The Role of Global Volatility Indices and Domestic Economic Factors on Investor Risk Appetite in Türkiye

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Abstract

Risk appetite refers to investors propensity to take risks and is directly affected by changes in macroeconomic conditions. Risk appetite is expected to decrease as financial difficulties increase during periods of economic recession and contraction, whereas it is expected to increase during favorable economic conditions. This study analyzes the impact of the gold volatility index (GVZ), crude oil volatility index (OVX), and Chicago Futures Exchange Volatility Index (VIX) (also known as global risk appetite), as well as local economic factors such as inflation (CPI) and interest rates, on the REKS index (known as the Turkish investor risk appetite indicator), which reflects the risk tendencies of domestic (REKS Domestic) and foreign (REKS Foreign) investors in Turkey for the period April 2010-November 2024, using the VAR method. The study's findings show that the REKS Foreign Index is significantly sensitive to global risk and volatility indicators, particularly OVX and VIX. In contrast, the impact of CPI on this index is relatively limited compared to other global indicators. The REKS Domestic Index, on the other hand, is more strongly influenced by domestic macroeconomic variables such as CPI and interest rates, compared to OVX. These results indicate that domestic risk appetite is primarily dependent on domestic economic conditions, while the REKS Foreign Index is more sensitive to global risk perception and volatility dynamics.

Keywords
Risk Appetite,
GVZ, VIX, OVX

JEL Classification
C32, G15, E44

Türkiye'de Yatırımcı Risk İştahı Üzerinde Küresel Volatilite Endekslerinin ve Yerel Ekonomik Faktörlerin Rolü

Öz

Risk iştahı, yatırımcıların risk alma eğilimini ifade eder ve makroekonomik koşullardaki değişikliklerden doğrudan etkilenir. Ekonomik durgunluk ve daralma dönemlerinde finansal zorluklar arttıkça risk iştahının azalması beklenirken, olumlu ekonomik koşullarda artması beklenir. Bu çalışmada, Altın Volatilite Endeksi (GVZ), Ham Petrol Volatilite Endeksi (OVX) ve Chicago Opsiyon Borsası Volatilite Endeksi (VIX) (küresel risk iştahı olarak da bilinir) gibi küresel volatilite endeksleri ile enflasyon (Tüketici Fiyat Endeksi, TÜFE) ve faiz oranları gibi yerel ekonomik faktörlerin, Türkiye'de yatırımcı risk eğiliminin göstergesi olarak bilinen REKS endeksi üzerindeki etkisi VAR yöntemi ile analiz edilmiştir. REKS endeksi, Nisan 2010-Kasım 2024 dönemi için Türkiye'deki yerli (REKS Yurt İçi) ve yabancı (REKS Yurt Dışı) yatırımcıların risk eğilimi endeksini göstermektedir. Çalışmanın bulguları, REKS Yurt Dışı endeksinin başta OVX ve VIX olmak üzere küresel risk ve oynaklık göstergelerine belirgin biçimde duyarlı olduğunu ortaya koymaktadır. Buna karşılık, TÜFE'nin bu endeks üzerindeki etkisinin diğer küresel göstergelere kıyasla nispeten sınırlı olduğu görülmektedir. REKS Yurtiçi endeksi ise özellikle TÜFE ve faiz oranları gibi yurtiçi makroekonomik değişkenlerden, OVX'e kıyasla, daha güçlü biçimde etkilenmektedir. Bu sonuçlar, yurtiçi risk iştahının ağırlıklı olarak yurtiçi ekonomik koşullara bağlı olduğunu; REKS Yurt Dışı endeksinin ise küresel risk algısı ve oynaklık dinamiklerine daha duyarlı olduğunu göstermektedir.

1. Introduction

Financial markets are dynamic systems in which uncertainty and risk perception play a major role in investors' decision-making processes. Volatility indicators in financial markets represent market participants' perception of future uncertainty and their sensitivity to market risk (Whaley, 2000). Although the phrase *risk appetite* is commonly used to indicate an acceptable level of risk, its definition remains somewhat ambiguous. It represents an inherent inclination to assume risk in a particular context, shaped by both an organization's risk culture and individual risk tendencies. Ultimately, risk appetite is articulated through externally quantifiable risk limits, which are established based on specific objectives. Risk appetite refers to investors' willingness to take risk and is affected by changes in the macroeconomic environment. Risk appetite is expected to decrease as financial difficulties increase due to economic contraction and recession, and increase in the opposite case. A decrease in risk appetite may cause investors to exit the market quickly, creating panic in the market. However, since different types of investors do not have the same level of risk appetite, the sensitivity of these different groups to changes in macroeconomic dynamics may differ, leading investors to exhibit different investment behaviors. Risk appetite is a relatively recent concept that has developed alongside the evolution of financial and corporate risk

management. While it is sometimes used interchangeably with risk tolerance or risk threshold, it is a far more intricate and multifaceted notion

One of the most important factors influencing investments in capital markets is the presence of favorable investment conditions such as macroeconomic and financial stability, predictable and transparent monetary policy, sufficient liquidity, and exchange rate stability. In providing the necessary investment conditions, investors' investment decisions are influenced by current market conditions and market volatility. With the estimation of volatility in stock markets, the volatility index has been stated as a representation of investor behavior. The Chicago Board Options Exchange introduced the Volatility Index (VIX) in 1993 to assess market volatility, building on the work of Black and Scholes (1973) and Merton (1973). This index is calculated based on the price movements of American-style call and put options, particularly those linked to the S&P 100 index, with an average maturity of 30 days (Luo & Zhang, 2012). The concept was originally developed by Black and Scholes (1973) and Merton (1973). When the VIX surpasses 30%, it signals heightened market uncertainty and increased volatility, suggesting that investment conditions are unfavorable. Under such circumstances, investors are likely to adopt a more risk-averse stance, reflecting a sense of fear toward investment. (Akdağ et al., 2020). Therefore, an increase in the VIX value can be expressed as an increase in risk and uncertainty in the markets. Conversely, a decline in the VIX value suggests a reduction in market volatility, an increase in investors' willingness to take risks, and a more optimistic outlook on future market conditions.

Increasing integration among global markets, financialization of the crude oil market and developments in energy markets have increased uncertainty in the crude oil market. Especially during the 2008 global financial crisis, the price of crude oil fell sharply, increasing investor uncertainty. Similar to the VIX index, the Oil Volatility Index (OVX), which is based on the volatility of option prices, was introduced by the CBOE during the 2008 global financial crisis as a measure of the market expectation of the 30-day volatility of crude oil prices and has emerged as an important measure to monitor the volatility of future oil prices as a measure of oil market uncertainty (Liu et al., 2013).

The Gold Volatility Index (GVZ), a measure of uncertainty in the international gold market, measures the market's expectation of the 30-day volatility of gold prices for options on gold shares (Bouri et al., 2017). Volatility indices like GVZ, OVX, and VIX, which are derived from option

prices, represent the market's expectations of future volatility throughout the remaining duration of the options. These indices are widely regarded as key indicators of market uncertainty, as they not only incorporate historical volatility data but also capture investors' outlook on future market conditions (Liu et al., 2013). Figure 1 shows the graph of OVX, GVZ and VIX indices between 2010 and 2024.
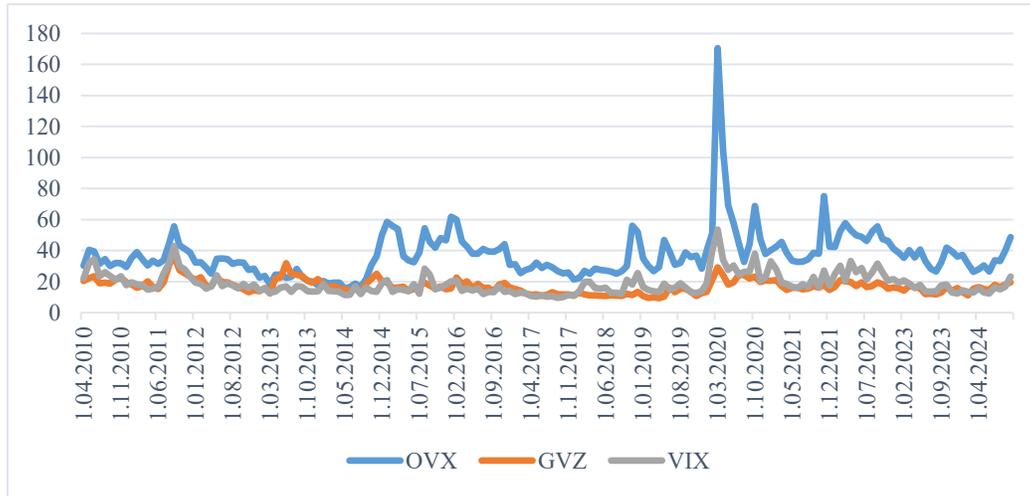

Figure 1. Trends in Global Volatility Indices. Figure is created by the authors using data obtained from the investing.tr website

Figure 1, which covers the period 2010-2024, shows that the OVX is significantly higher than the other indices, VIX and GVZ. The peak reached by the OVX in 2020 can be explained by the impact of major economic and geopolitical events that occurred during this period. In this period, the decline in global oil demand due to the onset of the COVID-19 pandemic and the sharp fluctuation in oil prices are thought to have increased the volatility level of OVX. On the other hand, it was observed that the VIX and GVZ values were generally close to each other, but the VIX index was slightly higher than the GVZ. This is attributed to the fact that the VIX, which measures the volatility of equity markets, is more sensitive to risk perception than the GVZ, which measures the volatility of gold, which is generally seen as a safe haven. In 2020, as in other indices, there was a significant increase in the VIX, but the relatively smaller increase in the GVZ can be explained by the demand for gold as a risk hedging instrument.

Risk Appetite Index (formerly known as RISE index) which has been published weekly by the Central Securities Depository (MKK) since 2005, was introduced to the markets as the 'REKS' on 11.07.2024. With REKS, market participation tendencies of capital markets investors are

measured and their data are published on the Data Analysis Platform (DAP). The Risk Appetite Index (REKS) is a dynamic index that changes over time depending on how much risk investors are willing to take and how the market changes. The calculation of REKS takes into account information such as individual investors' equity investments and umbrella funds that invest in equities. The index is calculated and reported separately for domestic and foreign investors, individual and institutional investors, and qualified investor groups. To reflect market dynamics as accurately as possible, investor groups formed within the framework of these threshold values are used to calculate the REKS value. Threshold values are determined for each relevant year based on current financial and economic developments. These thresholds are determined using macroeconomic and financial indicators such as the exchange rate (USD), unemployment rate, GDP per capita growth rate (USD), and average portfolio sizes in Turkish Lira (Merkezi Kayıt Kuruluşu, 2024). REKS index, which is formed as a result of changing and evolving market conditions, shows the current risk trends based on the behavior of domestic, foreign, domestic real, domestic corporate, domestic funds, domestic qualified and all investors. The graph of the REKS index for domestic and foreign investors between 2010 and 2024 is given in Figure 2.
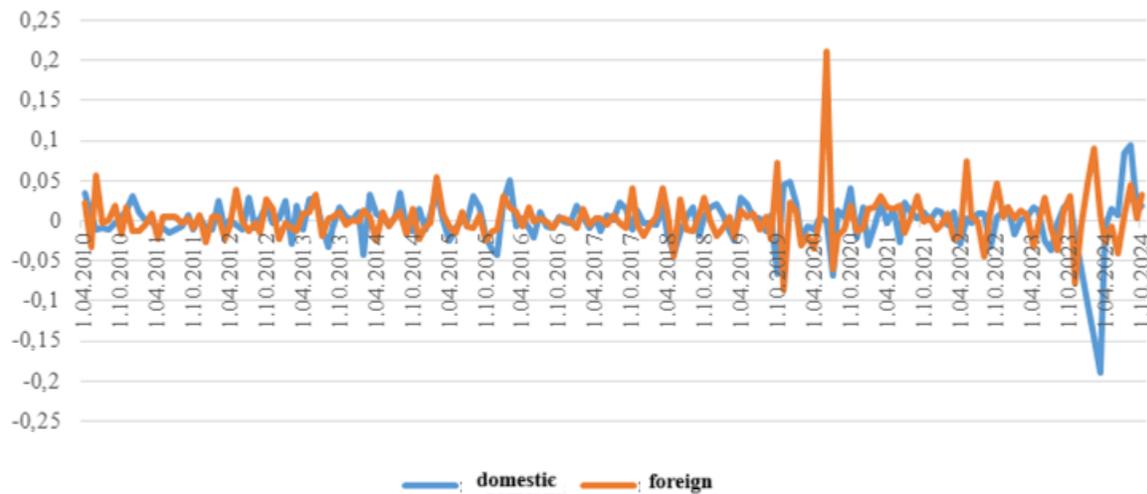

Figure 2. Trends in the REKS Index for Domestic and Foreign Investors. Figure is created by the authors using data obtained from the Central Securities Depository.

Figure 2 shows the differentiation between REKS Domestic and Foreign investors between 2010 and 2024. In general, the REKS Foreign is slightly higher than the REKS Domestic. Although

there are periods when both indices follow a parallel trend to a certain extent, this trend differs significantly in 2020 and 2023. In 2020, the significant increase in the REKS Foreign index is attributed to the increase in capital flows to emerging markets due to the volatility caused by the COVID-19 pandemic in global financial markets and the increased risk appetite of foreign investors seeking high returns. On the other hand, a sharp decline was observed in the REKS Domestic between the end of 2023 and the beginning of 2024. In this period, increasing inflationary pressures, tight monetary policies and volatility in the domestic market led to a significant decrease in the risk appetite of domestic investors. In general, the differences between REKS Domestic and Foreign indices reflect the different effects of global and domestic economic dynamics on investor behavior.

In the finance literature, investors' risk-taking tendencies are generally associated with interest rates, exchange rates (İskenderoğlu and Akdağ, 2019; Çelik et al. 2017), oil prices and gold prices (İskenderoğlu and Akdağ, 2019), BIST 100 and various other indices (Köycü, 2022; Yıkılmaz, 2022; Sözen et al, 2024) and CDS premiums (Uzkaralar and Kandır, 2020; Gemici et al., 2023). While the risk appetite of domestic investors in Türkiye is generally shaped by macroeconomic indicators such as the BIST 100 index and other indices (Balat, 2020; Demirci and Sinoplu, 2023; Avcı and Çınar, 2024) and CDS premiums, the risk appetite of foreign investors is more sensitive to global economic developments (Fettahoğlu, 2019; Sağlam, 2024). This difference necessitated a detailed analysis to understand the market behavior of domestic and foreign investors.

Investor risk appetite in emerging markets is expected to be sensitive to international financial indicators and domestic macroeconomic variables. In a market like Turkiye, which is vulnerable to external shocks and economic fluctuations, examining the factors affecting risk appetite is important for understanding investor behavior and developing economic policy. In this context, the aim of this study is to analyze the relationship between the REKS index, which represents investor risk appetite in Turkiye, and international volatility indicators such as GVZ, OVX and VIX indices. At the same time, the relative effects of international and domestic factors are evaluated by controlling for domestic macroeconomic indicators such as the Consumer Price Index (CPI) and interest rates.

This study analyzes the effects of global factors such as GDP, OVX, and VIX, and domestic economic factors such as CPI and interest rates, on the REKS Domestic and REKS Foreign indices, which are risk appetite indicators of domestic and foreign investors in Turkey, for the period 2010-2024.The study is expected to contribute to the literature in several ways. First, the study analyzes the REKS index, which represents the risk appetite of domestic and foreign investors, separately and analyzes the differences between the risk appetites of these two investor groups. The fact that such a distinction has not been addressed much in the Turkish literature makes this study stand out as a unique contribution to the field. Analyzing different volatility indicators such as GVZ, OVX and VIX and domestic factors such as CPI and interest rates in the same framework allows for a comparison of the effects of these indicators on domestic markets. This provides a more comprehensive understanding of the effects of different volatility indicators on investor decisions. Secondly, the effects of global volatility indicators, such as the GVZ, OVX and VIX indices, on domestic investor risk appetite are analyzed in detail. In this respect, the study offers an alternative and innovative perspective to the emerging markets literature. Finally, it is observed that the literature generally considers only the VIX index as an indicator of global volatility. However, the inclusion of the OVX and GVZ indices in addition to the VIX index in this study significantly contributes to the literature by expanding its scope. Furthermore, this contribution is particularly important for the local literature focusing on emerging countries like Turkey; it allows for a more holistic approach to analyses specific to local markets by considering global volatility indicators.

2. Literature

This part of the study reviews the studies examining the relationship between the risk appetite index and various financial indicators. In this context, Çelik et al. (2017) investigated the effects of inflation, money supply, exchange rate, interest rate and economic growth on the risk appetite index (RISE index) using regression analysis. The findings of the analysis show that interest rate and exchange rate increases have a negative effect on the RISE, while money supply and exchange rate have a positive effect. Fettahoğlu (2019) investigated the relationship between domestic and foreign investors' RISE and CDS premiums using a regression model. As a result of the study, it is determined that increases in risk appetite negatively affect CDS premiums. İskenderoğlu and Akdağ (2019) investigated the relationship between all investors' RISE and oil, exchange rates, gold and interest rates using Granger (1969) causality test and Breitung and Candelon (2006) frequency causality test. They find that there is unidirectional causality from oil

price and exchange rate to risk appetite in the long run. Moreover, it is concluded that changes in gold and interest rates have a significant effect on RISE in the short run. Balat (2020) tested the relationship between the RISE of domestic and foreign investors and the Borsa Istanbul 100 Index (BIST 100) using Johansen cointegration test and Granger (1969) causality analysis. As a result of the Johansen cointegration test, it is determined that the related variables move in tandem in the long run. In addition, it is determined that there is unidirectional causality from the BIST 100 index to the RISE variable of domestic and foreigners. Demirez and Kandır (2020) examined the effect of domestic investors' RISE and BIST 100 index on the portfolio return of the stocks of the firms in the lowest 10% of the market capitalization with a multiple regression model. As a result of the study, it is determined that the RISE of domestic investors has a limited effect on the related portfolio returns. Uzkaralar and Kandır (2020) investigated the causality relationship between RISE and CDS premiums using the Granger (1969) causality test. As a result of the study, bidirectional causality was found between the variables. Öztürk and Ersoy (2021) examined the effect of domestic and foreign RISE on BIST 100 index return by regression analysis. As a result of the study, it was determined that the changes in the RISE of domestic investors affect the BIST 100 index more than foreign investors. Köycü (2022) examined the relationship between the RISE and the BIST 100 index through the Granger (1969) causality test in two separate periods, before and after the COVID-19 Pandemic. The findings of the study show that there is a unidirectional causality relationship from BIST 100 to RISE in both periods analyzed. Yılmaz and Yıldız (2022) investigated the effect of volatility indices VXN (USA), V1X1 (Germany), V2TX (Europe), JNIV (Japan) and VIX index of selected countries on the ISE using ARDL bounds test. As a result of the study, it is found that the related international fear indices have an impact on the risk appetite of investors in Türkiye in the short and long run. Yıkılmaz (2022) analyzed the causality relationship between the RISE of all investors and BIST 30 futures return using Granger (1969) causality test. As a result of the analysis, it is found that there is a bidirectional relationship between all investors' RISE and BIST 30 futures return. Demirci and Sinoplu (2023) examined the relationship between the RISE of domestic and foreign investors and the stock returns of firms listed in the BIST 30 index using panel regression analysis. According to the findings of the analysis, while the RISE of domestic investors has an effect on the related stock returns, the RISE of foreign investors has no effect. Ergün et al. (2023) analyzed the relationship between VIX, EVX, CDS, GVZ, OVX variables and RISE using Granger causality test. As a result of the study, it was found that there is

causality from volatility indices to the risk appetite of all investors, and that OVX and GVZ indices have a greater impact on RISE. Gemici et al. (2023) investigated the effect of CDS, dollar exchange rate, gold prices, bond yields, OVX, VIX, Financial Stress Index from Emerging Markets (FSI) and Geopolitical Risk Index (GPR) on RISE. The quantile causality and regression model results show that among domestic factors, the CDS premium and among foreign factors, the FSI and the VIX index are more determinant of investors' risk appetite than the others. Avcı and Çınar (2024) examined the relationship between domestic and foreign RISE and selected Borsa İstanbul indices (BIST 30, BIST 50 and BIST 100) using Fourier cointegration and causality tests. As a result of the study, it was found that there was a cointegration relationship between all variables in the long term under structural breaks, and it was concluded that there was a one-way causality from all BIST indices included in the analysis to RISE. Önk and Saygın (2024) examined the relationship between Bitcoin and selected altcoin (Etherum, Binance Coin, Ripple, Cardano) returns and RISE and BIST 100 index using multiple regression analysis. As a result of the study, no significant relationship was found between RISE and related cryptocurrencies. Sağlam (2024) investigated the causality relationship between RISE (domestic and foreign) and BIST 100 index and the dollar in his study. Accordingly, according to the Toda-Yamamoto (1995) test results, a one-way causality relationship was found from BIST 100 index and dollar exchange rate to RISE of investors. Sözen et al. (2024) investigated the relationship between RISE, BIST 100 index, exchange rate, inflation and interest rates with the Toda-Yamamoto causality test. From the study findings, a one-way causality relationship was obtained from RISE to interest rate and from BIST 100 index to RISE.

When international studies on the subject are examined, it is observed that different indicators are used as a measure of risk appetite. When similar international studies on the subject are summarized; Baek et al. (2005) investigated the determinants of the risk appetite index, which is created as a component of various indicators. As a result of the study, it was determined that country risk has an effect on the risk appetite index. Hermosillo (2008) examined the relationship between bond prices of selected countries (Türkiye and 16 Eurozone countries) and the risk appetite index obtained using various indicators with the regression model in his study. As a result of the study, a significant relationship was found between the variables, and it was determined that the financial crises that occurred in the relevant countries negatively affected the risk appetite index. Qadan (2019) investigated the relationship between investors' risk appetite and precious metals with GJR-GARCH and Granger causality tests in his study. VIX was used as a measure of risk

appetite. As a result of the study, it was determined that the volatility in precious metal prices was caused by shocks experienced in VIX and economic uncertainty. Qadan and Bayaa (2020) tested the relationship between OVX and the global risk appetite indicator VIX fear index using the GARCH method. As a result of the study, it was found that OVX had an effect on the changes in VIX. Bauer et al. (2023) examined the effect of changes in monetary policy on the risk appetite index created by taking stock, credit and foreign exchange market risk indicators in their study. As a result of the study, it was found that changes in monetary policy had a significant effect on risk appetite. Kundu and Dilip (2023) analyzed the effect of the risk appetite index created with various indicators for India on the returns and return volatility of selected commodities (gold, silver etc.). As a result of the study, it was observed that increases in the risk appetite index increased the return on gold prices. Liu et al. (2023) investigated the volatility in risk appetite for stock options in the Chinese market in their study. As a result of the study, it was determined that changes in risk appetite showed significant differences for call and put options and that risk appetite had a significant asymmetric effect on option prices under the effect of leverage. Elgayar et al. (2024) tested the relationship between the risk appetite index, which shows the attitude of the Egyptian market towards risk and is created with various criteria, and Bitcoin returns with the VAR model. As a result of the study, it was determined that there was a positive and significant relationship between the variables. As a result of the Granger (1969) causality test, it was concluded that there was a one-way causality from the risk appetite index to Bitcoin returns.

3. Data and Methodology

3.1. Model and Dataset

In this study, the effects of GVZ, OVX and VIX indices and domestic economic factors such as CPI and interest rates on the risk appetite index of domestic and foreign investors were examined for the period 2010-2024. Since the REKS index, which shows the risk appetite of investors in Türkiye, has been calculated since 2010, the starting year of the study was determined as 2010. The data sets used in the study and their application methods are shown in Table 1.

Table 1

Data Used in the Study

Variable	Definition	Observation	Resource

REKS Domestic	Risk Appetite Index	01.04.2010 – 01.10.2024	Central Securities Depository
REKS Foreign	Risk Appetite Index	01.04.2010 – 01.10.2024	Central Securities Depository
GVZ	Gold Volatility Index	01.04.2010 – 01.10.2024	Investing
OVX	Oil Volatility Index	01.04.2010 – 01.10.2024	Investing
VIX	CBOE Volatility Index	01.04.2010 – 01.10.2024	Investing
CPI	Consumer Price Index	01.04.2010 – 01.10.2024	Central Bank of the Republic of Türkiye
IR	Interest Rate	01.04.2010 – 01.10.2024	Central Bank of the Republic of Türkiye

Note. *Monthly data was used in the study. Since the data for the REKS variable was published on a weekly basis, the 4-week averages of the data were taken and converted to monthly data. **Analysis was performed with the changes in the data. [(Pt) – (Pt-1) / (Pt-1)].

3.2. Methodology

The methodological framework of the study is based on VAR analysis, and simultaneous relationships and causality links between variables are examined. In addition, the interactions between variables are analyzed in detail using tools such as Granger causality test and impulse-response functions. Vector autoregressive models are a statistical model used to reveal linear interdependencies between multiple time series, introduced by Sims (1980). A VAR model consists of a system of equations in which each variable is expressed as a linear function of its own lags and the lags of all other variables in the system (George vd., 2008). This model is used especially to analyze the relationships between macroeconomic variables and to examine the dynamic effects of random shocks on variables (Sarı, 2008). The ability to reveal dynamic connections without imposing any limitations on the structural model is a feature that distinguishes the VAR model (Keating, 1990). The VAR model is not based on a theory that classifies variables as endogenous or exogenous. In addition, it offers the opportunity to make strong future predictions by including the past values of the dependent variable in the model. In this model, each variable in the system is considered as a linear function of both its own past values and the lagged values of other variables. However, the lag length is extremely important in order to accurately reflect the dynamic relationships between the variables. Therefore, the lag length should be determined carefully in VAR analysis. The standard representation of a two-variable VAR model is as follows:

$$yt = a_1 + \sum_{i=1}^{p} b_{1i} \, y_{t-i} \sum_{i=1}^{p} b_{2i} \, x_{t-i} + v_{1t} \tag{1}$$

$$x_t = c_1 + \sum_{i=1}^{p} d_{1i} y_{t-i} \sum_{i=1}^{p} d_{2i} x_{t-i} v_{2t} \tag{2}$$

In Equations 1 and 2, p represents the lag length and v represents the normally distributed random error terms with constant variance. Each equation in this model is estimated using the Ordinary Least Squares (OLS) method.

The VAR model can be summarized in the following steps: First, the suitability of the time series for analysis is evaluated. Since the theories used in time series analysis are generally based on stationary series, it is tested whether the series are stationary or not; if they are not stationary, the stationarization process is applied with appropriate methods. Because hypothesis tests based on non-stationary time series may not give reliable results. While the effect of a random shock given to the system in stationary series disappears over time, these effects can be permanent in non-stationary series. Then, the most appropriate lag length for the model is determined and causality relationships are tested. In the last stage, external shocks are applied to the model and the reactions of the variables to these shocks are analyzed (Işık & Acar, 2006).

In this study, the effects of global factors such as GVZ, OVX and VIX and domestic economic factors such as CPI and interest rates on the risk appetite index of domestic and foreign investors were discussed separately and the results were reported in the findings section.

4. Findings

In the study, unit root tests were applied to time series first. Unit root tests are used to examine the stationarity properties of time series. Stationarity in time series refers to the situation where the mean and variance of the series are constant over time and the covariance between two lagged time periods depends only on the lag period and not on time. In cases where the stationarity condition is not met, problems such as spurious regression may occur. Whether a time series has a unit root is most commonly analyzed with the Dickey-Fuller (DF), Improved Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The DF test tests the null hypothesis that the series contains a unit root against the alternative hypothesis that it does not contain a unit root (Harris, 1995, p. 28). In this study, the ADF unit root test was applied to the data and the results are shown in Table 2.

Table 2

ADF Stationarity Test

Variable	t-statistic (constant)	t-statistic (constant and trend)

REKS Domestic	-13.12397	-13.09219
REKS Foreign	-13.17040	-13.21745
GVZ	-14.46809	-14.42803
OVX	-13.44894	-13.43836
VIX	-16.58518	-16.56629
CPI	-3.802207	-7.384780
IR	-8.097234	-8.212801

All variables were analyzed with the ADF test according to the Schwarz criterion by adding the constant term and trend. In the ADF test, the null hypothesis (H_0) states that the relevant time series contains a unit root and therefore is not stationary. The alternative hypothesis (H_1) suggests that the series does not contain a unit root, in other words, it is stationary. Considering the obtained test statistics and their corresponding probability (p-value) results, if the p-values are below the 5% significance level, the H_0 hypothesis is rejected, and it is concluded that the series are stationary. Conversely, if the p-values are above the 5% significance level, the H_0 hypothesis cannot be rejected, and it is accepted that the series are not stationary. In this context, it was observed that the absolute values of the ADF test statistics were greater than the absolute values of the critical values at different significance levels (1%, 5%, and 10%) for all three variables. Furthermore, as shown in the table, the p values corresponding to the original values of the variables yielded statistically significant results at the 5% significance level. These findings indicate that the series is stationary. According to the results obtained, each variable was included in the model at the level where it was stationary. It was determined with ADF unit root tests that all series were stationary at the level, in the next stage of the study, separate VAR analysis steps will be applied for both REKS Domestic and REKS Foreign.

First of all, the model determining the effects of foreign investors on risk appetite was applied in the study and the analysis results performed to determine the appropriate lag length for the model are shown in Table 3. In the VAR model, the lag length indicates the times when the lag values of the dependent variable are included in the model as an explanatory variable.

Table 3

Determination of REKS Foreign Lag Length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3028.871	NA	2.45e+08	36.34576	36.45778	36.39123

1	-2088.499	1801.910	4856.111	25.51496	26.29913*	25.83324
2	-2020.970	124.5445	3334.238	25.13737	26.59368	25.72845*
3	-1970.083	90.19511	2801.062	24.95908	27.08753	25.82297
4	-1931.194	66.13406	2726.638*	24.92448*	27.72508	26.06118
5	-1897.446	54.96832	2836.451	24.95144	28.42418	26.36095
6	-1874.813	35.23691	3391.732	25.11153	29.25641	26.79384
7	-1831.098	64.91746	3174.834	25.01914	29.83616	26.97426
8	-1790.880	56.83473*	3127.432	24.96863	30.45779	27.19656

When the table is examined, the most appropriate lag length according to AIC and FPE information criteria is determined as 4 lags and the VAR model is estimated with 4 lags. After the VAR model is estimated, the causality relationship between the series is examined with the Granger causality test.

In the study, AR root analysis was used to test the stationarity of the model. The fact that the AR roots are within the unit circle shows that the VAR model is stationary and the estimation results obtained from the model are reliable. In Figure 3, the inverse roots of the AR polynomial of the REKS Foreign variable are presented.
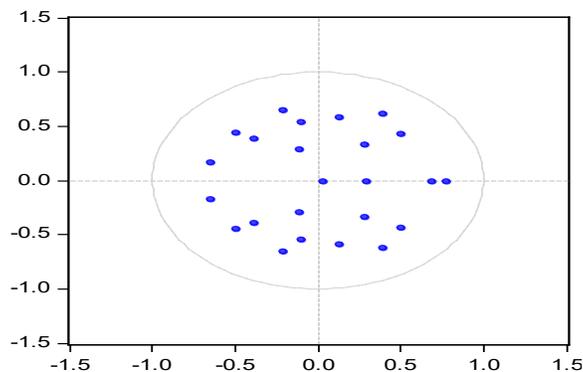

Figure 3. Inverse Roots of AR Polynomial

In the study, the existence of an autocorrelation problem in the error terms was analyzed with the LM test. The results obtained from the LM test for serial correlation are given in Table 4.

Table 4

LM Test for Serial Correlation

Lag	LM	P-value
0	42.61251	0.2079

1	42.11203	0.2234
2	42.97138	0.1973
3	49.97517	0.0608
4	36.14533	0.4619
5	42.61251	0.2079

In Table 4, the LM test result value being greater than 0.05 shows that there is no autocorrelation problem, in other words, the dependent variable in the model is sufficiently explained by its past balances.

In the next step of the study, the Granger causality test was applied with the VAR analysis calculated at the lag level determined by the information criteria. The causality test results are shown in Table 5.

Table 5

REKS Foreign Granger Causality Test

Independent	Chi-square	Df	Prob.
IR	6.088697	4	0.1926
GVZ	2.091126	4	0.7190
OVX	49.24801	4	0.0000
CPI	7.991347	4	0.0919
VIX	12.73725	4	0.0126
All	102.0286	20	0.0000

According to the analysis results, a Granger causality relationship was determined from the VIX, OVX and CPI variables to the risk appetite index of foreign investors. However, it is noteworthy that GVZ and interest rates do not have a significant causal effect on risk appetite. Since VIX is an index that generally measures volatility and investor fear in global markets, it shows that foreign investors take into account fluctuations in global markets in their decision-making processes. The fact that OVX has a significant effect on the risk appetite of foreign investors indicates that foreign investors may be sensitive to fluctuations in energy prices when investing in the Turkish market. Furthermore, the fact that the effect of the CPI variable on risk appetite is significant at the 10% significance level indicates that the effect of CPI is weaker and has limited statistical support compared to other variables. Therefore, it should be considered that the effect of CPI on risk appetite may be conditional and seasonal.
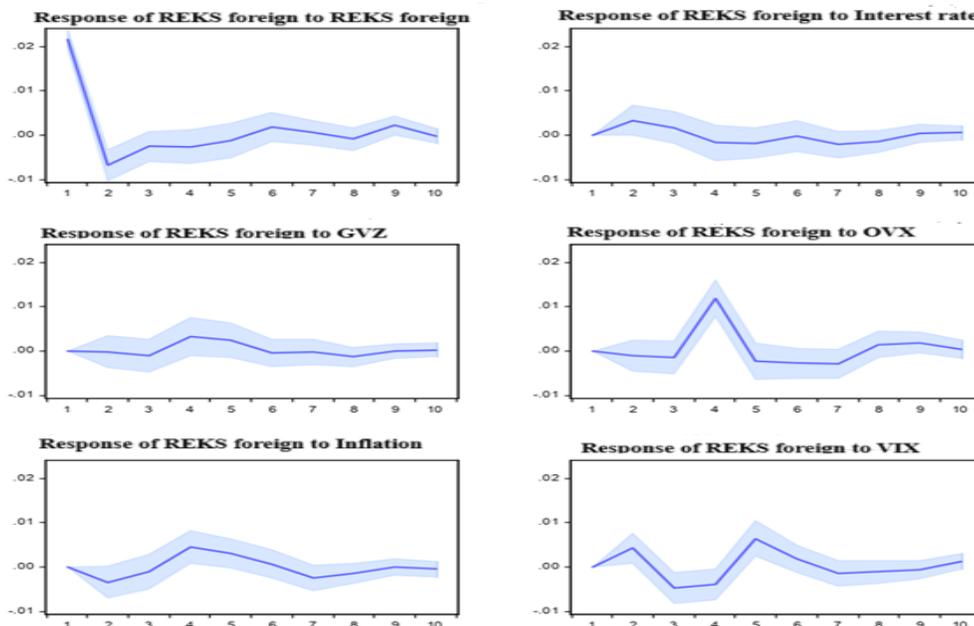
Figure 4. REKS Foreign Impulse-Response Graphs

REKS Foreign index variable shows a strong and negative reaction to its own shocks. However, it is observed that this effect decreases in a short time. Shocks originating from interest create a positive but limited effect on REKS foreign variable. Although shocks originating from VIX create a significant positive effect on REKS foreign in the first period, the effect turns negative after the second period and only reaches the balance in the seventh period. It is seen that the effect of shocks originating from OVX on REKS foreign is significantly positive in the fourth period and then reaches the balance. It is seen that the effect of shocks originating from GVZ on REKS foreign is quite limited and statistically insignificant.

In the next step of the study, variance decomposition, which is the last stage of VAR analysis, was performed and the test results are shown in Table 6.

Table 6

Variance Decomposition Results

Period	S.E.	REKS Foreign	IR	GVZ	OVX	CPI	VIX
1	0.021708	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
		(1.1E-14)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
2	0.023661	92.52152	2.042374	0.003545	0.169621	2.064911	3.198030
		(0.09208)	(0.02090)	(0.00091)	(0.00620)	(0.02190)	(0.02582)

3	0.024401	88.09598	2.431884	0.180638	0.486326	2.117487	6.687683
		(0.18805)	(0.02066)	(0.00640)	(0.00900)	(0.02064)	(0.04207)
4	0.028210	66.76956	2.193052	1.485896	18.34287	4.244763	6.963855
		(0.25114)	(0.02472)	(0.02036)	(0.05716)	(0.03300)	(0.04426)
5	0.029379	61.73679	2.394940	2.079652	17.50811	4.994505	11.28601
		(0.31262)	(0.02658)	(0.02123)	(0.05806)	(0.03735)	(0.05793)
6	0.029638	61.07646	2.357809	2.058731	18.07960	4.966993	11.46040
		(0.37647)	(0.02698)	(0.02145)	(0.06403)	(0.03799)	(0.06016)
7	0.029997	59.65290	2.811349	2.013545	18.61137	5.504154	11.40669
		(0.44187)	(0.02817)	(0.02206)	(0.07441)	(0.04208)	(0.06528)
8	0.030165	59.07857	3.007675	2.178259	18.66105	5.655056	11.41939
		(0.50837)	(0.03017)	(0.02308)	(0.08892)	(0.04556)	(0.07257)
9	0.030316	59.01508	2.991255	2.156721	18.88892	5.598982	11.34905
		(0.57584)	(0.03185)	(0.02404)	(0.10611)	(0.04888)	(0.08134)
10	0.030359	58.85352	3.015835	2.158779	18.85785	5.611070	11.50294

In the first periods, 88% of the variance of the forecast error of the REKS Foreign variable is due to its own past values. This shows that in the short term, REKS Foreign can be largely explained by its own dynamics. In the third period, the contribution of VIX is 7%, while the effect of Interest and CPI is 2%. It is seen that GVZ and OVX have a limited effect. In the sixth period, while the explanation rate of REKS Foreign from its own past values decreases to 61%, the contribution of OVX increases to 18% and the contribution of VIX increases to 11%. This situation shows that the effect of global market volatility indicators on REKS increases in the medium term. In particular, the significant increase in the contribution of VIX reveals the significant effect of changes in global market risk appetite on REKS Foreign variable. In the tenth period, the explanation rate of REKS Foreign variable decreases to 58%, while the contributions of VIX and OVX are fixed at 11% and 18%, respectively. This situation shows that in the long term, the dynamics of the REKS Foreign variable have become more dependent on global volatility indicators. In particular, the 18% contribution of OVX shows that the long-term movements of REKS Foreign are significantly affected by global risk perception.

In the next stage of the study, the effects of indices such as GVZ, OVX and VIX on the risk appetite index of domestic investors and domestic economic factors such as CPI and interest rates were examined with the same steps. The lag length was determined for the VAR analysis and the results are shown in Table 7.

Table 7

Determination of REKS Domestic Lag Length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3038.061	NA	2.74e+08	36.45582	36.56784	36.50129
1	-2090.429	1815.821	4969.658	25.53807	26.32224*	25.85635*
2	-2042.082	89.16755	4293.394	25.39020	26.84651	25.98128
3	-1997.572	78.89101	3893.120	25.28829	27.41674	26.15218
4	-1964.569	56.12594	4066.413	25.32418	28.12477	26.46088
5	-1926.141	62.58829	3999.688	25.29511	28.76784	26.70461
6	-1892.948	51.67841	4214.498	25.32872	29.47360	27.01103
7	-1845.186	70.92853	3758.308	25.18785	30.00487	27.14297
8	-1797.698	67.10801*	3393.507*	25.05028*	30.53944	27.27821

When the table is examined, the most appropriate lag length according to AIC, LR and FPE information criteria is determined as 8 lags and the VAR model is estimated with 8 lags. After the VAR model is estimated, the causality relationship between the series is examined with the Granger causality test.

AR root analysis was used to test the stationarity of the model in the study. The fact that the AR roots are within the unit circle shows that the VAR model is stationary and the estimation results obtained from the model are reliable. In Figure 5, the inverse roots of the AR polynomial of the REKS Domestic variable are presented.
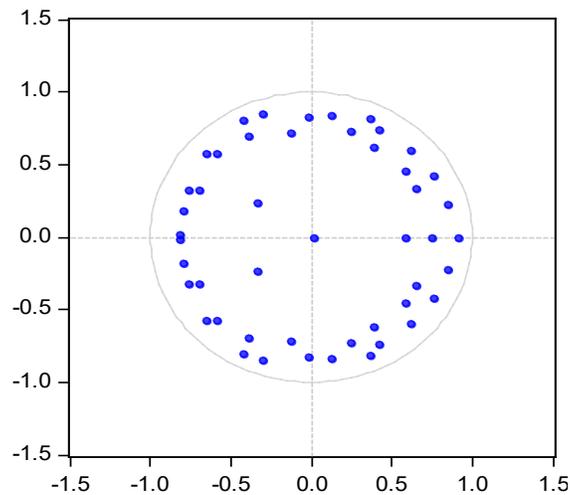

Figure 5. Inverse Roots of AR Polynomial

In the study, the LM test was used to analyze whether there was an autocorrelation problem in the error terms. The LM test result value in the table is greater than 0.05, which indicates that there is no autocorrelation problem, in other words, that the dependent variable in the model is sufficiently explained by its past balances. Table 8 shows the LM test results for serial correlation.

Table 8

LM Test for Serial Correlation

Lag	LM	P-value
1	29.68705	0.7620
2	34.66151	0.5322
3	54.82741	0.0230
4	60.02318	0.0072
5	36.25229	0.4569
6	23.92684	0.9384
7	36.19877	0.4594
8	30.43042	0.7304
9	37.73406	0.3899

The results of the Breusch-Godfrey Lagrange Multiplier (LM) test applied in the study show that there is no serial correlation between the error terms. The fact that the p-values obtained are above the 5% significance level indicates that the null hypothesis (H_0: There is no autocorrelation between the error terms) cannot be rejected. This supports the internal consistency of the model and reveals that autocorrelation does not constitute a problem in the VAR model.

Table 9

REKS Domestic Granger Causality Test

Independent	Chi-square	df	Prob.
IR	29.86896	8	0.0002
GVZ	8.026286	8	0.4309
OVX	16.65968	8	0.0339
CPI	24.14007	8	0.0022
VIX	9.848359	8	0.2758
All	105.6801	40	0.0000

According to the Granger causality test results, a Granger causality relationship was found from OVX, interest rate and CPI variable to the risk appetite index of domestic investors, but no significant causal effect of GVZ and VIX global risk measures on risk appetite was found. This result shows that domestic economic dynamics are largely effective on the risk appetite of domestic investors. Since interest rates are considered as an opportunity cost for investors, high interest rates generally reduce the demand for risky assets, while low interest rates can direct investors to riskier investments, inflation is a phenomenon that directly affects investors' perception of economic stability. It is expected that high inflation will reduce risk appetite, while low and stable inflation will increase the tendency to take risk. In addition, the fact that OVX is effective on the risk appetite of domestic investors may indicate that the volatility in energy prices is also taken into consideration by domestic investors.
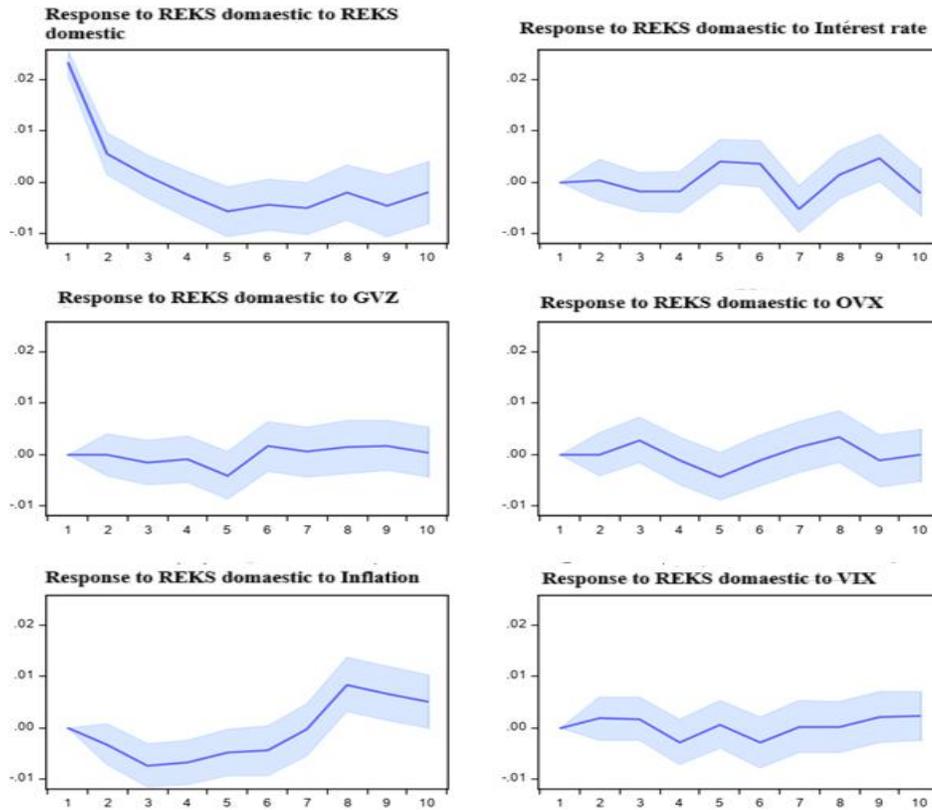

Figure 6. REKS Domestic Impulse-Response Graphs

The REKS Domestic variable shows a positive response to its own shocks in the first few periods. However, it is observed that this effect decreases in a short time. Shocks originating from the CPI have a limited, short-term and generally statistically significant effect on the REKS

Domestic. Shocks originating from the VIX have a slightly negative effect on the REKS Domestic at the beginning and then a positive effect. This finding shows that the Turkish stock market remains under pressure in periods when global risk perception increases. It is seen that this effect is short-term and decreases within 3-5 periods. The effect of shocks originating from the OVX on the REKS Domestic is generally limited. This situation reveals that the Turkish stock market does not show a strong sensitivity to the volatility in the oil markets. The effect of shocks originating from the GVZ on the REKS Domestic variable is quite limited. Therefore, this result can be interpreted as the volatility in the gold market does not directly affect the domestic stocks.

Table 10

Variance Decomposition Results

Period	S.E.	REKS Domestic	IR	GVZ	OVX	CPI	VIX
1	0.023222	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
		(8.2E-15)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
2	0.024154	97.61611	0.030291	0.003012	0.000293	1.831176	0.519114
		(0.10183)	(0.00292)	(0.00094)	(0.00030)	(0.02225)	(0.01261)
3	0.025599	87.08587	0.559278	0.387845	1.205089	9.867206	0.894711
		(0.19701)	(0.01052)	(0.01094)	(0.01881)	(0.05434)	(0.01858)
4	0.026877	79.88516	1.022800	0.472907	1.311766	15.37009	1.937270
		(0.28697)	(0.01725)	(0.01394)	(0.01813)	(0.07027)	(0.02298)
5	0.028856	73.36633	2.843225	2.450403	3.423574	16.19730	1.719167
		(0.36562)	(0.02537)	(0.02957)	(0.03147)	(0.07648)	(0.02255)
6	0.029960	70.24806	4.056359	2.545027	3.332704	17.25542	2.562423
		(0.44363)	(0.03505)	(0.02846)	(0.03450)	(0.08323)	(0.03010)
7	0.030879	68.86077	6.710047	2.422971	3.332044	16.25744	2.416725
		(0.51951)	(0.03951)	(0.02925)	(0.03447)	(0.09079)	(0.03033)
8	0.032300	63.30732	6.335188	2.380077	4.192475	21.57387	2.211074
		(0.59268)	(0.04153)	(0.03236)	(0.04075)	(0.11272)	(0.03104)
9	0.033779	59.78067	7.754535	2.425330	3.977707	23.65479	2.406963
		(0.66326)	(0.05196)	(0.03662)	(0.04186)	(0.13325)	(0.03354)
10	0.034345	58.15160	7.836197	2.360924	3.850923	25.03959	2.760770

In the first periods, 100%, 97% and 87% of the variance of the forecast error of the REKS Domestic index is due to its own past values. This shows that in the short term, REKS Domestic can be largely explained by its own dynamics. In the third period, the contribution of CPI is 9%

and the contribution of OVX is 1%. These results show that in the short term, global market volatility indicators have a limited effect on the REKS Domestic index. In the sixth period, the explanation rate of REKS Domestic from its own past values decreased to 70%, while the contribution of CPI increased to 17% and the contribution of interest increased to 7%. This situation shows that in the medium term, the effect of economic indicators on REKS Domestic increased. In the tenth period, the explanation rate of REKS Domestic from its own variance decreased to 58%, while the contributions of CPI and interest are seen as 25% and 7%, respectively. These results reveal that REKS Yerli is affected more by its own internal factors in the short term, but over time it also becomes sensitive to domestic market dynamics (CPI and interest).

5. Conclusion

In this study, the effects of global volatility indicators such as GVZ, OVX and VIX and domestic economic factors such as CPI and interest rates on the risk appetite index of domestic and foreign investors were examined for the period 2010-2024 using the VAR method. Granger causality tests, impulse response analyses and variance decomposition results provide important findings about the dynamic relationships between these variables. According to the Granger Causality Test Results in the study, it is seen that there are different variables affecting the REKS Domestic and REKS Foreign indices. For example, while there is a Granger causality from OVX, VIX and CPI to this index for the REKS Foreign index, the same causality is not the case for interest rates and GVZ. On the other hand, a causality from OVX, interest rates and CPI to the REKS Domestic index was found, but the same causality was not found for this index in GVZ and VIX. When the variance decomposition results are examined, it is seen that, consistent with other results, more than 80% of the error variance of the REKS Foreign index in the short term is due to its own lagged values, but this rate decreases to 58% in the 10th period. OVX contributes 18%, VIX 11% and CPI 5%, showing the effect of OVX and VIX on REKS Foreign in the medium and long term. Similarly, for the REKS Domestic index, more than 80% of the error variance is explained by its own lagged values in the early periods, but this rate decreases to 58% in the 10th period. CPI contributes 25%, interest rates 7% and OVX at a lower rate. These findings emphasize the decisive role of domestic economic conditions, especially CPI, on domestic markets. These findings reveal that domestic markets have lower sensitivity to indicators such as GVZ and VIX, which are global volatility measures. Although gold is considered a safe haven asset for investors in Türkiye, it is thought that the interest in gold is mostly shaped by physical gold demand and the

fact that GVZ cannot directly reflect this demand causes the gold volatility index to be insufficient in explaining the risk appetite of domestic and foreign investors. Similarly, the fact that domestic investors in Türkiye focus on domestic economic and political uncertainties rather than global indicators such as VIX may explain the lack of a significant effect of VIX on risk appetite in domestic markets. In contrast, it has been determined that the risk appetite of foreign investors in Türkiye is more sensitive to global factors, especially OVX and VIX. The significant effect of OVX on the risk appetite of foreign investors can be associated with the effects of fluctuations in oil prices on global economic growth. The effect of VIX reflects the effect of global investor risk perception and uncertainties on foreign markets. It can be said that foreign investors investing in developing countries such as Turkiye are more sensitive to uncertainties in global markets. This situation can be evaluated as an indicator of the efforts of investors operating in emerging markets to minimize their risks. When compared with similar studies in the literature, the findings of this study are consistent with Akdağ (2019) regarding the significant effect of interest rates on the REKS index, and with Gemici et al. (2023) regarding the role of the VIX index on investors' risk appetite. Empirical studies on Turkey have comprehensively examined the relationships between the REKS index, CDS premium, and various stock market indices. There are some limitations to this study. The VAR analysis used in the study assumes a linear relationship between the variables. In order to fully reflect market dynamics, nonlinear methods or machine learning approaches can be used in future studies. In addition, it is thought that the inclusion of additional factors such as exchange rates, geopolitical risks and other indices, which are not discussed in this study but have a place in the literature, will enable a more comprehensive analysis.

Declaration of Research and Publication Ethics

This study which does not require ethics committee approval and/or legal/specific permission complies with the research and publication ethics.

Researcher's Contribution Rate Statement

The authors contributed equally to the article.

Declaration of Researcher's Conflict of Interest

There are no potential conflicts of interest in this study.

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