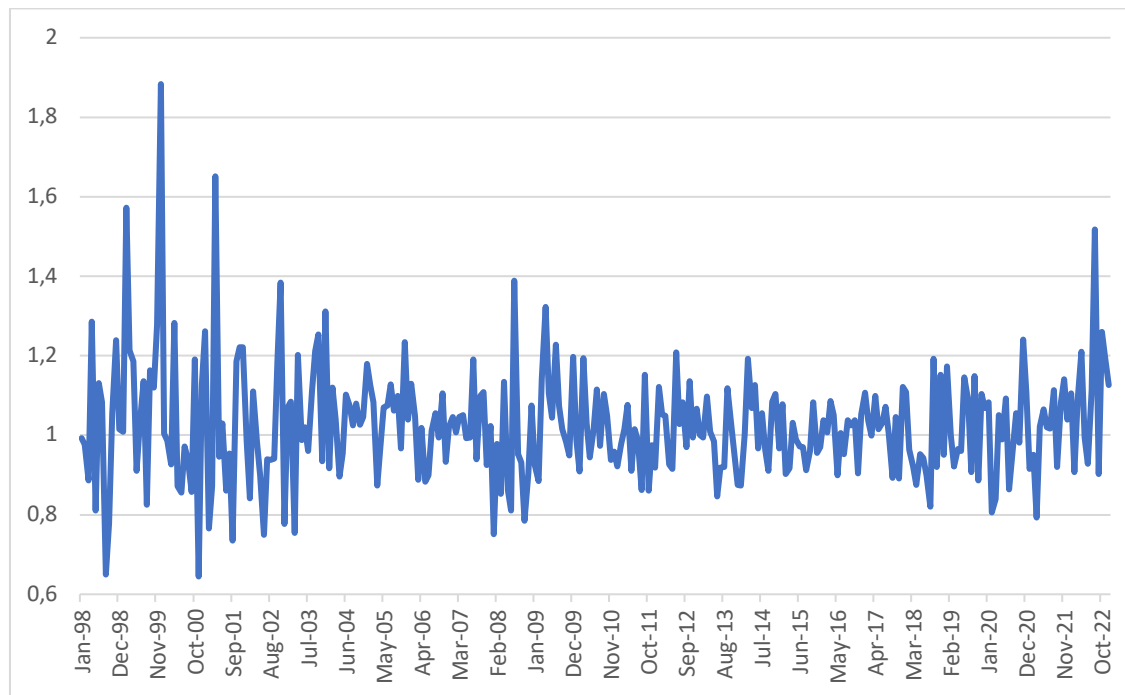
In the study, the XBANK index was used to represent the banking sector. The values of the XBANK variable are presented in Figure 5.6. As can be seen from the figure, there is a trend in the XBANK index values. For this reason, instead of using XBANK index values directly in the analysis, the increase rates compared to the previous month were used. These increase rate values are shown in Figure 5.7. As can be seen in the figure, the series is thus free from the trend.

Figure 5.6 XBANK Index Monthly Change (1997-2022)



As seen above, there is a trend in XBANK index values. For this reason, instead of using XBANK index values directly in the analysis, the increase rates compared to the previous month were used. These increase rate values are shown in Figure 5.7. As can be seen in the figure, the series is thus free from the trend.

Figure 5.7 XBANK Index Monthly Proportional Change (1997-2022)



It reflects the past performance and changes of the XBANK index. This evaluation shows that the index has experienced both big increases and big decreases in certain periods. For example, while the index was generally in a downward trend in 1998, a significant increase was recorded in April and June. Similarly, significant increases were experienced in February and December in 1999. While there was a great increase in July 2008, there was a significant decrease in October.

In addition, it is observed that the index has exhibited a fluctuating movement in general since 2009 and the trend is upwards. Significant increases were observed in the index in March and May 2014. Since 2016, the index has generally been in an upward trend, but there have also been decreases in some periods. Finally, while a great increase was recorded in November in 2020, there was a significant increase in April in 2022.

5.1.4 XYORT index

BIST Investment Trust (XYORT) index is an index calculated to measure the performance of investment trusts traded on Borsa Istanbul (BIST). This index is calculated based on the market values of the stocks of investment trusts and reflects the overall performance of investment trusts.

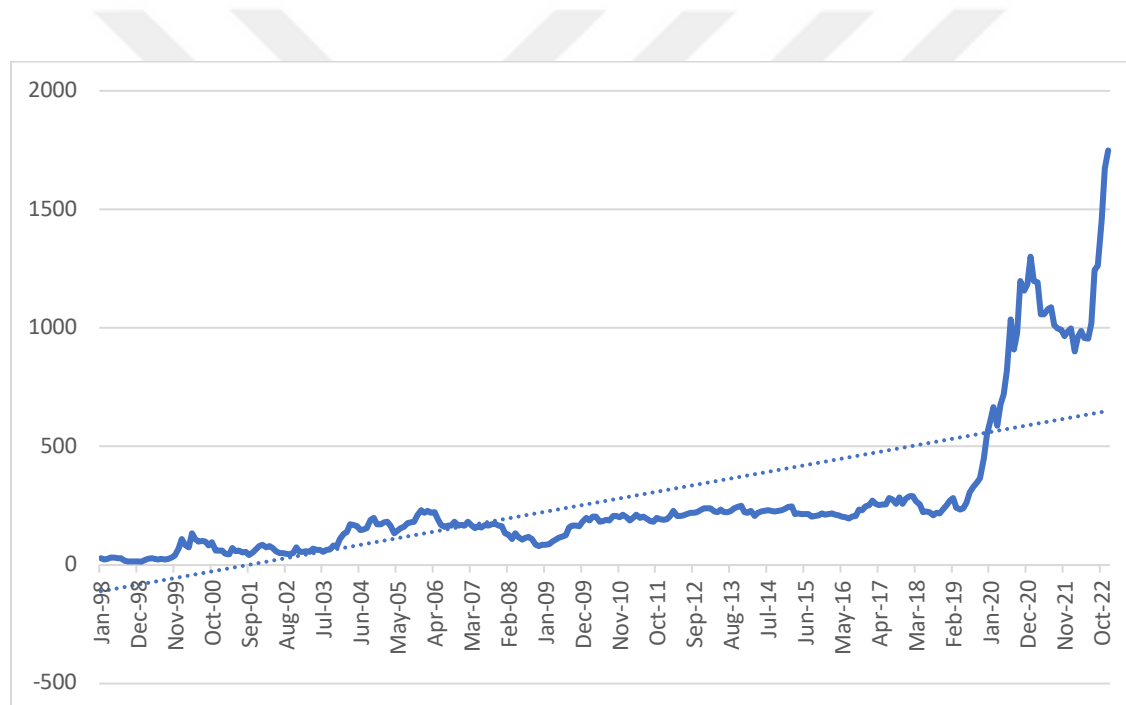
The XYORT index shows the general trends of the sector to investors by tracking the changes in the portfolio values of investment trusts and the movements in stock prices.

In addition, the XYORT index can help investors evaluate the performance of investment trusts and create their portfolio management strategies. This index is considered an important indicator of investment partnerships and is used as a reference point in the investment environment.

In the study, the XYORT index was used to represent the investment sector.

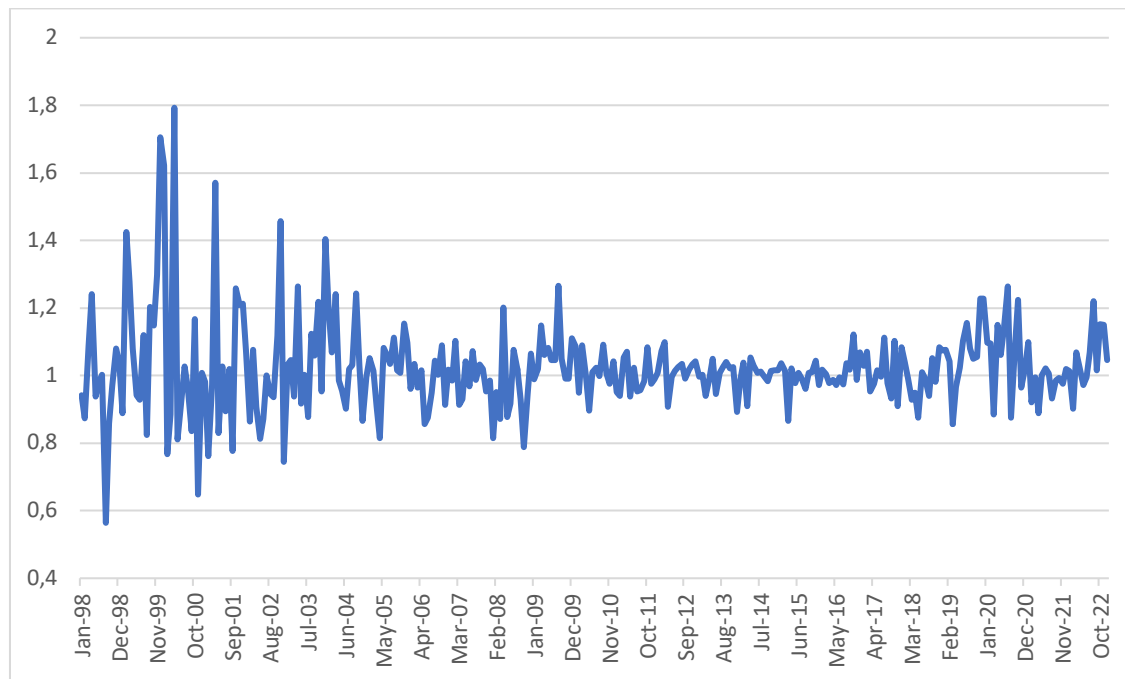
The values of the XYORT variable are presented in Figure 5.8.

Figure 5.8 XYORT Index Monthly Change (1997-2022)



As seen above, there is a trend in the XYORT index values. For this reason, instead of using the XYORT index values directly in the analysis, the increase rates compared to the previous month were used. These increase rate values are shown in Figure 5.9. As can be seen in the figure, the series is thus free from the trend.

Figure 5.9 XYORT Index Monthly Proportional Change (1997-2022)



When the monthly changes of XYORT index values are analyzed, it is seen that the index tends to fluctuate. Based on the rate of change, it is observed that the index value sometimes increases and sometimes decreases. While the index value increases steadily in some periods, it decreases steadily in other periods. These fluctuations occur depending on the performance of the stocks of investment trusts and market conditions. For example, while it can be thought that investment trusts generally exhibit a positive performance during periods when the index is on the rise, it can be thought that investment trusts generally perform poorly during periods when the index is decreasing. Therefore, the XYORT index can be used as an important indicator for investors to guide their investment decisions.

5.1.5 BIST Insurance (XSGRTRT) index

BIST Insurance (XSGRTRT) index is an index created to track the performance of stocks of insurance companies traded on Borsa Istanbul. This index is calculated based on the market values of companies in the insurance industry and aims to reflect the overall performance of the insurance industry.

The XSGRT index calculates the index value by monitoring the changes in the prices of the stocks of companies operating in the insurance industry.

This index can be used to observe the performance of insurance companies in the market and to analyze the general trends of the sector.

Investors can follow the XSGRTRT index when considering trading in the insurance industry or making industry-related decisions and evaluate stocks that are affected by changes in the index's value. At the same time, since the index provides an overview of the insurance sector, it can be used to understand the performance of the sector and to make comparative analyzes.

In this direction, the XSGRT index was used to represent the insurance industry in the study. The values of the XSGRT variable are presented in Figure 5.10.

Figure 5.10 Monthly Change in XSGRT Index (1997-2022)

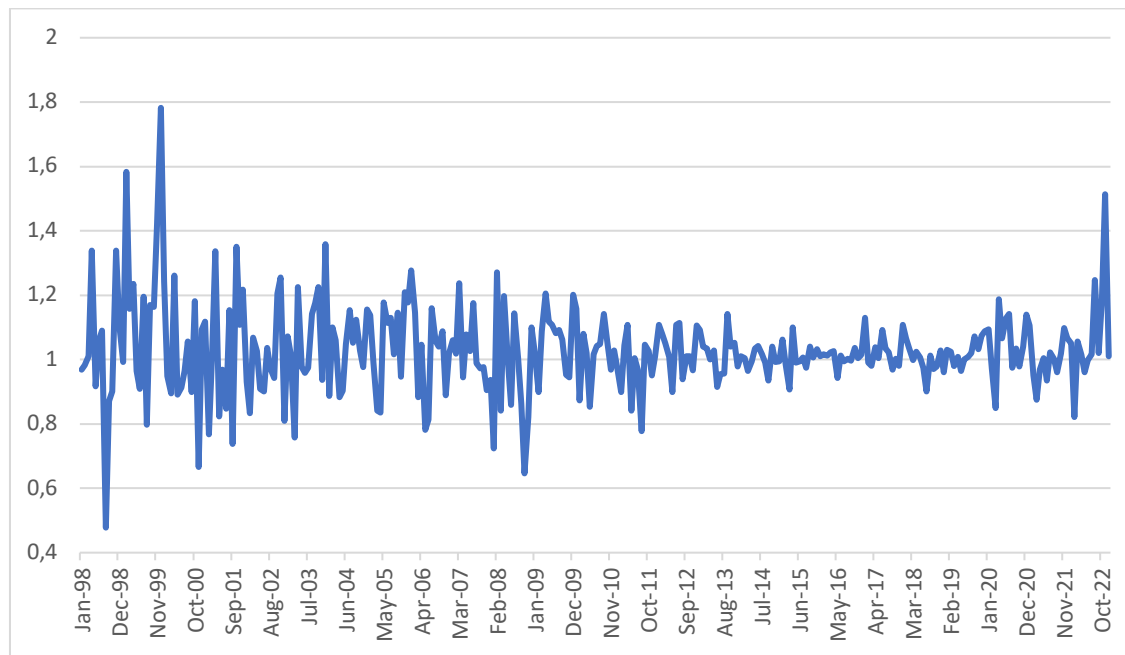


As seen above, there is a trend in the XSGRT index values. For this reason, instead of using the XSGRT index values directly in the analysis, the increase rates compared to the previous month were used.

These increase rate values are shown in Figure 5.11.

As can be seen in the figure, the series is thus free from the trend.

Figure 5.11 XSGRT Index Monthly Proportional Change (1997-2022)



Looking at the monthly rate of change of the XSGRT index, it is seen that the index fluctuates over time. According to the rate of change, it can be said that the index has experienced increases and decreases. While index values increased in some months, they decreased in some months. For example, while the index value was recorded as 1,339 in April 1998, this value decreased to 0.478 in August 1998. The reasons for these fluctuations can be based on various factors, for example, economic conditions, industry news, company performances, etc. In addition, when the general trend of the index is examined, it can be observed that there is a balance between increases and decreases over time.

Analyzing this data is important to provide an overview of the insurance industry and to predict the future performance of the index. Investors and industry analysts can monitor trends and potential opportunities in the insurance industry by considering the XSGRT index values.

Inflation rates generally affect stock market index values. Inflation often reduces the purchasing power of consumers and businesses. This may adversely affect the profits of companies and thus their stock prices. Therefore, high inflation rates can often cause a decline in stock market indices. However, this is not always the case. In some cases, certain industries or companies can mitigate the effects of inflation by increasing their costs or by becoming more efficient. In this case, the stock prices of these companies and therefore their index values may increase. For this reason, inflation values are not included in the scope of the study.

There are also factors that have direct and indirect effects on the indices considered in the study, such as economic conditions, regulations and policies, consumer preferences, technological changes, global trade and competition. However, in order to determine the direct effect of climate change, no other variable other than the temperature variable was used in the study.

5.2. Econometric Modeling

Econometric analysis techniques are used to make a more detailed analysis with large data sets. Thus, it is possible to better understand how the data set performed during the period. Within the scope of the study, regression analysis was performed to determine the effect of climate change on financial markets. Regression analysis is an econometric technique used to determine the relationship between the dependent variable and one or more independent variables. If the relationship between the variables is linear, then “linear regression analysis” is performed. In linear regression analysis, Least Squares Method is used to determine parameter estimates.

In economics, we can often observe situations where one variable can be affected by more than one variable. Moreover, these variables can also interact with each other. In this study, regression analysis was applied to determine the impact of climate change on the agricultural sector from a financial point of view. In regression analysis, while the independent variables are considered as the inputs of the model, the dependent variable is accepted as the output of the model and the relationship between these variables is tried to be determined.

As mentioned before, temperature values and XGIDA, XBANK, XYRT and XSGRT values were used in the study. While the difference of the temperature values compared to the same month of the previous year was used, the change value compared to the previous month was used for the index value of XGIDA XBANK, XYRT and XSGRT. After the variables to be used within the scope of the study are determined, a mathematical model is created that reveals the relationship between the variables in line with the data obtained. With this model, the predictive value of the dependent variable can be found. With the regression analysis, the importance and level of influence of the factors affecting the dependent variable can be determined (Aikeshan, 2014). The models formed in line with these data are as follows.

$$\Delta xgida_t = \beta_0 + \beta_1 * temp_t + \varepsilon_t \quad (1)$$

$$\Delta xyort_t = \beta_0 + \beta_1 * temp_t + \varepsilon_t \quad (2)$$

$$\Delta xsgrt_t = \beta_0 + \beta_1 * temp_t + \varepsilon_t \quad (3)$$

$$\Delta xbank_t = \beta_0 + \beta_1 * temp_t + \varepsilon_t \quad (4)$$

Here, “xgida”, “xyort”, “xsgrt” and “xbank” variables are used as dependent variables while “temp” variable is used as independent variable. The error term “ ε ” has been added to the model in order to represent all the other variables that are effective on the dependent variable in the model to be estimated but cannot be measured or cannot be directly included in the model due to simplicity and being specific to the specific subject. The error term indicates that the model is a stochastic model.

5.3. Results

5.3.1. 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	Δ xgida	Δ xbank	Δ xyrt	Δ xsgrt
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

	<u>Level</u>					
		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.

5.3.2 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 Dependent Variable <i>xgida</i>	Model 2 Dependent Variable <i>xbank</i>	Model 3 Dependent Variable <i>xyort</i>	Model 4 Dependent Variable <i>xsgrt</i>
fixed β_0	1,02414 (0,000)*	1.024398 (0,000)*	1.021622 (0,000)*	1.027721 (0,000)*
temp β_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
Scaled explained 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
Scaled explained 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
Scaled explained 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
Scaled explained 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 (Lagrange Multiplier) test is used to check whether there is autocorrelation (serial dependence) in the 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.

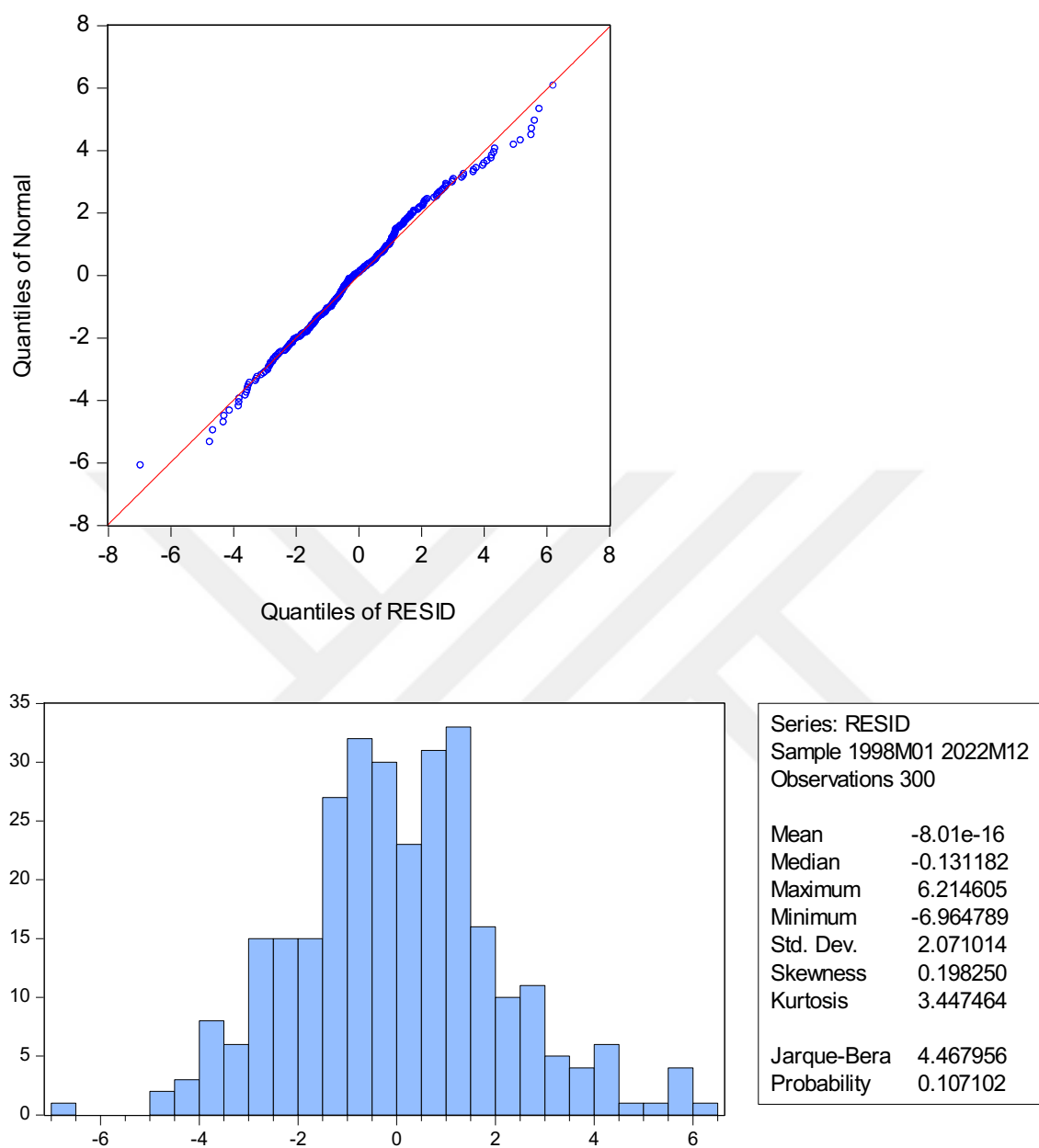
Another assumption that must be provided within the scope of the analysis is the assumption that the errors show a normal distribution. A QQ plot or histogram chart is used to test this assumption.

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.

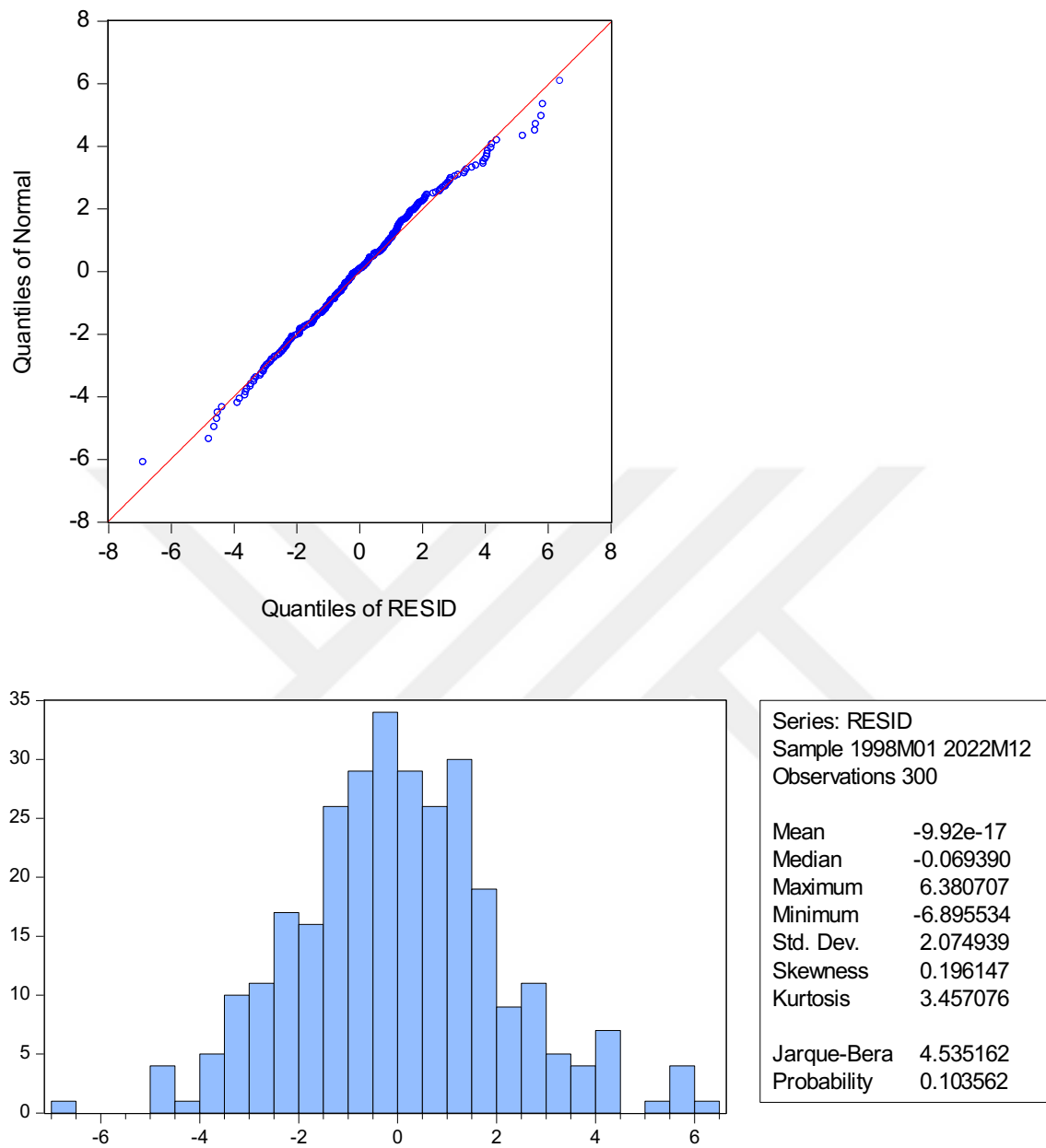
The QQ plot and histogram graph obtained for Model 1 are presented in Figure 5.12. When the results obtained are examined, it is seen that both the QQ plot and the histogram graph show a normal distribution in shape. In addition, skewness and kurtosis values and Jarque-Bera test results show that the error terms are normally distributed.

Figure 5.12. QQ Plot and Histogram Chart for Model 1



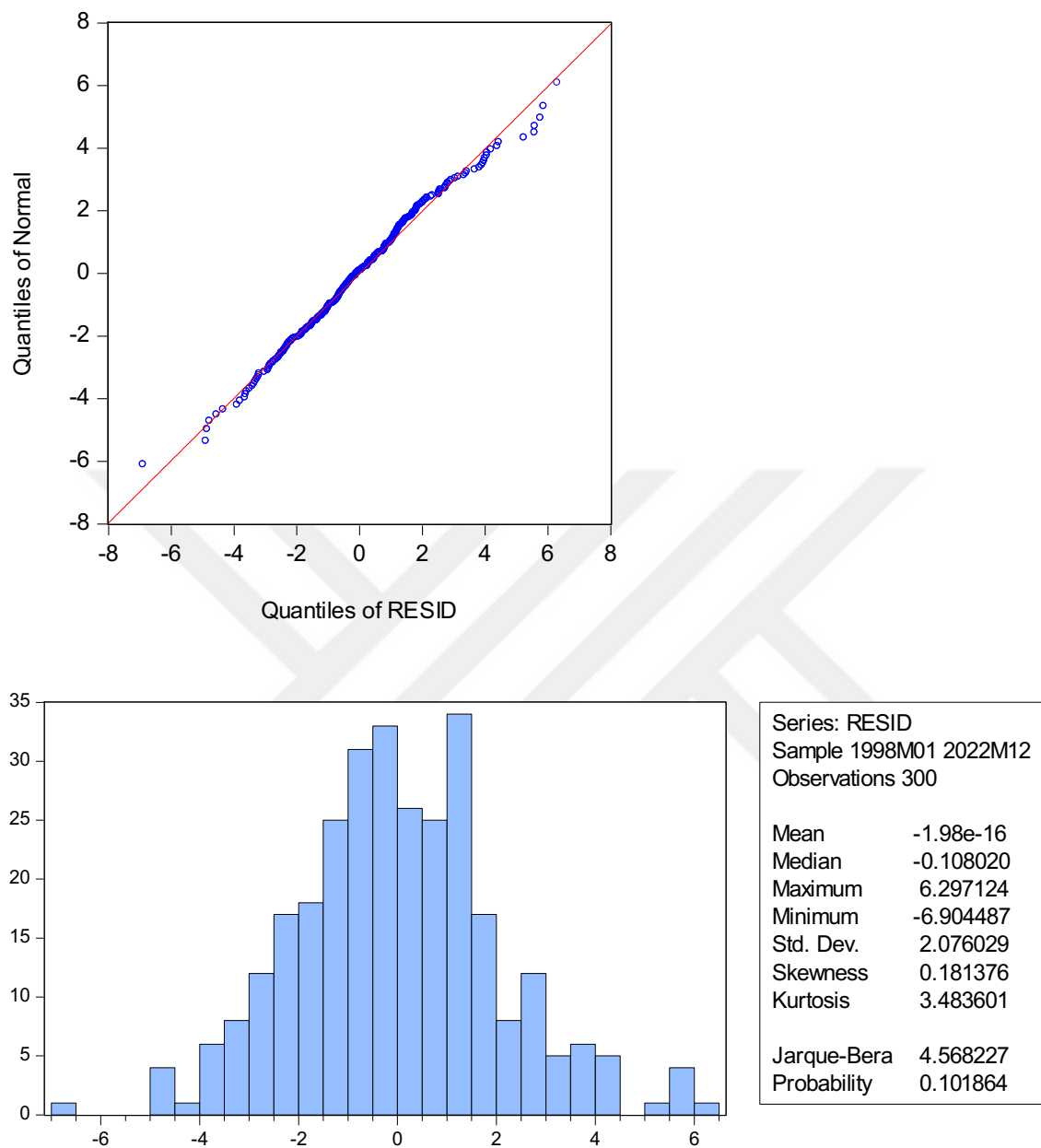
The QQ plot and histogram graph obtained for Model 2 are presented in Figure 5.13. When the results obtained are examined, it is seen that both the QQ plot and the histogram graph show a normal distribution in shape. In addition, skewness and kurtosis values and Jarque-Bera test results show that the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

Figure 5.13. QQ Plot and Histogram Chart for Model 2



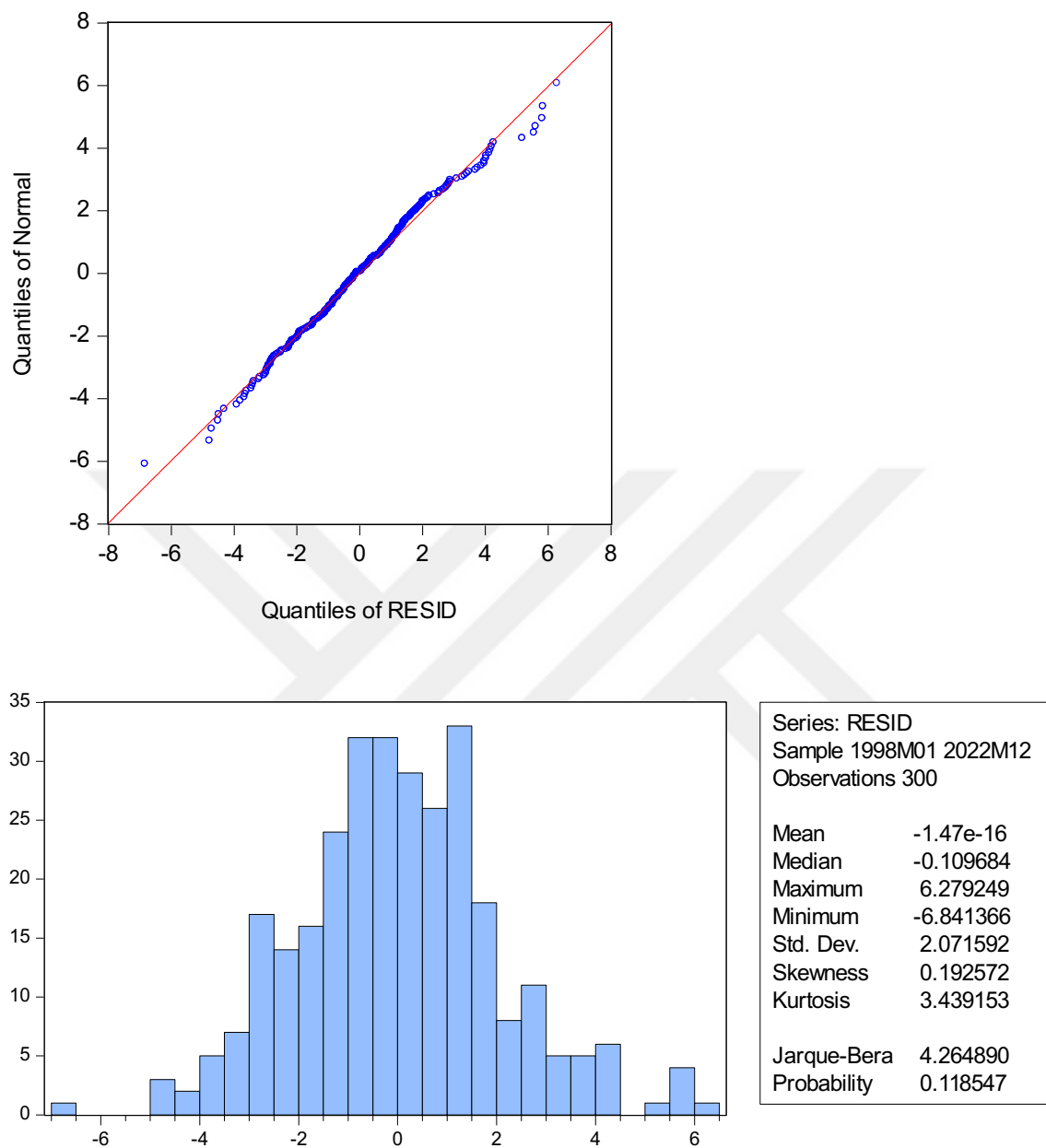
The QQ plot and histogram graph obtained for Model 3 are presented in Figure 5.14. When the results obtained are examined, it is seen that both the QQ plot and the histogram graph show a normal distribution in shape. In addition, skewness and kurtosis values and Jarque-Bera test results show that the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

6. Conclusion and Evaluation

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 increase physical 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 may affect 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 the study 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.

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.

7. Referances

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