DEPENDENCY STRUCTURE OF MAJOR COMMODITY INDICES WITH BIST100 AND WIG20: EFFETCS OF GLOBAL AND GEOPOLITICAL RISKS

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DEPENDENCY STRUCTURE OF MAJOR COMMODITY INDICES WITH BIST100 and WIG20: EFFECTS OF GLOBAL AND GEOPOLITICAL RISKS

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AFYONKARAHİSAR 2025

TEST OF THE OATH

I hereby declare that I have adhered to scientific ethical rules and citation principles throughout the preparation of my Master's thesis titled "**Dependency Structure of Major Commodity Indices with BIST 100 and WIG 20: Effects of Global and Geopolitical Risks."** I hereby acknowledge, declare, and undertake that any discrepancy is entirely my responsibility.

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ÖZET

BIST100 VE WIG20 İLE ANA EMTİA ENDEKSLERİNİN BAĞIMLILIK YAPISI: KÜRESEL VE JEOPOLİTİK RİSKLERİN ETKİLERİ

Yunusemre Salih ÇETINKAYA

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Kasım, 2025

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Finansal piyasalarda yatırımcılar ve politika yapıcılar çeşitli risklerle karşı karşıyadır. Yatırımcıların karşılaştığı en önemli risk türlerinden ikisi jeopolitik ve küresel risklerdir. Bu riskler, finansal piyasalarda dalgalanmalara yol açmaktadır. Ve bu dalgalanmalar bir piyasadan digerine yayılabilmektedir. Bu çalışmanın amacı, 2014'ten 2025 yılına kadar iki borsa endeksini (BIST 100 ve WIG 20) yakından etkileyebileceği düşünülen jeopolitik ve küresel riskler karşısında küresel riskler karşısında başlıca emtia endeksleri ve VIX endeksi ile borsa endeksi arasındaki dinamik volatilite bağlantılılığını analiz etmektir. Dinamik bağlantılılığın analizinde TVP-VAR yönteminin kullanıldığı çalışmada, başlıca emtia endeksleri olarak DJCIGR, DJCICL, DJCING and DJCIGC modele dahil edilmiştir. Öne çıkan değişkenler bağlamında, WIG 20 endeksi ile Diger Altı Degiken arasında, ele alınan yıllardaki küresel ve jeopolitik kriz dönemlerinde genel bir volatilite etkisi tespit edilirken; BIST 100 endeksi için DJCICL, VIX ve WIG20 arasındaki volatilite bağlantılılığı dikkat çekmektedir. Bulgular, ele alınan emtia değişkenleri bağlamında WIG20 endeksinin BIST100 endeksine kıyasla küresel ve jeopolitik risklere daha fazla duyarlı olduğunu göstermektedir. Bu durum söz konusu borsa endekslerinin VIX ile bağlantılılığında da benzerlik göstermektedir. Ayrıca, küresel ve jeopolitik risklerin arttığı dönemlerde BIST100 ve WIG20 endeksleri arasında volatilite bağlantılılığının da yüksek düzeylere çıktığı gözlenmiştir.

Anahtar Kelimeler: BIST100, WIG20, Emtia Piyasaları, TVP-VAR, Finansal Riskler

ABSTRACT

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Investors and policymakers in financial markets face a variety of risks. Two of the most significant risks investors face are geopolitical and global risks. These risks lead to volatility in financial markets, and these fluctuations can spread from one market to another. The aim of this study is to analyze the dynamic volatility connectivity between major commodity indices, the VIX index, and the stock market index against geopolitical and global risks that are thought to have a significant impact on two stock market indices (BIST 100 and WIG 20) from 2014 to 2025. Using the TVP-VAR method in the analysis of dynamic connectivity, the study included the major commodity indices DJCIGR, DJCICL, DJCING, and DJCIGC in the model. In terms of the prominent variables, a general volatility effect was detected between the WIG 20 index and the Other Six Variables during global and geopolitical crisis periods in the years studied. The volatility correlation between DJCICL, VIX, and WIG20 for the BIST 100 index is noteworthy. Findings indicate that, in the context of the commodity variables considered, the WIG20 index is more sensitive to global and geopolitical risks than the BIST100 index. This is similar to the correlation between these stock market indices and the VIX. Furthermore, the volatility correlation between the BIST100 and WIG20 indices has been observed to reach high levels during periods of increased global and geopolitical risks.

Keywords: BIST100, WIG20, Commodity Markets, TVP-VAR, Financial Risks

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INDEX OF SYMBOLS AND ABBREVIATIONS

%: Percentege
BIST 100: Istanbul Stock Market Index
WIG 2O: Polish Stock Market Index
DJCIGR: Dow Jones Commodity Grain Index
DJCICL: Dow Jones Commodity Crude Oil
DJCING: Dow Jones Commodity Natural Gas
DJCIGC: Dow Jones Commodity Gold
VIX: CBOE Volatility Index
TCI: Total Connectedness Index

INTRODUCTION

Risks in financial markets lead to volatility. To overcome these risks and uncertainties, investors must assess them and position themselves accordingly. Following the fundamental principle of finance "put all your eggs in one basket, lest they all break even," investors diversify their portfolios by diversifying their investments across multiple investment instruments to avoid risks and mitigate uncertainty.

Commodities have been at the center of life since the beginning of humanity and have been a critical tool in shaping the economy, being one of the main materials of production and constituting one of the main sources of life for humanity.In prehistoric periods, natural resources such as copper, iron, and stone were primarily utilized to craft tools and hunting implements. These innovations significantly enhanced human survival capabilities and paved the way for the development of agriculture and complex social organization.

Among agricultural commodities, staples like wheat, corn, and barley not only provided sustenance but also functioned as early mediums of exchange within barter economies. As settled societies emerged and production surpluses accumulated, precious metals particularly gold and silver evolved from decorative or basic utilitarian objects into widely recognized mediums of exchange and units of account, forming the foundation of standardized monetary systems (; Flandreau, 1996:865-869; Allen, 2011:14-19). Moreover, the global silver trade from the 16th to the 19th centuries marked the birth of an integrated global economy, especially through silver flows between the Americas, Europe, and China (Flynn & Giráldez, 2002:392-398).

The Industrial Revolution redefined the nature and utilization of commodities. From the late 18th century onward, the mechanization of production and economies of scale elevated commodities from mere means of exchange to primary inputs in industrial production. Coal emerged as the dominant energy source, powering steam engines, factories, and transportation systems (Fouquet, 2010:6588-6591). However, the mid-20th century witnessed a decisive shift toward hydrocarbons oil and natural gas driven by higher energy density, transportability, and post–World War II technological advances (Smil, 2017:235-241).

By the second half of the 20th century, commodities transcended their traditional role in physical trade to become core financial investment instruments. The emergence of

organized exchanges facilitated transparent pricing mechanisms, while derivative products such as futures contracts, options, and commodity indices enabled commodities to serve as hedging tools and portfolio diversifiers, particularly during periods of macroeconomic instability (Gorton & Rouwenhorst, 2006:47-49,63-65; Erb & Harvey, 2006:69-72,92-94).

Today, commodities such as oil, natural gas, gold, silver, wheat, and cotton remain foundational pillars of the global economy and serve as strategic levers in international relations. While their prices are shaped by standard supply demand fundamentals, they are also highly sensitive to external shocks namely geopolitical conflicts, trade sanctions, and global crises leading to pronounced volatility. For example, Zheng et al. (2023) demonstrate that geopolitical risk significantly increases the volatility of commodity futures, especially for energy-related commodities like crude oil, coal, and iron ore, while having a dampening effect on others, such as gold. This asymmetric volatility carries critical implications for investors, policymakers, and businesses navigating risk and uncertainty.

In this context, the main purpose of this study is to measure the dependence structure of major commodity indices on stock market indices and to try to determine the sensitivity of all variables considered to global and geopolitical risks. The analysis incorporates macroeconomic variables, global and geopolitical risk factors, and volatility dynamics to provide a comprehensive understanding of how commodity price movements influence equity markets. By adopting this approach, the study seeks to generate insights that are valuable for both academic research and practical investment decision-making.

In the study, two countries' stock market indices, BIST 100 and WIG20, and global commodity indices, Dow Jones commodity grains, Dow Jones commodity crude oil, Dow Jones commodity natural gas and Dow Jones commodity gold index as well as VIX (CBOE) indices were analyzed and their results were evaluated. In the study, historical data of the variables were taken daily from 2014 to 2025. TVP-VAR method was used as the model in the study.

The BIST 100 and WIG 20 indices discussed in the study were chosen because the two countries' sensitivity to the global and geopolitical risks identified in the study is believed to be similar. Furthermore, macroeconomic indicators such as inflation and growth rates, in addition to other variables analyzed, exhibit similar reactions and behave similarly during crisis periods. Both countries also have significantly high foreign trade

(World Bank, 2025, TUİK, 2025). From another perspective, the fact that both countries serve as bridges Türkiye being at the center of the European-Asian connection, and Poland being between Europe and Russia, thus creating a link to Asia through Europe places both countries at a geopolitically critical juncture. Therefore, any uncertainty or crisis that may arise in these continents would directly impact these countries.

In recent years, economic cooperation between Turkey and Poland has continued to strengthen. Turkey's exports to Poland reached 4.7 billion dollars in 2021, rising to 5.4 billion in 2022, 5.9 billion in 2023, and 6.2 billion in 2024. With these figures, Poland ranks as Turkey's 12th largest export destination as of 2024. Therefore, the growing trade ties between the two countries represent an important dimension that should not be overlooked (TÜİK, 2025).

This study is comprised of three sections. The first section examines and addresses financial markets, financial market instruments, and the concepts of systematic and unsystematic risk affecting financial markets and instruments, including volatility and its subheadings. The second section provides definitions and available global data for key critical commodities, and assesses these risks within the context of global and geopolitical risks during the analyzed period. In the third section, the purpose of the study, its scope and significance, the hypotheses of the study, the data collection method, the analysis method, the limitations of the study and the findings of the study are given and evaluated.

CHAPTER I

RISK AND VOLATILITY IN FINANCIAL MARKET

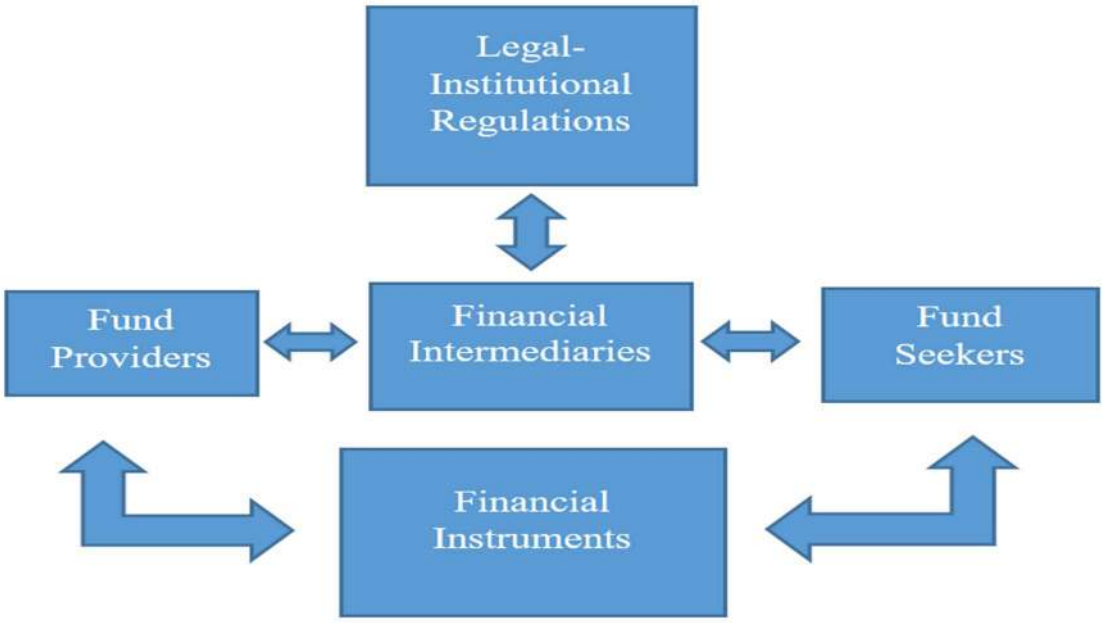
1. FINANCIAL MARKETS AND THEIR FUNCTIONING

Nowadays, financial markets are diversifying and investors are trading and holding their investments in these diversifying markets. Developments and risks in the markets affect investors directly or indirectly. In the following sections, we discuss both financial markets and mention about financial market instruments, the functioning of financial markets and the risks they are affected by.

1.1. FINANCIAL MARKETS

Financial markets are a transmission mechanism that allows businesses or individuals with excess funds to transfer these funds to businesses or individuals in need (Mihajlović, 2016:31). Any physical or virtual environment that allows individuals or institutions with excess savings in the economy to transfer these savings to individuals or institutions that will create added value by using them more efficiently is defined as a financial market. Transactions between those who supply and demand funds in markets are carried out through the purchase and sale of documents known as negotiable instruments. Therefore, financial markets are also markets where securities are traded (Yalçın, 2015:19).

Figure 1. Structure of Financial System



Source: Afşar, 2007: 189

Figure 1 characterizes and shows the positions of fund suppliers and fund demanders, and intermediary institutions and legal regulators in the supply of funds. While fund suppliers and demanders can exchange funds directly, they usually do this through intermediary institutions. Here, legal regulators function in the legality of transactions and other legal matters.

It is possible to classify financial markets according to various criteria. Those with a maturity of up to 1 year are called money markets and those with a maturity of 1 year or more are called capital markets. Financial markets are also classified according to whether there is a trading venue or not, and In this context, organized markets are places where transactions are conducted in a specific physical location or on an electronic system with standardized rules and transparency principles (such as stock exchanges), while unorganized markets (such as over-the-counter markets) are markets where parties meet directly under more flexible conditions and without a central structure. (Korkmaz and Ceylan,2017:3-4). There is another type of classification called primary market, secondary market, cash and derivatives markets. (Korkmaz and Ceylan,2017:3) Primary markets can be called places where companies offer securities directly to investors. Secondary markets are called markets where investors trade with each other (Schwartz,2019:1069.)

1.1.1. Money Markets Instruments

Money market instruments are classified as instruments such as treasury bills, bank acceptances, repo, commercial papers, Eurodollars, negotiable certificates of deposit, interbank funds, asset-backed securities (Küçük,2020:14).

Treasury bills are one of the short-term debt instruments and are issued at a discount, therefore their nominal value includes principal and interest (Dabbağoğlu,2010:54).

Bank acceptance is one of the most seasoned disobedient utilized in worldwide installments. It is an instrument comparable to a check utilized in shared installments between two exchanging accomplices who don't know each other and who work in numerous nations. The explanation "It is ready by the merchant and acknowledged by the importer's bank" is sent to the exporter or the exporter's bank, demonstrating that the installment will be made (Küçük,2020:14).

Repo can be defined as a contractual obligation to sell an existing security on a spot basis at a price close to the market price and an agreement to repurchase the same security at an agreed price at a specified or indefinite future date. Maturity reflects the spot price during the Repo period. Thus, repo is the simultaneous spot sale and forward purchase of the same financial instrument. There are two parties in a repo are called the seller and the buyer (Faure,2011:195).

Commercial paper is a short-term, unsecured debt instrument issued by corporations and foreign governments. It is sold directly or through brokers to institutional buyers, providing a low-cost alternative to bank loans, and allows large amounts of funds to be raised quickly and without the need for registration with the Securities and Exchange Commission (SEC). Investors earn market-compatible returns from the notes, the maturity and amount of which are adjusted to their needs (Hahn,1993:45).

Eurodollar deposits are examples of assets that substitute for bank debt in one country, with the yield tied to the collateral rate of another country. In effect, the Eurodollar market connects the United States to the rest of the world's foreign exchange markets, and the transmission mechanism works both ways (Levin,1974:207).

Transferable certificates of deposit are certificates issued by banks that certify the deposit of funds to be paid at a specified future date. Such certificates may be legally exchanged only by endorsement and delivery if payable to the order of the person specified therein, or only by delivery if payable to the bearer (Murdeshwar,1970:1606).

The interbank market is the market in which foreign exchange trading takes place between large private banks (CFI,2024).

Asset-backed securities (abs) An application that offers affordable financing options and improves capital structures. The company aims to eliminate asset-liability imbalances and ensure that the balance sheet is easily convertible, as well as improving liquidity and is a financing method aimed at increasing the efficiency of the System (Vatansever,2000:259).

1.1.2. Capital Market Instruments

In their studies, Osayi and Idume (2024) grouped capital market instruments under 6 headings: stocks, bonds, mutual funds, exchange traded funds, real estate investment trusts and derivatives (Osayi&Idume,2024).

Chui (2012) in his work states that the Oxford dictionary defines the term derivative as something that is derived or derived from something else, not something original. In the context of financial economics, a derivative financial instrument is generally defined as a financial contract that derives its value from an underlying asset or simply the value of the underlying asset (Chui,2012:3).

Stocks symbolize ownership in a company and give shareholders the right to a share of the company's assets and earnings. Investors can profit from dividends and increases in the value of their investments. Stocks are bought and sold on stock exchanges (Osayi&Idume,2024:3). After defining the stock, it is necessary to classify them and briefly mention the types of stocks classified. It is possible to examine these types under 5 headings: bearer and registered shares, ordinary and privileged shares, paid and unpaid shares, shares with and without premium, and founder and usufruct shares (Yerdelen Kaygın,2013).

The most important distinguishing feature of bearer and registered shares is whether they are written to the person in possession or not to the name but to the bearer. While bearer shares are easier to transfer, registered ones are not easy to transfer, partnership structures should be mentioned. Another criterion is the danger criterion. Bearer shares can be easily used by the person who acquires them when lost, but registered ones cannot be used (Aykut,2015:23).

Ordinary shares can be classified as nominal or non-par value, and at the same time, they provide equal rights to the person who holds them, such as the right to vote in the general assembly of the company in which the share is held, equality in profit distribution and liquidation transactions, and also the right to speak in the sale of assets on the company's balance sheet and other company mergers (Gök,2019:55).

The most important difference between preferred shares and ordinary shares is the privileges granted. If a shareholder is granted different rights than other shareholder, these are called preferred shares and preferred shares do not have to be equal to all shares, they can be valid for a single share. Examples of these privileges are dividend distribution, participation in liquidation and similar issues (Ünal,2000:2-3).

Shares issued with a cash capital increase are called "Paid shares", while shares issued with a capital increase provided by internal resources are called "Unpaid Shares"(SBKYB,2024).

According to the Turkish Commercial Code, it is not possible to issue shares below their nominal value. Shares issued above their nominal value are called "premium" shares, and those issued at their nominal value are called "non-premium" shares (Yerdelen Kaygın,2013:8).

Founder shares are a type of share certificate that does not represent a specific share of capital and does not grant its owners a say in management. These shares are registered in the names of the founders and issued free of charge in order to represent a specific participation right in return for the establishment service. There are shares that are given to certain people in return for various services and receivables after the establishment of the company, with a decision to be taken by the general assembly of the company. These shares do not represent a capital share like founder shares. In addition, shares that are paid back to the partner are also among these types of shares (Karslı,1989:343).

The Cambridge Dictionary (2025) defines a bond as a formal document issued by a government or a company that shows that you have lent money to be paid back at a specified rate of interest.

Sharpe says that investment funds involve processes such as security analysis, portfolio analysis and portfolio selection in the desired risk class, and portfolio managers must choose the most appropriate risk level from a diversified portfolio (Sharpe,1966:121).

Exchange traded funds (ETF) are investment companies that issue securities that are traded on public exchanges on an ongoing basis. Most exchange traded funds are legally structured as open-ended investment companies, and many aim to track a particular index of securities. Unlike traditional mutual funds, these funds allow investors to not only buy and sell stocks at the end of the trading day, but also to buy and sell stocks on an ongoing basis throughout the trading day (Ben-David et al.,2017:171).

Real Estate Investment Trusts (REIT) are closed end investment entities with publicly traded shares, acting as financial intermediaries to channel funds into the real estate sector. These trusts are often utilized by investors as a means to access the real estate asset class while achieving their return and portfolio objectives, benefiting from the liquidity offered by the secondary market for real investment trust’s (Corgel et al.,1995:14.)

Derivatives are a general term for legally protected contracts whose prices are incorporated into commodities, financial instruments or derivatives suitable for reference. (Malkawi,2014:42) Kayahan and Görkaş stated in their studies that derivative market products consist of 4 basic financial products in today's world; these are forward, futures, options and swaps (Kayahan and Görkaş,2023:324).

A forward contract is a commitment between two parties, established in advance, that outlines the conditions of a trade to be executed on a predetermined future date. These agreements are classified as "over-the-counter" (OTC) transactions, meaning they are directly negotiated between the involved parties rather than being facilitated through a centralized exchange. The key benefit of forward contracts is their adaptability, allowing customization of aspects such as the contract duration and the specific attributes of the asset being traded. However, both parties are exposed to the risk that the counterparty may default on its obligations (Sundaram,2012:3).

Futures contracts are transactions in which a buyer and seller commit to buy or sell a specific good or service in the future. The seller is in a “short” position when he sells a good that he does not have, and the buyer is in a “long” position when he commits to buy it in the future. These contracts are created by agreement of the parties with brokerage firms in accordance with set standards and are traded on specific exchanges (Oğlu,2001:94).

Option contracts are agreements that give the buyer, who pays a premium, the right to buy or sell an asset of a specified quantity and quality at a predetermined price on a specified date (European options) or before that date (American options) (Ersoy and Ünlü,2016:144).

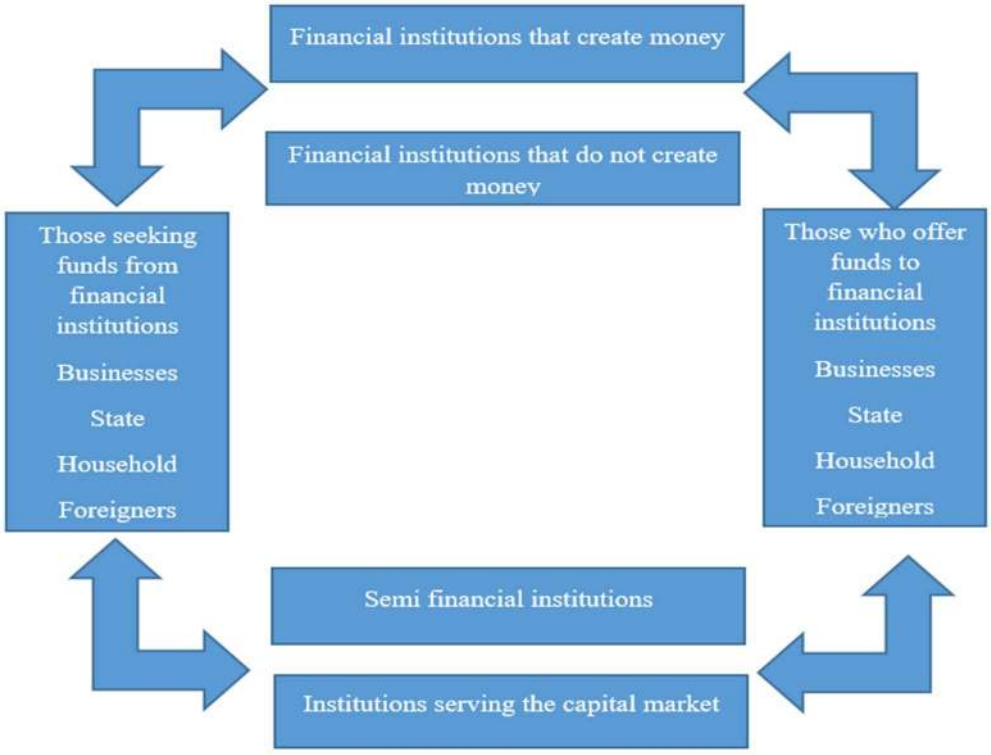
Swaps are forward contracts that form the basis of OTC derivatives, where two parties agree to exchange payments over a specified period of time according to set conditions. With the exception of currency swaps, the number of payments is usually based on an agreed notional amount that is not directly exchanged. Swap contracts are a privately negotiated OTC transaction, as they are carefully tailored to the needs of the parties. These periodic payments can be fixed or floating, and the swap takes place as each party demands the form of payment that the other has (Motes,1995:590).

1.2. FUNCTIONING OF FINANCIAL MARKET

In financial markets, the supply and demand for funds can be met directly or indirectly through financial intermediaries. In financial markets, funds are usually exchanged through financial intermediaries. In financial markets, when there is no intermediary institution involved in the exchange of funds, it is called direct financing. If funds are exchanged using an intermediary institution, it is called indirect financing (Aydın et al.,2014: 41-42).

Figure 2 characterizes and shows how funds flow between intermediary institutions. Accordingly, funds can be transferred through semi-intermediary institutions, while they can also be transferred through institutions that provide services to the capital market. On the other hand, intermediary institutions that provide the transfer between those who supply and demand funds are institutions that create money and those that do not create money in the financial markets. Thus, those who supply and demand funds in the financial markets meet.

Figure 2. The flow Of Funds Between Suppliers And Demanders Of Funds



Source: Aydın et al,2014:42

From an economic perspective, financial markets can be defined as a system or arrangement that facilitates the voluntary coming together of fund providers and fund

seekers. This definition encompasses three key elements. Firstly, these arrangements may range from loosely organized networks, such as foreign exchange markets, to highly structured entities, like futures markets. Secondly, the agreements formed within these markets may be formal contracts, but they are not necessarily required to be so. Lastly, while participation is voluntary, legal enforcement mechanisms may be utilized to ensure compliance with the agreements (Bailey, 2005).

Markets must fulfill several essential functions to operate effectively (Bailey, 2005).

Information Dissemination and Price Discovery: Financial Markets play a critical role in conveying information to participants, enabling them to discover the prices at which transactions can occur.

Provision of a Trading Mechanism: Financial Markets facilitate the formation of agreements by providing a platform or mechanism through which buyers and sellers can communicate and negotiate.

Execution of Agreements (Settlement Function): Financial Markets are responsible for ensuring the fulfillment of agreements by confirming transactions, clearing trades (registering the transfer of ownership with the issuer), and settling accounts (facilitating the exchange of funds). Furthermore, markets must safeguard against risks such as fraud, defaults, or other forms of misconduct. In this context that the regulation of financial markets becomes particularly significant.

2. RISK AND PORTFOLIO IN FINANCIAL MARKET

The risk that investors face when investing in financial market instruments is an important factor for them. Determining, measuring and managing risk represents the basic elements in interpreting and examining financial markets. Investors in financial assets generally do not put all of their eggs in one basket; that is, ınvestors are generally not happy to put all their financial assets in a single financial investment assets. Typically, an investor will hold a bundle of financial assets (Pilbeam, 2005:156). In general, investors are concerned with two basic variables, namely risk and return in their portfolio of assets. Most investors want to hold productive portfolios that provide optimal expected returns and, equivalently, minimize expected risk (Pilbeam, 2005:157).

The capital market has an almost infinite number of financial securities and real estate that investors and fund seekers can use to increase the value of their investments,

stabilize their returns, reduce risks, or provide investment financing by anticipating them. To achieve these three fundamental characteristics, most investors will favor to put money into a aggregate of monetary securities and/or physical assets. This aggregate of securities, investments and assets held by investors to meet their defined risk-return objectives is referred to as a Portfolio. Logically, each investor is inquisitive about investments that offer excessive return with low risk. According to Capital Asset Pricing Model (CAPM), any combination of securities that offer excessive return however low risk is taken into consideration efficient and need to consequently be preferred. Portfolio control is consequently described as the cautious selection, acquisition and monitoring of the overall performance of a combination of securities in the capital marketplace held by an investor and guarantees that the securities gain their designated funding targets over a designated preserving length and growth in price over successive preserving periods, as a consequence growing the efficient potential of the economy (gross constant capital formation) (Ngerebo-A&Torbira, 2014:23).

All risk concepts share the basic principle of probability, which is inherent in human nature. It can be said that individuals, institutions, and societies anywhere face multiple courses of action that produce positive and negative consequences in a chain that includes inaction. Risk assessment aids in identifying the option most likely to yield greater benefits than harms when compared to alternatives. Assuming the contingent nature of actions, risk can be defined as the probability that an undesirable state (adverse outcomes) may arise due to natural phenomena or human endeavors. This understanding suggests that humans inherently establish causal links between actions or events and their potential consequences. These outcomes can be influenced either by altering the initiating action or event or by mitigating its impacts. Thus, the concept of risk comprises three key components: the outcomes that affect what people value, the uncertainty or likelihood of their occurrence, and the specific context in which the risk may manifest (Renn, 2008:50). There are two types of risk, one is systematic risk and the other is non-systematic risk.

2.1. SYSTEMATIC RISK

Smaga Says Dow highlights that moral hazard, the most common type of systemic risk, plays a significant role in demotivating financial institutions. Systemic risk arises from: excessively risky actions by a single investor or group of investors, an aggressive organizational culture (focus on short-term profits), failure of financial system to collectively manage, which leads to inertia and an inability to adapt to changing economic

conditions (Smaga, 2014:3). Systematic risks are examined under 4 headings: exchange rate, market, inflation and global and geopolitical risks. These risks are examined in this section.

The greatest and most significant risk that economic decision makers face while carrying out economic activities and before making investment decisions arises from their inability to predict future exchange rates (Akarsu and Alacan, 2019:80). Currency risk was first defined by Adler and Dumas in 1984 as unexpected changes in exchange rates. According to this definition, possible and expected changes in exchange rates do not constitute exchange rate risk. The economic activities of companies have substantial impact on the economic development of countries. With globalization and liberalization, nations are developing in terms of consumption and production, aiming to foster the economies of developing countries. At the same time, in order to bring countries closer to each other and develop international economic relations, individuals, companies and countries in this cycle need to be aware of this transformation and take into account the risks that may be encountered. The foreign exchange market is larger than other markets in terms of volume and value. In particular, the collapse of the Bretton Woods system, the market-based exchange rate fixing and the subsequent oil shocks, depressions and political tensions have left global markets in a challenging position (Akarsu and Alacan, 2019:84).

Market risk refers to the possibility of loss due to risks like interest rate risk, foreign exchange rate risk, commodity price risk, option risk and stock price risk that arise from interest rate, exchange rate and price changes resulting from fluctuations in financial markets in financial positions held.(Akçay et al.,2009:137) market risk is expressed in another definition as follows the risk that the investment will not generate the desired profit due to fluctuations in the market (Özbilgin,2012:89).

Inflation risk is becoming major factor especially in countries with high inflation such as Turkey. The decrease in the purchasing power of money due to the increase in the general price level affects the effectiveness of securities investments. The inflation rate is an uncertainty and negatively affects investments. Because of this, inflation rate is a one of the key risk factor for investors. Inflation rate is a criterion for investors when making investment decisions. Real profit can only be achieved if the investment return is above inflation. Investments that provide fixed income (bonds, repo, etc.) are most

affected by inflation. Stocks are financial assets that are less affected by purchasing power (Usta and Demirelli, 2010:27).

political risk is the possibility of political events that could change the rate of return that investors expect from their investments (Kobrin,1979:68). Political risk in a country refers to the possibility that investments made may be negatively affected by deficiencies that may occur in the legislative, executive and judicial systems of the country. However, terrorist activities, internal and external international conflicts and strikes are also components of political risk (Bekaert et al.,2014:4).

Geopolitical risks (GPRs) are considered to be one of the determining factors that have a significant impact on economic fundamentals and stock market dynamics. Another important risk source, such as economic policy uncertainty (EPU), measures the uncertainty arising from economic and political developments, while GPR is said to have a higher probability of affecting economic and financial cycles more independently, as it includes risks such as wars, terrorist incidents and political conflicts. It is also stated that geopolitical risks are frequently emphasized by central bankers, financial circles and corporate managers as a factor shaping investment decisions and therefore have a significant impact on business cycles and global financial markets (Böyükaslan et al.,2024:73). Turkey, where one of our samples, the BIST100 index, is traded, has also encountered such political risks many times. For example; the Syrian civil war that started in 2011 and continued until December 2024, the coup attempts on July 15, 2016, the terrorist attacks in Eastern Anatolia that started in 1984 and still partially continues, the conflict between Israel and Palestine, and the war between Ukraine and Russia. Poland, where another sample, the WIG 20 index, is traded, has also been exposed to the risk of international conflict, which is one of the similar political risks. The war between Russia and Ukraine directly affected Poland. Approximately 3.5 million Ukrainian refugees came to Poland from Ukraine after the war. (Duszczyk & Kaczmarczyk, 2022). Turkey, one of the countries in our sample affected by geopolitical risks, has been directly affected by the events in Syria. The refugee flow from Syria has a direct impact on Turkey's social and economic life. Another geopolitical risk that has common effects between Turkey and Poland, which is our sample, is the Russia-Ukraine war, which has caused uncertainty in the energy market. Considering that Turkey's highest import item is energy, it has had an impact.

2.2. NON-SYSTEMATIC RISK

Unsystematic risk is the risk inherent in investments that is related to the conditions found in each company. It is possible to reduce this risk by diversifying (Utami&Lihu,2024:119). Unsystematic risks are examined under 3 headings: financial, industrial and occupational and management risks. Explanations related to these risks are made in this section.

It is possible to collect the financial risks faced by businesses under four headings: operational risk, credit risk, liquidity risk and market risk (Yücel et al.,2007:2). Operational risk is generally defined as all risks other than credit and market risks. The Basel Committee defined operational risk as the risk of loss that may arise due to inappropriate or malfunctioning internal processes, human factors, systems or external factors (Şahin,2011:21). The concept of liquidity is linked in the literature to the ability of an economic actor to exchange its holdings for goods and services or other assets. (Nikolaou,2009:10) credit risk is a type of risk that arises from the possibility that a party to a contract may default on its obligations (Brown&Moles,2014:1-2). market risk is a type of risk that arises from changes in stock prices, interest rates, exchange rates and commodity prices. in fact, market risk arises from the fluctuations in the market that organizations face (CFA Institute,2024).

The sales, profits and therefore stock prices of businesses operating in more than one sector may fluctuate significantly for various reasons. These fluctuations may not be affected by factors developing outside those sectors. For example, factors such as changes in consumer preferences, increased foreign competition, worker strikes in the sector and difficulties in supplying raw materials may affect the sales and profits of businesses in certain business lines and lead to changes in the prices of securities issued by these businesses (Bolak,2004:7-8).

Management risk is any type of risk that may harm the company's performance, reputation and its ability to continue as a sustainable company due to inefficient, inadequate or unethical company management. Management risk is a concern for shareholders, however, the board of directors can also be seen as a source of risk in its own right (Beecham, 2022).

2.3. PORTFOLIO AND PORTFOLIO THEORIES

A portfolio can be defined as a basket of financial assets that an investor assembles, taking into account the risks they will acquire and the risks they will face. These assets can be classified into a wide variety of investment instruments, such as stocks, bonds, currencies, commodities, and derivatives. The primary purpose of a portfolio is to achieve the highest possible return at a given level of risk or the lowest possible risk at a given level of return (Pilbeam, 2005:156). In this sense, a portfolio should not be seen merely as a random aggregation of different assets, but rather as a deliberately structured set of investments aimed at diversification and risk management.

In the finance literature, the relationship between risk and return lies at the core of the portfolio concept. While traditional approaches considered diversification across asset classes as a way to reduce risk, they lacked a systematic measurement framework. With the emergence of Modern Portfolio Theory, covariance and correlation between asset returns began to be considered, demonstrating that diversification can only eliminate unsystematic risk (Markowitz, 1952). Consequently, portfolio construction has been placed on a mathematical foundation, enabling investors to form "efficient portfolios" by accounting for the interrelationships between different assets.

At this point, commodity markets stand out as one of the key application areas of portfolio theory. Commodities particularly gold, oil, agricultural products, and their indices—offer investors the opportunity for diversification and hedging. For instance, gold is widely regarded as a "safe haven" asset, while oil and natural gas prices reflect energy sector fluctuations that may either increase or balance portfolio risk (Erb & Harvey, 2006: 70-75; Gorton & Rouwenhorst, 2006:54-63). Thus, the role of commodity markets in portfolios goes beyond speculative gains, serving as a critical strategic instrument for investors seeking protection against systematic risks.

In conclusion, a portfolio lies at the heart of investors' rational decision-making processes in financial markets, providing a framework for the joint management of different asset classes. Particularly, the integration of commodity markets into portfolios not only enhances return potential but also reduces the uncertainty investors face during periods of heightened global and geopolitical risks.

Portfolio theories are central to the study of finance as they provide a systematic framework for evaluating how investors can maximize returns while minimizing risks

through diversification. The essential premise is that portfolios composed of multiple assets can achieve a more favorable risk–return profile than individual investments (Fabozzi & Markowitz, 2011). Traditional approaches emphasized diversification primarily in qualitative terms, whereas modern theories quantify this relationship through mathematical models.

The most influential milestone was the introduction of Modern Portfolio Theory (MPT) by Markowitz (1952), which established risk as a measurable concept expressed by variance, and return as the expected value. This development enabled investors to construct "efficient portfolios" and marked the beginning of a new era in portfolio management. Over time, the theory has been expanded and refined, with mean–variance optimization becoming the cornerstone of asset allocation practices (Elton et al., 2009:141-164).

In recent years, portfolio theory has been extended to include alternative asset classes such as commodities, real estate, and exchange-traded funds. Commodities in particular have been found to improve portfolio resilience by providing diversification benefits and serving as hedges against inflation and macroeconomic shocks. Recent empirical studies confirm that integrating commodities into traditional stock–bond portfolios increase stability during financial crises and enhances long-term performance (Tang & Xiong, 2012:54-65; Bhardwaj et al., 2014:3100-3102;). These findings highlight the dynamic nature of portfolio theories, which continue to evolve in response to new asset classes and global economic realities.

2.3.1. Traditional Portfolio Theory

Traditional portfolio theory reflects the early stage of investment thought, developed before the advent of quantitative finance models. It emphasizes that investors can reduce exposure to uncertainty by diversifying across different assets, sectors, or regions. Diversification was viewed as the key mechanism for balancing risk and return, even though risk itself was not formally measured (Lintner, 1965:587-588).

In this framework, investors generally constructed portfolios by combining equities with bonds, relying more on practical guidelines than on analytical optimization. The approach primarily aimed at preserving capital and generating stable returns over time, rather than achieving maximum efficiency (Mossin, 1968). However, one of its

main shortcomings was the lack of an explicit method to evaluate the correlation among assets, which limited its ability to determine the “optimal” allocation.

Despite these limitations, the traditional view provided the intellectual foundation for more advanced portfolio models. Later studies began to incorporate formalized measures of risk and return, thereby laying the groundwork for modern portfolio theory and mean–variance analysis (Sharpe, 1964:425-434; Fama, 1965:34-39).

2.3.2. Modern Portfolio Theory

Modern Portfolio Theory (MPT) marks a fundamental shift in investment science, introducing a quantitative framework for analyzing the relationship between risk and return. Developed by Markowitz (1952), MPT emphasizes that the risk of a portfolio should not be assessed solely on the individual variance of each asset but on the covariance among them. By mathematically modeling expected returns and variances, Markowitz demonstrated how investors could construct efficient portfolios that achieve the highest return for a given level of risk, thereby formalizing the principle of diversification (Elton & Gruber, 1977:415-419).

The introduction of the “efficient frontier” concept was central to this framework, as it identified the set of portfolios that optimize the trade-off between risk and return. This innovation laid the foundation for subsequent theories in asset pricing and capital markets, including the Capital Asset Pricing Model (CAPM) developed by Sharpe (1964) and Lintner (1965). These later contributions extended MPT by linking portfolio risk to expected returns in equilibrium market conditions.

Empirical studies have further validated the practical relevance of MPT, showing that diversified portfolios can significantly reduce unsystematic risk while maintaining attractive levels of expected return (Fama & French, 1992:427-429). Moreover, the framework has proven adaptable to different asset classes, including commodities, which have been shown to improve portfolio efficiency by providing inflation hedging and diversification benefits (Jensen et al., 2002). As a result, MPT remains one of the most influential and enduring theories in modern finance.

2.3.3 Mean-Variance Model

The mean–variance model represents the mathematical backbone of Modern Portfolio Theory and remains one of the most enduring frameworks in finance. Its central idea is that investors evaluate portfolios based on two criteria: expected return, reflecting

the weighted average of asset returns, and variance, which captures the degree of risk or uncertainty (Levy & Markowitz, 1979:308-309). What distinguishes this model is its explicit incorporation of covariance between assets, showing that true diversification benefits arise when assets do not move perfectly together.

Within this framework, the efficient frontier defines the set of portfolios that provide the maximum expected return for a given level of risk or, equivalently, the minimum risk for a given return. Portfolios lying below this frontier are considered inefficient because they expose investors to unnecessary risk (Jobson & Korkie, 1980:544).

Although the model's assumptions such as normally distributed returns and investors' reliance solely on mean and variance have been debated, its relevance has been confirmed in numerous empirical studies. For example, DeMiguel et al. (2009:1939-1940) highlight that mean–variance optimization generally outperforms naïve diversification strategies, even though implementation requires accurate estimation of input parameters. Furthermore, recent contributions have extended the model to account for global portfolios and alternative assets, demonstrating its applicability beyond traditional stock–bond allocations (Harvey et al., 2010:1-2).

3. VOLATILITY IN FINANCIAL MARKET

Volatility is a measure of the variability in price over a certain period of time and expresses the standard deviation of the logarithmic transformed price or price index over a certain period of time. Increases in unemployment rates, political uncertainties, price uncertainties in financial assets traded on stock exchanges, increases and decreases in foreign exchange and interest rates due to economic uncertainties in countries are described as volatility in the financial market and cause the risk factor to emerge rapidly together with the uncertainties in the markets (Çelik,2019:33).

Scott emphasizes in his paper that an in-depth examination of financial market volatility necessitates a theoretical framework for understanding how capital market instruments are priced within these markets. and the theory should provide an explanation of how capital market asset prices are determined and why and how prices change in a dynamic world (Scott,1991:583).

According to the asymmetric stochastic volatility model, decreases in financial asset returns lead to an increase in the volatility of these assets, while increases in returns

lead to a decrease in volatility. However, the level of uncertainty caused by negative returns is higher than the uncertainty caused by positive returns of the same magnitude. This asymmetric relationship between returns and volatility can be explained by the fact that adverse developments in financial markets lead to a decline in corporate stock prices. This decline in stock prices increases the company's risk level by raising the debt-to-equity ratio. Increased risk perception, in turn, leads to an increase in the expected volatility of the related stock. From this perspective, the process that starts with a decline in stock returns also creates an asymmetric effect that results in an increase in the volatility of the financial asset (Büberkökü,2019:506).

Aygören argues that volatility in financial markets is an important factor that investors should look at when making investment decisions. however, According to Aygören investors cannot make price forecasts because any unexpected situation will affect their perception of future price forecasts. The author emphasizes that investors are more interested in the concept of volatility than future price forecasts. share price volatility is related to risk. If the volatility of a stock is high, the share price can be as high or as low, but volatility does not equal risk. In the capital asset pricing model, it is understood that the risk of a stock depends not only on volatility but also on the correlation relationship (Aygören,2005:200-201).

The concept of mean reversion plays a central role in the analysis of financial time series and asset pricing. Mean reversion refers to the tendency of a financial asset's price or return to move toward its historical average over time (Poterba & Summers, 1988:3). This phenomenon implies that deviations from a long-term equilibrium level are not permanent and that extreme values are followed by adjustments in the opposite direction.

From a modeling perspective, mean reversion is commonly captured by stochastic processes such as the Ornstein-Uhlenbeck process, which assumes that asset prices exhibit a “pulling force” back toward their mean level (Uhlenbeck & Ornstein, 1930:823). The presence of such a force implies predictability in price movements, which contradicts the notion of a purely random walk. The relevance of mean reversion challenges the Efficient Market Hypothesis (EMH), particularly its strong form, which posits that prices fully reflect all available information and follow a random walk (Fama, 1970:386). However, empirical studies have demonstrated that certain asset prices do show patterns of mean reversion, especially in the medium to long term (Lo & MacKinlay, 1988:41; Balvers et al., 2000:745-746).

From a behavioral finance perspective, mean reversion is often attributed to investor overreaction and subsequent correction. Prices that deviate excessively due to market sentiment or irrational behavior tend to revert to more fundamental values over time (Barberis et al.,1998:307-308). These cyclical patterns serve as the basis for contrarian investment strategies, which involve buying undervalued (loser) assets and selling overvalued (winner) ones in anticipation of a return to the mean (Jegadeesh & Titman, 1993:65). Furthermore, mean reversion is closely related to other market phenomena such as momentum and reversal effects, and is widely utilized in quantitative investment models, asset allocation, and risk management frameworks. The degree and speed of mean reversion may vary across markets and asset classes, depending on factors such as market efficiency, liquidity, investor composition, and regulatory environment (Kim et al.,1991:515-516).

One of the most prominent structural features observed in financial time series is volatility clustering. This phenomenon refers to the tendency of volatility to appear in bursts over time, where periods of high volatility are likely to be followed by high volatility, and low volatility periods tend to follow one another. In other words, financial asset prices often exhibit phases of tranquility and turbulence in succession. This behavior contradicts the assumptions of the random walk hypothesis embedded in classical financial theories, which postulate that price changes are independent and identically distributed (Mandelbrot, 1963:394-396).

Volatility clustering is inherently related to the non-constancy of conditional variance in time series data. To address this, Engle (1982) introduced the Autoregressive Conditional Heteroskedasticity (ARCH) model, proposing that volatility can depend on past error terms. This approach revolutionized the modeling of macroeconomic and financial time series. Subsequently, Bollerslev (1986) extended this model by developing the Generalized ARCH (GARCH) model, which incorporates both short-term and long-term persistence in volatility dynamics. These models have become foundational tools in forecasting, risk measurement, and derivative pricing.

Moreover, volatility clustering is not merely a technical attribute of time series but also reflects deeper behavioral and microstructural aspects of financial markets. It has been linked to the psychological reactions of investors, the delayed diffusion of information, and heightened risk perception during periods of uncertainty. These behavioral underpinnings are well documented in the literature and suggest that volatility

clustering may arise from herding behavior and feedback effects among market participants (Lux & Marchesi, 1999; Cont, 2001). Thus, volatility clustering stands as both a statistical regularity and an indicator of underlying market dynamics, offering insights into the complexity and inefficiencies of financial systems.

In financial time series and risk analysis, the concept of fat tails refers to the empirical observation that extreme values such as dramatic losses or gains occur more frequently than predicted by the normal distribution. This characteristic implies a higher probability of rare but impactful events, which challenges the assumption of thin-tailed Gaussian models commonly used in classical finance (Mandelbrot, 1963; Cont, 2001). Fat tails are a defining feature of financial return distributions and are closely associated with high kurtosis and tail risk, making them central to modern approaches in financial modeling and risk assessment (Rachev et al., 2005).

In statistical terms, a fat-tailed distribution exhibits a higher concentration of probability in the tails than a normal distribution, indicating the potential for more frequent large deviations from the mean. These distributions are often modeled using heavy-tailed alternatives such as the Pareto**,** Cauchy**,** or Student's t-distribution, which better capture the empirical properties of asset returns (Cont, 2001). Mandelbrot (1963), in his seminal work, demonstrated that financial markets do not conform to the assumptions of the Gaussian framework, highlighting the limitations of traditional models in accounting for extreme events.

Fat tails are particularly relevant in fields such as risk management, portfolio optimization, derivative pricing, and insurance analytics, as they suggest that so-called rare events may occur with non-trivial probability and cause substantial economic impact. This insight has led to a critical reassessment of conventional risk models, which often underestimate tail risk and fail to capture the dynamics of crisis-prone environments (Taleb, 2007). In this context, understanding and modeling fat-tailed behavior is essential for designing more resilient financial systems.

The Volatility Index (VIX) is a calculation derived from the average prices of call and put options on the S&P 500 Index and is designed to measure the expected 30-day constant volatility of US stock markets. It is the most widely recognized volatility indicator globally and is closely monitored by various market participants. Changes in the VIX are globally recognized as risk criteria (Bloom, 2009:624). For example, an increase in the VIX implies a decrease in risk appetite, and in this case, investors prefer

safe markets and financial instruments When the market moves excessively up or down, investors take action to buy or sell. This leads to strong fluctuations in option volatility and hence in the VIX. In general, a VIX below 20 is interpreted as low volatility and low risk, while a VIX above 30 is interpreted as high volatility and uncertainty (Cohen & Qadan, 2010:39).

CHAPTER II

GLOBAL COMMODITY MARKETS

Commodity means any kind of goods and products that are subject to trade. In economic literature, the term commodity is mostly used as a commercial good. It is known that strategic commodity products such as gold, silver, copper, oil, natural gas, wheat, barley, and corn, which have a very old history and are currently evaluated for consumption, savings, and investment purposes in many industries, occupy a significant place in global commodity markets today (Sertkaya,2022:88). In this section, agricultural commodities, metal commodities, and energy commodities are discussed, and their definitions and graphs related to production and foreign trade data are provided. Detailed evaluations are made regarding these.

1. AGRICULTURAL COMMODITIES

1.1. WHEAT

Wheat (*Triticum aestivum*) has long played a vital role in ensuring global food security. Beyond its widespread use in the production of essential food products such as bread, pasta, biscuits, and breakfast cereals (Shewry & Hey, 2015:178-179), it has now emerged as a strategic financial asset actively traded in global commodity markets. Wheat futures, especially those listed on major exchanges like the Chicago Board of Trade (CBOT)**,** are utilized by producers, investors, and speculators for hedging against price volatility and for profit-seeking purposes (Irwin & Sanders, 2010:12-13).

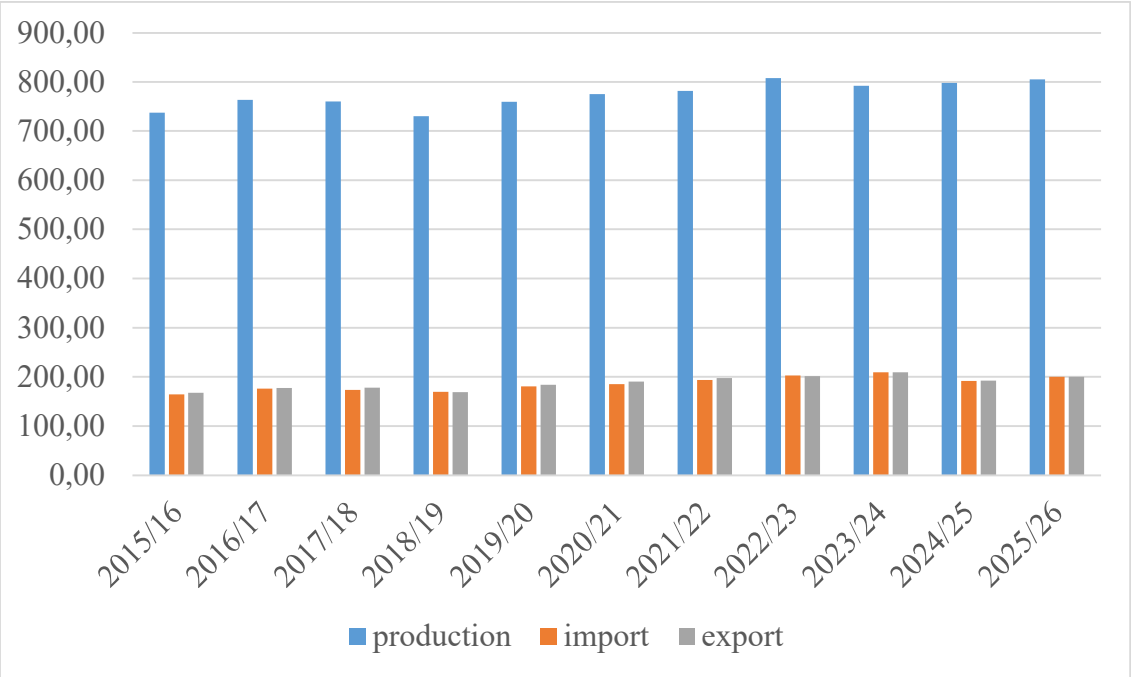
The pricing of wheat is influenced not only by supply-demand fundamentals but also by broader forces such as climate change, geopolitical developments, exchange rate fluctuations, and the financialization of commodity markets in recent decades (Tang & Xiong, 2012). These dynamics have transformed wheat from a purely agricultural product into a financial instrument closely tied to global economic and political trends.

Moreover, empirical analyses have demonstrated that wheat, like many other agricultural commodities, exhibits characteristics typical of financial time series namely volatility clustering, mean reversion, and fat-tailed distribution behavior. For example, Onour & Sergi (2011) model global food commodity prices (including wheat) and show that a student-t GARCH specification outperforms the normal distribution model, indicating leptokurtosis and mean-reverting volatility patterns. A focused study by Čermák et al., (2017) on wheat futures further corroborates these findings, confirming

that a GARCH (1,1) model effectively captures volatility clustering and fat-tail behavior suggesting long-run reversion of volatility. These stylized facts position wheat not just as a fundamental food commodity but also as a strategic financial asset**,** suitable for portfolio diversification, inflation hedging, and risk management frameworks where understanding tail-risk and dependence structures is essential.

In this context, wheat today functions as both an indispensable component of the global food system and a multi-dimensional commodity that is deeply embedded in the logic and fluctuations of financial markets.

Figure 3. Wheat Production, Import and Export in the World



Source: AMIS,2025 (Note: The 2024/2025 data is included in the table as expected estimated data. The 2025/2026 data is Forecasted data.)

Figure 3 shows world wheat production, export and import quantities. Global wheat production, which was 737.23 Mt in 2015/16, has shown an overall upward trend with fluctuations, peaking at 807.53 Mt in 2022/23. Production slightly declined in 2023/24 **(**791.95 Mt**),** is estimated to recover in 2024/25 **(**798.10 Mt**),** and is forecasted to increase further in 2025/26 **(**805.32 Mt). This trajectory highlights long-term growth in global wheat output, while also reflecting the influence of climatic variability and geopolitical conditions on short-term volatility.

In terms of trade, global wheat imports grew from 164.12 Mt in 2015/16 to 209.26 Mt in 2023/24, with a temporary decline projected for 2024/25 **(**191.78 Mt**)** before stabilizing at 200.01 Mt in 2025/26. Exports followed a similar path, rising from 167.47

Mt in 2015/16 to 209.54 Mt in 2023/24, with projections of 192.38 Mt for 2024/25 and 200.02 Mt for 2025/26.

These dynamics illustrate that the global wheat market, like maize, is increasingly exposed to both systematic risks (such as global economic uncertainty, the COVID-19 pandemic, and the Russia–Ukraine war) and unsystematic risks (such as climate shocks and localized supply disruptions). While the long-term upward trajectory signals resilience in production and trade, downturns in years such as 2018/19 and 2024/25 confirm the inherent volatility of global commodity markets. Such fluctuations are directly relevant to the dependency structures between commodity markets and financial indices, shaping price volatility and investor risk perceptions.

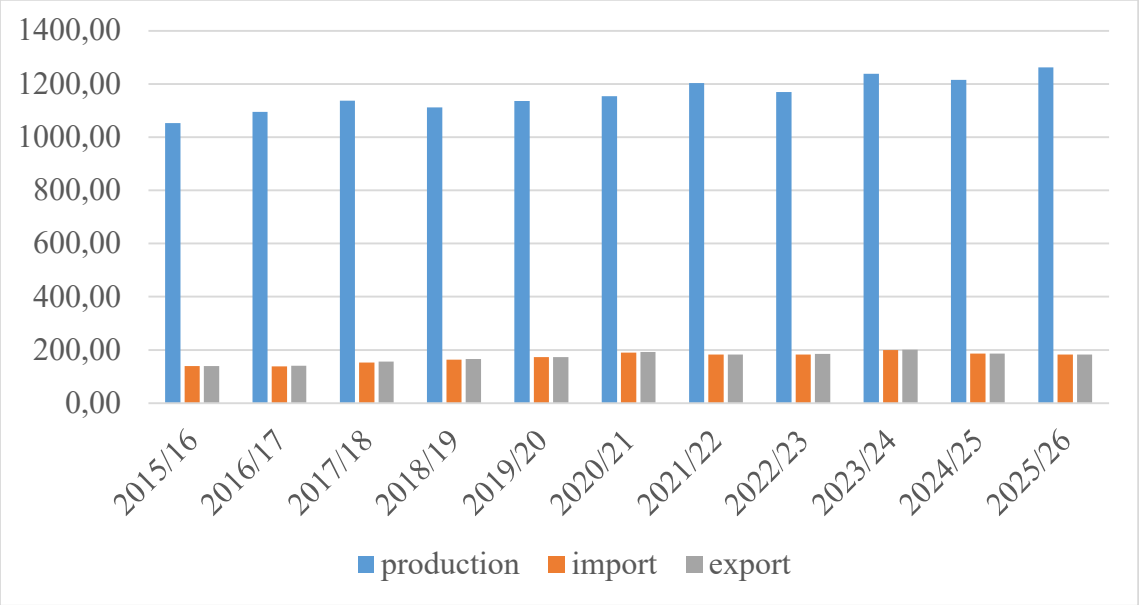
1.2. CORN

This name, derived from the Greek Zea (Life of Life) and the Tino language, combines the Arawak term Mahiz and is also related to the continuity of life. Origi nating from the complex cultures of Mexico and Central America, corn was used approximately 10,000 years ago. Archaeological evidence indicates that the domestication process began at least 6,000 years ago and originated in various regions. In sacred texts, the term ‘corn’ typically refers to wheat and barley. Corn is not only a staple food but also plays a significant role in indigenous cosmology, such as Maya mythology. Additionally, the ‘three sisters’ farming system, where corn is grown alongside beans and squash, demonstrates the plant's nutritional value and complementary agricultural functions. Therefore, corn is a central agricultural product with both biological evolution and cultural symbolism (Kazerooni et al,2019:35-36). In human consumption, maize appears in a wide range of forms, including maize flour, cornflakes, corn oil, glucose and fructose syrups, and traditional preparations such as nixtamal (Ranum et al., 2014:105-107). In addition to its central role in livestock feeding particularly in poultry and cattle maize also serves as a vital industrial raw material**,** especially through its starch and derivatives used in paper, textile, pharmaceutical, adhesive, and bioplastic industries.

In the energy sector, maize plays a key role in ethanol production**.** In the United States, for instance, approximately 40% of total maize production is allocated to the biofuel industry (Ranum et al., 2014:106). Furthermore, by-products from maize processing such as corn gluten meal, corn fiber, and germ are utilized in various domains including animal feed**,** functional food additives**,** flavor enhancers, and biological culture media (Jiao et al., 2022:3-4).

Due to its multilayered utility, maize has emerged not only as a global food staple but also as a strategic raw material for sustainable industry**,** bioenergy**,** green technology, and the broader bioeconomy**.**

Figure 4. Corn Production, Import And Export In The World



Source: AMIS,2025 (Note: The 2024/2025 data is included in the table as expected estimated data. The 2025/2026 data is Forecasted data)

Figure 4 shows world corn production, export and import quantities. Global Corn production, which stood at 1,052.93 Mt in 2015/16, has followed a fluctuating yet overall upward trajectory, reaching a peak of 1,237.36 Mt in 2023/24. Although a slight decline is projected for 2024/25 (1,215.28 Mt), production is expected to rise again in 2025/26 (1,262.06 Mt). This indicates a long-term growth trend in global maize output, while also reflecting the impact of climate conditions and geopolitical factors on short-term fluctuations.

On the trade side, global corn imports increased from 139.42 Mt in 2015/16 to 199.06 Mt in 2023/24, with a partial decline forecast for 2024/25 (186.25 Mt), before stabilizing around 182.78 Mt in 2025/26. Similarly, exports rose from 139.24 Mt in 2015/16 to 200.14 Mt in 2023/24, with projections indicating 182.79 Mt for 2025/26.

These patterns reveal that the global corn market has become increasingly sensitive to both systematic risks (such as global economic uncertainty, the pandemic, and geopolitical conflicts) and unsystematic risks (such as climate change and regional production issues). While the long-term upward trend in production and trade signals resilience, the declines observed in periods such as 2018/19 and 2024/25 confirm the

volatile nature of global commodity markets. Such fluctuations influence dependency structures with financial indices, primarily through price volatility and shifts in investor risk perception.

1.3. COTTON

Cotton (*Gossypium* spp.) is a highly valued agricultural product globally, with wide-ranging uses in both traditional textile manufacturing and modern sustainable industries. In the textile sector, cotton fibers are extensively used in fabric, yarn, and technical textile production. Increasingly, cotton is also employed in nonwoven applications such as filter materials, hygiene textiles, and eco-friendly packaging solutions (Krifa & Stevens, 2016:747-748).

By-products of cotton production also offer critical value. Materials such as cottonseed and stalks are utilized in the food and feed industries, as well as in the production of bioenergy, bioplastics, and agricultural soil enhancement agents (Nkomo., 2018:90-92). In particular**,** biochar derived from cotton residues has shown potential to improve soil carbon retention and contribute to environmental restoration and carbon sequestration strategies (Tao et al., 2024:4-6).

These diverse applications elevate cotton from being merely an agricultural commodity to a strategic raw material for sustainable industry, bioeconomy, renewable energy, and green technology development.

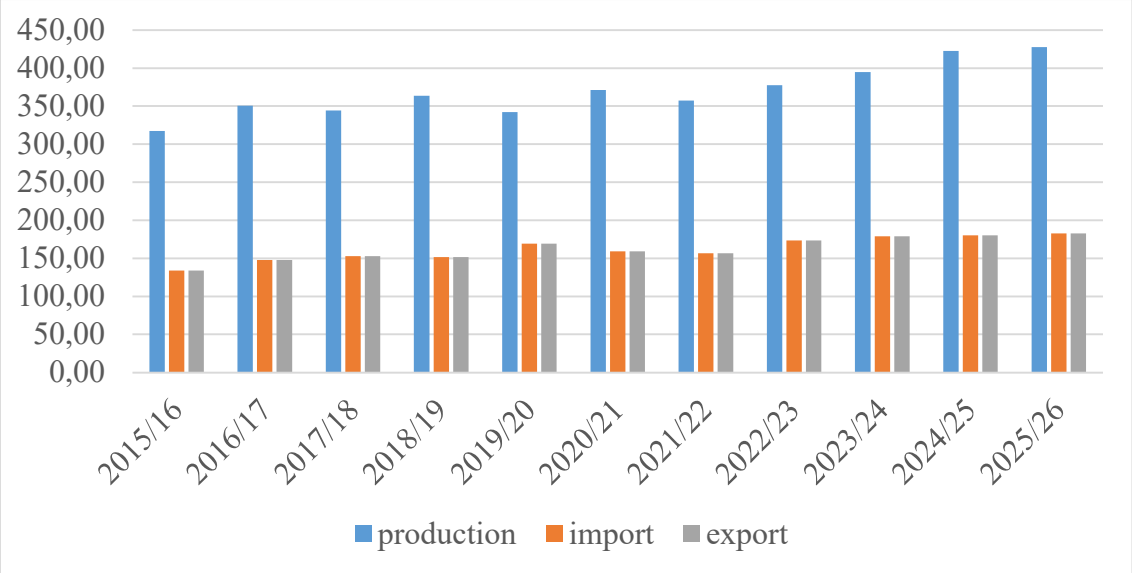
1.4. SOYBEAN

Soybean is a strategically important product both in agricultural commodity markets and in the global food chain. Due to its high protein and oil content, it is widely used in the food industry, animal feed production, and the biodiesel sector. Today, Brazil and the United States account for approximately 66% of global soybean production, while China is the largest importer, purchasing more than 60% of the world's soybean imports (USDA,2024; Reuters, 2025).

Soybean futures are commonly traded on markets such as the Chicago Board of Trade (CBOT). Prices of CBOT soybean futures have shown correlations with equity markets during certain periods, providing important data for individual investors and portfolio managers in the context of risk management (CME Group, 2023).

Within the Dow Jones Commodity Grain Index (DJCIGR) used in this study, soybean constitutes a significant component of the index's price movements. Therefore, analyzing the effects of global and regional risks particularly geopolitical developments on grain index prices through soybean, and subsequently on stock indices such as BIST100 and WIG20, is directly aligned with the main objective of this research.

Figure 5. Soybean Production, Import and Export in the World



Source: AMIS,2025 (Note: The 2024/2025 data is included in the table as expected estimated data. The 2025/2026 data is Forecasted data)

Figure 5 shows world soybean production, export and import quantities. Global soybean production, which was 317.22 Mt in 2015/16, has displayed a generally upward trend despite notable fluctuations. Production rose significantly to 371.03 Mt in 2020/21, experienced a decline in 2021/22 (357.16 Mt**),** and then recovered to 394.82 Mt in 2023/24. It is estimated to continue rising, reaching 422.56 Mt in 2024/25 and 427.67 Mt in 2025/26. These shifts highlight the long-term growth trajectory of soybean output, while also underlining the influence of climate variability and geopolitical dynamics on short-term volatility.

Soybean imports increased from 133.85 Mt in 2015/16 to 178.89 Mt in 2023/24, with forecasts pointing to further growth at 180.22 Mt in 2024/25 and 182.88 Mt in 2025/26. Exports followed a parallel pattern, rising from 133.85 Mt in 2015/16 to 178.89 Mt in 2023/24, and are expected to reach 182.88 Mt in 2025/26. This symmetry between imports and exports reflects the high degree of global interdependence in soybean trade.

Unlike wheat and maize, soybeans are particularly sensitive to trade policy shifts and demand dynamics from major importers such as China. This makes the market highly exposed not only to climate shocks but also to geopolitical disputes and supply chain disruptions. The strong growth in production and trade volumes underscores the strategic importance of soybeans in global food security and biofuel markets, while the observed fluctuations highlight how quickly external shocks can reshape price movements and global trade balances. In this respect, the soybean market provides a unique lens through which to understand the interplay between agricultural commodities, global risk factors, and financial market stability. (FAO,2023)

2. METAL COMMODITIES

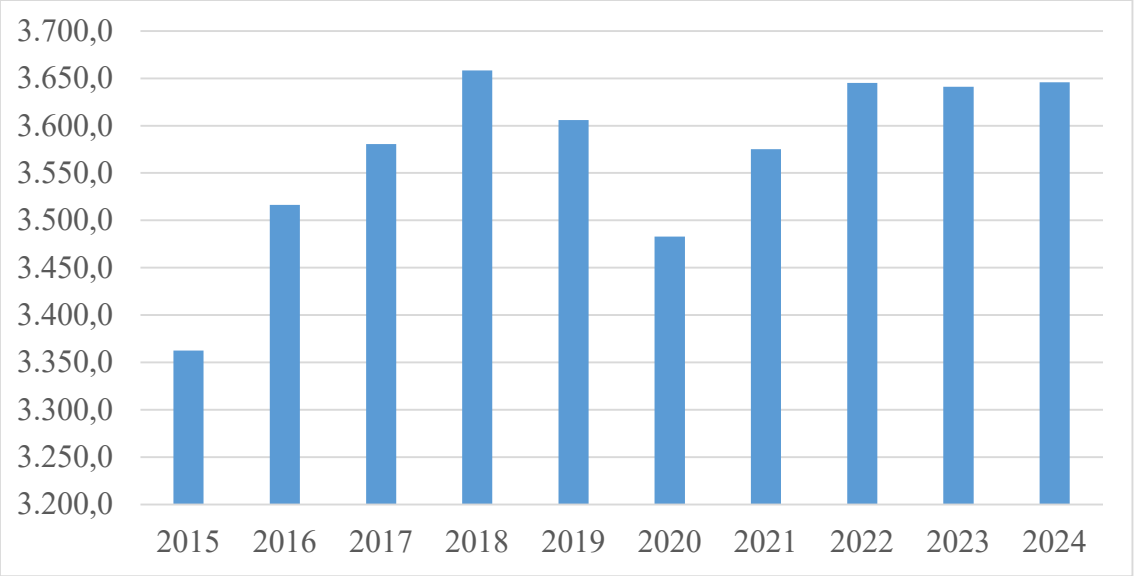
2.1. GOLD

Gold (*Au*) is a high-density, chemically inert precious metal that can be found in its natural state. Its physical properties—such as high thermal and electrical conductivity, corrosion resistance, and malleability—have made it valuable throughout history. Gold has long been used in jewelry and decorative arts, and today it is also critical in precision-demanding fields such as electronics, medical technology, and aerospace (World Gold Council, 2021).

Beyond its industrial and aesthetic value, gold plays a significant role in financial markets. It has historically been considered a store of value and a safe haven, especially during periods of inflation, currency turbulence, and global uncertainty. Empirical studies have shown that gold prices exhibit characteristics typical of financial time series, such as volatility clustering**,** fat-tailed distributions**,** and a safe-haven behavior particularly visible during times of market stress (Madani & Ftiti, 2022).

Reboredo (2013) demonstrates that gold exhibits a negative correlation with the US dollar**,** making it an effective tool for portfolio risk reduction**.** Consequently, gold serves multiple financial functions: it acts as an inflation hedge**,** contributes to portfolio diversification**,** and provides stability against macroeconomic uncertainty**.** In addition, gold's behavior often moving in the opposite direction of oil and foreign exchange markets makes it a valuable component in diversified investment strategies (Madani & Ftiti, 2022; Reboredo, 2013).

Figure 6. Gold Production in the World



Source: World Gold Couincil, 2025

Figure 6 shows world gold production quantities. Global gold production rose from 3,362.4 tons in 2015 to a peak of 3,658.4 tons in 2018**,** after which it largely stabilized, fluctuating within a relatively narrow band between 3,482–3,645 tons through 2024. This pattern indicates that while gold supply expanded steadily in the first half of the observed period, in recent years production has reached a plateau, constrained by factors such as declining ore grades, rising extraction costs, and regulatory or environmental limitations in key producing regions.

Unlike agricultural commodities, gold is less influenced by climatic or seasonal factors and more by systematic risks such as global economic cycles, monetary policy, and geopolitical uncertainty. Even without detailed trade data, production stability combined with gold's well-established role as a safe-haven asset underscores its importance in times of financial volatility. In this respect, while wheat, maize, and soybean reflect demand driven food security concerns, gold highlights the investment and hedging side of commodity markets. Its relatively steady production, contrasted with demand surges during crises, plays a central role in shaping correlations with equity indices such as BIST100 and WIG20, particularly under conditions of heightened global risk perception.

2.2. SILVER

Silver has historically held significant value both as an industrial commodity and as an investment asset. Compared to gold, its lower price levels make it a more accessible store of value for investors. In global commodity markets, silver is widely used not only in jewelry and decorative items but also in high-tech applications such as electronics, solar panels, medical devices, and chemical catalysts (Silver Institute, 2024).

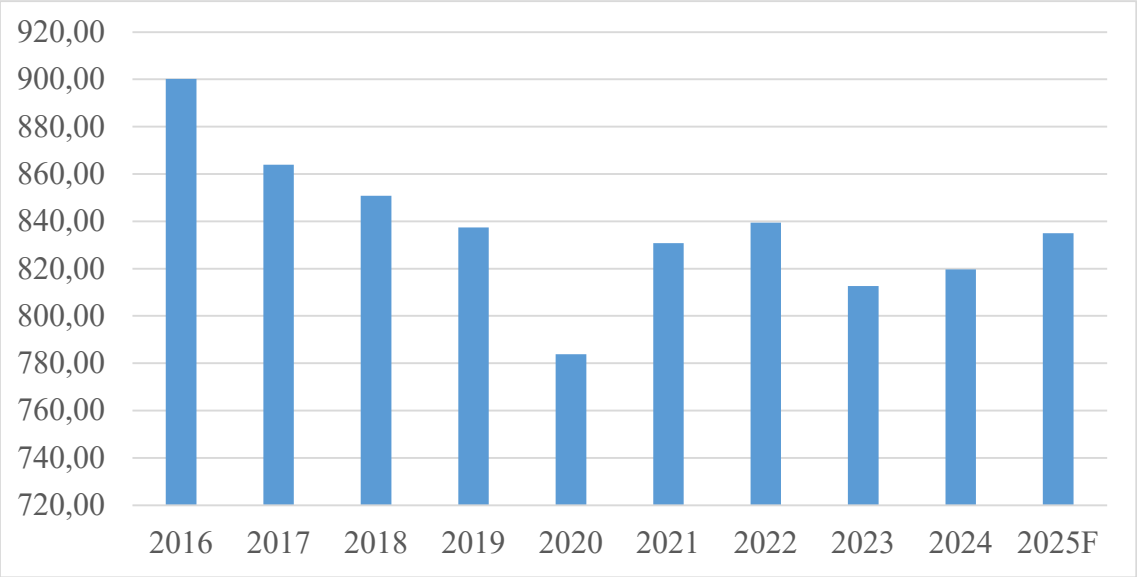
According to the *World Silver Survey 2024*, approximately 54% of global silver demand in 2023 originated from the industrial sector, 26% from jewelry and silverware production, and 19% from investment demand. For 2024, industrial demand is projected to rise by 9%, which is expected to result in the second-largest supply deficit in the last 20 years (Kitco News, 2024). This trend indicates that the expansion of green energy technologies and the increase in electronics production may exert upward pressure on silver prices.

Silver prices are sensitive not only to changes in supply-demand balance but also to global economic conditions, geopolitical developments, monetary policies, and fluctuations in the value of the U.S. dollar. In times of crisis and uncertainty, silver like gold tends to act as a "safe haven," although it often exhibits higher volatility than gold (Baur & Smales, 2020:6-7).

In international markets, silver is traded on futures exchanges such as the London Metal Exchange (LME) and COMEX. Prices on these markets serve as benchmarks for both physical trade and derivative products. Empirical evidence also shows that there are significant relationships between silver prices and other financial indicators, and that oil and interest rate shocks can influence silver price volatility (Hammoudeh & Yuan, 2008:607-610).

Although the primary focus of this study is the Dow Jones Commodity Gold Index (DJCIGC), silver prices are highly correlated with gold and, at times, demonstrate sharper price movements. Therefore, developments in the silver market can serve as an important indicator in understanding the overall dynamics of the global precious metals market and can be taken into account when analyzing investor behavior and market risk appetite.

Figure 7. Silver Production in the World



Source: World Silver Survey,2025

Figure 7 shows world silver production quantities. Global silver production has shown a gradual decline from 900.1 tons in 2016 to a low of 783.8 tons in 2020, reflecting the impact of reduced mining activity, lower ore grades, and temporary disruptions caused by the COVID-19 pandemic. After 2020, production partially recovered, reaching 839.4 tons in 2022**,** but dropped again to 812.7 tons in 2023 before stabilizing at 819.7 tons in 2024. For 2025, production is forecasted at around 835 tons, suggesting a modest recovery but still below the levels recorded a decade earlier.

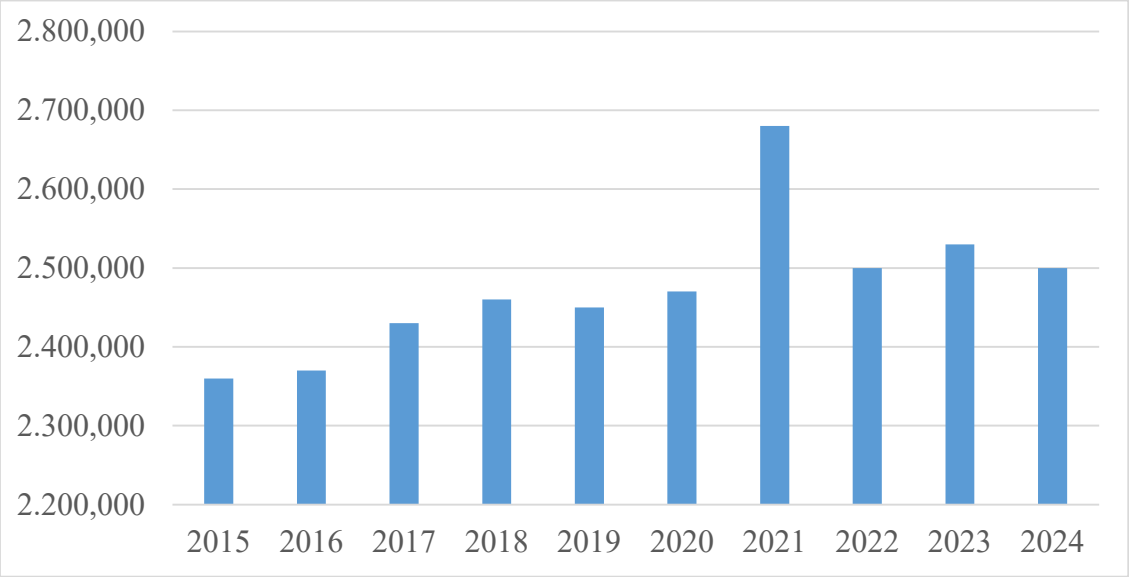
Unlike bulk commodities such as wheat or maize, silver similar to gold functions both as an industrial input and as a financial asset. This dual role makes silver particularly sensitive to both systematic risks (such as global recessions, monetary policy, and financial market volatility) and unsystematic risks (such as mine-specific disruptions and regional supply challenges). The overall production trend indicates structural supply constraints, which can amplify price volatility when demand rises in response to geopolitical tensions or investor demand for safe-haven assets. In this way, silver's production dynamics and financial role position it as a key commodity for understanding how non-agricultural resources interact with equity indices and broader financial markets under conditions of global uncertainty.

2.3. IRON

Iron is symbolized by (fe) in the elemental table and has been known by different names in many civilizations throughout history and has transformed human history thanks

to steel production. Iron, which is usually found in compounds in nature, is rare in its pure form and is not preferred in industry due to its low strength. Iron used in industry is actually a material alloyed with carbon; it is classified as iron, steel and cast iron according to its carbon content. Iron finds dating back to ancient times in Mesopotamia and Anatolia show how important this metal has been for humanity (Fathalizadeh,2013:53).

Figure 8. Iron Production in the World



Source: USGS, 2025

Figure 8 shows world iron production quantities. Global iron production, which stood at 2,360 Mt in 2015**,** has shown a steady upward trend over the past decade. Between 2016 and 2019, production gradually increased to around 2,460 Mt**,** with a modest rise to 2,470 Mt in 2020. A notable surge occurred in 2021, when output reached 2,680 Mt**,** reflecting the post-pandemic recovery in industrial activity and infrastructure investment. In the following years, production stabilized within the 2,500–2,530 Mt range, standing at 2,500 Mt in 2024**.**

The data illustrates that global iron production has maintained long-term stability with moderate growth, while short-term fluctuations have been shaped by systematic risks (global economic slowdowns, the pandemic, geopolitical tensions) and unsystematic risks (regional mining policies, environmental restrictions). As iron is the primary input for steelmaking, these production trends are closely tied to developments in construction, automotive, and heavy industry worldwide.

2.4. COPPER

The element copper was introduced by the ancient Egyptians around 4000 BC. In the light of the information obtained, it has been concluded that the oldest known copper ore deposits are in Cyprus. In Latin it is called 'cuprum'. As a result of the studies carried out at Çatalhöyük in Turkey, it was found that the history of the use of copper can be traced back to 7000 BC (Ministry of energy and natural resources,2024).

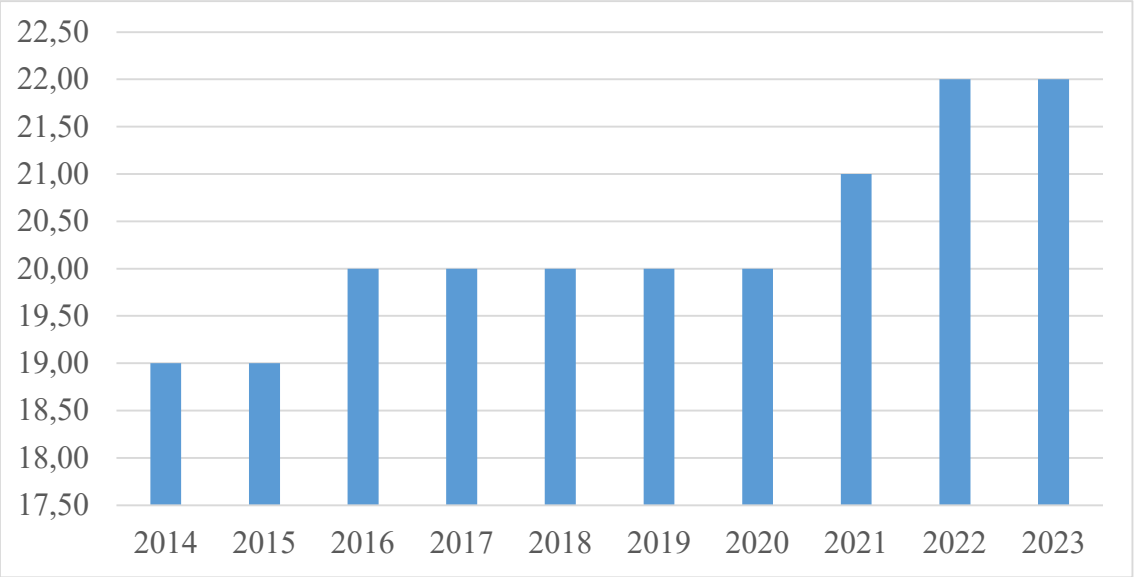
Table 1. Historical Development Copper Mining in Anatolia

Year	Location	Discovery / Usage
10,000 B.C.	Karain and Beldibi Caves	First metal findings
7000–8000 B.C.	Çatalhöyük (Konya)	First copper metal ornaments
7000–6500 B.C.	Çayönü Mound (Ergani)	First copper mining and forging, annealing—hook, blade
6500–4000 B.C.	Çayönü Mound (Ergani)	Possibly smelting of copper from malachite ore
5000 B.C.	Can Hasan Mound (Karaman)	Copper casting
3700–3300 B.C.	Bronze Age (Central Anatolia)	Bronze production from copper and tin complex ores
4000–2000 B.C.	Anatolia	Sumerians, Bronze Age development, copper extraction
2000–1750 B.C.	Anatolia	Assyrians, Ergani copper mine, silver mining
1680–1200 B.C.	Anatolia (Hattusa–Çorum)	Hittites, Copper Metallurgy – Beginning of the Iron Age
860–540 B.C.	Anatolia	Lydians and Urartians – development of copper mining
150 B.C. – 700 A.D.	Anatolia–Cyprus–Aegean–Balkans	Development of copper mining and trade

Source: Ehsani and Yazıcı,2016:47

In the table 1 above, historical data on the historical development of copper in Anatolia is given and information on the regions where and how it was used is also presented. Copper was used mixed with other metals and traded in financial markets as its demand increased.

Figure 9. Copper Production in the World



Source: Ministry of Energy and Natural Resources,2025

Figure 9 shows world copper production quantities. Global copper production remained relatively stable between 2014 and 2020, fluctuating around 19–20 million tons annually. A modest increase began in 2021, with production reaching 21 Mt, followed by 22 Mt in both 2022 and 2023. This steady growth in recent years reflects expanded mining capacity in Latin America and Africa, as well as sustained global demand driven by industrialization and infrastructure development.

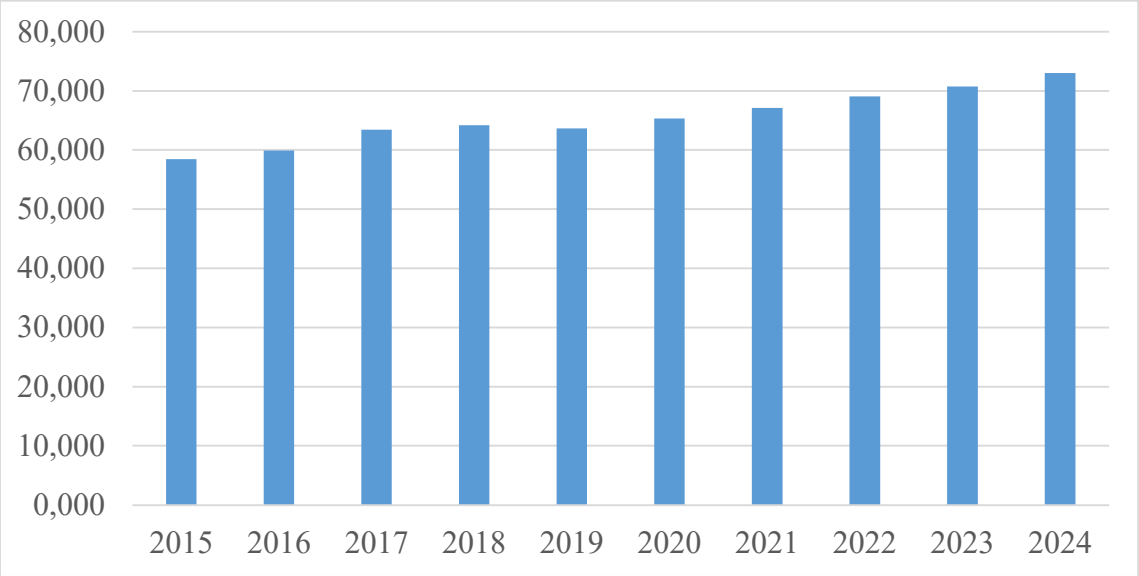
Unlike precious metals such as gold and silver, copper is predominantly an industrial commodity**,** heavily tied to economic growth, construction, electronics, and more recently the global energy transition. Its relatively stable production trend indicates supply resilience, but demand-side pressures, particularly from China as the world's largest consumer, play a critical role in shaping price volatility. Copper's sensitivity to systematic risks such as global economic slowdowns, trade disputes, or geopolitical tensions, makes it a bellwether for industrial activity and investor sentiment. (World Bank,2025)

Overall, the data suggests that while copper supply has been largely predictable, its strategic role in renewable energy technologies, electric vehicles, and green infrastructure places it at the core of the commodity–equity nexus. For financial indices such as BIST100 and WIG20, which are influenced by global commodity cycles, copper production and price dynamics serve as a leading indicator of industrial momentum and global economic confidence.

2.5. ALUMINUM

Aluminum is a chemically active metal that does not exist in elemental form in nature, but constitutes 8% of the earth's crust in the form of compounds. It was first produced as a metallic powder by Hans Oersted in 1825 by heating aluminum chloride with potassium amalgam and then evaporating mercury. Industrial aluminum production was made possible by the Hail-Heroult method developed in 1886. With this method, pure alumina is first obtained from bauxite and then electrolyzed with cryolite. Aluminum is the most widely used metal in industry after iron due to its light weight, conductivity and resistance to corrosion. Since it is soft in its pure form, it is alloyed with silicon, magnesium and copper and is widely used especially in the automotive, utensil, construction and household goods sectors. Aluminum oxide can be transformed into materials such as sapphire, ruby and sandpaper (Kubaş and Saral,2017:83-84).

Figure 10. Aluminum Production in the World



Source: International Aluminum Institute,2024

Figure 10 shows world aliminum production quantities. Global aluminum production rose steadily from 58.5 Mt in 2015 to 73.0 Mt in 2024**,** reflecting its growing role in global industry. The increase highlights aluminum's strategic importance as a lightweight, versatile metal widely used in construction, transport, packaging, and renewable energy infrastructure**.**

As an energy intensive commodity, aluminum is sensitive to systematic risks such as global trade tensions, energy price fluctuations, and economic cycles (Chen, 2023). while also exposed to unsystematic risks like policy shifts or supply disruptions in major

producers (notably China). Overall, its production trend underscores aluminum's position as a core industrial metal, closely tied to both global economic performance and the energy transition (IEA,2022).

3. ENERGY COMMODITIES

3.1. CRUDE OIL

Crude oil is one of the most significant energy sources in the global economy, used not only in direct energy production but also as a fundamental input in industry, transportation, and the petrochemical sector. Its prices are influenced by factors such as global economic growth, energy policies, production quotas, geopolitical tensions, exchange rate fluctuations, and inventory levels (Hamilton, 2009:8-9).

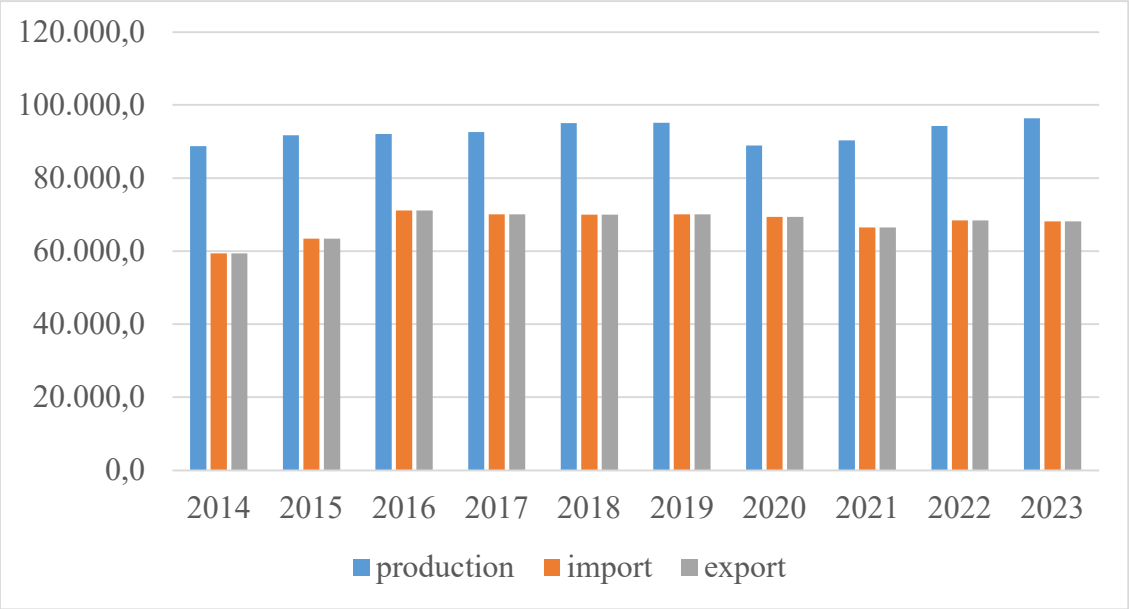
In the global oil market, the most widely used benchmarks for pricing are Brent and WTI crude oil. Brent is the standard for Europe, Asia, and Africa, while WTI is mainly used in the Americas. As a net oil importer, Turkey is highly sensitive to fluctuations in oil prices. Price increases in oil tend to raise production costs and inflation, exerting downward pressure on the BIST100 index (Kilian & Zhou, 2020).

Poland, on the other hand, derives about 25% of its total energy supply from oil and has been attempting to reduce its dependency on Russian imports through diversification policies. Following the Russia–Ukraine war, energy supply security has become a critical issue in terms of both prices and sourcing (IEA, 2023).

From a financial market perspective, fluctuations in crude oil prices directly affect the market value of companies in energy-intensive sectors. Many studies have found the impact of oil prices on stock indices to be asymmetric; the negative effects of price increases are often stronger than the positive effects of price decreases (Sadorsky, 1999).

The Dow Jones Commodity Crude Oil Index (DJCICL) measures changes in crude oil prices and serves as an important tool for investors to assess risks and opportunities in the energy market. In this study, analyzing the connection between DJCICL and BIST100/WIG20 will help reveal how energy price shocks are transmitted to stock markets in emerging and transition economies.

Figure 11. Crude Oil Production, Import and Export in the World



Source: Statistical Review of World Energy 2024

Figure 11 shows world crude production, export and import quantities. Global crude oil production moved between 88,728 tb/d in 2014 and 95,172 tb/d in 2019, reaching its highest pre-pandemic level just before the COVID-19 crisis. In 2020, production dropped sharply to 88,928 tb/d**,** reflecting the collapse in global demand as lockdowns, travel restrictions, and industrial slowdowns drastically reduced oil consumption. This downturn was one of the steepest declines in modern oil history, illustrating the vulnerability of energy commodities to global health and economic crises.

Imports and exports followed a similar trajectory. Both peaked above 70,000 tb/d in 2016–2019**,** but exports in particular fell to 69,374 tb/d in 2020 and continued to remain below earlier highs through 2021 **(**66,500 tb/d**)**, 2022 **(**68,397 tb/d**)**, and 2023 **(**68,124 tb/d**)**. These lower export levels, compared to the mid-2010s, are strongly associated with geopolitical and global risks**.** The Russia–Ukraine war (beginning in 2022) reshaped global trade flows, with Western sanctions on Russian crude disrupting established routes, while energy security concerns forced many countries to diversify supply sources. At the same time, OPEC+ production management policies and uncertainty in global economic growth restrained export recovery.

In this context, the oil market demonstrates the combined effect of systematic risks (pandemic-driven demand shocks, global recessions, geopolitical conflicts) and unsystematic risks (country-specific sanctions, regional production cuts) on both supply and trade. Crude oil thus remains not only a cornerstone of the global energy system but

also a key channel through which geopolitical instability and global risk perceptions influence financial markets and stock indices.

3.2. NATURAL GAS

Natural gas is playing an increasingly important role in the global energy mix, with widespread use in electricity generation, industrial processes, and residential heating. As the fossil fuel with the lowest carbon emissions, it has gained strategic importance in the context of climate change mitigation policies (IEA, 2023).

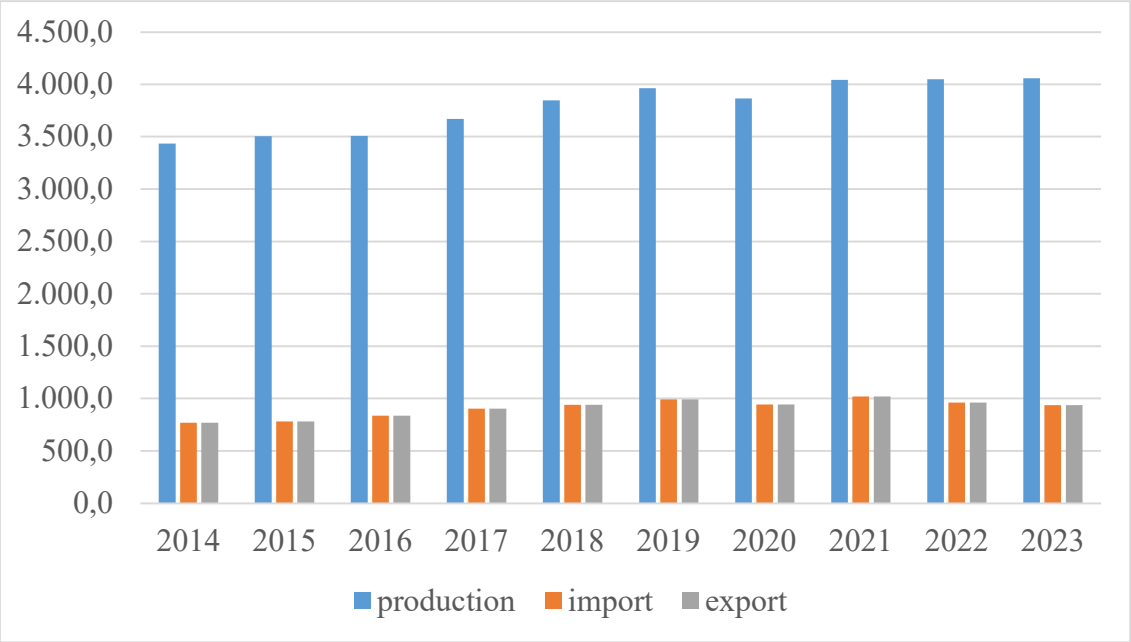
Although natural gas prices show some correlation with oil prices, different factors influence the supply–demand balance. Severe winter weather, storage levels, LNG trade, fluctuations in renewable energy generation, and disruptions in pipeline infrastructure can all increase price volatility. The Russia–Ukraine war in 2022 caused severe supply shocks in the European gas market, leading to historically high TTF (Title Transfer Facility) prices (IEA, 2023).

Turkey imports approximately 99% of its natural gas, making it highly sensitive to price volatility. Strategies such as LNG imports, pipeline agreements, and the expansion of renewable energy capacity aim to mitigate these impacts. Poland, by contrast, has sought to reduce its dependence on Russia by increasing imports from Norway via the Baltic Pipe and expanding LNG terminal capacity (IEA,2024)

In financial markets, increases in natural gas prices can raise costs for energy-intensive sectors, narrowing corporate profit margins and putting downward pressure on stock prices. Energy price shocks can also affect stock indices indirectly through the economic growth and inflation channels (Filis., 2010:881-882).

The Dow Jones Commodity Natural Gas Index (DJCING**)** tracks global natural gas price movements and serves as a key indicator in analyzing the impact of this variable on financial markets. In this study, examining the relationship between DJCING and BIST100/WIG20 will be essential for understanding the spillover dynamics of energy price shocks into stock markets

Figure 12. Natural Gas Production, Import and Export in the World



Source: Statistical Review of World Energy 2024

Figure 12 shows world natural gas production, export and import quantities. Global natural gas production rose from 3,435.6 bcm in 2014 to over 4,059.2 bcm in 2023**,** showing steady growth over the decade. The only notable slowdown occurred in 2020**,** when production fell slightly to 3,866.2 bcm as the COVID-19 pandemic suppressed industrial activity and energy demand. However, unlike crude oil, the decline was relatively modest, underlining natural gas's role as a transitional energy source less sensitive to short-term demand shocks.

Trade flows (imports and exports) followed a parallel trajectory, expanding from ~769 bcm in 2014 to a peak of 1,020 bcm in 2021**,** before declining to 962 bcm in 2022 and 936.9 bcm in 2023. The drop after 2021 reflects geopolitical risks, most notably the Russia–Ukraine war, which disrupted long-established pipeline flows to Europe. Western sanctions on Russian energy, combined with Europe's diversification efforts towards LNG imports, reshaped global natural gas trade patterns. These disruptions were accompanied by price volatility and supply security concerns, underscoring natural gas's vulnerability to geopolitical instability.

Overall, the data highlights how natural gas, while exhibiting stable long-term production growth, is increasingly shaped by systematic risks (global economic downturns, pandemics, major geopolitical conflicts) and unsystematic risks (pipeline accidents, regional policy shifts). Its dual role—as both a key industrial input and a

transitional energy commodity in the decarbonization agenda—makes it central to understanding the interaction between energy markets, risk perceptions, and financial indices.

3.3. COAL

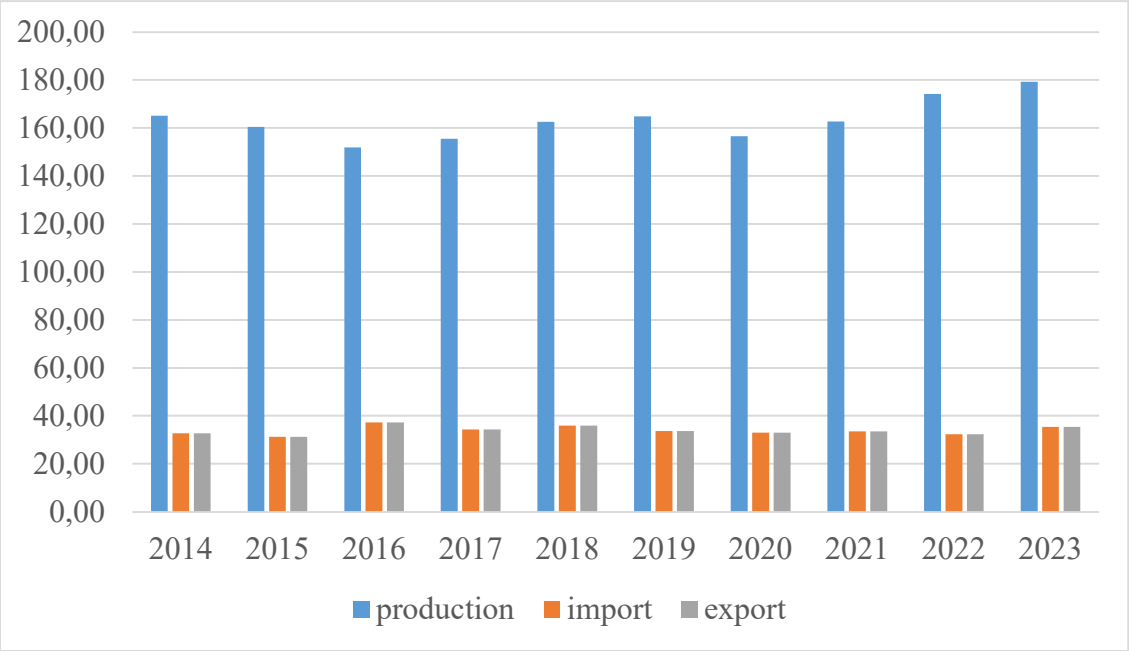
Coal has been one of the cornerstones of energy supply since the Industrial Revolution, particularly as a strategic resource for electricity generation and heavy industry. According to the International Energy Agency (IEA, 2023), coal still accounts for a significant share of global energy supply, and demand remains high in Asia-Pacific regions, creating notable price volatility in financial markets.

From a financial market perspective, coal prices are not directly traded in the same way as oil or gold futures. However, they are closely linked to carbon regulations, supply–demand dynamics, and geopolitical factors. The literature emphasizes that energy prices have substantial impacts on financial markets. Wong (2023), for instance, demonstrates that coal futures prices in China strongly respond to supply and demand shocks, playing an important role in volatility forecasting. This highlights the direct and regional influence of energy commodities on financial markets.

Furthermore, energy shocks generally increase volatility in financial markets, and coal prices confirm this dynamic in the Chinese stock market by strengthening the linkage between energy and capital markets (Kang & Ratti, 2013).

Therefore, coal remains a strategic commodity, not only for energy security but also for financial market dynamics. For investors, policymakers, and businesses, analyzing coal's financial volatility is crucial for risk management and economic forecasting strategies.

Figure 13. Coal Production, Import and Export in the World



Source: Statistical Review of World Energy 2024

Figure 13 shows world coal production, export and import quantities. Global coal production fluctuated between 151–165 EJ in the mid-2010s, before declining in 2016 **(**151.9 EJ**)** and during the COVID-19 pandemic in 2020 **(**156.5 EJ**).** However, production rebounded strongly afterwards, reaching 174.1 EJ in 2022 and 179.2 EJ in 2023**,** marking the highest levels of the past decade. This recovery reflects coal's enduring role in power generation, especially in emerging economies, despite global decarbonization efforts.

International coal trade (imports and exports) remained relatively stable in the range of 31–37 EJ throughout the period. The modest variations suggest that while coal is globally traded, a significant share of consumption is domestically supplied. Imports peaked in 2016 (37.25 EJ) and exports mirrored this pattern, but both flattened around 33–35 EJ after 2019.

From a risk perspective, coal markets are shaped by systematic risks such as global climate policy, the energy transition, and economic cycles. At the same time, unsystematic risks including domestic policy shifts (e.g., China and India's coal production targets) and supply disruptions play an important role. The sharp rebound after 2020 underscores how geopolitical and energy security concerns, particularly during the Russia–Ukraine war and the global energy price surge, temporarily reinforced coal's role despite long-term decarbonization trends. (IEA,2023)

Overall, coal production and trade dynamics illustrate the tension between short-term energy security needs and long-term sustainability goals. This duality is critical for understanding how energy commodities interact with financial indices: rising coal output signals immediate economic resilience, but also highlights transition risks that increasingly influence investor sentiment and global portfolio strategies.

CHAPTER III

DEPENDENCY STRUCTURE OF MAYOR COMMODITY INDICES WITH BIST100 AND WIG20:EFFECTS OF GLOBAL AND GEOPOLITICAL RISKS

1. PURPOSE AND SIGNIFICANCE OF THE STUDY

1.1 PURPOSE OF THE STUDY

The primary aim of this study is to examine the dependency structure between the BIST100 and WIG20 stock market indices and major global commodity indices, with a particular focus on how global and geopolitical risks influence these interrelationships. By analyzing the dynamic interactions across equities and commodities, the study seeks to reveal whether diversification benefits exist for investors in emerging and transition economies such as Turkey and Poland. Furthermore, the research aims to identify which of the two indices BIST100 or WIG20 has exhibited stronger resilience to global and geopolitical shocks, thereby maintaining greater stability during periods of heightened uncertainty. In doing so, the study not only contributes to the literature on financial integration, risk transmission, and portfolio diversification, but also provides practical implications for policymakers, institutional investors, and portfolio managers in formulating strategies to mitigate risk in volatile market conditions.

1.2. SCOPE AND SIGNIFICANCE OF THE STUDY

Commodity markets allow producers and consumers to access them in a centralized and liquid market. These market actors can also use commodity derivatives to hedge against future consumption or production risks. Speculators, investors and arbitrageurs also play an active role in these markets (Yalama and Coşkun, 2013:145).

Over time, some commodities, such as precious metals, have been considered as effective hedges against inflation. As an alternative asset class, a diverse range of commodities can help diversify a portfolio. Since commodity prices often tend to move in the opposite direction to stocks, some investors may be concerned about market volatility, may seek to reduce their risk by investing in commodities (Thanh, 2015: 44).

Commodities are economic instruments both as a cost input and an investment instrument, and performs a crucial financial function. Commodity prices determinants of stock performance by affecting firms' production costs has become a well-known phenomenon. In addition to this, today's diversified thanks to financial technologies,

market participants can use commodities as both an investment alternative and a safe asset during turbulent times. Therefore, in the context of the negative economic impacts of the COVID-19 pandemic and the continuous rise in commodity prices in the global economy, the increased attention on commodity prices is not coincidental. Especially for developing countries specific dynamics require closer monitoring of commodity prices (Camgöz, 2023:581).

Russia and Ukraine are among the most important exporters of various commodities. For example, Russia and Ukraine together account for around 30% of global wheat exports; 20% of corn, fertilizers and natural gas; and 11% of oil. The increased geopolitical risks resulting from the war between these two countries and their impact on commodity prices have led to increased market volatility. Rising commodity prices, in turn, have led investors to focus on the economic outlook and inflation. further raises concerns about the future prospects (Güneysu, 2022:362).

The emergence of the COVID-19 pandemic has disrupted the economic activities of countries and has become a real threat to the global economy and financial markets. In fact, the world's leading stock exchanges showed the first reactions to the spread of the COVID-19 pandemic in early February 2020 Globally, equity markets fell by nearly 30 percent, volatility increased, and credit spreads on non-investment grade debt widened Moreover, there are expectations that the economic impact of the COVID-19 pandemic could be comparable to the Great Depression and even worse. On the other hand, many studies from the past to the present suggest that there is an important link between financial markets and historical events such as geopolitical events, political and terrorist incidents, or disease outbreaks (Karpuz and Koç, 2022:78).

The COVID-19 pandemic has negatively affected the growth data of Poland, with a growth rate of 4.6% in 2019, declining to -2% in 2020 and falling into a negative economy. After the easing of the covid 19 pandemic and strict health policies were lifted, a good recovery was seen with 6.9% in 2021, but after the start of the Russian and Ukrainian war, this figure decreased to 5.3% in 2022, 0.1% in 2023 and 2,9% in 2024 (WORLD BANK,2025).

The COVID-19 outbreak also had a negative impact on Turkey's growth data, causing it to hover below the long-term average growth rate. The growth rate, which was 0.8% in 2019, was seen as 1.9% in 2020. After the Covid 19 outbreak eased and strict health policies were lifted, a good recovery was seen in 2021 with 11.4%, but after the

start of the war between Russia and Ukraine, this figure dropped to 5.5% in 2022, 5.1% in 2023 and 3.2% in 2024 (WORLD BANK,2025).

It is possible to observe that the COVID-19 pandemic has also had a negative impact on the inflation rate in Poland. The inflation rate, which was 2.2% in 2019, rose to 3.4% in 2020, to 5.1% in 2021, to 14.4% in 2022 due to the effect of the Russian-Ukrainian war, and this rate continued with 11.5% in 2023 and 3.8% in 2024 (WORLD BANK,2025).

It is possible to see a similar effect in Turkey. In 2019, an inflation rate of 15.2% was observed, followed by 12.3% in 2020 and 19.6% in 2021, when the real impact of the COVID-19 pandemic was felt. The crisis in the region following the start of the Ukraine-Russia war in 2022 had an impact on this figure being seen at 72.3% and 53.9% in 2023 and 58.5% in 2024 (WORLD BANK,2025).

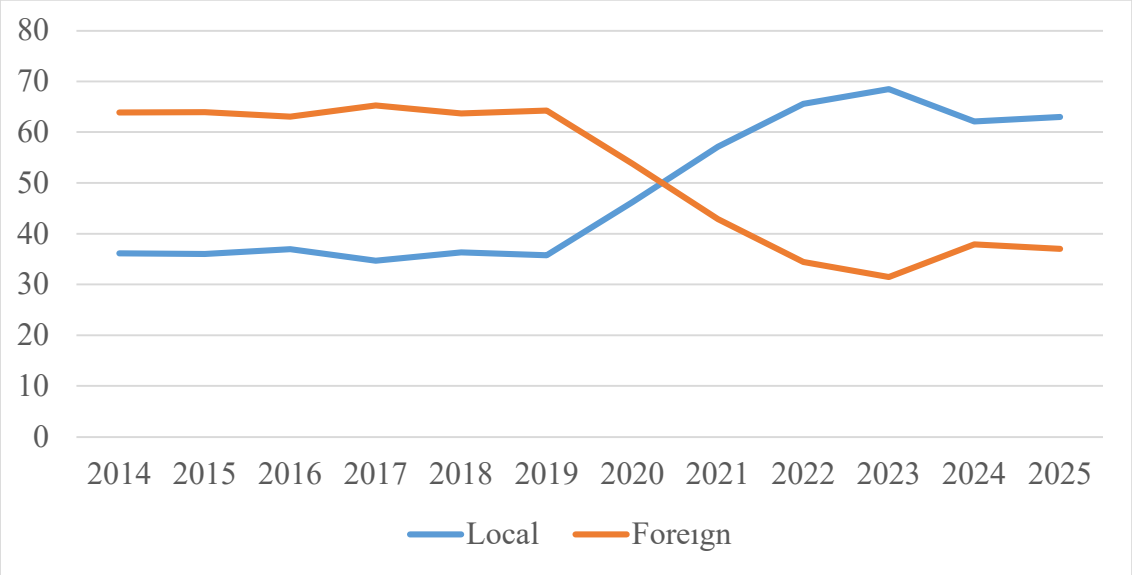
The Russian-Ukrainian War and the COVID-19 pandemic have had profound economic and social impacts on geopolitically strategic countries such as Poland and Turkey. Both countries have faced economic challenges during the pandemic, including disruptions in supply chains, rising inflation rates and a slowdown in economic growth. The two countries may have been affected by macroeconomic effects at similar rate. The wave of migration following the war between Ukraine and Russia in recent years has had a significant impact on both countries. Poland acts as a bridge between Russia and Europe due to its location in Europe. Trade relations between Russia and European countries are carried out through this country's territory. Especially after the outbreak of the war between Russia and Ukraine, the disruption in the supply chain and the commencement and tightening of trade embargoes imposed on Russia have caused volatility in commodity markets and an increase in prices. Turkey also acts as a bridge between Asia and Europe due to its location. Especially after the outbreak of the war between Russia and Ukraine, Turkey has also been negatively affected by the supply chain problems experienced in the Black Sea and Turkey has also begun to be seen as a new route for trade with Asia. In addition, most of the people who migrated from Ukraine due to the war migrated to Poland and the number of people who migrated to Turkey is also considerable.

On the other hand, the increase in trade cooperation between Poland and Turkey has been on the rise in recent years, with Turkey exporting 4.7 billion dollars to Poland in 2021, which increased to 5.4 billion in 2022 and 5.9 billion in 2023. As of 2023 and

6.2 billion in 2024, Poland is Turkey's 12th largest export partner. When evaluated in this context, the trade relationship between Turkey and Poland should not be ignored (TÜİK, 2025).

Market dynamics are shaped not only by economic and financial fundamentals but also by shocks driven by uncertainty (Antonakakis et al.,2017). Among these shocks, geopolitical risk stands out as it encompasses political tensions, the threat of war, military conflicts, and acts of terrorism (Alqahtani et al., 2020). Unlike other forms of risk, geopolitical risk has a unique character and is regarded as a crucial factor influencing investment behavior and stock market fluctuations (Caldara et al., 2018; Baur & Smales, 2020). As a result, episodes of insecurity, terrorism, and political unrest intensify uncertainty in financial markets, often leading investors to delay or withdraw their stock investments (Antonakakis et al., 2017).

Figure 14. Retention Rates of Publicly Traded Companies According to Market Value



Source: SPK, 2025

Note: Since the analysis date of the study by the author is from 03.07.2014 and the data were taken until 01.09.2025, the rates of domestic and foreign investors in Istanbul Stock Exchange were calculated according to the 12-month average data, taking these months into account.

The significant decline in the retention rate of foreign investors and the increase in the share of domestic investors between 2014 and 2025 indicate a structural shift in the BIST 100 that reduces its sensitivity to global and geopolitical risks. Because foreign investors tend to exit the market quickly during periods of uncertainty, global risks create

stronger volatility effects in foreign-weighted indices like the WIG20. Conversely, the increased weight of domestic investors in the BIST weakens the market impact of external shocks. This supports the thesis's finding that "the BIST 100 is more resilient to global shocks, while the WIG20 is more sensitive." However, the occasional speculative behavior of domestic investors makes the BIST more vulnerable to domestic political and economic uncertainties rather than global risks.

This study will be conducted on a total of 7 variables BIST100, WIG20, Dow Jones commodity grain (DJCIGR), Dow jones commodity crude oil (DJCICL), Dow jones commodity natural gas (DJCING), Dow jones commodity gold (DJCIGC) indices and VIX (S&P 500 volatility) index. The analysis will cover a starting from 03.07.2014 to 01.09.2025, While examining the relationship between variables between these dates, global and geopolitical risks in this time period were taken into account. In this study, the effect of selected global commodity indices on market indices will be analyzed by making a comparative analysis of two countries Poland and Turkey.

In this study, 7 variables (BIST 100, WIG 2O DJCIGR, DJCICL, DJCING, DJCIGC and VIX) were considered and analyzed. The analyzed hypotheses are listed below.

H1: The connectedness between the Dow Jones Commodity Grain Index (DJCIGR) and the BIST 100 Index is sensitive to global and geopolitics risks.

H2: The connectedness between the Dow Jones Commodity Grain Index (DJCIGR) and the WIG 20 Index is sensitive to global and geopolitics risks.

H3: The connectedness between dow jones commodity crude oil index (DJCICL) and Bist 100 index is sensitive to global and geopolitics risks.

H4: The connectedness between dow jones commodity crude oil index (DJCICL) and Wig 20 index is sensitive to global and geopolitics risks.

H5: The connectedness between dow jones commodity natural gas index (DJCING) and Bist 100 index is sensitive to global and geopolitics risks.

H6: The connectedness between dow jones commodity natural gas index (DJCING) and Wig 20 index is sensitive to global and geopolitics risks.

H7: The connectedness between dow jones commodity gold index (DJCIGC) and Bist 100 index is sensitive to global and geopolitics risks.

H8: The connectedness between dow jones commodity gold index (DJCIGC) and Wig 20 index is sensitive to global and geopolitics risks.

H9: The connectedness between the fear index (VIX) and Bist 100 index is sensitive to global and geopolitics risks.

H10: The connectedness between the fear index (VIX) and Wig 20 index is sensitive to global and geopolitics risks.

2. LITERATURE REVIEW

Below is a table Some articles scanned from studies measuring the impact of macroeconomic variables on stock market indices. The reason for conducting this extensive literature review is to demonstrate the sheer number of scientific studies on this topic and to provide insight into which gaps in the literature it fills.

Table 2. Literature Review

Authors (Year)	Market / Period	Variables	Methodology	Key Findings
Maghayereh (2002)	Jordan (Jan 1987 – Dec 2000)	Interest rate, exports, foreign services, inflation, SPI	Cointegration Test, Vector Error Correction Model (VECM)	Found a long-run relationship between the selected macroeconomic variables and Jordanian stock prices.
Adam & Tweneboah (2006)	Ghana – 1991Q1 to 2006Q4	FDI, TBR, CPI, ER	Johansen Multivariate Cointegration Test, Vector Error Correction Model (VECM), Impulse Response Function, Forecast Error Variance Decomposition	Stock prices show long-run cointegration with macroeconomic variables: inflation (+), FDI (+), interest rates (–), and exchange rate depreciation (–).
Rjoub et al. (2009)	Istanbul Stock Exchange (Turkey), Jan 2001 – Sep 2005, monthly data	TSIR, UI, RP, RER, M1, UR	APT (Chen, Roll & Ross, 1986), 6 macro factors, OLS on 13 portfolios, DW test for serial correlation, term structure = long-term gov. Bonds – short-term T-bills yield spread	Unanticipated Inflation significant in 7 portfolios, Risk Premium in 3, Term Structure in 1, Money Supply in 2; Real Exchange Rate & Unemployment not significant; effects vary, overall explanatory power low
Ozer et al. (2011)	Turkey (Jan 1996 – Dec 2009)	IR, MS, FTB, IPI, Gold, EXR, CPI	Least Squares Method, Johansen–Juselius Cointegration Test, Granger Causality Test, VEC Model	Found a relationship between some macroeconomic variables and the IMKB-100 index.

Table 2. (Continue) Literature Review

Authors (Year)	Market / Period	Variables	Methodology	Key Findings
Sayılgan and Süslü (2011)	11 developing countries (1996–2006)	ER, IR, SP500, INTR, GDP, MS, OP	Panel data analysis	Stock returns were affected by exchange rate, inflation rate, and S&P500 index; no significant relationship with interest rate, GDP, money supply, and oil prices.
Özmerdivanlı (2014)	Turkey (Jan 2003 – Feb 2014)	Oil prices, BIST100 index	Engle–Granger Cointegration Test, Granger Causality Test	Found one-way causality from BIST100 index to oil prices; determined a long-term relationship between oil prices and BIST100 index.
Sancar et al. (2017)	Turkey (Jan 2000 – Dec 2016)	Money supply, consumer price index, exchange rate	Unit Root and Cointegration Tests with Structural Break, FMOLS, DOLS Regression	Found a long-term connection between variables; positive correlation between money supply, CPI, and stock prices; negative correlation between exchange rate and stock prices.
Budak et al. (2017)	Turkey	ER, IR, PPI	ADF and PP Unit Root Tests, ARDL Cointegration Test	Found long-term cointegration between BIST indices (100, 30, 50) and exchange rate, interest rate, PPI.
Jamaludin et al. (2017)	Singapore, Malaysia, Indonesia / Jan 2005 – Dec 2015	Money Supply (M2), Exchange Rate (REER), Inflation (CPI)	Panel least squares regression combining cross-section and time-series data; monthly data from DataStream, comparison between conventional and Islamic stock indices	ER & Inflation significantly affect conventional & Islamic stock returns; Inflation has stronger negative impact, Money Supply insignificant; Islamic indices more responsive to macro changes.
Loudon, (2017)	G7 countries (Canada, France, Germany, Italy, Japan, UK, USA), Jan 1973 – Jun 2011	GFU, SMR, RFR	Applied Markov regime-switching and GARCH-M models on Datastream monthly returns, with excess returns based on 1-month Eurocurrency rates.	The intertemporal risk–return relation changes over time depending on global financial market uncertainty. A strong negative relationship exists between uncertainty and the reward-to-variability ratio in all G7 markets, indicating higher risk aversion during periods of uncertainty.

Table 2. (Continue) Literature Review

Authors (Year)	Market / Period	Variables	Methodology	Key Findings
Syzdykova & Tanrıöven (2018)	Japan, South Korea, Malaysia, Singapore (Jan 1990 – Dec 2017)	Oil prices	VAR Model, Generalized Impulse Response Function, Variance Decomposition Analysis	Oil price changes affect the stock markets of the examined countries differently.
Koyuncu (2018)	Turkey (1988–2016)	IR, IPI, REG, INFL	DF-GLS Unit Root Test, Cointegration Tests, FMOLS, DOLS Regression Analyses	Found a general relationship between BIST100 index and macroeconomic variables; inflation and industrial production increase the index, while interest rates and real economic growth have a negative effect.
Yiğiter et al. (2018)	Turkey (1998–2013)	INFL, ER, GDP	VAR Model, Causality Analysis, Impulse-Response Analysis	Found a negative relationship between Borsa Istanbul Industrial Index and inflation, exchange rate, and GDP.
Balcilar et al. (2018)	Global	GPR, SMR	Quantile Regression, Spillover Analysis	Geopolitical risks significantly affect stock market returns, with varying intensity across quantiles.
Schmidt, P.S. Et al. (2019)	23 OECD & major markets (Europe, US, Japan, etc.), 1991–2018 (varied start dates).	VW returns, HML, SMB, WML, RMW, CMA	TRD/TRW factors, validated & tested (Carhart/FF/HXZ); SMB size effect, cost-adjusted.	Country-level factors strongly correlate with benchmarks; size premium mainly in smallest firms, mostly disappears after trading costs except some effect remains in U.S.
Fattah & Kocabıyık (2020)	Turkey, USA (Jan 2010 – Feb 2019)	MS, EXR, CPI, EXIM, IR, IPI, Oil, Gold	Lee-Strazicich Unit Root Test, Akaike Information Criterion, Toda-Yamamoto Causality Test	Turkey: Money supply ↔ exchange rate with BIST100; CPI → BIST100; no link with IPI, oil, gold. USA: Money supply → S&P500; no other links.
Czapkiewicz & Choczyńska (2021)	USA (S&P500), Germany (DAX), UK (FTM), Poland (WIG), Turkey (XU); Jan 2001 – Jan 2019 (monthly data)	Unemp., LT rate, CPI, oil, ZEW, VIX, TED.	Markov-switching model with dynamic probability matrix; GARCH-type models (EGARCH, TGARCH) and VAR models; stationarity tested with Dickey–Fuller	Two regimes: low-volatility/positive returns vs high-volatility/negative returns; Long-term rates affect all markets (opposite in developed vs emerging); Oil, Bonds, ZEW support stability; VIX, TED increase instability

Table 2. (Continue) Literature Review

Authors (Year)	Market / Period	Variables	Methodology	Key Findings
Gurgul et al. (2021)	Warsaw Stock Exchange (WIG20) / January 2004 – July 2019	13 U.S. indicators: CCI, CPI, DGO, EHS, HS, IP, ISM, IJC, NFP, NHS, PPI, GDP, RS.	Event study (5-min WIG20, rank test); abnormal returns for good vs. bad news.	US macro announcements strongly affected WIG20 during 2007–2013, especially NFP, with immediate (≤5 min) reactions; impact weakened after 2014.
Setiawan et al. (2021)	ASEAN (Indonesia, Malaysia, Singapore, Thailand, Philippines) & CEE (Hungary, Poland, Slovenia) / 2002–2019	Market Cap, Stock Traded, CPI, Unemp., FDI	Panel data regression (random effects model) using World Bank World Development Indicators (WDI) data; diagnostic tests for multicollinearity, heteroskedasticity, serial correlation; Hausman test, Breusch-Pagan LM test	GDP growth positively linked to stock market capitalization, total stock traded, Inflation, and FDI; negatively linked to Unemployment and domestic stock traded
İlarslan and Yıldız (2022)	Turkey (BIST100) & Poland (WIG20), Dec 2008 – Nov 2020	International Wheat, rice, sugar, and beef prices	Quantile Regression, FMOLS, DOLS	Agricultural prices affect both countries' stock markets at different levels. The effect is stronger in Turkey, while Poland's market reacts more moderately.
Udo, S.S. Et al. (2022)	Nigeria – Nigerian Stock Exchange (All-Share Index), annual data from 1985 to 2020	GDPG, M2, ER, SIR, IR	Autoregressive Distributed Lag (ARDL) estimation technique to test long-run relationships among variables	Stock market performance is positively linked to GDP, money supply, exchange rate, and interest rates, while inflation has a negative effect; stable macro policies are key.
Madurapperuma (2023)	Sri Lanka / Monthly data, Jan 2010 – Dec 2021 (132 observations), ASPI from Colombo Stock Exchange	ASPI, IP, CPI, exchange rate, T-bill, CD rate, crisis.	ADF test, Bounds Testing Approach, CUSUM & CUSUMQ stability tests, Johansen Cointegration, Vector Error Correction Model (VECM)	Long-run stable relationship between stock prices, macroeconomic variables, and economic crisis. CPI, IP, ER, TB, CD, and economic crisis significantly influence ASPI in the long run; economic crisis has a strong short-run effect.

Table 2. (Continue) Literature Review

Authors (Year)	Market / Period	Variables	Methodology	Key Findings
Ligocka (2023)	CEE markets: Sofix, Crobex, PX, BUX, WIG20, BET, SAX, OMX (Tallinn, Riga, Vilnius); 2004Q1–2021Q4.	M3, CPI, GDP	Augmented Dickey-Fuller (ADF) test, Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, Chow test (structural breaks), Pearson correlation, Johansen Cointegration Test, VECM estimations, Granger Causality Test	GDP, CPI, and M3 significantly influence CEE stock indices in the long term, with limited short-term effects. Macroeconomic stability enhances market predictability and policy impact.
Mota et al. (2023)	2010–2019 (post-GFC & sovereign debt crisis)	INF, IR, EXR (EUR-USD, EUR-JPY), GDP, UNEMP, Oil (Brent), Gold	GARCH models, multiple linear regression, and correlation analysis using quarterly closing prices of main indices and commodity futures (Brent oil from ICE, gold from CME)	Portuguese market depends on EUR-USD, oil, gold; Japanese on gold, EUR-JPY; U.S. on EUR/JPY rates and Brent. Inflation & GDP growth boost markets, while interest rates & unemployment hurt them.
Arifoğlu et al.,2023	Turkey, 2018–2022	IMP, MCP, generation by primary resources	TVP-VAR (connectedness)	Relationship is time-varying; global events (Covid-19, Russia–Ukraine) increased connectedness; intraday market shifted from volatility receiver to transmitter post-Covid.
Gökgöz and Kayahan (2023)	2017–2022, Bitcoin & Developed/Emerging Stock Markets	BTC, MSCI USA, MSCI Europe, MSCI EM	TVP-VAR	Bitcoin acts as volatility receiver vs. developed markets, but weak transmitter vs. emerging markets. MSCI USA is main volatility emitter, MSCI EM main receiver. Global events (Covid-19, Russia–Ukraine) intensified spillovers.
Xu et al. (2024)	Global – S&P500, Bonds, Gold, Oil, 2003–2022	FFR, INF, ADS, EPU, GPR	Volatility Multiplicative Error Model (vMEM) and vMEM-X (with macroeconomic shocks); Realized volatility measures, Volatility spillover index	Without shocks, stocks transmit volatility mainly to oil, while bonds and gold absorb it; with shocks, oil becomes more sensitive but bonds and gold remain stabilizers.
Moizz, A., Akhtar, S.J. (2024)	2008–2023 incl. GFC, 2016 demonetisation, COVID-19, RU–UA war	WACR, WPI, M3, EXR (USD/INR)	ARDL bounds test, ECM (long/short-run), Bayesian robustness, Bai–Perron break test, Granger causality.	Cointegration confirmed; M3 boosts NIFTY50, WACR, Inflation, ER depreciation reduce it; COVID-19 & major events caused structural breaks

Table 2. (Continue) Literature Review

Authors (Year)	Market / Period	Variables	Methodology	Key Findings
Khan et al. (2024)	Multiple countries with varying economic structures	GDP, INF, IR, Unemp., FX	Cross-country econometric analysis combined with machine learning algorithms (e.g., LSTM, SVM) and traditional econometric techniques to enhance prediction accuracy	Macroeconomic indicators predict stock markets, with advanced economies showing stable responses and emerging markets more vulnerable to external shocks.
Alaskar & AlAli (2024)	Kuwait / 2003–2023	GDP, Interest Rate, Oil Prices, Exchange Rate, CPI, FDI	Quarterly data; Descriptive statistics, Augmented Dickey-Fuller (ADF) unit root test; Engle-Granger cointegration test; Granger causality test	Kuwait's stock market shows long-run links with GDP, interest rates, oil, exchange rates, and CPI; strong causality from oil, inflation, and FDI, reflecting oil dependence.
Keswani et al. (2024)	India / Jan 2009 – Dec 2019 (monthly data)	GDP, DI, FII, FX, GP, IR, INF	Augmented Dickey-Fuller (ADF) and Phillips–Perron (PP) unit root tests, Johansen Cointegration Analysis, Vector Error Correction Model (VECM), VECM Granger Causality Test, Variance Decomposition (VAD)	GDP, Disposable Income, FII positively affect long-term stock returns; Interest Rates, Government Policies, Exchange Rates, Inflation negatively affect; short-term impacts significant, GDP & Disposable Income main contributors
Agyemang-Badu et al. (2024)	13 African stock markets, 2003–2022	FX, CPI, T-bill rate, M3/M2+, Brent oil	Markov Switching Regression Model	Identified two regimes: tranquil (low volatility) and crisis (high volatility). Macroeconomic variables significantly impact both regimes, with stronger effects during tranquil periods.
Hatamerad et al. (2024)	Four OPEC members (Iran, Kuwait, Saudi Arabia, Nigeria) / 1996–2018 *(1999 and 2022 excluded to avoid extreme events such as the pandemic)*	CPI, INF, EG, EXR, EXP, IMP, Gold, OPEC Oil, BMG	Bayesian Model Averaging (BMA), Regularized Linear Regression (RLR), jointness analysis	CPI and money growth strongly boost stock prices; OPEC oil weakly negative; exchange rates, trade, and gold also matter with varying effects.

Table 2. (Continue) Literature Review

Authors (Year)	Market / Period	Variables	Methodology	Key Findings
Lazuardi & Adlan (2025)	Indonesia – Composite Stock Price Index (CSPI), monthly data 2009–2024	DJIA, S&P 500, CPI	Vector Error Correction Model (VECM), Cointegration Test, IRF, VDC	DJIA → positive & significant in long run, positive but insignificant short run; S&P 500 → negative & insignificant long run, negative & significant short run; Inflation → positive & significant long run, insignificant short run; overall explanatory power ~54%.
Ghimire et al. (2025)	Nepal – NEPSE, annual data 2000–2023	GDP, Inflation, M2, IR, Public Sector Credit, Remittance	ARDL bounds test, ECM, ADF & PP unit root tests	Long-run cointegration confirmed; GDP has negative effect; PSC and Remittance positively affect stock market capitalization; Inflation, Interest, and Money Supply not significant long-run; in short-run, interest rate negative and significant.
Iqbal & Saleem (2025)	Pakistan – PSX (KSE-100), 2000–2022 (Monthly)	CPI, IR, ER, GDP Growth	Regression analysis; ADF & PP unit root tests; Breusch-Pagan-Godfrey, BG Serial Correlation LM, Ramsey RESET; mediation analysis (Unsystematic Risk)	Macroeconomic variables significantly affect stock performance; GDP (+), inflation, interest, and exchange rates (–); effects mediated by unsystematic risk. Rising interest rates ↑ borrowing costs → higher risk. Highlights unique mediating role of unsystematic risk in Pakistan.
Saim et al. (2025)	U.S. Equity Market – S&P 500 Total Return Index, 2000–2023	Interest Rate (FFR), Inflation (CPI), Real GDP Growth, Exchange Rate (DXY), Unemployment	Granger causality, Johansen cointegration, GARCH models, Impulse response	GDP growth (+) and interest rates (–) are strongest drivers of stock returns; inflation ↑ volatility; exchange rate & unemployment weaker short-term effects; findings support semi-strong EMH & APT.
Zhang et al. (2025)	China – SSEC Index, 2012–2024 (Daily returns + Monthly data)	GDP, INF, IR, EPU	CNN-BiLSTM-Attention + GARCH-MIDAS	Hybrid model outperforms benchmarks; mixed-frequency integration (daily + monthly) ↑ accuracy; macro vars & EPU enhance predictive power.

In the scanned literature, mostly Vector error correction model (Maghayereh, 2002, Adam & Tweneboah, 2006, Madurapperuma, 2023, Ligocka,2023 Keswani et al.,2024, Lazuardi & Adlan, 2025). Granger casuality test (Ozer et al.,2011, Ozmerdivanlı,2014, Keswani et al.,2024, Alaskar& AlAli,2024, Saim et al.,2025) Panel data analysis (Sayılgan and Süslü,2011, Jamaladinet et al,2017, Setiawan et al.,2021) Var model (Syzdykova & Tanrıöven, 2018, Yiğiter et al., 2018, Czapkiewicz & Choczyńska, 2021), ARDL Test (Udo, S,S et al., 2022, Moizz A & Akhtar, s.j, 2024, Ghimire et al., 2025) Joensen cointegration test (Anokye & Tweneboah, 2006, Ozer et al., 2011, Ligocka, 2023, Madurapperuma, 2023, Keswani et al, 2024, Saim et al., 2025) ADF test (Budak et al., 2017, Ligocka, 2023, Madurapperuma, 2023, Keswani et al., 2024, Iqbal & Saleem, 2025) BMA (Moizz, A., Akhtar, S,J, 2024, Hatamerad et al., 2024) GARCH model (Loudon,2017, Czapkiewicz & Choczyńska,2021, Mota et al.,2023, Saim et al., 2025, Zhang et al., 2025) were used. The most commonly used methodologies some studies listed above are presented. It has been observed that VAR models are used in the literature. The TVP VAR model, which will be used in this study, was chosen as a more useful model for better visualization of time-sensitive breaks and propagation, and was adopted for the study. This distinguishes this study from other studies in the literature in terms of modeling.

In the literature review, studies generally examined macroeconomic variables such as inflation, unemployment and GDP growth rates. Although some studies examined the prices of commodities such as oil and gold, no study measuring commodity indices was found.

One aspect that distinguishes this study from the literature is the diversity of macroeconomic variables used. As seen in the literature review above, macroeconomic variables generally include inflation, nominal gross domestic product, money supply, unemployment, exchange rates, and interest rates. The Dow Jones commodity indices chosen in this study play a significant role in capturing global commodity movements. The study also aims to fill a gap in the literature through the macroeconomic variables used.

3. DATA

Secondary data for the 7 variables (BIST 100, WIG 20, DJCIGR, DJCICL, DJCING, DJCIGC, and VIX) were obtained from investing.com as daily opening prices covering the period from July 3, 2014, to September 1, 2025. The starting date of July 3,

2014, was selected since the Dow Jones commodity indexes included in the study became available from this date. To avoid a substantial loss of observations resulting from differences in trading days across countries, missing values on holidays were forward-filled using the most recent available trading day's data. As the logarithmic return formula was applied to the data, the initial observations dated July 3, 2014, were excluded from the analysis.

$$ln\left(\frac{p_t}{P_{t-1}}\right)$$

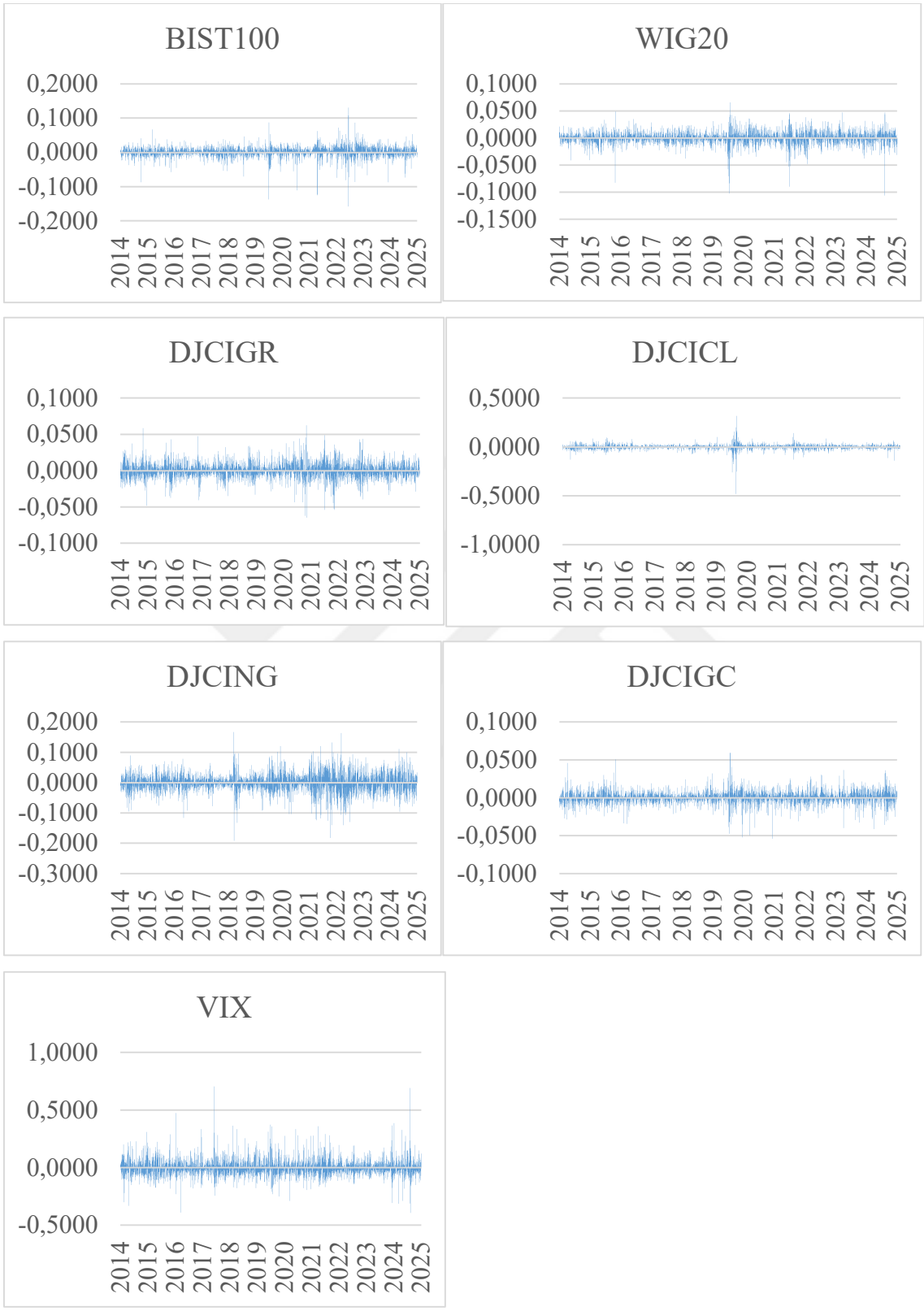
Table 3. Variables Description

Short Name	Explanations	Date Range
BIST 100	The BIST100 index is an indicator that measures the performance of the top one hundred stocks traded on Borsa Istanbul in terms of market capitalization and trading volume. BIST 100 is also considered an indicator of the Turkish stock market (Dinçkal,2024).	03.07.2014-01.09.2025
WIG 20	The WIG20 index is a free-float capitalisation-weighted stock index of 20 corporations on the Warsaw Stock Exchange. The WIG20 was created in April 1994 and the base value was set to 1,000 (Capital,2024).	03.07.2014-01.09.2025
DJCIGR	The Dow Jones Commodity Grain Index (DJCIGR) is an index that tracks the price performance of major grain crops in agricultural commodity markets. It reflects changes in the prices of major grain crops such as corn, wheat and soybeans and provides investors with information about the general trend in these markets (S&P 500 Global,2023).	03.07.2014-01.09.2025
DJCICL	The Dow Jones Commodities Crude Oil Index (DJCICL) is an index that tracks the performance of crude oil prices. This index reflects price movements in the crude oil market, providing investors with information about changes in oil prices (S&P 500 Global,2023).	03.07.2014-01.09.2025
DJCING	The Dow Jones Commodity Natural Gas Index (DJCING) is an index that tracks the performance of natural gas prices. This index reflects price changes in the natural gas market, providing investors with information about movements in natural gas prices (S&P 500 Global,2023).	03.07.2014-01.09.2025
DJCIGC	The Dow Jones Commodity Gold Index (DJCIGC) is an index that tracks the performance of gold prices. This index reflects price movements in the gold market, providing investors with information about changes in gold prices (S&P 500 Global,2023).	03.07.2014-01.09.2025
VIX	The Volatility Index (VIX) is a calculation derived from the average prices of call and put options on the S&P 500 Index and is designed to measure the expected 30-day constant volatility of US stock markets (Bloom, 2009; Cihangir, 2019).	03.07.2014-01.09.2025

3.1 TIME PATH CHARTS

Figure 15 shows the time series graphs for the variables under consideration, representing the logarithmic returns of the variables. As can be seen in the graphs, there were significant negative and positive fluctuations in some periods during the analyzed period.

Figure 15. Time Path Charts



3.2. DESCRIPTIVE STATISTICS

Descriptive statistics for the variables are given in Table 4 below.

The "kurtosis" values in Table 4 reveal that the return distributions of all indices deviate from a normal distribution. The sharp peaks and thick tails in the series indicate that extreme price movements both upward and downward occur more frequently than in a normal distribution. This suggests that markets occasionally experience periods of intense volatility and that volatility tends to cluster.

Table 4. Descriptive Statistics

	BIST100	**WIG20**	**DJCIGR**	**DJCICL**	**DJCING**	**DJCIGC**	**VIX**
Mean	0.00659	0.0000398	0.00000279	-0.000118	−0.0000961	0.000236	0.000107
Skewness	-1,078***	-0,892735	0,027	-2,046***	-0,212***	-0,074*	1,252***
Kurtosis	17,584***	13,44949	4,696***	63,81***	4,419***	6,868***	11,435***
JB	53327,218***	19095,18	3747,171***	694698,888***	3348,202***	8017,85***	23283,164***
Std.Dev	0,013925	0,010639	0,009794	0,023517	0,027389	0,00786	0,066070
ADF T-Statiscis	-63,01872	-62,67423	-61,90771	-22,39395	-65,45547	-65,25952	-68,89406
%1 Level	-3,960290	-3,960290	-3,960290	-3,960294	-3,960290	-3,960290	-3,960290
%5 Level	-3,410927	-3,410907	-3,410907	-3,410909	-3,410907	-3,410907	-3,410907
%10 Level	-3,127258	-3,127258	-3,127258	-3,127260	-3,127258	-3,127258	-3,127258

According to the Jarque–Bera test, the vast majority of the series do not meet the assumption of normal distribution. This result indicates that the data are not symmetrical around the mean and that extreme values occur more frequently than expected. In other words, the distribution of the series deviates statistically from normality, indicating that returns in financial markets can occasionally exhibit extreme volatility.

An examination of standard deviation values reveals significant fluctuations in the returns of the BIST 100 and WIG 20 indices. The relatively high standard deviations in both indices indicate that investors face periodically increasing uncertainty and price volatility in these markets. This suggests that the risk levels of the indices increase and market reactions become more acute, particularly during periods of changing global developments and economic expectations.

4. ANAYLYSIS METHODS

In this study we have used the time-varying parameter vector autoregressive (TVP-VAR) model developed by Antonakakis et al., 2017 but first introduced by Diebold and Yılmaz, 2012 is used to construct the connectedness measures. The main advantages of this model are as follows: (i) outlier sensitivity is solved by using the Kalman filter,

(ii) the problem of randomly selecting the sliding window length is eliminated, (iii) the problem of losing observations (data) is eliminated, making it usable for smaller data sets (akyıldırım et al. ,2022:352). Antonakakis et al. 2017 suggested a TVP-VAR based connectedness strategy to overcome the first limitation. TVP-VAR connectedness approach has some advantages over the traditional connected approach; i) it monitors more precisely the variations in the parameters, ii) it avoids losing observations, iii) it is less effective by outliers, and iv) it does not require the selection of arbitrary window size. The second limitation has been resolved by Lastrapes and Wiesen, who proposed a connected ness approach that normalizes the model based on the goodness-of-fit matrix (R2). Their joint spillover index resulted in a more natural interpretation of connectedness measurements as well as a more realistic depiction of the propagation process (Chen et al. ,2022:4).

In equations (1) and (2), the terms "X_t, $\Sigma\varepsilon$, θ_t, and u_t" denote vectors of dimension "n × 1", while "Σi, β, and u" represent matrices with the size "n × n".

$$Xt = \beta X_{t-1} + \Sigma\varepsilon_t + \varepsilon_t \quad (1)$$

$$vec(\beta_t) = vec(\beta_{t-1}) + \theta_t \varepsilon_t, \varepsilon_t \sim n(0, U_t) \quad (2)$$

According to Arifoğlu et al. (2023), the connectedness framework is primarily based on the vector moving average representation introduced by Diebold and Yılmaz (2012). In their study, this framework is further operationalized by employing the impulse-response generalized functions developed by Koop et al. (1996) together with the generalized forecast error variance decomposition suggested by Pesaran and Shin (1998). Within this context, the generalized variance decomposition is formally expressed in Equation (3).

$$Q_{ij}^{p}(V) = (\sigma ii^{-1} \Sigma h=0H-1 (ei' Ah \Sigma ej)^2) / (\Sigma h=0H-1 (ei' Ah \Sigma A'h ei)) , \quad \Sigma j=1n Q_{ij}^{p}(V) = 1 \quad (3)$$

Equation (4) defines the total connectedness index (TCI), which measures the degree of connectedness across all variables:

$$C_{ij}(V) = \Sigma i \neq j \, Q_{ij}^{p}(V) / \Sigma i=1n \, \Sigma j=1n \, Q_{ij}^{p}(V) \quad (4)$$

This index reflects the overall spillover effects between variables, excluding each variable's own lag effect. The decomposition of total connectedness into directional spillovers is expressed in equations (5) and (6):

$C_i \rightarrow_j^p(V) = \Sigma i \neq j \; Q_{ij}^p(V)$ (5)

$C_i \leftarrow_j^p(V) = \Sigma i \neq j \; Q_{ji}^p(V)$ (6)

Equation (5) corresponds to the spillovers transmitted from variable "p" to the remaining variables, whereas equation (6) captures the spillovers received by "p" from the others. The difference between the two is taken as the net volatility spillover, shown in equation (7):

$C_{it}(V) = C_i \rightarrow_j^p(V) - C_i \leftarrow_j^p(V)$ (7)

According to equation (7), when the value is greater than zero, the variable acts as a transmitter of volatility, while a negative value indicates that the variable is a receiver of volatility.

Finally, equation (8) demonstrates the net pairwise directional connectedness (NPDC), which identifies the relative dominance of volatility spillovers between two variables:

$NPDC_{ij}(H) = Q_{ij}^p(H) - Q_{ji}^p(H)$ (8) (Arifoğlu et al.,2023).

5. FINDINGS

5.1. AVARAGE AND TOTAL CONNECTEDNESS

The table regarding the average connectivity of the variables is given in Table 5 below, and the total connectivity graph over the years is given in Figure 16 and evaluated. In order to avoid misleading graphics, the graphics were created using data as of 01.09.2014.

Table 5. Average Connectedness

	BIST100	**WIG20**	**DJCIGR**	**DJCICL**	**DJCING**	**DJCIGC**	**VIX**	**FROM**
BIST100	82,41	6,65	1,43	1,85	0,92	1,16	5,58	17,59
WIG20	6,17	74,07	1,43	3,4	1,37	1,97	11,59	25,93
DJCIGR	1,23	1,91	88,05	4,12	1,47	1,65	11,56	11,95
DJCICL	1,68	3,66	3,97	82,23	2,39	2,81	3,32	17,77
DJCING	1,02	1,41	1,55	2,77	90,71	1,31	1,23	9,29
DJCIGC	1,12	2,59	1,62	3,26	1,16	87,99	2,25	12,01
VIX	5,03	11,22	2,21	1,74	1,03	1,74	76,86	23,14
TO	16,25	27,45	11,22	18,31	8,31	10,64	25,47	117,68
Inc.Own	98,66	101,52	99,27	100,54	99,05	98,64	102,32	cTCI/TCI
NET	-1,34	1,52	-0,73	0,54	-0,95	-1,36	2,32	19,61
NPT	1	5	2	4	0	3	6	

Table 5 shows the connectivity data for all hypotheses. The connectivity data between the two stock market indices, BIST 100 and other variables, was determined to be 17.59, while that of the other stock market index, WIG 20, was determined to be 25.93. When the average connectivity table is examined, the amount of volatility that WIG 20 spreads to other variables is 27.45, while BIST 100 ZUN is 16.25. In other words, WIG 20 affects other indices in terms of spread more than BIST 100. In addition, detailed risk analyses are provided below.

When Appendix 1 is examined, it is observed that the two stock indices, BIST100 and WIG20, which constitute the main subject of the study, receive connectivity and activation from other variables in similar periods. These periods are 2014, 2016, 2020, 2022, and 2025.

It is assumed that the biggest reason for the increase in connectivity in 2014 was the political anxiety experienced due to Russia's involvement in the genocide and the Syrian refugees migrating to Türkiye due to the Syrian civil war and the desire of these refugees to go to Europe (Konak, 2009, Bozkurt,2018, Kıllıoğlu, 2024). There was an unexpected drop in oil prices in 2014, causing volatility in global energy markets (Bardoff&Losz,2014).

Another event that occurred in 2016 was the Brexit referendum. This led to political uncertainty in EU internal relations (Yeni Şafak, 2016), and Turkey, as a candidate state, was affected by this political uncertainty. Here, we should not forget the coup attempt in Türkiye in 2016. Although it is considered as an internal factor, it can be said that it created serious uncertainty for Türkiye's trade partners and allies in military, social and political terms (Bloomberg, 2016). In 2020, a global crisis profoundly impacted not only Turkey and Poland but the entire world: the COVID-19 pandemic.

The COVID-19 pandemic shocked global markets, negatively impacting and stagnating commercial and economic life. This led to uncertainty and price fluctuations in energy markets. It also created uncertainty in Turkey and Poland, which import energy, leading to negative price movements in stock market indices (Köftecioğlu and Paksoy, 2024).

Another significant development in 2020 was the Nagorno-Karabakh War between Armenia and Azerbaijan. This not only created security uncertainty for Turkey but also raised concerns about the Baku-Ceyhan-Tbilisi oil pipeline, which carries oil

through Turkey, thus impacting energy markets (S&P Global Commodity Insights, 2020; Reuters, 2023).

The Russia-Ukraine war, which occurred in 2022, deeply affected both countries. Poland's geographical proximity suggests it was more severely affected. During the war, 3.5 million Ukrainian refugees arrived in Poland, creating a socioeconomic crisis in Poland. Furthermore, since Turkey and Poland are among the energy-importing countries, the involvement of Russia, an energy-producing state, in the war is assumed to have created serious concerns in energy markets. The Black Sea region has become riskier due to the war, leading to political and economic concerns among the Black Sea coastal states. Türkiye, one of the states with the largest coastline on the Black Sea, is assumed to have been directly affected (Erol and Başaran, 2022, Bakan, 2022, Duszczyk & Kaczmarczyk, 2022).

In 2025, Russian drones threatened Polish airspace, causing a crisis. This constitutes a security problem for Poland and, consequently, for NATO member states, of which Poland is a member. (Barrington & Plucinska, 2025) Turkey has been directly affected by the Palestine-Israel crisis, and its social structure should be taken into account. The influence of religious belief has crises experienced in agricultural products. Climate changes and oil price fluctuations have led to uncertainty issues regarding agricultural product prices in 2025 (Şencan, 2025). The announcement of new tariffs for countries around the world by American President Trump after his election also appears to be a factor that increases uncertainty and global risks (The White House,2025). The relevant volatility graphs for the comments are attached.

Figure 16. TCI

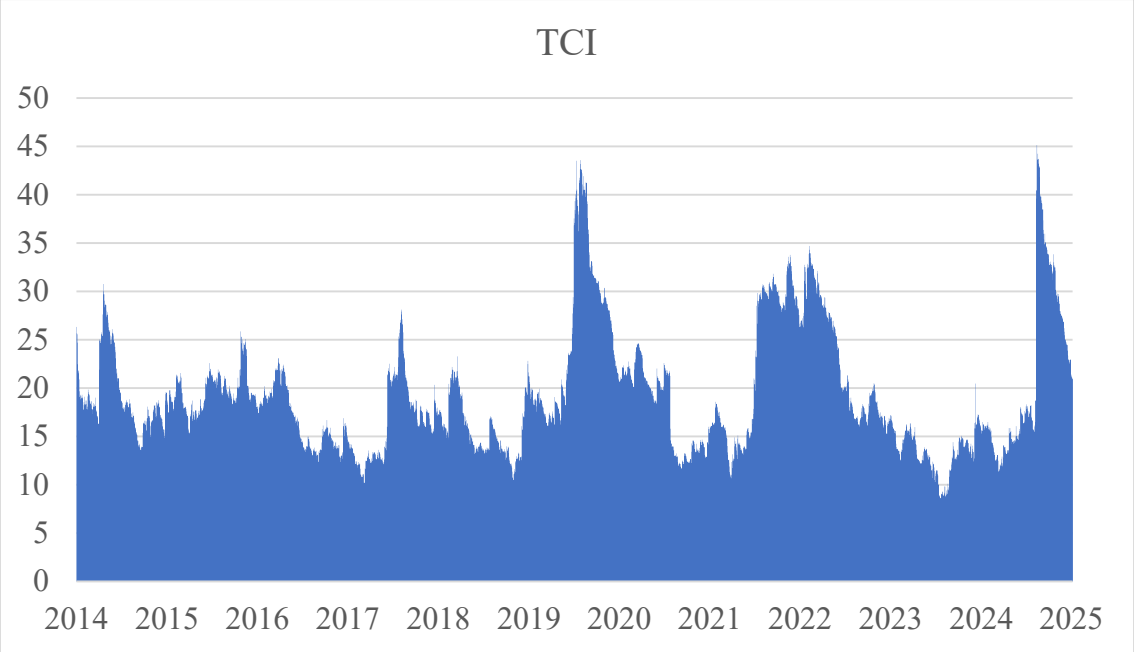


Figure 16 shows the total connectivity graph for variables. It is clear that there has been a significant increase in connectivity in certain periods. The most notable years are 2014, 2015, 2018, 2020, 2022, and 2025. It is assumed that the increased connectivity between variables in these years is due to risks caused by tensions in global markets and fluctuations caused by geopolitical events.

The primary drivers of volatility spillover in 2014 are assumed to be Russia's annexation of Crimea and the Syrian civil war. These two crises are thought to have impacted the stock market indices considered. Russia's annexation of Crimea led to an energy crisis and a security problem in the Black Sea region, while the Polish index, WIG 20, is likely to be affected. A possible convergence of this impact on Turkey is the assumption that it could trigger an energy crisis (Konak, 2009, Kıllıoğlu, 2024). The Syrian civil war is believed to have created significant migration pressure on Turkey, increasing geopolitical risk and negatively impacting the Turkish stock market index. Its impact on Poland can be considered continental. It is possible to hypothesize that Poland and other European Union member states were exposed to both commercial and security risks as a result of the Syrian civil war and felt pressure from refugee migration. This, in turn, evolved into a global crisis (Bozkurt, 2018). There was an unexpected drop in oil prices in 2014, causing volatility in global energy markets (Bardoff&Losz,2014).

In 2015, the effects of the Syrian war continued, and a migration flow began in Europe. Therefore, Turkey, which served as a buffer zone, is believed to have been exposed to greater risks and significantly affected by this risk (Bozkurt, 2018).

In 2018, a significant increase was observed in the amount of volatility Turkey swept across other indices. The main reason for this was Turkey's currency crisis during that period (Akkoç, 2023). The US-China trade war, which also occurred during this period, had a general impact (Şanlı and Ateş, 2020).

A situation that led to general volatility across all indices occurred in 2020. The Covid-19 pandemic has caused a major disruption in Turkey and the world. the volatility spread by other indices, The factor that caused the significant fluctuation in energy prices here was the collapse of oil prices (Köftecioğlu and Paksoy, 2024). The DJCING and DJCICL indices, among the indices discussed here, were directly affected, exhibiting and retaining significant volatility. Another geopolitical issue that needs to be addressed in 2020 is the second Nagorno-Karabakh conflict. The conflict is assumed to have caused volatility in global oil and natural gas markets through the security of energy pipelines in the South Caucasus. Azerbaijan's status as a major regional producer and exporter has led to supply security concerns being reflected in prices (S&P Global Commodity Insights, 2020; Reuters, 2023).

Another major crisis for the two countries was the start of the Russia-Ukraine war, which took place in 2022, and there was a huge increase in energy prices, which caused intense One of the conditions that causes volatility spillover is an increase throughout the data, as clearly observed in Figure 16. The biggest problem this creates for both countries is energy costs. Because both countries are importers, it has been directly affected. Another problem is the onset of the migration crisis. Poland was the country most affected. Since the beginning of the war, approximately 3.5 million Ukrainian refugees migrated and settled in Poland. This led to serious changes in Poland's socio-economic structure, negatively affecting inflation, unemployment, and growth data. Although the migration crisis did not directly affect Turkey, there were also refugees migrating from Ukraine to Turkey (Erol and Başaran, 2022, Bakan, 2022, Duszczyk & Kaczmarczyk, 2022).

Another problem is the conflicts in the Middle East. The conflict between Palestine and Israel, which began not only in 2024 but also continued into 2025, has led to uncertainty in global oil and energy markets. (Kantarcı and Birsel, 2025) Another point

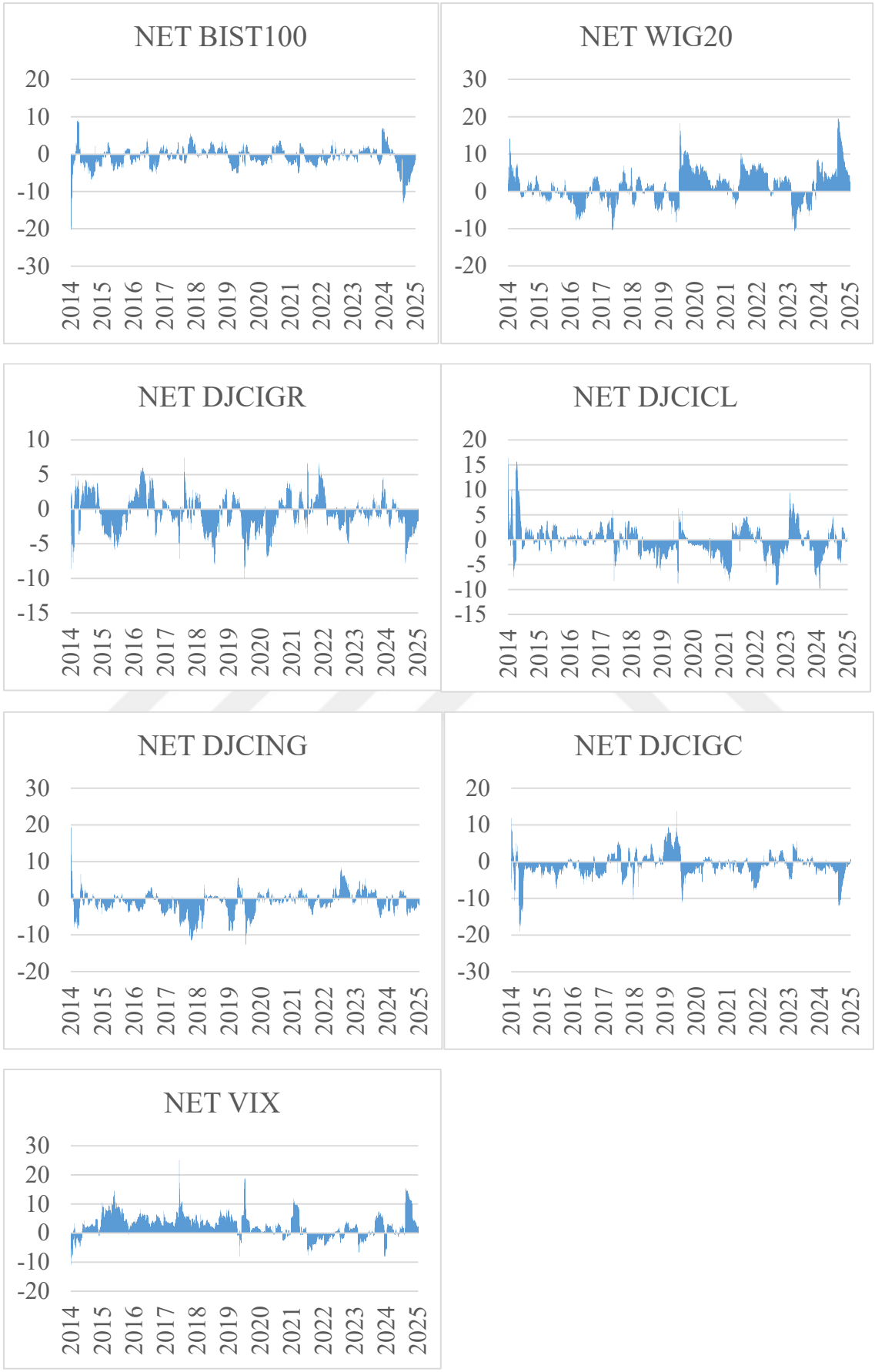
worth mentioning here is that this tension creates a security problem for Eastern Mediterranean energy resources. This situation directly impacted Turkey, which is conducting natural gas exploration in the Eastern Mediterranean (Köksoy and Bakır, 2025).

In 2025, Russian drones threatened Polish airspace, causing a crisis. This constitutes a security problem for Poland and, consequently, for NATO member states, of which Poland is a member. (Barrington & Plucinska, 2025) Turkey has been directly affected by the Palestine-Israel crisis, and its social structure should be taken into account. The influence of religious belief has created pressure on politics (Kızılgeçit et al., 2025). Another crisis stems from the climate-related crises experienced in agricultural products. Climate changes and oil price fluctuations have led to uncertainty issues regarding agricultural product prices in 2025 (Şencan, 2025). The announcement of new tariffs for countries around the world by American President Trump after his election also appears to be a factor that increases uncertainty and global risks (The White House,2025).

5.2. NET DYNAMIC CONNECTEDNESS

In this section, Net graphs of volatility transfers in negative and positive periods for the variables discussed are included.

Figure 17. The Volatility Of Variables İn Positive And Negative Periods



The net graphs shown in Figure 17 are the graphs that emerge after comparing the volatility received by the variables and the volatility they spread to others. Here, the indicators in the negative part represent the volatility the variable received from others in the period, and the ones in the positive part are the periods of volatility it spread to others.

The commodity gold index we're considering in 2025 is a significant volatility recipient, while the VIX index is a significant spreader during the same period. The conclusion we can draw from this is that when the fear index spreads volatility, changes occur in the commodity gold index. This creates the assumption that investors and individuals consider gold a safe haven during periods of global and geopolitical crisis.

An examination of the periods reveals that the indices follow a volatile course. Volatility transfers and purchases occurred, particularly during the risk periods considered in the study. In 2014, the BIST 100 index was a significant receiver, while the WIG 20 appeared to be both a significant volatility spreader and buyer during the same period. In 2020, the BIST 100 index fluctuated, but generally acted as a volatility receiver, while the WIG 20 acted as a volatility spreader. A similar pattern is likely to be observed in 2022. During this period, the BIST 100 index, while still volatile, generally acted as a volatility receiver. The WIG 20 acted as a general volatility spreader. In 2024, the two country indices appear to be in the same situation. Both indices are volatility spreaders. In 2025, a similar situation will be seen in other previous years, with BIST 100 being a receiver and WIG20 being a volatility distributor.

In other words, the decline in the proportion of foreign investors and the increase in the proportion of domestic investors in 2025 have begun to transform the BIST 100 index into a structure that reduces its sensitivity to global and geopolitical risks. Here, the outflow of foreign investors tends to increase volatility spreads, similar to the WIG20 in other stock exchanges. Conversely, the increasing trend in domestic investors mitigates the impact of global shocks. However, it's worth adding the following comment: the BIST 100 is affected by both the speculative behavior of domestic investors and its own internal dynamics. (SPK,2025)

5.3. PAIRWISE DYNAMIC CONNECTEDNESS

In Figure 18 below, a comparative table is given regarding the volatility transfers of the variables to each other, and in Figure 19, net graphs regarding the negative and positive periods between these variables are given.

Figure 18. Volatility Comparisons Among Variables

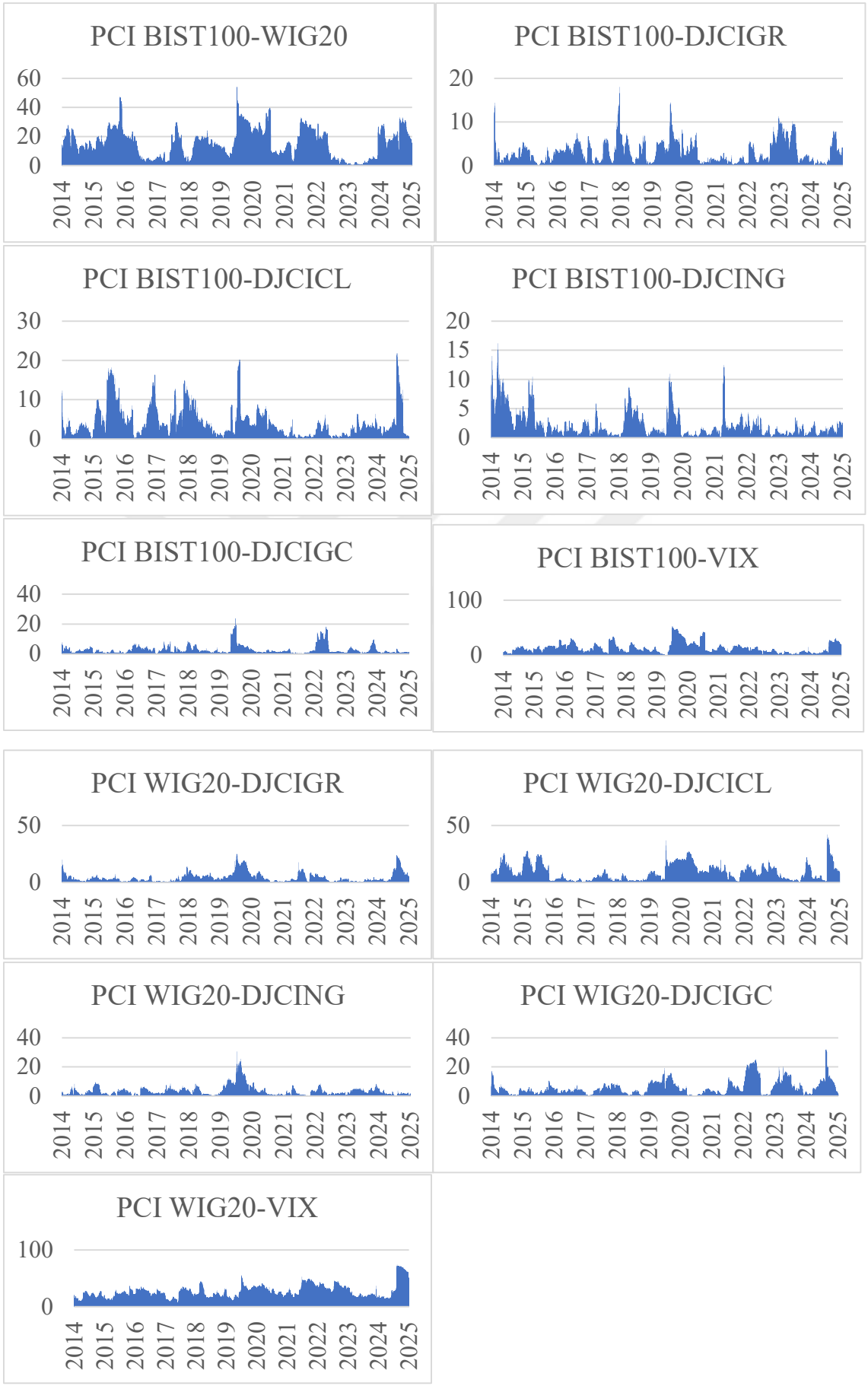


Figure 18 shows the volatility distribution graphs for each variable compared to the other. The most striking of these graphs are those between BIST 100 and the VIX index, between BIST 100 and WIG 20, between WIG 20 and VIX, between WIG 20 and DJCICL, and between DCCICL and DJCIGC.

An examination of the graph reveals volatility spillover across all variables, particularly during the risk periods examined. When examining the two stock market indices that form the main focus of this study, the following stand out: There is a significant volatility spillover between the BIST100 and VIX during the risk periods considered and evaluated. The same situation is also observed between the BIST100 and WIG20, which adds significance to the study. The two stock market indices spread volatility to each other during risk periods. Another situation is observed between the BIST100 and DJCICL. This suggests that energy commodities and indices have an impact on the BIST100 index. The same situation occurred between WIG20 and DJCICL, suggesting that the two countries are sensitive to energy indices. Another volatility spillover occurred between the WIG20 and VIX. Significant increases were observed especially during periods of significant crises such as Covid-19, the Russia-Ukraine war and oil crises. Other variables highlighted for WIG20 are: DJCIGC, DJCIGR, and DJCIGR.

The prominent reason for the commodity grains index's prominence here is that COVID-19 stands out as a significant factor. The geopolitical risk exposure for Poland in 2020 and 2022 is significant. The countries involved in the war are grain producers and exporters. Poland's geopolitical proximity has increased its exposure to risk. Another prominent factor here is the natural gas index, which has been affected by similar risks. The 2014 oil crisis and Russia's annexation of Crimea have increased volatility in energy markets. COVID-19 had a general impact on markets in 2020, and the proximity to the war between Russia and Ukraine in 2022 has further impacted Poland. The threat posed by Russian drones to Polish airspace in 2025 also sparked a political crisis and escalated tensions. The 2025 Palestine-Israel war emerged as a global crisis. It's safe to say that the war's proximity to the Gulf states created uncertainty and fear in energy markets.

Figure 19. The Volatility Of Between Two Variables In Positive And Negative Periods

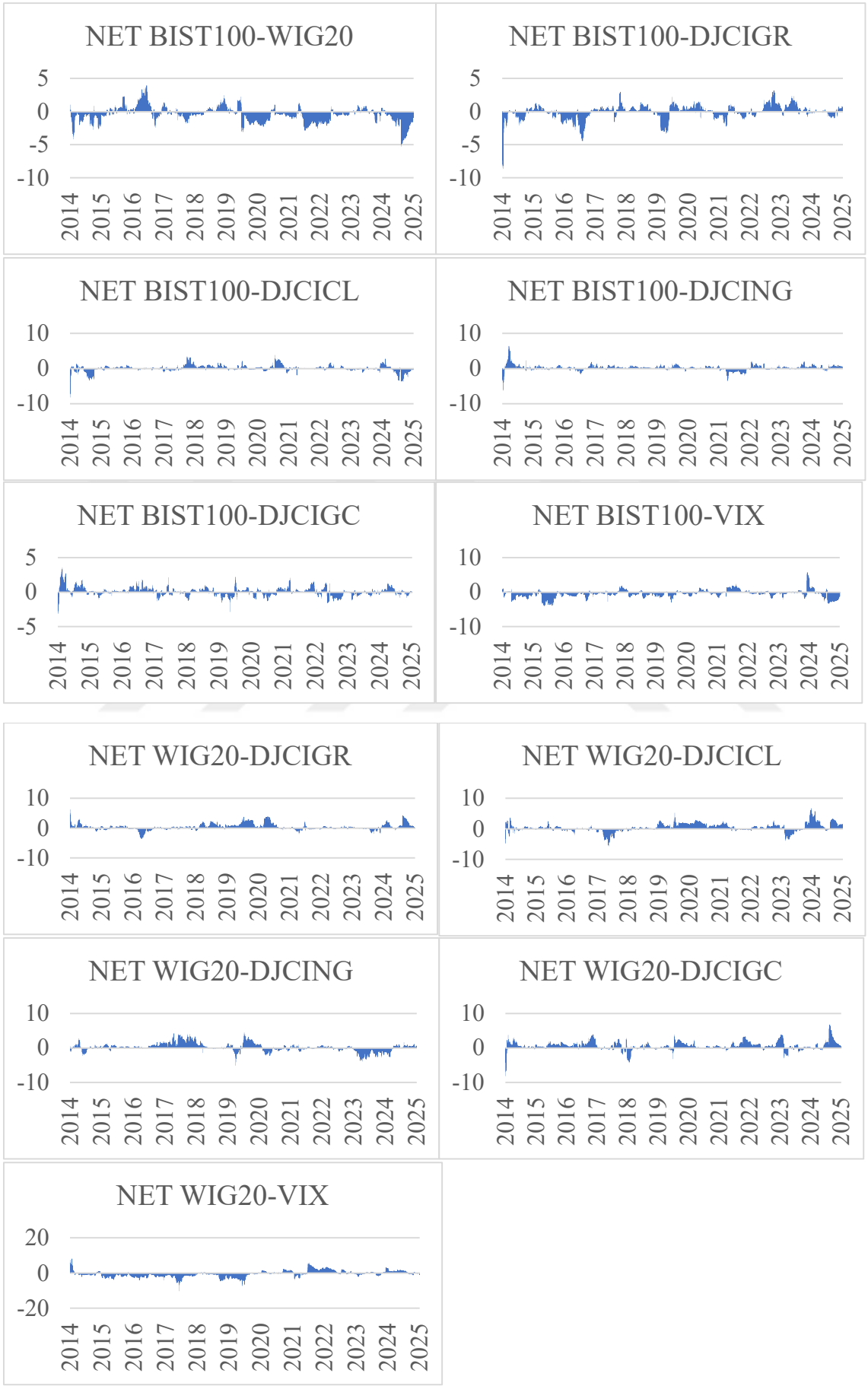


Figure 19 is the graph after the offsetting of the spread of the comparative volatility spread indices of two variables. The negative indicators express the volatility spread that the variables received from others in the specified periods, while the positive indicators reflect the volatility amounts that they spread.

5.4. VARIABLES NETWORK

Figure 20 below shows the network figure showing the connection between variables.

Figure 20. Variables Network

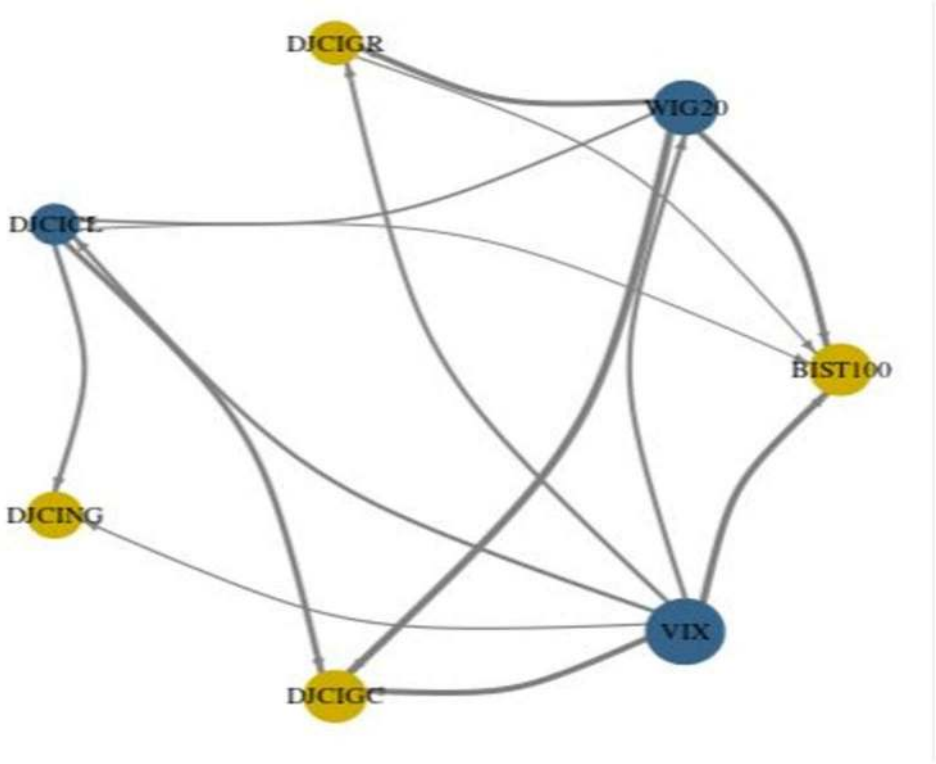


Figure 20 shows the network shape between variables. The direction of the arrows in this graph indicates which variable affects which. The direction of the arrow is affected by where the arrow lands. The thickness and thinness of the arrows indicate the intensity of the effects; thicker and darker arrows indicate greater impact. Furthermore, there are also indirect, though not direct, effects. When the volatility spread is examined holistically together with other graphs, the following variables stand out: a relationship between BIST100 and VIX, WIG20 and DJCICL. WIG20, DJCIGC, DJCIGR, DJCING, DJCICL and VIX index are among the prominent variables.

6. LIMITATIONS OF THE STUDY

Due to the Dow Jones indexes used in this thesis's starting date, the analysis began on July 3, 2014, and the period between September 1, 2025, was covered. Due to the different selection of variables and the method used, it is possible to extend the data date set. When examined in terms of variables, a total of Seven variables were used. Increasing the number of variables here could yield results that provide clearer interpretations. When examined in terms of the model, the TVP-VAR model was used in the thesis, and the ADF test was applied to assess the stationarity of the data. Other models like Garch, could also be used.

DISCUSSION AND CONCLUSION

Risks cause volatility in financial markets. This study focuses on the fluctuations in commodity markets caused by variables considered in terms of global and geopolitical risks.

The main objective of this study is to analyze the dependency structure between the BIST100 and WIG20 stock market indices and major global commodity indices, focusing particularly on how global and geopolitical risks shape these interrelationships. By examining the dynamic interactions between equity and commodity markets, the study aims to determine whether diversification opportunities exist for investors in emerging and transition economies such as Turkey and Poland. Additionally, the research seeks to identify which of the two indices, BIST100 or WIG20, demonstrates greater resilience to global and geopolitical shocks, thereby maintaining stronger stability during periods of heightened uncertainty.

This study examines variable data between July 3, 2014, and September 1, 2025, to identify financial risks during this period. The aim is to determine the sensitivity of two country indices to global and geopolitical risks within the context of these variables. The analysis results of the study indicate that the Polish index exhibits a more sensitive structure to the major commodity indices considered, while the BIST 100 index is relatively less sensitive. When the total volatility results are examined, the Turkish BIST 100 index is more affected by its own internal dynamics, while the WIG 20 index is more affected by other variables.

The primary drivers of volatility spillover in 2014 are assumed to be Russia's annexation of Crimea and the Syrian civil war. These two crises are thought to have impacted the stock market indices and the Commodity indices considered. Russia's annexation of Crimea led to an energy crisis and a security problem in the Black Sea region, while the Polish index, WIG 20, is likely to be affected. A possible convergence of this impact on Turkey is the assumption that it could trigger an energy crisis (Konak, 2009, Kıllıoğlu, 2024). The Syrian civil war is believed to have created significant migration pressure on Turkey, increasing geopolitical risk and negatively impacting the Turkish stock market index. Its impact on Poland can be considered continental. It is possible to hypothesize that Poland and other European Union member states were exposed to both commercial and security risks as a result of the Syrian civil war and felt pressure from refugee migration. This, in turn, evolved into a global crisis (Bozkurt,

2018). There was an unexpected drop in oil prices in 2014, causing volatility in global energy markets. (Bardoff&Losz,2014)

In 2015, the effects of the Syrian war continued, and a migration flow began in Europe. Therefore, Turkey, which served as a buffer zone, is believed to have been exposed to greater risks and significantly affected by this risk (Bozkurt, 2018). It is assumed that the sudden drop in oil prices has exacerbated the fluctuations this year. This could directly lead to a fluctuation of up to 16 in the DJCICL index (BBC News, 2015). This has had a positive impact on both Turkey and Poland. This is a similar common factor, as both countries are oil importers, resulting in a decrease in energy costs.

In 2016, a significant development occurred for Türkiye. On July 15, 2016, a coup attempt occurred as an internal factor, suggesting that the BIST 100 index significantly impacted other indices (Appendix 2) (Bloomberg, 2016). Another event that occurred in 2016 was the Brexit referendum. This led to political uncertainty in EU internal relations (Yeni Şafak, 2016), and Turkey, as a candidate state, was affected by this political uncertainty.

Volatility relatively decreased in 2017, but considering the global crises in this area, North Korea's missile tests are believed to have created an atmosphere of fear worldwide (Berlinger & Whiteman, 2018), and the trade tensions between the US and the EU are thought to have directly affected both countries (Euronews, 2017). Poland, as an EU member state, is directly exposed to this risk, while Turkey, as one of its largest trading partners is the EU and the US, is affected (TUİK, 2025).

In 2018, a significant increase was observed in the amount of volatility Turkey swept across other indices. The main reason for this was Turkey's currency crisis during that period (Akkoç, 2023). The US-China trade war, which also occurred during this period, had a general impact (Şanlı and Ateş, 2020).

While significant volatility was not observed in 2019, the main risks worth mentioning are: the intensification of the Brexit process put pressure on Europe, and the tension between the US and Iran led to increases in energy prices (Bloomberght, 2019, Tuygun, 2021). Iran's position as a major oil and natural gas producer is significant, and its geographical proximity to Turkey is among the factors thought to have led to geopolitical tensions. A situation that led to general volatility across all indices occurred in 2020.

The Covid-19 pandemic has caused a major disruption in Turkey and the world. For all indices, the total volatility index is figure 16, and for the volatility spread by other indices, Appendix 1 and 2 should be considered. The factor that caused the significant fluctuation in energy prices here was the collapse of oil prices (Köftecioğlu and Paksoy, 2024). The DJCING and DJCICL indices, among the indices discussed here, were directly affected, exhibiting and retaining significant volatility. Another geopolitical issue that needs to be addressed in 2020 is the second Nagorno-Karabakh conflict. The conflict is assumed to have caused volatility in global oil and natural gas markets through the security of energy pipelines in the South Caucasus. Azerbaijan's status as a major regional producer and exporter has led to supply security concerns being reflected in prices (S&P Global Commodity Insights, 2020; Reuters, 2023) (Appendix 1 and 2).

Although a recovery was observed in 2021 with the passing of the Covid-19 pandemic, another crisis occurred in the supply chain, which was caused by the Covid-19 pandemic and whose impact continues. This, as a global crisis, negatively impacted both Poland, which serves as a bridge for Europe, and Turkey, which serves as a bridge connecting Asia and Europe (Akkartal, 2022).

Another major crisis for the two countries was the start of the Russia-Ukraine war, which took place in 2022, and there was a huge increase in energy prices, which caused intense One of the conditions that causes volatility spillover is an increase throughout the data, as clearly observed in Figure 16. The biggest problem this creates for both countries is energy costs. Because both countries are importers, it has been directly affected. Another problem is the onset of the migration crisis. Poland was the country most affected. Since the beginning of the war, approximately 3.5 million Ukrainian refugees migrated and settled in Poland. This led to serious changes in Poland's socio-economic structure, negatively affecting inflation, unemployment, and growth data. Although the migration crisis did not directly affect Turkey, there were also refugees migrating from Ukraine to Turkey (Erol and Başaran, 2022, Bakan, 2022, Duszczyk & Kaczmarczyk, 2022).

Global interest rate hikes occurred in 2023, creating a global capital risk. The tight monetary policies implemented cooled economies and were reflected in growth rates (Bloomberght, 2023). A major crisis unique to Turkey occurred, and on February 6, 2023, 10 provinces in Turkey's southeastern Anatolia region suffered major destruction. This led to a major rupture in the Turkish economy (Büyükoğlu et al., 2024). Military spending

in Poland increased due to the war between Russia and Ukraine, creating fear. (Macrotrends, 2025) Great uncertainty arose before the 2024 US elections, and this emerged as a political crisis worldwide. The WIG 20 and BIST 100 indices, already sensitive to geopolitical and global risks, were directly affected by these events. (Duffin et al., 2024)

Other events that occurred in 2024 were as follows: Discussions about energy transitions began in Europe, and the European Green Deal also played a role in this process. Carbon emissions and natural resource-based energy consumption became topics of discussion, leading directly or indirectly to energy uncertainty in the EU and countries directly associated with the EU. (Strielkowski et al., 2024) Another problem is the conflicts in the Middle East. The conflict between Palestine and Israel, which began not only in 2024 but also continued into 2025, has led to uncertainty in global oil and energy markets. (Kantarcı and Birsel, 2025)

Another point worth mentioning here is that this tension creates a security problem for Eastern Mediterranean energy resources. This situation directly impacted Turkey, which is conducting natural gas exploration in the Eastern Mediterranean (Köksoy and Bakır, 2025).

In 2025, Russian drones threatened Polish airspace, causing a crisis. This constitutes a security problem for Poland and, consequently, for NATO member states, of which Poland is a member. (Barrington & Plucinska, 2025) Turkey has been directly affected by the Palestine-Israel crisis, and its social structure should be taken into account. The influence of religious belief has created pressure on politics (Kızılgeçit et al., 2025). Another crisis stems from the climate-related crises experienced in agricultural products. Climate changes and oil price fluctuations have led to uncertainty issues regarding agricultural product prices in 2025 (Şencan, 2025). The announcement of new tariffs for countries around the world by American President Trump after his election also appears to be a factor that increases uncertainty and global risks (The White House,2025). To be evaluated in another context, it is the total network shape. Here, the BIST 100 index was directly affected by WIG 20, VIX, and DJCICL. The indices with the highest density were found to be WIG 20 and VIX, while WIG 20 was significantly affected by the VIX, BIST 100, DJCIGC, DJCIGR and DJCING indexes.

When evaluated in the context of the variables considered, according to the average connectivity analysis results in Table 5, it was determined that the WIG 20 index

had a higher level of connectivity with the variables considered, at 25.93, while the BIST 100 index had a relatively lower connectivity, at 17.59. According to the results, it was assumed that the WIG 20 index was more sensitive to global and geopolitical risks in the context of the variables considered.

The study's findings also have implications for investors and policymakers. The variables considered are energy and commodity indices. These indices are important because they measure global markets. Based on the results obtained and analyzed from 2014 to 2025, the BIST 100 index appears to be more secure for investors. Correlations were identified among all variables, concluding that these variables are sensitive to global and geopolitical risks.

We believe that incorporating different country indices into our studies could further highlight the differences. Furthermore, by increasing the number of variables, we anticipate a holistic risk assessment. It is crucial for investors in financial markets and policymakers who will adjust market regulations to assess risks and present them periodically. When diversifying their portfolios, investors invest in various investment instruments, seeking to minimize their risk exposure and maximize their returns.

We believe this study will provide insights for investors wishing to invest in the financial markets in Poland and Turkey, in the context of the commodity and energy indices discussed. This will allow investors to better assess their exposure to geopolitical and global risks in the context of these two countries and their strategic locations, and to choose more secure investment instruments in their portfolios accordingly.

The situation is considered critical for policymakers, as economic stability and the reliability of stock market indices are crucial for both domestic and foreign investors, ensuring their confidence. We believe this study will provide policymakers with more reliable information regarding commodity and energy indices, which are considered in terms of their exposure to global and geopolitical risks.

Here, another suggestion emerges for policymakers: It would be possible to protect against inflation by making forward-looking agreements to reduce exposure to volatility in critical energy commodities such as natural gas and oil, especially in fossil fuel-dependent countries like Turkey and Poland. This would ensure price stability and make countries less affected by such global and geopolitical risks.

According to the WEF (2025) report, increasing global "geoeconomic fragmentation" is reshaping trade and capital flows, impacting emerging economies like Turkey and Poland in terms of both risks and opportunities. Energy and commodity dependence makes these two countries more vulnerable to global shocks, while disruptions in energy supply chains increase volatility in stock market indices. Turkey's energy importing structure and Poland's fossil fuel-based industrial base similarly exacerbate this vulnerability. Furthermore, strong institutions and regional collaborations increase resilience to economic fluctuations. Turkey's alignment with EU energy markets and Poland's continued intra-EU financial coordination are critical in this context. Furthermore, deepening capital markets, strengthening financial literacy, and enhancing human capital are seen as key elements that will enable both countries to more effectively manage global risks.

Our recommendations for future studies are as follows: Given the commonality of the two analyzed countries' sensitivity to certain risks and the significant trade closeness between Turkey and Europe, it is assumed that there are more similarities. Another suggestion we have for other studies is to include other sub-indices traded on Borsa Istanbul and WIG into the model and determine their connection with the Dow Jones index and VIX index that we discussed in our study. This will provide more specific results regarding industries and variables in future studies.

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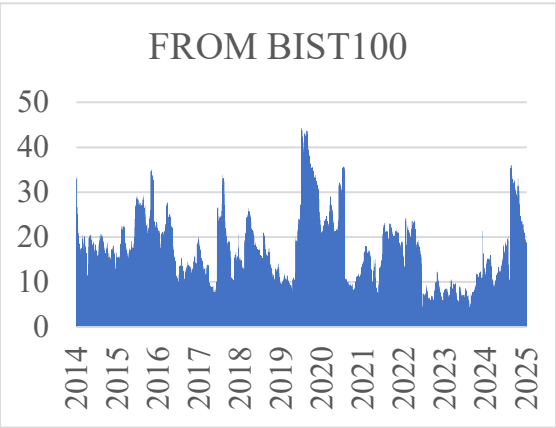
APPENDIX

Appendix 1: The Effects That Each Variable Receives From Other Variables

The volatility graphs in Appendix 1 are presented separately for each variable and represent the volatility each variable receives from the others. As can be seen in the graphs, fluctuations for each variable increase in some periods. This coincides with the global and geopolitical risks to be discussed.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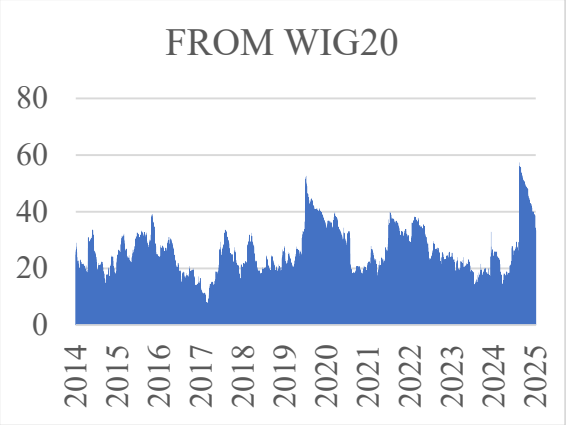
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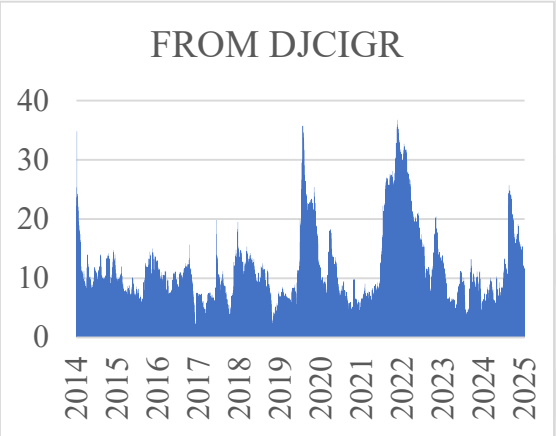
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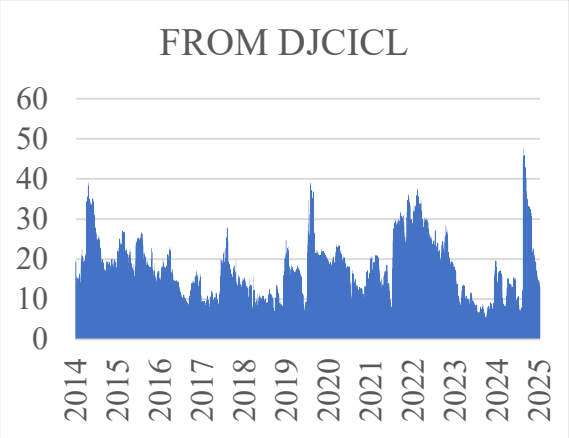
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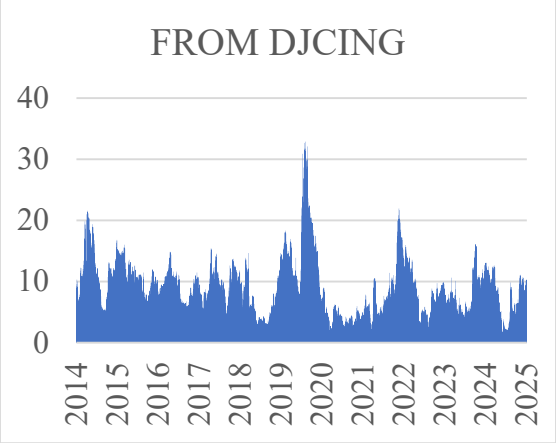
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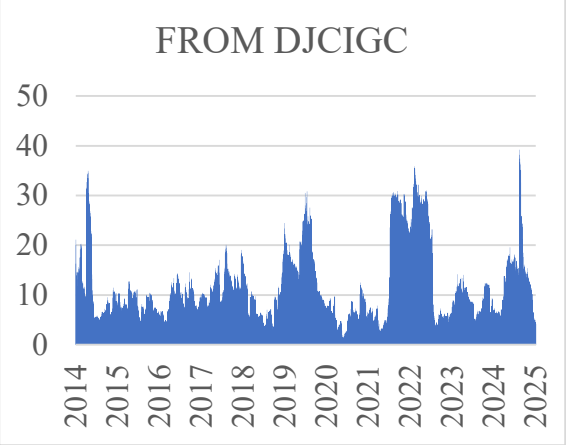
FROM DJCIGC
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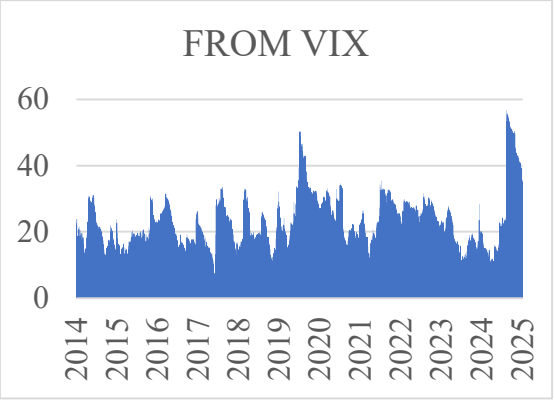
FROM VIX
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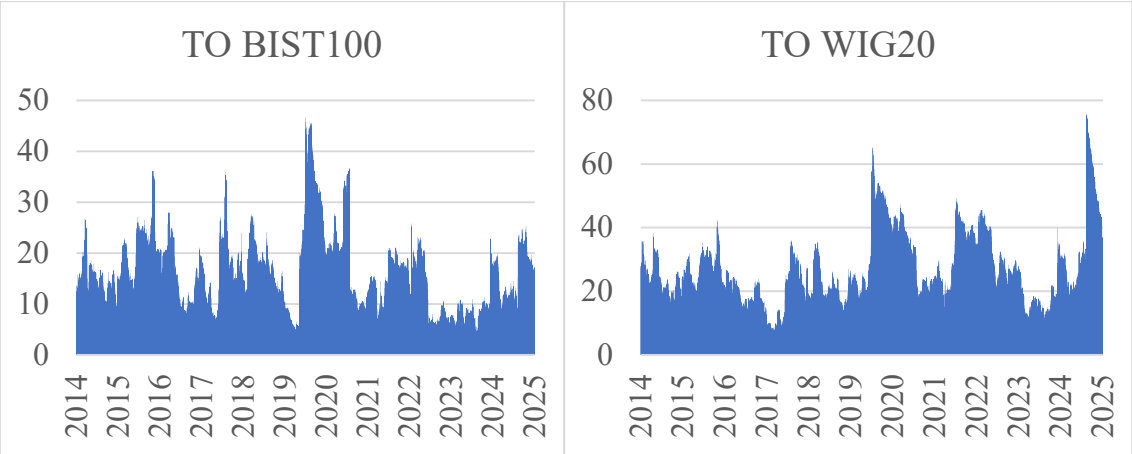
Appendix 2: The Effect That Each Variable Has On Other Variables

The graphs in Appendix indicate the volatility that each variable has spread from itself to others. Increases are observed here in certain periods, and these increases can be said to be related to geopolitical and global risks.


TO BIST100
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TO WIG20
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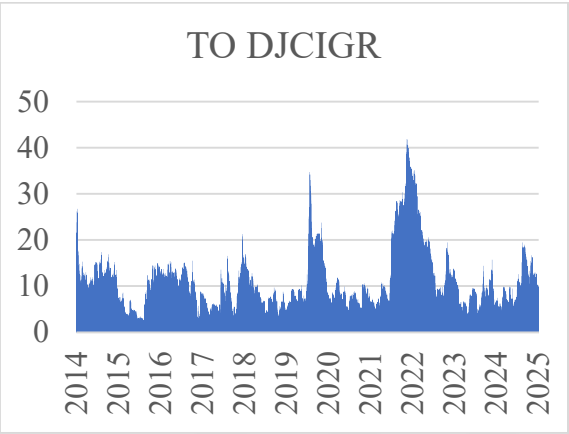
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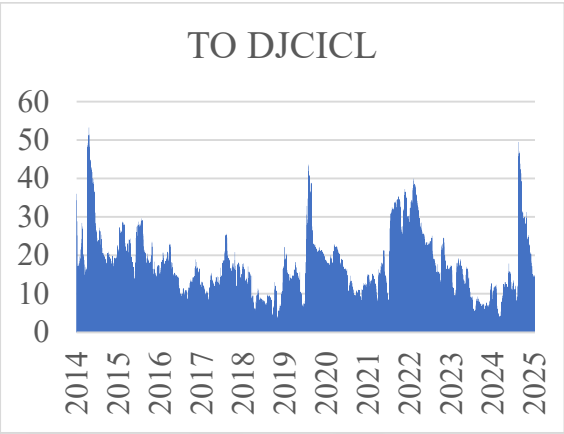
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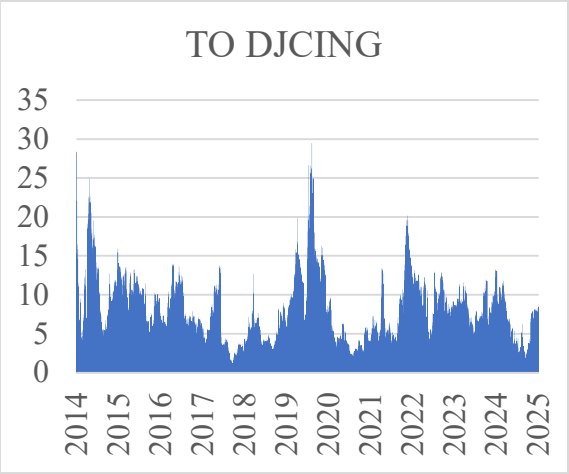
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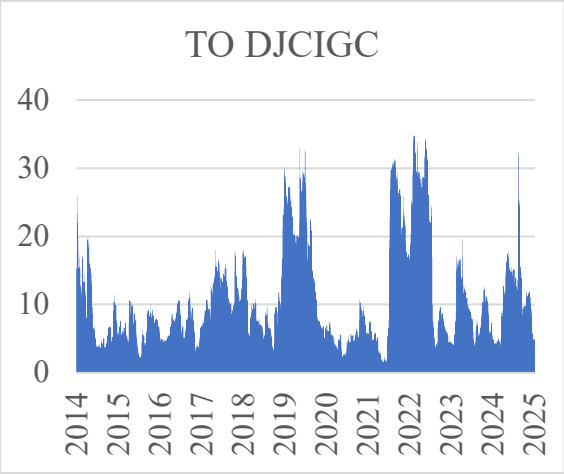
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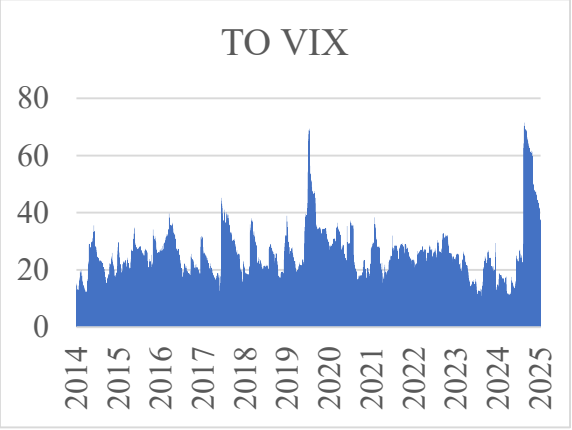
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GENİŞLETİLMİŞ TÜRKÇE ÖZET

GİRİŞ

Finansal piyasalardaki riskler dalgalanmalara yol açmaktadır. Bu risk ve belirsizliklerin üstesinden gelebilmek için yatırımcıların söz konusu riskleri değerlendirmeleri ve buna göre pozisyon almaları gerekir. Finansın temel ilkelerinden biri olan "tüm yumurtaları aynı sepete koyma ki hepsi birden kırılmasın" anlayışından hareketle, yatırımcılar riski azaltmak ve belirsizliği hafifletmek amacıyla yatırımlarını birden fazla yatırım aracına dağıtarak portföylerini çeşitlendirirler.

Emtialar, insanlığın başlangıcından bu yana hayatın merkezinde yer almış; üretimin temel girdilerinden biri olarak ekonominin şekillenmesinde kritik bir araç olmuş ve insanlık için başlıca yaşam kaynaklarından birini oluşturmuştur.

Günümüzde petrol, doğal gaz, altın, gümüş, buğday ve pamuk gibi emtialar hâlâ küresel ekonominin temel direkleri olmayı sürdürmekte ve uluslararası ilişkilerde stratejik kaldıraç işlevi görmektedir. Bu emtiaların fiyatları standart arz–talep dinamikleriyle şekillense de jeopolitik çatışmalar, ticari yaptırımlar ve küresel krizler gibi dış şoklara son derece duyarlıdır ve bu durum belirgin bir volatiliteye yol açmaktadır.

Bu bağlamda, bu çalışmanın temel amacı, başlıca emtia endekslerinin hisse senedi piyasası endekslerine olan bağımlılık yapısını ölçmek ve ele alınan tüm değişkenlerin küresel ve jeopolitik risklere duyarlılığını belirlemeye çalışmaktır.

1. ARAŞTIRMANIN AMAÇ VE KAPSAMI

Bu çalışmanın temel amacı, BIST100 ve WIG20 hisse senedi piyasası endeksleri ile başlıca küresel emtia endeksleri arasındaki bağlılık yapısını incelemek ve küresel ile jeopolitik risklerin bu karşılıklı ilişkiler üzerindeki etkisini ortaya koymaktır. Hisse senedi ve emtia piyasaları arasındaki dinamik etkileşimler analiz edilerek, Türkiye ve Polonya gibi gelişmekte olan ve geçiş ekonomilerinde yatırımcılar için çeşitlendirme avantajlarının bulunup bulunmadığı araştırılmaktadır. Ayrıca, çalışma kapsamında BIST100 ve WIG20 endekslerinden hangisinin küresel ve jeopolitik şoklara karşı daha güçlü bir dayanıklılık sergilediği ve artan belirsizlik dönemlerinde daha yüksek istikrarı koruyabildiği belirlenmeye çalışılmaktadır.

Bu çalışma, toplam yedi değişken üzerinde yürütülecektir: BIST100, WIG20, Dow Jones Emtia Tahıllar (DJCIGR), Dow Jones Emtia Ham Petrol (DJCICL), Dow

Jones emtia doğalgaz (DJCING), Dow Jones Emtia Altın (DJCIGC) endeksleri ile VIX (S&P 500 volatilite) endeksi. Analiz, 03.07.2014 ile 01.09.2025 tarihleri arasını kapsayacaktır. Bu tarihler arasındaki değişkenler arasındaki ilişkiler incelenirken, söz konusu dönem boyunca meydana gelen küresel ve jeopolitik riskler de dikkate alınmıştır.

2. LİTERATÜR

Çalışamaya ilişkin ilgili bazı litaratür özetleri aşagıda verilmiştir.

İlarslan ve Yıldız (2022), çalışmalarında 2008–2020 yılları arasında Türkiye BIST100 endeksi ve Polonya WIG20 endeksi üzerine bir inceleme gerçekleştirmişlerdir. Çalışmalarında uluslararası buğday, pirinç, şeker ve sığır eti fiyatlarına ait değişken verilerini ele alarak Quantile Regression, FMOLS ve DOLS yöntemleriyle analiz yapmışlardır. Bulgularında, tarım fiyatlarının her iki ülkenin borsa endeksini farklı seviyelerde etkilediğini; bu etkinin Türkiye'de daha güçlü, Polonya'da ise daha ılımlı bir seyir izlediğini saptamışlardır.

Arifoğlu ve diğerleri (2023), çalışmalarında 2018–2022 yılları arasında Türkiye IMP, CMP ve birincil kaynaklarla üretime ait değişken verilerini ele alarak TVP-VAR yöntemi ile analiz etmişlerdir. Bulgularında, değişkenler arasındaki ilişkilerin zamanla değiştiğini, COVID-19 ve Rusya–Ukrayna Savaşı'nın bağlantılılığı artırdığını ve günlük piyasanın COVID-19 sonrası dönemde oynaklık alıcısı konumundan oynaklık vericisi konumuna geçtiğini saptamışlardır.

Gökgöz ve Kayahan (2023), çalışmalarında 2017–2022 dönemine ait Bitcoin ile gelişmiş ve gelişmekte olan piyasalara ilişkin BTC, MSCI Amerika, MSCI Avrupa ve MSCI EM değişken verilerini ele alarak TVP-VAR yöntemi ile analiz gerçekleştirmişlerdir. Bulgularında, Bitcoin'in gelişmiş piyasalara karşı oynaklık alıcısı, gelişmekte olan piyasalara karşı ise zayıf bir oynaklık yayıcısı (aktarıcısı) konumunda olduğunu; MSCI Amerika'nın ana oynaklık alıcısı, MSCI EM 'in ise ana oynaklık alıcısı durumunda bulunduğunu saptamışlardır. Ayrıca COVID-19 ve Rusya–Ukrayna Savaşı gibi küresel olayların oynaklık taşmalarını artırdığını belirlemişlerdir.

Agyemang-Badu ve diğerleri (2024), çalışmalarında 2003–2022 yılları arasında 13 Afrika borsa endeksi üzerinde bir inceleme gerçekleştirmişlerdir. Çalışmalarında döviz kuru, Tüketici Fiyat Endeksi, hazine bonosu faiz oranı, M3/M2+ ve Brent petrol değişkenlerine ait verileri ele alarak Markov Switching Regression Model yöntemi ile analiz yapmışlardır. Bulgularında, iki rejim belirlemişlerdir: sakin (düşük oynaklık) ve

kriz (yüksek oynaklık). Makroekonomik değişkenlerin her iki rejimi de önemli ölçüde etkilediğini ve sakin dönemlerde daha güçlü etkiler yarattığını saptamışlardır.

Ghimire ve diğerleri (2025), çalışmalarında 2000–2023 yılları arasında Nepal (NEPSE) üzerine bir inceleme gerçekleştirmişlerdir. Çalışmalarında GSYİH, enflasyon, M2, döviz kuru (OR), kamu sektörü kredisi ve havale değişkenlerine ait verileri ele alarak ARDL bounds test, ECM ve ADF & PP birim kök testleriyle analiz yapmışlardır. Bulgularında, uzun vadede bir eş bütünleşme ilişkisi tespit etmişlerdir. GSYİH'nin negatif bir etkiye sahip olduğunu, kamu sektörü kredisi ve havalenin borsa değerlerini pozitif etkilediğini; enflasyon, faiz ve para arzının uzun vadede anlamlı olmadığını saptamışlardır. Ayrıca kısa vadede faizin negatif ve anlamlı bir etkisi olduğunu belirlemişlerdir.

3. BULGULAR

BIST100 ve diğer değişkenler arasındaki bağlılık (connectivity) değeri 17,59 olarak belirlenirken, diğer hisse senedi piyasası endeksi olan WIG20'nin bağlılık değeri 25,93 olarak tespit edilmiştir. Ortalama bağlılık tablosu incelendiğinde, WIG20'nin diğer değişkenlere yaydığı volatilite miktarı 27.45 iken, BIST100 için bu değer 16.25'tir. Başka bir ifadeyle, WIG20'nin yayılım etkisi (spillover) BIST100'e kıyasla daha yüksektir ve diğer endeksleri daha fazla etkilemektedir.

Çalışmanın ana konusunu oluşturan BIST100 ve WIG20 endeksleri, benzer dönemlerde diğer değişkenlerden bağlantı (connectivity) ve etki (activation) almaktadır. Bu dönemler 2014, 2016, 2020, 2022 ve 2025 yıllarıdır.

2014 yılında bağlantı artışının en büyük nedeni olarak, Rusya'nın soykırıma karışması ve Suriye iç savaşı nedeniyle Türkiye'ye göç eden Suriyeli mültecilerin Avrupa'ya gitme isteğinin yarattığı siyasi kaygı gösterilmektedir (Konak, 2009; Bozkurt, 2018; Kıllıoğlu, 2024).

Ayrıca 2014 yılında petrol fiyatlarında beklenmedik bir düşüş yaşanmış, bu durum küresel enerji piyasalarında volatiliteye yol açmıştır (Bardoff & Losz, 2014).

2016 yılında gerçekleşen diğer önemli olay, Brexit referandumudur. Bu durum AB iç ilişkilerinde siyasi belirsizliğe yol açmış (Yeni Şafak, 2016) ve aday ülke konumundaki Türkiye'yi de etkilemiştir. Ayrıca 2016'daki Türkiye'deki darbe girişimi — her ne kadar içsel bir faktör olarak değerlendirilse de — Türkiye'nin ticaret ortakları

ile askeri, sosyal ve siyasi müttefikleri açısından ciddi bir belirsizlik yaratmıştır (Bloomberg, 2016).

2020 yılında Türkiye ve Polonya'yı olduğu kadar tüm dünyayı derinden etkileyen küresel bir kriz yaşanmıştır: COVID-19 pandemisi.

COVID-19 pandemisi küresel piyasaları sarsmış, ticari ve ekonomik hayatı durma noktasına getirmiştir. Bu durum enerji piyasalarında belirsizlik ve fiyat dalgalanmalarına yol açmıştır. Enerji ithalatçısı ülkeler olan Türkiye ve Polonya'da da belirsizlik yaratmış ve borsa endekslerinde olumsuz fiyat hareketlerine neden olmuştur (Köftecioğlu & Paksoy, 2024).

2020 yılındaki diğer önemli gelişme, Ermenistan ile Azerbaycan arasındaki Dağlık Karabağ Savaşı'dır. Bu durum yalnızca Türkiye için güvenlik belirsizliği yaratmakla kalmamış, Türkiye üzerinden petrol taşıyan Bakü–Tiflis–Ceyhan boru hattına ilişkin endişeleri artırarak enerji piyasalarını da etkilemiştir (S&P Global Commodity Insights, 2020; Reuters, 2023).

2022 yılında yaşanan Rusya–Ukrayna Savaşı, her iki ülkeyi de derinden etkilemiştir. Polonya'nın coğrafi yakınlığı nedeniyle daha ağır etkilendiği varsayılmaktadır. Savaş sırasında 3,5 milyon Ukraynalı mülteci Polonya'ya gelmiş ve ülke için sosyoekonomik bir kriz yaratmıştır. Ayrıca Türkiye ve Polonya enerji ithalatçısı ülkeler olduğundan, enerji üreticisi bir devlet olan Rusya'nın savaşa dahil olması enerji piyasalarında ciddi belirsizlik yaratmıştır.

Karadeniz bölgesi savaş nedeniyle daha riskli hale gelmiş, kıyıdaş devletlerde siyasi ve ekonomik kaygılar artmıştır. Karadeniz'de en uzun kıyı şeridine sahip ülkelerden biri olan Türkiye'nin doğrudan etkilendiği varsayılmaktadır (Erol & Başaran, 2022; Bakan, 2022; Duszczyk & Kaczmarczyk, 2022).

2025 yılında Rus insansız hava araçlarının Polonya hava sahasını tehdit etmesi bir krize yol açmıştır. Bu durum Polonya ve dolayısıyla üyesi olduğu NATO ülkeleri açısından bir güvenlik sorunu oluşturmaktadır (Barrington & Plucinska, 2025).

Aynı yıl Türkiye'nin Filistin–İsrail krizinden doğrudan etkilendiği ve ülkenin sosyal yapısının bu süreçte dikkate alınması gerektiği ifade edilmektedir. Dinsel inançların etkisi ve tarımsal ürünlerde yaşanan krizler önem taşımaktadır. İklim değişiklikleri ve petrol fiyatlarındaki dalgalanmalar 2025 yılında tarım ürünleri fiyatlarında belirsizlik sorunları yaratmıştır (Şencan, 2025).

Bunun yanında, ABD Başkanı Trump'ın seçim sonrası dünya ülkeleri için yeni tarifeler açıklaması da belirsizliği ve küresel riskleri artıran bir diğer faktör olarak görülmektedir (The White House, 2025).

4. SONUÇ

Riskler, finansal piyasalarda volatiliteye yol açmaktadır. Bu çalışma, küresel ve jeopolitik riskler açısından ele alınan değişkenlerin emtia piyasalarında yarattığı dalgalanmalar üzerine odaklanmaktadır. BIST100 ve WIG20 hisse senedi piyasası endeksleri ile başlıca küresel emtia endeksleri arasındaki bağımlılık yapısını incelemek ve küresel ile jeopolitik risklerin bu karşılıklı ilişkileri nasıl etkilediğini ortaya koymaktır. Hisse senedi ve emtia piyasaları arasındaki dinamik etkileşimler analiz edilerek, Türkiye ve Polonya gibi gelişmekte olan ve geçiş ekonomilerindeki yatırımcılar için çeşitlendirme avantajlarının bulunup bulunmadığı araştırılmaktadır.

Çalışmanın analiz sonuçları, Polonya endeksinin ele alınan başlıca emtia endekslerine karşı daha duyarlı bir yapıya sahip olduğunu, buna karşın BIST 100 endeksinin göreceli olarak daha düşük bir duyarlılık sergilediğini göstermektedir. Toplam volatilite sonuçları incelendiğinde ise Türkiye'nin BIST 100 endeksinin daha çok kendi iç dinamiklerinden etkilendiği, WIG 20 endeksinin ise diğer değişkenlerden daha fazla etkilendiği görülmektedir.

Finansal piyasalardaki yatırımcılar ve piyasa düzenlemelerini yapacak politika yapıcılar açısından risklerin değerlendirilmesi ve bunların periyodik olarak sunulması çok önemlidir. Portföylerini çeşitlendirirken yatırımcılar, risk maruziyetlerini en aza indirmeye ve getirilerini maksimize etmeye çalışarak çeşitli yatırım araçlarına yatırım yaparlar.

Burada, politika yapıcılar için başka bir öneri ortaya çıkmaktadır: Türkiye ve Polonya gibi fosil yakıtlara bağımlı ülkelerde, özellikle doğal gaz ve petrol gibi kritik enerji emtialarında oynaklığa maruziyeti azaltmak için ileriye dönük anlaşmalar yapılarak enflasyona karşı korunmak mümkün olacaktır. Bu, fiyat istikrarı sağlayacak ve ülkelerin bu tür küresel ve jeopolitik risklerden daha az etkilenmesine imkân tanıyacaktır.

Türkiye'nin AB enerji piyasaları ile uyumu ve Polonya'nın AB içi mali koordinasyonu sürdürmesi bu bağlamda kritiktir. Ayrıca, sermaye piyasalarının derinleştirilmesi, finansal okuryazarlığın güçlendirilmesi ve beşerî sermayenin

geliştirilmesi her iki ülkenin küresel riskleri daha etkin bir şekilde yönetmesini sağlayacak temel unsurlar olarak görülmektedir.

Analiz edilen iki ülkenin belirli risklere duyarlılıklarının ortak olması ve Türkiye ile Avrupa arasındaki önemli ticari yakınlık dikkate alındığında daha fazla benzerlik olduğu varsayılmaktadır. Diğer çalışmalar için bir diğer önerimiz, Borsa İstanbul ve WIG'de işlem gören diğer alt endekslerin de modele dahil edilerek, çalışmamızda ele aldığımız Dow Jones endeksi ve VIX endeksi ile bağlantılarının belirlenmesidir.