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Level Analysis of the Relationship between Inflation, Exchange Rate, CBRT and Fed Interest Rates of Turkish Foreign Trade

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Abstract

Foreign trade has become one of the important elements of the financial structure of countries. Money transfer mechanisms have the power to determine the direction of trade in the world. In the study; Türkiye's exports acording to the country groups were used. In the period 2013:1-2023:11; Panel cointegration, Autoregressive Distributed Lag (ARDL) and Granger causality analyses were used to determine the relationship levels between the Central Bank of the Republic of Türkiye (CBRT), Federal Reserve System (FED) interest rates, Wholesale Price Index (WPI), Consumer Price Index (CPI) and Türkiye's foreign trade. has been used. As a result of the study; Findings have been obtained that Turkish exports are not affected by the CBRT interest rate decisions and WPI in the short or long term. While the increase in FED interest rates causes a decrease in all of Türkiye's exports in the long term, it reduces exports to the Turkic Republics, OECD, EFTA, BSEC, CIS, OIC and D8G in the short term. It has been concluded that while there is a unidirectional causality relationship between the CBRT and FED interest rates, WPI and CPI and Türkiye's exports, there is a bidirectional causality relationship between the exchange rate and Türkiye's exports.

Keywords: *Money Transfer Mechanisms, Türkiye Exports, Cointegration Test, Granger Causation, ARDL.*

Introduction

Foreign trade has a special power today, as it did in the Age of Trade Colonies before Christ. It is an important financial resource not only for the trading country but also for the healthy continuation of the global economy. When we look at the world economic history, especially in the twentieth century, efforts to eliminate national customs borders increased the speed of foreign trade. This system paved the way for the world to become a single market. Foreign currency is primarily needed for globalising international trade. The reserve currency, which is the strongest in international markets and accounts for 59% of national central banks, is the US Dollar (US$) (Mirgani, 2022). In addition to financial markets, real markets are affected not only by foreign exchange volatility but also by inflation and interest rates. The large-scale use of US dollars as reserve money in the world can be reflected in the interest rate reduction/increase monetary policy decisions taken by the FED in the economies of many countries (Köylü & Yücel, 2019: 166). Interest rates, exchange rate movements and inflation parameters that affect the country's real and financial markets also affect domestic and foreign trade. Positive or negative market conditions, whether in developed or developing economies, have the effect of spreading to wide geographies due to the contagion effect.

In this study, the trade between EU countries to which Türkiye exports, European countries outside the EU, countries in Asia, Africa, South and North America, Australia and countries that can be divided into groups according to economic cooperation organizations, is analyzed by comparing the dollar exchange rate, inflation, CBRT interest rates and FED interest rates. The level of relationship between exchange rates is examined. In this context, in this study; The relationship between the monthly US$ exchange rate, WPI and CPI variables between 2013-2023 was examined with panel data analysis in terms of cointegration and Granger Causality. Two separate models were created in the study. The country groups (horizontal sections) in the first model consist of EU, Other Europe, North Africa, Other Africa, North America, Central America, South America, Near and Middle East, Other Asia and Australia countries. The country groups (horizontal sections) in the second model consist of OECD, EFTA, Black Sea Economic Cooperation,

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Economic Cooperation Organization, Commonwealth of Independent States, Turkic Republics, Organization of Islamic Cooperation, D8G and other countries.

As a result of the study; The increase in the exchange rate and CPI causes exports from Türkiye to the country groups in the first model to increase in the short and long term. The increase in FED interest rates causes exports to the country groups in the first model to increase in the short term and decrease in the long term. Findings have been obtained that the change in the CBRT interest rate and WPI does not affect the exports to the country groups in the first model in the short and long term. In Model 2; While the increase in the exchange rate is not the reason for exports from Türkiye to the country groups in the second model in the short term, it causes exports to increase in the long term. The increase in FED interest rates causes exports from Türkiye to the country groups in the second model to decrease in the short and long term. It has been found that the change in the CBRT interest rate, WPI and CPI does not affect the exports to the country groups in the second model in the short and long term. Additionally, while there is a unidirectional causality relationship between Turkish exports, interest rate and inflation, a bidirectional causality relationship was determined with the exchange rate. Short-term shocks in FED interest rates, exchange rates and CPI variables balance in the long term. It has been observed that while the increase in the exchange rate and CPI caused Türkiye's exports to increase, the increase in the FED interest rate caused exports to decrease.

Theoretical Framework

Foreign trade is the whole of exports and imports of international goods and services. International trade brings foreign currency into the country through the sale of goods and services, and foreign exchange comes out of the country with goods and services coming from abroad, narrowing the country's foreign exchange reserves. However, if the country strives to produce goods and/or services that it can buy from other countries at affordable prices, this will disrupt the country's budget balance. In addition, the country may face the threat of losing its productivity in the areas in which it specializes. Another important factor is that excessive imports will cause another disease in the country. Ultimately, such a situation will cause a contraction in production. The country in question will also have to face many problems that the contraction will bring. Türkiye is a country that adopted an export-based growth policy after 1980. Foreign exchange reserves are an important resource not only for Türkiye but for all countries.

The exchange rate is the equivalent of a country's currency with another country's currency (Krugman & Wells, 2006: 154). Exchange rate; They are grouped as real and nominal. While the real exchange rate shows the purchasing power of a country's national currency abroad, the nominal exchange rate shows the rate at which the currencies of two different countries can be bought and sold (Abel et al. 2017: 524–528). Since securities and capital markets are not sufficiently developed in developing countries, the exchange rate channel is one of the main assets affected by monetary policies (Mishkin, 2001: 28). Central banks use exchange rates as a money transfer mechanism. CBRT implements the floating exchange rate policy.

Inflation is a phenomenon that determines the exchange value of commodities in economies (Mankiw, 2011: 205–206). While high inflation is considered a chronic macroeconomic problem in developed and developing countries, policies are being implemented to cope with this problem. When we look at the economic history of Türkiye, inflation reached double digit figures in the last quarter of the 20th century. While inflation rates in Türkiye decreased to single digits at the beginning of the 21st century, this situation changed ten years later and started to remain in double digits again. Inflation is one of the leading chronic structural problems in Türkiye.

To maintain economic balance in Türkiye, it is important to keep the exchange rate, interest rate and inflation rate close to each other and the change in these data to be low. The relationship between interest rates, exchange rate and inflation can be seen in Figure 1.

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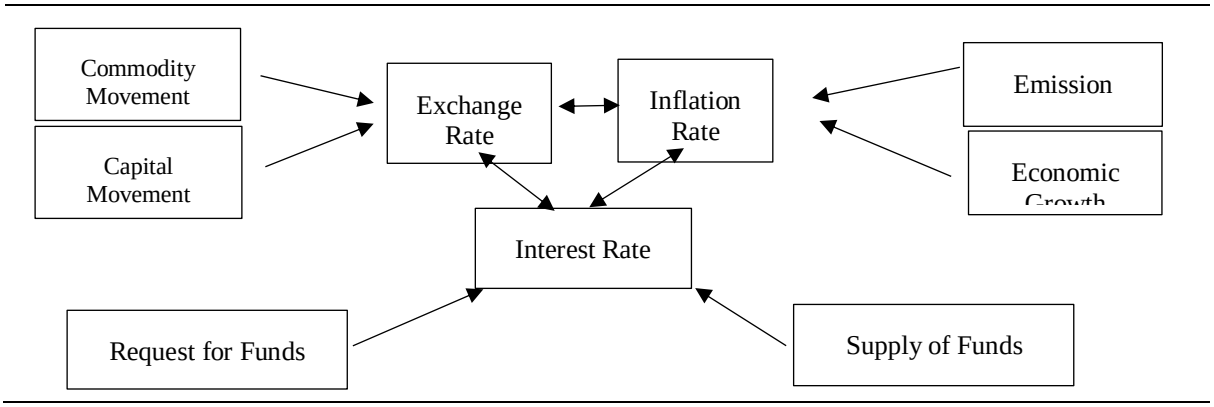
Figure 1: Relationship between Interest Rates, Exchange Rate and Inflation



Source: Ekren, 2002: 10; Sever & Mızrak, 2007: 267

Literature Review

There are many studies in the literature examining the relationship between exchange rates, inflation, interest and foreign trade. However, when looking at these studies, no study was found that evaluated exchange rate, inflation, country interest rate and FED interest rates together. When the results of the studies are examined, they show similarities or differences. Studies reaching different results; The general characteristics may be affected by the study period, the difference in the economic policies of the countries in the samples studied, the difference in analysis techniques or the types of countries.

Studies in the literature have been conducted by evaluating one or more of the international trade, exchange rate, inflation and interest parameters. Table 1 below was created by taking samples from many studies conducted in this context.

Table 1: Literature Case Studies

Author	Subject	Data Set Period	Method	Result
Wilson, &. Takacs (1979)	Price and exchange rate effects on foreign trade of industrially developed countries.	13 Countries with Developed Industries 1957-1977	Junz-Rhomberg Metod	While interest rates and prices in the fixed-rate period remain constant, exchange rate changes have a major impact on trade.
Buckle &. Pope (1985)	Inflation and trade rates in a foreign exchange-constrained economy	New Zealand 1974-1985	RBNZ-BHP Model	It is concluded that export prices are more inflationary than import prices.
Perée & Steinherr (1989)	Exchange rate uncertainty and foreign trade relations in the USA	USA 1960-1985	Mathematical Analysis	A trade relationship with foreign exchange has been determined, not in the short or long term, but in the medium term.
Chen, Tsaur & Liu (1989)	Modelling currency substitution,	China 1989	Mathematical Analysis	The relative inelasticity of import demands causes the terms of

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	inflation and trade dynamics.			trade to fall below the equilibrium value.
Arize, Osang & Slottje (2000)	Effects of exchange rate fluctuation on foreign trade in thirteen underdeveloped countries.	13 Underdeveloped Countries 1973-1996	Johansen Cointegration	Uncertainties and increases in exchange rates have caused a significant decrease in export demand at all times in the countries examined.
Kara & Nelson (2003)	Relationship between exchange rate and inflation in the UK.	UK 1964–2001	The exchange rate disconnect model. Pricing-to-market models. Exchange rate disconnect morel. Scandinavian' or monetary approach	In the UK, there is a close relationship between exchange rate changes and the rate of change in prices of products labelled as imported consumer goods. In the UK, there is a very weak relationship between consumer price index inflation and the real exchange rate. However, this relationship remained weak in UK data.
Gül & Ekinci (2006)	Checking the existence of a causal relationship between inflation and exchange rate in Türkiye.	Türkiye 1995-2004	Regression Analysis	There was no causal relationship between the exchange rate and foreign trade.
Reyes (2007)	The relationship between exchange rate pass-through and inflation in developing economies	Developing countries 1989-2004	Correlation Analysis	The effects of the exchange rate on inflation are significant in developing economies.
Kataranova (2010)	The relationship between exchange rate and inflation in Russia.	Russia 2000-2008	Distributed Delay Model	The initiative of the exchange rate affects inflation.
Omankhanlen (2011)	The impact of exchange rate and inflation on foreign direct investments. Nigerian example.	Nigeria 1980-2009	Linear Regression	While inflation does not affect foreign direct investments, it does affect the exchange rate.
Karaçor & Gerçeker (2012)	The relationship between real exchange rate and foreign trade in Türkiye.	Türkiye 2003-2010	Johansen Cointegration, Granger Causality	No cointegration relationship was found between the real exchange rate and foreign trade.
	Pakistan ithalat, ihracat, reel döviz	Pakistan	Cointegration	

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Bibi, Ahmad & Rashid (2014)	kuru ve doğrudan yabancı yatırımlarını değerlendirmek	1980-2011	DOLS (Dynamic Ordinal Least Squares)	There is a long-term relationship between the growth of the economy and the exchange rate.
Chaudhary, Hashmi & Khan (2016)	Exchange rate and foreign trade relations in Asian countries	Greater South Asia and Southeast Asia 1979-2010	The Autoregressive Distributed Lag (ARDL)	The results show that the long-term relationship between exchange rates and exports exists in more than half of the countries. In the sample countries included in the study; The relationship between exchange rate and foreign trade exists only in one country.
Senadza, & Diaba, (2017)	Sahra Altı Afrika'da döviz kuru oynaklığının ticarete etkisi	11 Sub-Saharan African Ülkeleri 1993-2014	GARCH (EGARCH) models	Kısa dönemde döviz kuru oynaklığı. İhracatı olumsuz etkilerken, uzun dönemde etkisi bulunamamıştır.
Galal, & Lan (2017)	Relationship between Inflation and Foreign Trade	Egypt 2010 - 2016	VAR model	No strong relationship was found between foreign trade and inflation. It has been determined that there are high inflation rates in Egypt. When foreign trade statistics are examined, it is determined that imports are higher than exports.
Low & Chan, (2017)	Relationship between exchange rate, interest rate, inflation and economic growth in Malaysia	Malaysia 1997-2016	Unit Root Test, Co-integration Test, Vector Error-Correction Modeling (VECM), Impulse Response Function (IRF) Variance Decomposition.	There is a long-term relationship between the data.
Kang & Dagli (2018)	International trade and exchange rates.	72 Ülke 2001–2015	Gravity model	A positive relationship was found between the real exchange rate and foreign trade. Exports

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				are a contributing factor to the exchange rate.
Mandigma (2019)	Exchange Rate and Foreign Trade Relationship	ASEAN-4 Endonezya, Malezya, Filipinler &Tayland. 1970–2016	The AutoRegressive Distributed Lag (ARDL)	There is a long-run relationship between US$ and foreign trade for all four ASEAN economies.
Turna &. Özcan (2021)	Effects of macroeconomic variables such as interest rate and exchange rate on inflation in the Turkish economy.	Türkiye 2005-2019	The AutoRegressive Distributed Lag (ARDL)	In Türkiye It is concluded that exchange rate and interest rate variables cause inflation in the short and long term. has been reached
Aytekin & Okyay (2022)	The relationship between exchange rate inflation and foreign trade	Türkiye 2004-2019	Johansen Cointegration test Granger Causality test	Türkiye's; Exchange rate, inflation, export and import figures affect each other in the long run. conclusion has been reached.
Köse & Aslan (2023)	The impact of real exchange rate uncertainty on Turkish foreign trade.	Türkiye 2002-2017	Structural VAR (SVAR) model	Since Turkye's exports are largely dependent on imported inputs Exchange rate uncertainties have a high impact.
Dey (2023)	Effects of inflation on Bangladesh foreign trade.	Bangladesh 1986-2020	Dickey-Fuller (ADF-) test, The Phillips-Perron (PP) test, Johansen's cointegration test, the ordinary least squares (OLS) method, the fully modified OLS (FMOLS) method, the lagged regression technique	It has been determined that exports have a positive and significant effect on inflation. It was concluded that imports have a positive but insignificant effect on inflation. In addition, it was determined that the previous period's exports had a negative effect and imports had a positive effect on the current period inflation.

When the literature is examined, no study has been found examining the impact of the interest rate increase/decrease decisions taken by the FED and the CBRT, inflation rates and the US$ on Türkiye's international trade.

Method

In the methodology of this study, cointegration, the Granger causality test and the ARDL model were used. The cointegration test was developed by Søren Johansen and Katarina Juselius (1990). It is a model created

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to test the cointegration element, which expresses a constant combination of at least two series whose levels are not constant. In the panel Granger causality analysis developed by Kónya (2006), the cross-sectional dependency between the series in the panel is calculated. ARDL model was used to control short and long-term causality relationships.

In the study, panel cointegration, panel ARDL and Granger causality analyses were used for the relationship between Türkiye's exports and exchange rate, FED interest, CBRT interest, WPI and CPI variables. Before the analyses, logarithmic and inverse transformations were made to make the variables suitable for normal distribution; Cross-section dependence and stationarity tests were applied. Cross-section dependence refers to the correlation or interdependence of panels in panel data sets. Depending on the presence of cross-sectional dependence, the unit root tests to be applied for stationarity differ from the first and second generations. For cross-section dependence in the study, first of all, the relative sizes of time (T) and the number of cross-sections (N) are important. In this study, 131-month periods between the 1st month of 2013 and the 11th month of 2023 (T=131); There are 11 countries (N=11) in the first model and 8 countries (N=8) in the second model. In this case, since T(131) > N(11), Breusch and Pagan (1980) LM test was used.

Although cross-sectional dependence is taken into account for the unit root test to be used in the stationarity analysis of the series, the fact that the independent variables (exchange rate, CBRT interest, WPI, CPI) belong only to Türkiye, in other words, are repeated for each country group, eliminates the existence of a cross-section. Since there was no cross-section, the IPS (Im-Pesaran_Shin) (2003) test, one of the first generation unit root tests, was used to examine the stationarity of the independent variables. For the export variable from Türkiye to country groups, the Cross-sectionally Augmented IPS (CIPS) test, which is one of the second-generation unit root tests developed by Pesaran (2007), was used since the LM test result of Breusch and Pagan (1980) indicates the existence of cross-sectional dependence.

The panel ARDL model was used to determine the short and long-term relationships between the independent and dependent variables, and cointegration analysis was carried out with the help of Kao (1999) and Pedroni (1999) tests to determine the long-term relationship before the Panel ARDL model. In large data sets, the assumptions for the dynamic Generalized Method of Moments (GMM) are often inappropriate and the prediction is distorted. In these cases, a popular alternative, the Pooled Mean Group (PMG) estimator by Pesaran, Shin, and Smith (2001), is more appropriate. This model takes the cointegration form of the simple ARDL model and adapts it to a panel setting by allowing the intercepts, short-run coefficients, and cointegration terms to vary across cross-sections. In this study, the PMG (mixed/pooled mean group) estimator offered in the Eviews package program was used as an estimator in the Panel ARDL model.

When short- or long-term relationships were detected between variables, panel causality testing was performed. In this study, the Panel Granger causality test offered in the Eviews package program was used for panel causality testing.

Data collection tools in the study; The interest rate decisions of the CBRT and FED between 2013 and 2023 were accessed from the official websites of the CBRT and FED. Türkiye's exports, CPI and WPI data by country groups are provided from the data of the Turkish Statistical Institute (TUIK).

Analysis of Data and Findings

In this study, the relationship between Türkiye's exports and exchange rate, FED interest, CBRT interest, WPI and CPI variables was examined with panel data analysis in terms of cointegration and causality. Exporting countries were considered in two groups and two separate models were established.

The country groups (horizontal sections) in the first model consist of EU, Other Europe, North Africa, Other Africa, North America, Central America, South America, Near and Middle East, Other Asia and Australia countries. The country groups (horizontal sections) in the second model consist of OECD, EFTA, Black Sea Economic Cooperation, Economic Cooperation Organization, Commonwealth of

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Independent States, Turkic Republics, Organization of Islamic Cooperation, D8G and other countries. Türkiye's export datas are taken from Turkish Statistical Institute's web page.

Analysis and Findings Regarding the First Model of the Research

Country groups in Model 1; EU, Other Europe, North Africa, Other Africa, North America, Central America, South America, Near and Middle East, Other Asia and Australia.

Table 2 lists the variables, abbreviations and descriptive statistics included in the research.

Table 2. Descriptive Statistics of Model-1 Variables

Series	Abbreviation	Log	Min.	Maks.	Avg.	SS	Ç.	B.
Export (Thousand USD)	IHRCT	LNIHR	5.242,986	9.986.902	1.410.509	1.874.881	0,404[a]	2,356[a]
Exchange Rate (USD/TL)	DVIZ	LNDVZ	1,754	28,820	7,202	6,613	0,596[a]	2,332[a]
FED Interest Rate (%)	FEDF	LNFDF	0,250	5,500	1,293	1,491	0,481[a]	1,732[a]
CBRT Interest Rate (%)	TCF	LNTCF	4,500	40,00	12,032	6,574	0,462[a]	2,523[a]
WPI (%)	TEFE	LNTEF	3,180	128,940	26,762	32,595	0,548[a]	2,242[a]
CPI (%)	TUFE	LNTUF	7,320	72,450	18,690	17,941	0,435[b]	1,928[b]

Ç: Distortion B: Kurtosis [a]: After logarithmic transformation [b]: Post reverse transformation

According to the skewness (<1) and kurtosis (<3) values in Table 2, it was determined that the series obtained after logarithmic and inverse transformation showed normal distribution.

As in regression models, there is a prerequisite of stationarity in panel regression analyses. In panel data analysis, first or second-generation unit root tests are applied for the stationarity of the series, depending on cross-sectional dependence and cross-sectional dependence. In the first model of this study, there are 11 country groups (number of horizontal sections = 11) and 131 periods (between the 1st month of 2013 and the 11th month of 2023). In this case, since T(131) > N(11), the Breusch & Pagan LM test is more suitable for testing horizontal dependence. When $p<0.05$ in the Breusch & Pagan LM test, it means that the null hypothesis is rejected and there is cross-sectional dependence between the series. The null hypothesis to be tested is:

H_0 = No dependence between sections (H0 pij = 0; where each i ≠ j)

Table 3. Model-1 Cross-Section Dependency

Series	sd	Breusch-Pagan LM	Peseran Scaled LM	Bias-Corrected Scaled LM	Pesaran CD
LNIHR	55	3547,796**	333,025**	332,983**	58,654**
LNDVZ	55	7205,000**	681,726**	681,683**	84,882**
LNFDF	55	7205,000**	681,726**	681,683**	84,882**

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LNTCF	55	7205,000**	681,726**	681,683**	84,882**
LNTEF	55	7205,000**	681,726**	681,683**	84,882**
LNTUF	55	7205,000**	681,726**	681,683**	84,882**

*p<0,05 **p<0,01

When the cross-sectional dependency results in Table 3 are examined, as in other tests, the Breusch-Pagan LM test statistic is also significant at the 0.05 (p<0.05) and 0.01 (p<0.01) levels. It is understood that the "no dependence" hypothesis is rejected and there is cross-sectional dependence. Since it was understood that there was a dependency (correlation) between the horizontal sections in the export series, the CIPS (Cross-sectionally Augmented IPS) (Pesaran, 2006) test, one of the second-generation unit root tests, was used for the stationarity test. In the CIPS test, the null hypothesis (H0) indicates the existence of a unit root, and when p < 0.05, it is understood that there is no unit root and the series are stationary. Since the exchange rate, FED interest rate, CBRT interest rate, WPI and CPI series do not differ in each country group (there is no horizontal section), the IPS (Im-Pesaran-Shin) test, one of the first generation unit root tests, was used. When stationarity cannot be achieved, the series must be made stationary by taking their first or second-order differences.

Table 4. Model-1 Unity Root Test

	At the level *I*(0)		**1. Different *I*(1)**		
Seris	**Constant Without Trend**	**Constant Trend**	**Constant Without Trend**	**Constant Trend**	**Decision**
LNIHR	-4,151**	-5,166**	-9,194**	-9,338**	*I*(0)
LNDVZ	12,326	5,934	-15,255**	-16,051**	*I*(1)
LNFDF	0,511	1,101	-8,120**	-6,335**	*I*(1)
LNTCF	-3,264**	-6,699**	-8,417**	-6,609**	*I*(0)
LNTEF	-4,131**	-6,439**	-5,752**	-3,493**	*I*(0)
LNTUF	1,717	-2,527**	-5,788**	-3,472**	*I*(0)

*p<0,05 **p<0,01

Table 4, it has been determined that exports, CBRT interest rate, WPI and CPI series are stationary at the level, while exchange rate and FED interest rate are not stationary at the level and become stationary when their first differences are taken. Since the model is a combination of series that become stationary at the level and difference, it shows that it would be appropriate to test the existence of short- and long-term relationships. For short and long-term relationships, the panels must first be co-integrated. Table 5 shows the cointegration test results.

Table 5. Model-1 Cointegration Test

Test	**Statistics Used**	**Statistical Value**
Kao	ADF t	-3,794**
Pedroni	Panel v	8,256**
	Panel rho	-28,239**
	Panel PP	-23,395**
	Panel ADF	-9,166**

*p<0,05 **p<0,01

In both Kao and Pedroni tests used for panel cointegration, the null hypothesis (H0) is "there is no cointegration". When the statistical values in Table 5 are examined, it shows that the null hypothesis is

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rejected at the five statistical values used ($p < 0.05$) and there is cointegration between the panels, in other words, it provides evidence that the panels in the series are integrated together.

Since the periods in the series are monthly, the maximum lag length was chosen as 6, and the AIC (Akaike) information criterion was used to determine the most appropriate model and the appropriate lag length. According to the AIC criterion, the most appropriate lag length for the appropriate model PMG (Pooled Mean-Group) estimator and each of the independent variables was determined to be 4. Table 6 shows the Panel ARDL model results. There are average-group coefficients for the short-term relationship and pooled coefficients for the long-term relationship.

Table 6. Model-1 Panel ARDL Test

Forecast Period	Coefficient	SH	T	p
Long Term				
LNDVZ	0,122	0,037	3,309	**0,001**
LNFDF	-0,082	0,011	-7,474	**0,000**
LNTCF	-0,001	0,028	-0,028	0,977
LNTEF	-0,062	0,041	-1,519	0,129
LNTUF	6,275	1,513	4,148	**0,000**
Short term				
COINTEQ	-0,552	0,067	-8,291	0,000
D(LNDVZ)	-0,204	0,191	-1,066	0,286
D(LNDVZ(-1))	0,229	0,075	3,039	0,002
D(LNDVZ(-2))	-0,076	0,106	-0,716	0,474
D(LNDVZ(-3))	0,111	0,091	1,223	0,222
D(LNFDF)	0,037	0,013	2,857	0,004
D(LNFDF(-1))	0,147	0,043	3,402	0,001
D(LNFDF(-2))	0,135	0,034	3,951	0,000
D(LNFDF(-3))	-0,007	0,019	-0,395	0,693
D(LNTCF)	0,043	0,040	1,075	0,283
D(LNTCF(-1))	0,028	0,023	1,234	0,217
D(LNTCF(-2))	0,095	0,024	3,970	0,000
D(LNTCF(-3))	-0,025	0,047	-0,538	0,591
D(LNTEF)	-0,009	0,072	-0,128	0,898
D(LNTEF(-1))	0,047	0,103	0,456	0,649
D(LNTEF(-2))	0,071	0,074	0,963	0,336
D(LNTEF(-3))	0,074	0,066	1,116	0,265
D(LNTUF)	1,400	5,542	0,253	0,801
D(LNTUF(-1))	0,582	5,033	0,116	0,908
D(LNTUF(-2))	-9,454	2,511	-3,765	0,000
D(LNTUF(-3))	5,123	2,369	2,162	0,031
C	6,569	0,712	9,227	0,000

The fact that the error correction coefficient (COINTEQ) is negative (between 0 and -2) and significant also gives information that the variables are cointegrated. The COINTEG coefficient was found to be negative (-0.552) and significant at the 1% significance level ($p<0.01$). In other words, it means that shocks experienced in the short term are balanced in the long term. According to the Panel ARDL results in Table 6;

It has been determined that there is no significant long-term relationship ($p>0.05$) between the CBRT interest rates and WPI variables and exports from Türkiye to the country groups in model 1. It has been determined that there is a significant long-term relationship ($p<0.05$) between exchange rate, FED interest rates and CPI variables and exports from Türkiye to the country groups in model 1. According to the

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cointegration (COINTEG) coefficient, short-term shocks in the exchange rate, FED interest rates and CPI variables come to balance in the long term (after approximately 2 months) (1/0.552=1.812).

A 1% increase in the exchange rate (LNDVZ) causes a 0.12% increase in exports from Türkiye to the country grouped in number 1 in the model.

A 1% increase in the FED interest rate (LNFDF) causes a 0.08% decrease in exports from Türkiye to the model 1 country groups in the model.

The 1% increase in the CPI (LNTUF) applies to the country groups in the model (EU, Other Europe, North Africa, Other Africa, North America, Central America, South America, Near and Middle East, Other Asia and Australia) from Türkiye. It causes a 6.27% increase in exports.

Granger Causality Test was used to determine the causality relationship between variables. In test statistics, the null hypothesis (H0) is "X variable is not the cause of Y." In this case, when the p-value of the F statistic is less than 0.05 ($p<0.05$), it is understood that X is the cause of the Y variable. Since the first model of this study examines the relationship between exports from Türkiye to country groups and exchange rate, FED interest rate, CBRT interest rate, WPI and CPI variables, only the causality relationship between the said variables and exports is shown in Table 7.

Table 7. Model-1 Panel Granger Causality Test

H_0 Hypothesis	**Number of Observations**	**F**	**p**
The exchange rate is not the reason for exports	1386	2,604	**0,034**
Exports are not the cause of the exchange rate		7,359	**0,000**
FED interest rates are not the reason for exports	1386	5,037	**0,000**
Exports are not the reason for Fed interest rates		0,796	0,528
CBRT interest rates are not the reason for exports	1397	1,228	0,297
Exports are not the reason for CBRT interest rates		4,360	**0,002**
WPI is not the reason for exports	1397	1,407	0,229
Exports are not the reason for WPI		8,088	**0,000**
CPI is not the reason for exports	1397	2,559	**0,037**
Exports are not the reason for the CPI		0,851	0,493

According to the Panel Granger causality test results in Table 7;

There is a bidirectional causality between the exchange rate and exports from Türkiye to the country groups in model 1. Just as the exchange rate is the reason for exports to those countries, exports to those countries are also the reason for the exchange rate.

There is a one-way causality between the FED interest rate and exports from Türkiye to the country groups in model 1. FED interest rates are the reason for exports from Türkiye to these countries, but exports to these countries are not the reason for FED interest rates.

CBRT interest rate and exports from Türkiye to the country groups classified in model 1. CBRT interest rates are not the reason for exports from Türkiye to these countries, but exports to these countries are the reason for CBRT interest rates.

There is a one-way causality between WPI and exports from Türkiye to the country groups in model 1. WPI is not the reason for exports from Türkiye to those countries, but exports to those countries are the reason for WPI.

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There is a one-way causality between CPI and exports from Türkiye to country groups. CPI is the reason for exports from Türkiye to these countries, but exports to these countries are not the reason for CPI.

Analysis and Findings Regarding the Second Model of the Research

The country groups (horizontal sections) in the second model consist of OECD, EFTA, Black Sea Economic Cooperation, Economic Cooperation Organization, Commonwealth of Independent States, Turkic Republics, Organization of Islamic Cooperation, D8G and other countries. Table 8 lists the variables included in the research, their abbreviations and descriptive statistics.

Table 8. Descriptive Statistics of Model-2 Variables

Series	Abbreviation	Log	Min.	Maks.	Avg.	SS	Ç.	B.
Export (Thousand USD)	IHRCT	LNIHR	83.171,36	13.380.378	2.239.766	2.720.896	0,098 [a]	2,437 [a]
Exchange Rate (USD/TL)	DVIZ	LNDVZ	1,754	28,820	7,202	6,613	0,596 [a]	2,332 [a]
FED Interest Rate (%)	FEDF	LNFDF	0,250	5,500	1,293	1,491	0,481 [a]	1,732 [a]
CBRT Interest Rate (%)	TCF	LNTCF	4,500	40,00	12,032	6,574	0,462 [a]	2,523 [a]
WPI (%)	TEFE	LNTEF	3,180	128,940	26,762	32,595	0,548 [a]	2,242 [a]
CPI (%)	TUFE	LNTUF	7,320	72,450	18,690	17,941	0,435 [b]	1,928 [b]

Ç: Distortion B: Kurtosis [a]: After logarithmic transformation [b]: Post reverse transformation sonrası

According to the skewness (<1) and kurtosis (<3) values in Table 8, it was determined that the series obtained after logarithmic and inverse transformation showed normal distribution.

As in regression models, there is a prerequisite of stationarity in panel regression analyses. In panel data analysis, first or second-generation unit root tests are applied for the stationarity of the series, depending on cross-sectional dependence and cross-sectional dependence. In the first model of this study, there are 11 country groups (number of horizontal sections = 11) and 131 periods (between the 1st month of 2013 and the 11th month of 2023). In this case, since T(131) > N(11), the Breusch & Pagan LM test is more suitable for testing horizontal dependence. When $p<0.05$ in the Breusch & Pagan LM test, it means that the null hypothesis is rejected and there is cross-sectional dependence between the series. The null hypothesis to be tested is:

H0 = No dependence between sections (H0 pij = 0; where each $i \neq j$)

Table 9. Article-2 Horizontal Section Dependency

Seris	sd	Breusch-Pagan LM	Peseran Scaled LM	Bias-Corrected Scaled LM	Pesaran CD
LNIHR	28	1257,378**	164,282**	164,251**	30,442**

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LNDVZ	28	3668,000**	486,415**	486,385**	60,564**
LNFDF	28	3668,000**	486,415**	486,385**	60,564**
LNTCF	28	3668,000**	486,415**	486,385**	60,564**
LNTEF	28	3668,000**	486,415**	486,385**	60,564**
LNTUF	28	3668,000**	486,415**	486,385**	60,564**

*p<0,05 **p<0,01

When the cross-sectional dependency results are examined in Table 9, as in other tests, the Breusch-Pagan LM test statistics are significant at the 0.05 (p<0.05) and 0.01 (p<0.01) levels, and it is seen that "there is no dependence between the cross-sections" It is understood that the " hypothesis is rejected and there is cross-sectional dependence. Since it was understood that there was a dependency (correlation) between the horizontal sections in the export series, the CIPS (Cross-sectionally Augmented IPS) (Pesaran, 2006) test, one of the second-generation unit root tests, was used for the stationarity test. In the CIPS test, the null hypothesis (H0) indicates the existence of a unit root, and when p < 0.05, it is understood that there is no unit root and the series are stationary. Since the exchange rate, FED interest rate, CBRT interest rate, WPI and CPI series do not differ in each country group (there is no horizontal section), the IPS (Im-Pesaran-Shin) test, one of the first generation unit root tests, was used. When stationarity cannot be achieved, the series must be made stationary by taking their first or second-order differences.

Table 10. Model-2 Unit Root Test

	Level *I*(0)		**1. Difference *I*(1)**		
Seris	**Constant Without Trend**	**Constant Trend**	**Constant Without Trend**	**Constant Trend**	**Decision**
LNIHR	-4,239**	-4,779**	-9,161**	-9,327**	*I*(0)
LNDVZ	10,512	5,068	-13,009**	-13,688**	*I*(1)
LNFDF	0,435	0,939	-6,927**	-5,402**	*I*(1)
LNTCF	-2,784**	-5,713**	-7,178**	-5,636**	*I*(0)
LNTEF	-3,522**	-5,491**	-4,906**	-2,979**	*I*(0)
LNTUF	1,464	-2,146*	-4,936**	-2,962**	*I*(1)

*p<0,05 **p<0,01

Table 11. Model-2 Cointegration Test

Test	**Statistics Used**	**Statistical Value**
Kao	ADF t	-3,672**
Pedroni	Panel v	3,527**
	Panel rho	-10,605**
	Panel PP	-10,417**
	Panel ADF	-7,067**

*p<0,05 **p<0,01

In both Kao and Pedroni tests used for panel cointegration, the null hypothesis (H0) is "there is no cointegration". When the statistical values in Table 10 are examined, it shows that the null hypothesis is rejected at the five statistical values used (p < 0.05) and there is cointegration between the panels, in other words, it provides evidence that the panels in the series are integrated together.

Since the periods in the series are monthly, the maximum lag length was chosen as 6, and the AIC (Akaike) information criterion was used to determine the most appropriate model and the appropriate lag length. According to the AIC criterion, the most appropriate lag length for the appropriate model PMG (Pooled

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Mean-Group) estimator and each of the independent variables was determined to be 4. Table 12 shows the Panel ARDL model results. There are average-group coefficients for the short-term relationship and pooled coefficients for the long-term relationship.

Table 12. Model-2 Panel ARDL Test

Forecast Period	Coefficient	SH	T	p
Long Term				
LNDVZ	0,129	0,050	2,593	**0,010**
LNFDF	-0,052	0,015	-3,533	**0,000**
LNTCF	-0,002	0,038	-0,044	0,965
LNTEF	0,052	0,055	0,946	0,345
LNTUF	1,052	2,063	0,510	0,610
Short term				
COINTEQ	-0,361	0,077	-4,672	0,000
D(LNDVZ)	0,059	0,328	0,179	0,858
D(LNDVZ(-1))	0,366	0,213	1,720	0,086
D(LNDVZ(-2))	-0,163	0,033	-4,964	0,000
D(LNDVZ(-3))	0,021	0,131	0,159	0,874
D(LNFDF)	0,089	0,019	4,609	0,000
D(LNFDF(-1))	0,044	0,036	1,216	0,224
D(LNFDF(-2))	0,117	0,010	11,801	0,000
D(LNFDF(-3))	-0,045	0,018	-2,527	0,012
D(LNTCF)	-0,031	0,044	-0,702	0,483
D(LNTCF(-1))	0,077	0,097	0,794	0,427
D(LNTCF(-2))	0,117	0,084	1,396	0,163
D(LNTCF(-3))	0,034	0,027	1,290	0,197
D(LNTEF)	-0,042	0,043	-0,973	0,331
D(LNTEF(-1))	0,086	0,019	4,613	0,000
D(LNTEF(-2))	0,091	0,068	1,333	0,183
D(LNTEF(-3))	0,066	0,026	2,557	0,011
D(LNTUF)	-12,315	6,655	-1,851	0,065
D(LNTUF(-1))	7,646	4,166	1,835	0,067
D(LNTUF(-2))	-13,212	5,008	-2,638	0,009
D(LNTUF(-3))	5,005	2,061	2,429	0,015
C	4,936	1,184	4,168	0,000

The fact that the error correction coefficient (COINTEQ) is negative (between 0 and -2) and significant also gives information that the variables are cointegrated. The COINTEG coefficient was found to be negative (-0.361) and significant at the 1% significance level ($p<0.01$). In other words, it means that shocks experienced in the short term are balanced in the long term. According to the Panel ARDL results in Table 11;

It has been determined that there is no significant long-term relationship ($p>0.05$) between CBRT interest rates, WPI and CPI variables and exports from Türkiye to the country groups in model 2. It has been determined that there is a significant long-term relationship ($p<0.05$) between the exchange rate and FED interest rate variables and exports from Türkiye to the country groups in model 2. According to the cointegration (COINTEG) coefficient, short-term shocks in the exchange rate and FED interest rate variables balance in the long term (after approximately 3 months) (1/0.361=2.771).

A 1% increase in the exchange rate (LNDVZ) causes a 0.13% increase in exports from Türkiye to the country groups in group 2 in the model.

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A 1% increase in the FED interest rate (LNFDF) causes a 0.05% decrease in exports from Türkiye to the country groups in the second model.

Granger Causality Test was used to determine the causality relationship between variables. In test statistics, the null hypothesis (H0) is "X variable is not the cause of Y." In this case, when the p-value of the F statistic is less than 0.05 ($p<0.05$), it is understood that X is the cause of the Y variable. Since the relationship between exports from Türkiye to the country groups in the first model of this study and the exchange rate, FED interest rate, CBRT interest rate, WPI and CPI variables were examined, only the causality relationship between the said variables and exports is shown in Table 13.

Table 13. Model-2 Panel Granger Causality Test

H_0 Hypothesis	**Number of Observations**	**F**	**p**
The exchange rate is not the reason for exports	984	3,180	**0,001**
Exports are not the cause of the exchange rate		2,389	**0,015**
FED interest rates are not the reason for exports	984	3,743	**0,000**
Exports are not the reason for Fed interest rates		1,605	0,119
CBRT interest rates are not the reason for exports	984	1,699	0,094
Exports are not the reason for CBRT interest rates		0,548	0,820
WPI is not the reason for exports	984	3,169	0,001
Exports are not the reason for WPI		2,855	**0,004**
CPI is not the reason for exports	984	3,105	**0,002**
Exports are not the reason for the CPI		1,648	0,107

According to the Panel Granger causality test results in Table 13;

There is a bidirectional causality between the exchange rate and exports from Türkiye to the country groups in the second model. Just as the exchange rate is the reason for exports to those countries, exports to those countries are also the reason for the exchange rate.

There is a one-way causality between the FED interest rate and exports from Türkiye to the country groups in the second model. FED interest rates are the reason for exports from Türkiye to these countries, but exports to these countries are not the reason for FED interest rates.

There is no causality between the CBRT interest rate and exports from Türkiye to the country groups in the second model.

There is a one-way causality between WPI and exports from Türkiye to the country groups in the second model. WPI is not the reason for exports from Türkiye to those countries, but exports to those countries are the reason for WPI.

There is a one-way causality between CPI and exports from Türkiye to the country groups in the second model. CPI is the reason for exports from Türkiye to these countries, but exports to these countries are not the reason for CPI.

Concusion

Türkiye's export revenues to the EU, European countries outside the EU, Africa, Asia, America, Austria, Turkic Republics, OECD, EFTA, Black Sea Economic Cooperation countries, Economic Cooperation Organization, Commonwealth of Independent States, Organization of Islamic Cooperation and D8G country groups It contributes to Türkiye's export-oriented growth policies.

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While international trade is significantly affected by production capacities in domestic markets, it is also affected by exchange rates, interest rates and inflation indicators. When international trade is evaluated in terms of the aforementioned indicators, it is important for countries whether the impact direction is positive or negative.

In this context, the study examined to what extent Türkiye's exports were affected by the exchange rate, inflation, CBRT and FED interest rates in the period between 2013 and 2023. As a result of the analysis; Türkiye's exports are affected only by the interest rates determined by the CBRT (except for Model 2 countries) and the FED interest rates in the long term. The study showed that there is a significant long-term relationship between exchange rate, interest rates and inflation and Türkiye's exports.

Türkiye's exports to the EU, Other Europe, North Africa, Other Africa, North America, Central America, South America, Near and Middle East, Other Asia and Australia; While there is a two-way causality relationship with the exchange rate, a one-way causality relationship with WPI, CPI, FED and CBRT interest rates is clearly seen. In addition, a 1% increase in the exchange rate causes a 0.12% increase in exports; A 1% increase in the FED interest rate causes a 0.08% decrease in exports; A 1% increase in CPI causes a 6.27% increase in exports. While there is a bidirectional causality relationship with the exchange rate in Türkiye's exports to OECD, EFTA, Black Sea Economic Cooperation, Economic Cooperation Organization, Commonwealth of Independent States, Turkic Republics, Organization of Islamic Cooperation and D8G groups, there is a unidirectional causality relationship with WPI, CPI and FED interest rates. There is a relationship. In addition, in sales to the countries subject to these exports; A 1% increase in the exchange rate results in a 0.13% increase; A 1% increase in the FED interest rate caused a 0.05% decrease.

As a result, in Türkiye's econometric analysis covering the period between 2013 and 2023; It is possible to say that Turkish exports are affected by inflation and interest rates as well as exchange rates. To break the resistance of shock effects on the parameters that negatively affect Turkish exports, economic uncertainties must be resolved and an environment of trust must be created in the markets.

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