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PAPER

The Effect of Exchange Rate Volatility on Bilateral Trade between Turkey and European Union Countries: Asymmetric Analysis with Markov Regime Switching Models

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Abstract This study aims to reveal the asymmetric effect of real exchange rate volatility on bilateral trade between Turkey and 8 European Union member countries under different economic cycles. Accordingly, monthly data from January 2005 to December 2021 were analyzed with Markov regime switching models. The findings show that an increase in real exchange rate volatility reduces bilateral trade between Turkey, Belgium, and Germany during periods of economic expansion, while bilateral trade between Turkey and Poland decreases during periods of economic contraction. In addition, while it was detected that an increase in real exchange rate volatility decreased the bilateral trade between Turkey and Italy, and Romania in both expansion and contraction periods of the economy, no significant finding was obtained regarding the effect on bilateral trade between Turkey and France, the Netherlands and Spain. The findings prove that the Marshall-Lerner condition and J-curve effect are not valid in trade with the relevant EU countries.

Keywords: Real Exchange Rate Volatility, Bilateral Trade, European Union Countries, Kruse Nonlinear Unit Root Test, Markov Regime Switching Models.

JEL Classification: B17, B27, D53.

Introduction

The effect of the changes in the exchange rate on the foreign trade balance is among the main issues of macroeconomics. This issue is important because of two reasons. The first is that policymakers often worry whether the trade is occurring at an appropriate level based on the idea that the trade balance is optimal for intertemporal

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trade. Knowing how the changes in the exchange rate affect the trade balance, in the long run, can help policymakers target the trade balance over the relevant time scale. The second reason is that the fluctuations in the trade balance affect the countries' national income in the short run. In this respect, knowing how changes in the exchange rate affect the trade balance can contribute to policymakers targeting national income (Hacker and Hatemi-J, 2004).

In the literature, the effect of the exchange rate on the trade balance is handled differently in various theories and hypotheses. In the theory of international trade, it is argued that when a country aims to close the deficit in the trade balance, one of the expected economic policy consequences of this attempt of the country will be the devaluation of the real national currency and the devaluation of the currency will affect the trade balance through trade volume and price channels. The depreciation of the foreign currency and the inability of import and export volume to adapt in the short-term cause imports to be more expensive and exports cheaper; thus, the foreign trade balance deteriorates in the short run. The effect of the trade volume emerges in the trade relations established with the countries and increases the trade balance by compensating for the short-term deterioration in the long run (Yildirim and Saraç, 2022). In traditional economic theory, it is argued that the positive result of devaluation depends on the elasticity of exports and imports. Provided that the sum of these elasticities, known as the Marshall-Lerner (ML) condition, is greater than one, an improvement in the trade balance is expected after the currency depreciation. In this context, it can be said that real depreciation can increase the trade balance in two different ways. The first of these is that due to the depreciation of a country's currency, depending on the number of exports, domestic goods become more expensive than foreign goods, and thus export goods gain a more competitive position in international markets. Second, since goods imported from other countries will be more expensive, depreciation of a country's currency can reduce the number of imports, which in turn can cause a trade balance surplus (Laksono and Edison, 2020).

Magee (1973) draws attention to the letter J, underlining the short and long-term uncertainty effects of currency depreciation. Known as the J-curve in the literature, this curve focuses on the dynamics of the trade balance shifting from the short-term to the long-term following the devaluation of the national currency. Magee (1973) also emphasizes that the J-curve phenomenon is related to pre-existing trade contracts that must be fulfilled in the short run. In this context, the trade balance improves when new post-depreciation contracts begin to dominate bilateral trade relations. Krueger (1983) also states that the existence of the J-curve phenomenon can be attributed to the purchase of goods already in transit and under contract at the time of a change, and the completion of these transactions may depend on the short-term change in the trade balance. Arndt and Dorrance (1987) point out that the so-called J-curve effect occurs when national currency prices for exports are sticky. The ML condition can explain this situation, which means obtaining the desired devaluation result depending on the export and import flexibility. Bahmani-Oskooee (1985), who tested the situation in practice for the first time, defends some situations where the deterioration in the trade balance continues despite the ML condition being met and proposes a trade policy that focuses on short-term dynamics and follows the trade balance after devaluation. In other words, Bahmani-Oskooee (1985) argues that devaluation first worsens the trade balance and then improves it due to the lag structure.

This study aims to reveal the asymmetric effect of real exchange rate volatility on bilateral trade under different economic cycles. When the literature is examined; although it is seen that studies investigating the effect of exchange rate and volatility on Turkey's bilateral trade with various countries are frequently conducted with nonlinear models, no study has been found that tests the effect of exchange rate volatility under different economic cycles by considering the European Union (EU) countries. For this reason, the study is considered to have an original value and is expected to contribute to the literature.

The rest of the study is structured as follows: First, in the literature review section, the studies in the literature on the relevant subject are summarized. Then, in the data set and method section, the data source is explained, and information about the Markov regime switching models used in the study is presented, and the findings obtained from the analyses are reported in the findings section. Finally, in the conclusion and evaluation section, the findings obtained in the research are evaluated theoretically, and policy recommendations are made by revealing the similar and different aspects of the findings from the findings in the literature.

Literature Review

Adam Smith's trade theory states that trade between two nations is based on Absolute Advantage, and David Ricardo states that if the cost of producing a good in a country is lower than in other countries, then this country has a comparative advantage in the production of this good. There are theories that reveal international trade in the literature, such as Mercantilism, which is an economic policy designed to limit imports and maximize exports for the enrichment of a country. The focus of these theories is the trade balance. The balance of trade is an essential part of the international economy. Many factors affect the international economy macroeconomically, such as exchange rate/exchange rate volatility, inflation rate, GDP growth rate, product competition between the relevant countries through the export-import price index, and tariff problems.

Exchange rate/exchange rate volatility comes first among the factors whose macroeconomic effects are tested in the literature. Empirical research on the effect of exchange rate/exchange rate volatility has increased in the post-2000 period, and two main empirical research groups formed on the basis of the J-curve phenomenon. The first set of empirical research uses the aggregate trade balance approach and considers the trade flows between a country and the rest of the world. The second group of empirical studies either applies the collective trade flow between the two countries or examines bilateral trade at the sectoral level. This section summarizes studies examining the effect of exchange rate and exchange rate volatility on bilateral trade between countries and which are thought to contribute to the research.

While the findings of the studies conducted by Hacker and Hatemi-J. (2004) and Bal and Demiral (2012) to investigate the effect of the real exchange rate on bilateral trade based on error correction model revealed that the J-curve effect was valid, Akbostanci (2004) and Bahmani-Oskooee et al. (2005) found that the J-curve hypothesis was not valid. Similarly, in the study conducted by Çelik and Kaya (2010) to investigate the effect of the real exchange rate with the panel cointegration test, the findings showed that the J-curve effect was not valid. The study of Halicioglu (2007) and that of Laksono and Edison (2020) determined that the Marchel-Lerner conditions were met for some trading partners. In the study carried out by Halicioglu (2008) to investigate the effect of the real exchange rate with ARDL models, it was determined that the real depreciation of the TL in several countries had a positive effect on Turkey's trade balance in the long run, while an increase in the real dollar exchange rate was found to improve the bilateral trade balance both in the short and long-term. In the study of Ergin Ünal (2021), it was determined that a decrease in the real exchange rate affected the trade balance negatively for Turkey. In the studies conducted by Ari et al. (2019), Bahmani-Oskooee et al. (2016), Bahmani-Oskooee and Baek (2019), Bahmani-Oskooee and Halicioglu (2017), Bahmani-Oskooee and Karamelikli (2021) to test the effect of the real exchange rate with ARDL and NARDL models, it was determined that NARDL model results supported the J-curve hypothesis relatively more. Findings obtained by Dogru et al. (2019) and Küçüksoy and Akkoç (2020) contradicted the J-curve theory. In addition, in the study of Karamelikli (2019), it was determined that there was an asymmetrical relationship in the short-term, while in the study of Karamelikli and Erkuş (2017), it was determined that increases and decreases in the exchange rate positively affected the trade between the two countries. The effect of the real exchange rate on bilateral trade was tested with the Markov regime switching ARDL model in the study by Thanh et al. (2020) and with the Fourier ADL model in the study by Toktaş (2021). Thanh et al. (2020) found the effect of being asymmetrical and convergent in the long-term, while in the study of Toktaş (2021), it was found that there was no significant effect.

Regarding the studies on the effect of the exchange rate volatility on bilateral trade between foreign countries, Bahmani-Oskooee et al. (2013) examined the effect of volatility in the real exchange rate on bilateral trade between the USA and Brazil, using the GARCH and ARDL model, and found that sectors are sensitive to the changes in the exchange rate risk and that large sectors are not affected by the so-called risk. In Smallwood's (2019) study, the effect of the exchange rate uncertainty on bilateral export growth for China's top 10 export markets was tested with the multivariate DCC-GARCH model. As a result of the analysis, it was determined that while the exchange rate uncertainty did not significantly affect the trade with the USA, it had trade deterrent effects for almost all the remaining countries. Among the studies investigating the effect of the real exchange rate volatility with GARCH, ARDL, and NARDL models, Bahmani-Oskooee and Aftab (2017), Bahmani-Oskooee and Arize (2022), Bahmani-Oskooee and Nouira (2020) and Xu et al. (2022) found that there are short and long-term asymmetric effects.

Vergil (2002) tested the effect of the real exchange rate volatility on Turkey's real exports to the USA, Germany, France, and Italy using ARIMA, GARCH, and error correction models. As a result of the research, it was found that the effect of the exchange rate volatility on real exports is negative. Nazlioglu (2013) examined the effect of the real exchange rate volatility on Turkey's exports from 20 sectors with the highest export potential to 20 big trading partners with a panel cointegration test. As a result of the research, it was determined that the effect of the real exchange rate volatility on Turkish exports differs between sectors, and Turkey benefits from the depreciation of the Turkish lira. Karakas et al. (2017) investigated the effect of the real TL/Ruble exchange rate volatility on bilateral trade between Turkey and Russia with the Johansen cointegration test and error correction models. As a result of the analyses, it was found that an increase in the volatility of TL and Ruble currencies in the long -term has a positive effect on imports and exports, and a volatility increase in TL in the short-term increases exports. Gacener Atış et al. (2020) examined the effect of the real exchange rate volatility on bilateral trade between Turkey and OECD countries with generalized autoregressive score (GAS) and Markov regime switching ARMA models on a sectoral basis under different economic cycles. As a result of the analysis, it was determined that an increase in the volatility of the real exchange rate during the contraction periods of the economy positively affects the total exports of sectors such as livestock and foodstuffs, animal, vegetable fats and oils, candles, but does not have a significant effect on other sectors. In addition, it was found that an increase in the volatility of the real exchange rate during the contraction periods of the economy has a positive effect on the imports of machinery and transportation, various manufactured goods, livestock and foodstuffs, alcohol and tobacco, and gross goods, while the effect on the import of non-renewable materials other than fuel is negative. Finally, it was found that an increase in the real exchange rate volatility during the expansion periods of the economy has a positive effect on the import of non-renewable materials other than livestock and foodstuffs, alcohol and tobacco, mineral fuels, fuel oil, petroleum, vegetable, and animal oils and various manufactured goods.

Bahmani-Oskooee and Durmaz (2021) examined the effect of Euro/TL exchange rate volatility on 62 sectors trading between Turkey and EU countries with GARCH, ARDL and NARDL models. As a result of ARDL model estimations, it was determined that volatility has short-term effects on 26 Turkish industries exporting to the EU and 40 EU industries exporting to Turkey, and this effect persists in the long run in only 11 Turkish and 19 EU export sectors. As a result of NARDL model estimations, it was found that there are short-term asymmetric volatility effects on 8 Turkish and 49 EU export sectors. Yıldırım and Saraç (2022) examined the effect of the volatility in the real Euro/TL exchange rate on bilateral trade between Turkey and Germany using Markov regime switching models and stated that the changes in the real exchange rate positively affected the bilateral trade balance during the expansion periods of the economy. However, it was determined that the J curve effect is valid in the bilateral trade relations of Turkey and Germany due to the export-increasing effect of the real exchange rate in the expansion period of the economy.

Data Set and Method

The purpose of the current study is to investigate the effect of the real exchange rate volatility on bilateral trade between Turkey and EU member countries. To this end, monthly data for the period 2005:1-2021:12 were used in the study. In the selection of EU member countries, the rankings of 20 countries that Turkey exports and imports the most, as published by TUIK (2022), were taken as a basis, and 8 EU member countries in both rankings were included in the analysis. In the study, the monthly trade balance of Turkey with its trading partner j is expressed as TB_j and calculated as "the ratio of Turkey's imports from country j to its exports to country j."

In the study, the monthly real exchange rate between TL and the currency of trading partner j is expressed with RER_j and calculated with the formula (P_j x $NERT$)/ PT. In the formula, P_T and P_j represent Turkey's consumer price index data and country j, respectively. $NERT$, which represents the nominal exchange rate, represents the number of T_L per currency of country j, and the increase in $NERT$ shows the depreciation of T_L according to the currency of country j.

Finally, since the GDP data are published quarterly, the seasonally adjusted monthly industrial production index (IPI_j) data of countries (country j) were considered as a proxy for this data. In the study, data on trade balance were obtained from IMF's Direction of Trade Statistics, consumer price index and industrial production index data from IMF's International Financial Statistics and nominal exchange rate data from TCMB's EVDS databases. In the study, the analyses were carried out with Eviews and Oxmetrics and R programs, and the data set information of the study is given in Table 1.

Table 1. Data Set Information of the Study

Variables	Explanation	Studies Using the Variables
TB_j	Monthly trade balance of Turkey with its trading partner j	Karamelikli (2019), Karamelikli and Erkuş (2017), Küçüksoy and Akkoç (2020).
RER_j	Monthly real exchange rate between TL and currency of trading partner j	Bahmani-Oskooee and Karamelikli (2021), Karamelikli (2019).
IPI_j	Seasonally adjusted monthly industrial production index of country j	Bahmani-Oskooee and Karamelikli (2021), Bahmani-Oskooee and Zhang (2014), Bal and Demiral (2012), Hacker and Hatemi-J (2004), Karamelikli (2019).

In the study, the natural logarithm of the industrial production index data was taken, the proportionally calculated trade balance data was included in the scope of the analysis in its current form, and the real exchange rate returns were calculated over the monthly real exchange rates of the countries with the help of the equation (1):

$$RERR_{j,t} = ln\left(P_{j,t}/P_{j,t-1}\right) \tag{1}$$

In equation (1), $RERR_{j,t}$ is the return for month t of the real exchange rate between TL and the currency of trading partner j, $P_{j,t}$ represents the real exchange rate between TL and the currency of trading partner j in month $t-1$, $P_{j,t-1}$ represents the real exchange rate between TL and the currency of trading partner j in month t-1. Table 2 shows the descriptive statistics of the variables.

Table 2. Descriptive Statistics of the Variables

Variables	Mean	Median	Minimum	Maximum	Standard Deviation	Kurtosis	Skewness	Jarque-Bera
BTB	1.363803	1.331353	0.528302	2.495026	0.350593	0.284529	2.860993	2.902484
FTB	1.242128	1.251306	0.709851	2.098531	0.278017	0.223747	2.802422	2.02398
GTB	1.450181	1.457187	0.892867	2.134529	0.233537	0.099244	3.05262	0.356658
ITB	1.442056	1.393527	0.705956	2.91523	0.402766	0.793161	3.702797	25.46246***
NTB	0.923361	0.896969	0.417879	1.767499	0.252366	0.512194	3.333521	9.816812***
PTB	1.296247	1.232235	0.590261	2.486824	0.392253	0.444787	2.705638	7.426329**
RTB	0.998236	0.931942	0.407889	1.694297	0.297032	0.315154	2.180419	9.041973**
STB	1.115631	1.106379	0.379381	1.938363	0.346774	-0.00397	2.359348	3.472131
lnBIPI	4.649374	4.646398	4.429663	4.964042	0.099855	0.324765	3.607458	6.689656**
lnFIPI	4.628178	4.618003	4.215003	4.752644	0.062277	-1.36196	12.25173	786.7462***

Variables	Mean	Median	Minimum	Maximum	Standard Deviation	Kurtosis	Skewness	Jarque-Bera
lnGIPI	4.658889	4.678468	4.356568	4.772759	0.06891	-1.24079	4.910568	82.96382***
lnIIPI	4.600228	4.577591	3.995318	4.816435	0.103939	-0.51115	8.233114	240.4754***
lnNIPI	4.601314	4.604933	4.507538	4.604933	0.014698	-4.26449	21.24686	3431.473***
lnPIPI	4.83769	4.862608	4.404739	5.332715	0.25551	-0.01096	1.771789	12.76349***
lnRIPI	4.762329	4.777972	4.316626	5.051147	0.193344	-0.21204	1.856033	12.59022***
lnSIPI	4.618406	4.591495	4.184596	4.859646	0.116898	0.613875	3.430212	14.31535***
lnTIPI	4.830678	4.835609	4.404739	5.294722	0.252291	-0.0177	1.740904	13.41978***
RERR_B	0.003438	-0.00045	-0.11607	0.153814	0.034914	0.577973	5.492354	63.84383***
RERR_F	0.002849	-0.00074	-0.12177	0.157248	0.035396	0.517488	5.528833	63.15139***
RERR_G	0.003068	-0.0008	-0.12093	0.153376	0.035263	0.458775	5.484085	59.31471***
RERR_I	0.002962	0.00023	-0.12283	0.156306	0.035172	0.558181	5.658244	70.31009***
RERR_N	0.003293	-0.00096	-0.11928	0.153569	0.035307	0.499105	5.383742	56.49025***
RERR_P	0.003725	0.000588	-0.11891	0.152418	0.035083	0.564974	5.481047	62.8655***
RERR_R	0.003772	0.001632	-0.12207	0.15864	0.038142	0.681889	5.65795	75.48716***
RERR_S	0.003304	-0.00149	-0.11363	0.153846	0.035804	0.54807	5.275712	53.96744***

*** and ** denote significance at the 1% and 5% significance level, respectively. RERR_B represents the real exchange rate returns of Belgium, RERR_F those of France, RERR_G those of Germany, RERR_I: those of Italy, RERR_N those of the Netherlands, RERR_P those of Poland, RERR_R those of Romania and RERR_S those of Spain. lnBIPI denotes the industrial production index whose natural logarithm is taken for Belgium, lnGIPI for Germany, lnIIPI for Italy, lnNIPI for the Netherlands, lnPIPI for Poland, lnRIPI for Romania, lnSIPI for Spain and lnTIPI for Turkey. In addition, BTB, FTB, GTB, ITB, NTB, PTB, RTB and STB refer to Turkey's bilateral trade (trade balance) with Belgium, France, Germany, Italy, Netherlands, Poland, Romania and Spain, respectively.

According to Table 2, the mean of the sample average of all the series is positive and the real exchange rate returns and the means of the series related to the trade balance and industrial production indices, excluding NTB and RTB series, are above 1. Standard deviation values for all the series show that the volatility level of all the series related to trade balance is higher than the series related to the industrial production index and real exchange rate returns. When the skewness and kurtosis criteria are considered together, the fact that the kurtosis coefficients of the series are different from 3 and the skewness coefficients are different from 0 provides clues that the series are not normally distributed. According to Table 2, while left skewness and negative asymmetry are dominant in series with negative skewness coefficients, the fact that the skewness coefficients are mostly positive indicates that the series are right skewed and show positive asymmetry. Similarly, the fact that the kurtosis coefficients are higher than three mostly means that the series is steeper than the normal distribution and show a leptokurtic distribution with a thick tail feature, while it can be said that the distribution curves are flatter in the series with kurtosis coefficients smaller than 3. According to the Jarque-Bera test, which tests the assumption of normality, it was determined that the series are not normally distributed since the p probability values of all the series, except for the BTB, FTB, GTB and STB series, are 0.0000. The obtained findings show that asymmetrical behaviors are experienced in the series and provide evidence that research should be done based on regime switching.

In the study, the stationarity structures of the series were tested with the Kruse (2011) nonlinear unit root test. Kapetanios et al. (2003) expressed the model to be used for testing the unit root fundamental hypothesis against the global stationary ESTAR (Exponential Smooth Transition Autoregressive Model) process using the Taylor approach as follows (Kapetanios et al., 2003, p.363):

$$\Delta y_t = \delta y_{t-1}^3 + error\ term \tag{2}$$

In the test, t-statistics are calculated for $\delta=0$ versus $\delta<0$, and critical values of t_{NL} statistics are obtained for raw data, mean-free and trend-free cases. The Kruse (2011) test, on the other hand, taking into account the probability of non-zero position parameter ($c\neq0$) of real-world samples, developed the Kapetanios et al. (2003) test. In his study, Kruse (2011) proposed the estimation of the following model under the assumption of $c\neq0$, leaving aside the assumption of $c=0$ in the study by Kapetanios et al. (2003) (Kruse, 2011):

$$\Delta y_t = \phi y_{t-1}(1-exp\{-\gamma\,(y_{t-1}-c)^2\}) + \varepsilon_t \tag{3}$$

Following the Kapetanios et al. (2003) test, the first-order Taylor approximation becomes $G(y_{t-1},\gamma,c) = (1-\exp\{-\gamma\,(y_{t-1}-c)^2\})$ around $\gamma = 0$ and test regression proceeds as follows:

$$\Delta y_t = \beta_1 y_{t-1}^3 + \beta_2 y_{t-1}^2 + \beta_3 y_{t-1} + u_t \tag{4}$$

Again following Kapetanios et al. (2003) test, the power of the test is increased by making the following arrangement; . From here, the test proceeds as follows (Kruse, 2011):

$$\Delta y_t = \beta_1 y_{t-1}^3 + \beta_2 y_{t-1}^2 + u_t \tag{5}$$

In Equation (4), $\beta_1 = \gamma\phi$ and $\beta_2 = -2c\gamma\phi$. From here, Kruse (2011) proposed the τ test to test the unit root fundamental hypothesis ($H_1: \beta_1 < 0, \beta_2 \neq 0$) against the global ESTAR process ($H_1: \beta_1 < 0, \beta_2 \neq 0$) and this test statistic is as follows (Güris et al., 2016):

$$\tau = t^2_{\beta^{\frac{1}{2}}=0} + 1\,(\hat{\beta} < 0)\, t^2_{\beta_{1=0}} \tag{6}$$

The test statistics given in Equation (6) were tabulated in the Kruse (2011) test for the three cases also mentioned in the Kapetanios et al. (2003) test, and the critical values were specified.

The Markov regime switching regression (MSR) model was used to test the research hypothesis. The MSR model was first developed by Hamilton (1989). This model is used to model the nonlinear structure in time series models. The MSR model proposed by Hamilton (1989) includes different equations for different regimes. The model can reveal macroeconomic series' dynamic structures and behaviours by allowing the equations to change. The most striking feature of the model is that the process consisting of at least two regimes is combined with a variable that acts as a dummy variable and is specified as a regime variable through the unobservable state variable following the first-order Markov chain. This way, it is possible to evaluate periods with different characteristics (expansion-contraction, etc.) separately (Evci et al., 2016; Hamilton, 2010). The relationship between an autoregressive model and a Markov regime-switching autoregressive model in the AR(1) process can be expressed as follows:

$$y_t = c_1 + \Phi y_{t-1} + \varepsilon_t \tag{7}$$

For the series, the process AR(1) can be represented with a different constant when there is a change that will change the mean of the series:

$$y_t = c_2 + \Phi y_{t-1} + \varepsilon_t \tag{8}$$

Based on Equations (7) and (8), the series can be defined as having two regimes as follows (Tsay, 2006):

$$y_t = \begin{cases} c_1 + \sum_{i=1}^{p} \Phi_{1,i} y_{t-i} + \varepsilon_{1t} & If\ s_t = 1 \\ c_2 + \sum_{i=2}^{p} \Phi_{1,i} y_{t-i} + \varepsilon_{2t} & If\ s_t = 2 \end{cases} \tag{9}$$

According to Equation (9), if the series is in the first regime, $s_t=1$ and if the series is in the second regime, then $s_t=2$. In addition, P_{ij} represents constant transition probabilities between regimes and binary regimes can be shown as follows:

$$P_{i,j} = \begin{bmatrix} P_{11} & P_{12} \\ P_{21} & P_{22} \end{bmatrix} \tag{10}$$

Depending on the regimes, the transition probabilities matrix can be expressed as follows (Hamilton, 1989):

$$P_{11} = [S_t = 1 \mid S_{t-1} = 1] = p, \tag{11}$$

$$P_{12} = [S_t = 2 \mid S_{t-1} = 1] = 1 - p, \tag{12}$$

$$P_{21} = [S_t = 1 \mid S_{t-1} = 2] = q, \tag{13}$$

$$P_{21} = [S_t = 1 \mid S_{t-1} = 2] = q, \tag{14}$$

According to this representation, p is the probability of being in the first regime again in the next period, $1-p$ is the probability of being in the second regime in the next period while it is in the first regime in this period. Similarly, q indicates the probability of being in the first regime in the next period while it is in the second regime in this period, and $1-q$ indicates the probability of being in the second regime in the next period when it is in the second regime in this period. The sum of the transition probabilities is equal to one and the probability values cannot be negative. Thus, the Markov regime-switching model can be defined as in equation (15) (Barca and Arabacı, 2020):

$$y_t = \mu_{st} + \varepsilon_t \; ve \; \varepsilon_t \sim iid(0, \sigma^2) \tag{15}$$

This model can be evaluated in two stages as the models in which the regime (MSM) changes according to the conditional mean and according to the (MSI) constant . MSI models can be shown as in Equation (16):

$$y_t = C_{st} + \Phi y_{t-1} + \varepsilon_t \tag{16}$$

Here, the constant term of changes with the regime. The MSM model can be defined as in Equation (17):

$$y_t - \mu_{st} = \Phi(y_{t-1} - \mu_{st-1}) + \varepsilon_t \tag{17}$$

According to Equation (17), the mean of changes with the regime.

Findings

In the study, unit root tests of real exchange rate returns were first performed with the ADF test in order to create real exchange rate volatility series on a country basis, and it was determined that all the series did not contain unit roots because the test statistics at the 1% significance level were higher than the critical values. Then, the existence of the variable variance feature in the series was tested with the ARMA models and ARCH tests most suitable for the series, and the findings are given in Table 3.

Table 3. Results for the Most Suitable ARMA Models and ARCH Tests

	Results for the Most Suitable ARMA Model					ARCH Test Results	
Series	**AR(1)**	**MA(1)**	**Log(L)**	**AIC**	**Q(14)**	**ARCH(10)**	**ARCH(20)**
RERR_B (ARMA(0,1)	-	-0.4834*** (0.0635) [0.0000]	411.52	-4.024	13.724** [0.0436]	2.4057*** [0.0005]	1.3652*** [0.0070]
RERR_F (ARMA(1,0)	0.3017*** (0.0688) [0.0000]	-	399.87	-3.910	25.699** [0.0187]	3.8366*** [0.0001]	2.0614*** [0.0073]
RERR_G (ARMA(1,0)	0.3204*** (0.0685) [0.0000]	-	401.82	-3.929	26.487** [0.0187]	3.8184*** [0.0001]	2.0633*** [0.0072]

	Results for the Most Suitable ARMA Model					ARCH Test Results	
Series	**AR(1)**	**MA(1)**	**Log(L)**	**AIC**	**Q(14)**	**ARCH(10)**	**ARCH(20)**
RERR_I (ARMA(1,0)	0.3145*** (0.0687) [0.0000]	-	401.96	-3.930	25.012** [0.0230]	3.9626*** [0.0001]	2.1115*** [0.0057]
RERR_N (ARMA(0,1)	-	0.4997*** (0.0637) [0.0000]	410.05	-4.010	11.672** [0.0447]	2.9363*** [0.0019]	1.6012*** [0.0079]
RERR_P (ARMA(1,0)	0.3397*** (0.0683) [0.0000]		404.15	-3.952	26.482** [0.0146]	4.1258*** [0.0000]	2.1147*** [0.0056]
RERR_R (ARMA(1,0)	0.1896*** (0.0704) [0.0080]	-	379.10	-3.705	20.426** [0.0351]	1.7744*** [0.0044]	2.3994*** [0.0087]
RERR_S (ARMA(1,0)	0.3165*** (0.0688) [0.0000]	-	398.41	-3.895	25.143** [0.0221]	3.5810*** [0.0002]	1.9290*** [0.0036]

RERR_B represents the real exchange rate returns for Belgium, RERR_F for France, RERR_G for Germany, RERR_I for Italy, RERR_N for the Netherlands, RERR_P for Poland, RERR_R for Romania and RERR_S for Spain. In the estimation of the ARMA model, the maximum likelihood estimation method was taken into account. .***, ** , * denote statistical significance at 1%, 5% and 10% significance levels, respectively, ( ) standard errors, [ ] p probability values, Log(L) maximum likelihood value, and AIC Akaike information criterion. In addition, Lijung Box Q(14) represents the autocorrelation in the 14^{th} lag, ARCH(10) and ARCH(20) represent the varying variance values in the 10^{th} and 20^{th} lags.

Table 3 shows the most suitable ARMA models and ARCH test results determined according to AIC and LL values. Ljung Box Q test results in Table 1 show the presence of autocorrelation in the residuals of the ARMA model obtained for all the series. ARCH test results, on the other hand, indicate that there is a varying variance effect in the residuals of the models. After the most suitable ARMA models, the most suitable volatility models for the series were investigated under different distributions. The findings obtained from the most suitable models according to AIC information criteria, Log(L) values and Pearson goodness-of-fit statistics are presented in Table 4.

Table 4. Suitable Model Estimation Results for the Series of Real Exchange Rate Volatility of Countries

	Belgium GARCH (1,1)	Netherlands GARCH (1,1)	France GARCH (1,1)	Spain GARCH (1,1)
Mean Equation	$RERR_t = \mu + \theta_1 RERR_{t-1} + \varepsilon_t$		$RERR_t = \mu + \phi_1 RERR_{t-1} + \varepsilon_t$	
μ	0.001820 (0.0030201) [0.5474]	0.000977 (0.0030228) [0.7469]	0.002168 (0.0031830) [0.4966]	0.002738 0.0031291) [0.3827]
ϕ_1	-	-	0.266282*** (0.076479) [0.0006]	0.271628*** (0.076217) [0.0005]
θ_1	0.372692*** (0.085238) [0.0000]	0.397197*** (0.085022) [0.0000]	-	-
Variance Equation	$\sigma_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2$			
ω	5.133636*** (1.8362) [0.0057]	5.115773*** (1.7419) [0.0037]	5.401356*** (1.7091) [0.0018]	5.291931*** (1.8254) [0.0042]
α_1	0.188221** (0.11139) [0.0427]	0.187248** (0.11163) [0.0451]	0.157128** (0.088267) [0.0366]	0.163488** (0.084962) [0.0458]
β_1	0.321695** (0.18262) [0.0397]	0.322864** (0.16325) [0.0494]	0.371689*** (0.13532) [0.0066]	0.381036** (0.15125) [0.0126]
γ_1	-	-	-	-
S_T	-	-	-	-
SS_T	5.244027*** (1.6731) [0.0020]	-	-	-
ln(k)	0.054400 (0.091439) [0.5526]	-	-	-
v	-	1.386268*** (0.20736) [0.0000]	-	-
Log(L)	422.291	417.718	405.491	404.551

	Belgium GARCH (1,1)	Netherlands GARCH (1,1)	France GARCH (1,1)	Spain GARCH (1,1)
AIC	-4.091534	-4.056336	-3.945725	-3.936463
SIC	-3.977285	-3.958409	-3.864119	-3.854857
Q(50)	51.2433 [0.3857]	48.6893 [0.4856]	69.7303 [0.2273]	61.6502 [0.1060]
Q^2(50)	32.9010 [0.9526]	36.6397 [0.8842]	33.1974 [0.9486]	33.0636 [0.9504]
ARCH(10)	0.60190 [0.8110]	0.88858 [0.5450]	0.96877 [0.4723]	0.80299 [0.6260]
ARCH(20)	0.60853 [0.9024]	0.74314 [0.7766]	0.68730 [0.8347]	0.56293 [0.9328]
ARCH(50)	0.56378 [0.9868]	0.67002 [0.9409]	0.59704 [0.9774]	0.59071 [0.9795]
Pearson (40)	39.5616	38.7734	47.0493	43.1084
Pearson (50)	48.4778	41.0887	53.8966	60.7931
Pearson (60)	65.0788	55.6207	63.3054	69.2167

*, **, *** represent statistical significance at 10%, 5%, and 1% significance levels, respectively. ( ) denotes standard errors and [ ] p denotes probability values, Log(L) denotes the maximum likelihood value, AIC and SIC denote the Akaike and Schwarz information criteria, respectively, μ denotes the constant of the mean equation, ω denotes the constant of the variance variable, and denote the AR (1) and MA(1) parameters, β_1, $\alpha 1$and γ_1 denote the ARCH, GARCH and leverage (GJR) parameters respectively for the (1,1) volatility model, GED denotes the generalized error term, S_T and SS_T denote the student t and skewed student t distributions, ln(k) denotes the asymmetry parameter for the skewed student t distribution, v GED denotes DF statistics of the distribution, Pearson (40), Pearson (50) and Pearson (60) values denote the Pearson Goodness-of-Fit test statistics in different cells.

When the findings of the GARCH(1,1) models estimated for Belgium, France, Italy, the Netherlands, Poland and Spain are examined, it is seen that all the other parameters related to the mean and conditional volatility equation, except for the constant term of the mean equation and the asymmetry parameter of the model estimated for Belgium, are statistically significant at the 5% significance level in general. When the findings of the Ljung Box Q and Q2 and ARCH test are examined, it is seen that the problems of autocorrelation and varying variance in the error terms of the models are resolved. The fact that the coefficients of the ARCH and GARCH models for the models are positive and that the parameter sums are smaller than 1 but not close to 1 mean that the stationarity condition of the GARCH models is met and that the instantaneous shock effect and the permanence degree of the shock are low. The low values of the Pearson goodness-of-fit test statistics estimated for the models in different cells indicate that the estimation performance of the models is high. The fact that the skewed student t parameter of the model estimated for Belgium is statistically significant at the 1% significance level and positive indicates that the series of real exchange rate returns exhibits positive asymmetry and thick-tailed characteristics. In addition, the fact that the GED coefficient is statistically significant at the 1% significance level and is less than 2 in the model estimated for the Netherlands indicates that the real exchange rate returns have a thick tail feature.

Table 4. Suitable Model Estimation Results for the Series of Real Exchange Rate Volatility of Countries

	Italy GARCH (1,1)	**Poland GARCH (1,1)**	**Germany GJR-GARCH (1,1)**	**Romania GJR-GARCH (1,1)**
Mean Equation	$RERR_t = \mu + \theta_1 RERR_{t-1} + \varepsilon_t$		$RERR_t = \mu + \phi_1 RERR_{t-1} + \varepsilon_t$	
μ	0.002038 (0.0032446) [0.5307]	0.002869 (0.0033051) [0.3863]	0.004949 (0.0031233) [0.1147]	0.005939 (0.0056001) [0.2902]
ϕ_1	0.281672*** (0.075439) [0.0022]	0.302064*** (0.076937) [0.0001]	0.266692*** (0.080592) [0.0011]	0.212297** (0.096934) [0.0297]
θ_1	-	-	-	-
Variance Equation	$\sigma_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2$		$\sigma_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 + \gamma_1 \varepsilon_{t-1}^2 (\varepsilon_{t-1} < 0)$	
ω	5.168865*** (1.6462) [0.0019]	4.983349*** (1.6054) [0.0022]	2.195167 (1.3788) [0.1130]	0.315507** (0.15105) [0.0380]
α_1	0.172938** (0.094720) [0.0494]	0.168630** (0.092712) [0.0304]	0.290151** (0.17871) [0.0342]	0.100075*** (0.026400) [0.0002]
β_1	0.369006*** (0.12871) [0.0046]	0.377833*** (0.13596) [0.0060]	0.707571*** (0.18205) [0.0001]	0.895933*** (0.039093) [0.0000]
γ_1	-	-	-0.369368** (0.17093) [0.0319]	-0.235673*** (0.064825) [0.0004]
S_T	-	-	-	8.963128** (4.3136) [0.0390]

	Italy GARCH (1,1)	Poland GARCH (1,1)	Germany GJR-GARCH (1,1)	Romania GJR-GARCH (1,1)
SS_T	-	-	5.248573*** (0.583689) [0.0000]	-
ln(k)	-	-	0.134768 (0.11700) [0.2508]	-
v	-	-	-	-
Log(L)	408.198	410.761	420.287	399.817
AIC	-3.972397	-3.997642	-4.061939	-3.870118
SIC	-3.890791	-3.916036	-3.931369	-3.755869
Q(50)	60.4670 [0.1261]	57.9323 [0.1790]	62.3346 [0.1638]	38.8818 [0.8493]
$Q^2(50)$	33.7807 [0.9401]	31.9475 [0.9638]	25.8382 [0.9963]	15.4678 [0.9999]
ARCH(10)	0.96138 [0.4788]	0.99966 [0.4455]	0.39792 [0.9463]	0.16784 [0.9981]
ARCH(20)	0.70822 [0.8138]	0.68320 [0.8387]	0.43437 [0.9837]	0.42078 [0.9866]
ARCH(50)	0.62168 [0.9678]	0.53459 0.9922]	0.50068 [0.9961]	0.75889 [0.8592]
Pearson (40)	48.2315	47.0493	49.0197	36.4089
Pearson (50)	54.8818	61.2857	47.9852	47.9852
Pearson (60)	82.8128	74.5369	60.9409	68.6256

*, **, *** represent statistical significance at 10%, 5%, and 1% significance levels, respectively. ( ) denotes standard errors and [ ] p denotes probability values, Log(L) denotes the maximum likelihood value, AIC and SIC denote Akaike and Schwarz information criteria, respectively, μ denotes the constant of the mean equation, ω denotes the constant of the variance equation,and denote the AR (1) and MA(1) parameters, β_1, α1and γ_1 denote the ARCH, GARCH and leverage (GJR) parameters respectively for the (1,1) volatility model, GED denotes the generalized error term, S_T and SS_T denote the student t and skewed student t distributions, ln(k) denotes the asymmetry parameter for the skewed student t distribution, v GED denotes DF statistics of the distribution, Pearson (40), Pearson (50) and Pearson (60) values denote the Pearson Goodness-of-Fit test statistics in different cells.

When the findings of the GJR-GARCH(1,1) models estimated for Germany and Romania are examined, it is seen that all the other parameters related to the mean and conditional volatility equation, except for the constant term of the mean equation and the asymmetry parameter of the model estimated for Germany, are statistically significant at the 5% significance level in general. When the findings of the Ljung Box Q and Q2 and ARCH test are examined, it is seen that the problems of autocorrelation and varying variance in the error terms of the models are resolved. The fact that the coefficients of ARCH and GARCH models are positive and that the parameter sums are smaller than 1, but very close to 1, indicates that the stability conditions of the model are met but that the volatility persistence is high and that past shocks have an effect on the volatility in the current period. The low values of the Pearson goodness-of-fit test statistics in different cells mean that the estimation performance of the models is high. The fact that the skewed student's t parameter of the model estimated for Germany is statistically significant and positive at the 1% significance level indicates that the real exchange rate returns exhibit positive asymmetry and thick-tailed characteristics. The fact that the student t parameter of the model estimated for Romania is statistically significant at the 5% significance level and positive indicates that the real exchange rate returns have a thick tail feature. Finally, the fact that the GJR parameter of both models is statistically significant at the 5% significance level and negative means that there is a leverage effect in the series of real exchange rate returns and negative news and developments affect real exchange rate volatility more than positive news and developments. After the real exchange rate volatility series was created, the linearity structures of all the series used in the analysis were tested with the BDS test developed by Brock et al. (1996), and the findings are reported in Table 5.

Table 5. BDS Linearity Test Results

	BDS Statistics	**Standard Error**	**Probability Values**
BTB	0.182177***	0.007964	0.0000
FTB	0.133823***	0.007852	0.0000
GTB	0.051052***	0.009392	0.0000
ITB	0.111822***	0.009524	0.0000
NTB	0.171213***	0.009450	0.0000
PTB	0.194264***	0.007817	0.0000
RTB	0.246417***	0.006404	0.0000
STB	0.279972***	0.007008	0.0000
lnBIPI	0.411679***	0.011517	0.0000
lnFIPI	0.458831***	0.010983	0.0000
lnGIPI	0.443542***	0.011809	0.0000

	BDS Statistics	Standard Error	Probability Values
lnIIPI	0.499393***	0.012231	0.0000
lnNIPI	0.178623***	0.010600	0.0000
lnPIPI	0.538504***	0.005431	0.0000
lnRIPI	0.489657***	0.005450	0.0000
lnSIPI	0.510518***	0.012817	0.0000
lnTIPI	0.534112***	0.005360	0.0000
RERV_B	0.102651***	0.018223	0.0000
RERV_F	0.035098***	0.009129	0.0001
RERV_G	0.236542***	0.016989	0.0000
RERV_I	0.035325***	0.009173	0.0001
RERV_N	0.102824***	0.018701	0.0000
RERV_P	0.035047***	0.009129	0.0001
RERV_R	0.361005***	0.010663	0.0000
RERV_S	0.152451***	0.018557	0.0000

*** denotes significance at 1% significance level. Since BDS test results were statistically significant at 1% significance level in all the dimensions, only the 6th dimension values were reported. In the table, RERV_B represents the real exchange rate volatility series for Belgium, RERV_F for France, RERV_G for Germany, RERV_I for Italy, RERV_N for the Netherlands, RERV_P for Poland, RERV_R for Romania and RERV_S for Spain. lnBIPI represents the natural logarithmic industrial production index series for Belgium, lnFIPI for France, lnGIPI for Germany, lnIIPI for Italy, lnNIPI for Netherlands, lnPIPI for Poland, lnRIPI for Romania, lnSIPI for Spain and lnTIPI for Turkey. In addition, BTB, FTB, GTB, ITB, NTB, PTB, RTB and STB refer to the bilateral trade (balance of trade) series of Turkey with Belgium, France, Germany, Italy, Netherlands, Poland, Romania and Spain, respectively.

When Table 5 was examined, the null hypothesis constructed on the idea that there is a linear structure as the probability values are less than 1% significance level for all the dimensions was refuted and it was determined that all the series have a nonlinear structure. Therefore, the stationarity of the series was tested with the nonlinear Kruse unit root test. In this test, the alternative hypothesis that reflects the global stationary ESTAR process is tested against the null hypothesis, which states that the series contains a unit root depending on the ESTAR process. The findings obtained from raw, mean-free, and trend-free data tests are given in Table 6.

Table 6. Kruse Unit Root Test Results

	Raw Data	Mean-Free Data	Trend-Free Data
BTB	22.4156*** (1)	24.1435*** (1)	20.9590*** (1)
FTB	17.7909*** (1)	9.1848* (1)	10.1418 (1)
GTB	22.5898***(2)	12.3714**(3)	12.9620**(3)
ITB	34.3258*** (1)	25.5565*** (1)	19.7294*** (1)
NTB	11.7549**(2)	9.5752*(1)	11.6941**(1)
PTB	15.5529*** (1)	12.0561** (1)	15.5022** (1)
RTB	15.0516*** (1)	15.7600*** (1)	14.4466** (1)
STB	9.0685* (1)	10.7284** (1)	11.3797** (1)
lnBIPI	3.6215(1)	3.2672(1)	14.6039**(1)
lnFIPI	11.8973**(1)	78.7610***(1)	95.3309***(1)
lnGIPI	9.7985**(1)	52.5603*** (1)	61.0007*** (1)
lnIIPI	5.6633(0)	210.3901***(1)	160.1381***(1)
lnNIPI	26.1232***(0)	34.9020***(0)	36.1295***(0)
lnPIPI	5.1067(0)	2.1823 (0)	23.7151*** (1)
lnRIPI	4.9744(0)	4.0793(0)	23.6179***(0)
lnSIPI	3.7696(1)	98.4613*** (1)	124.4339***(1)
lnTIPI	3.1730(0)	0.7268(0)	40.8331***(1)
RERV_B	19.3882***1)	19.4566***(1)	19.3907***(1)
RERV_F	17.5815***(1)	17.2599***(1)	17.1207***(1)
RERV_G	37.4563*** (1)	38.8808*** (1)	37.7859***(1)
RERV_I	17.7661***(1)	18.0440***(1)	17.8717***(1)
RERV_N	20.5768***(1)	21.0500***(1)	21.1585***(1)
RERV_P	17.3351***(1)	17.6126***(1)	17.4660***(1)
RERV_R	55.5701***(1)	53.9157***(1)	46.8893***(1)
RERV_S	17.8257***(1)	17.1443***(1)	16.9644***(1)

RERV_B represents the real exchange rate volatility series for Belgium, RERV_F for France, RERV_G for Germany, RERV_I for Italy, RERV_N for the Netherlands, RERV_P for Poland, RERV_R for Romania and RERV_S for Spain. lnBIPI represents the natural logarithmic industrial production index series for Belgium, lnFIPI for France, lnGIPI for Germany, lnIIPI for Italy, lnNIPI for the Netherlands, lnPIPI for Poland, lnRIPI for Romania, lnSIPI for Spain and lnTIPI for Turkey. In addition, BTB, FTB, GTB, ITB, NTB, PTB, RTB and STB refer to the bilateral trade (balance of trade) series of Turkey with Belgium, France, Germany, Italy, Netherlands, Poland, Romania and Spain, respectively. ***, ** and * indicate significance at 1%, 5%, and 10% significance levels, respectively. Critical values at 1%, 5%, and 10% significance levels are 13.15, 9.53, and 7.85 for raw data, 13.75, 10.17, and 8.60 for mean-free data, and 17.10, 12.82 and 11.10 for trend-free data, respectively. Values in parentheses are appropriate lag lengths.

When Table 6 is examined, it is seen that the null hypothesis of the existence of a unit root for all the series cannot be accepted at the 5% significance level. In other words, all series are stationary at this level. After the determination of stationarity, the effect of real exchange rate volatility on Turkey's bilateral trade with its trading partners was analyzed with Markov regime switching regression models, and the findings are reported in Table 7a and 7b.

Table 7a. Markov Regime Switching Model Estimation Results (Belgium, France, Germany, Italy)

Model Parameters	BEL-TUR (Dependent Variable -BTB)	FRA-TUR (Dependent Variable -FTB)	GER-TUR (Dependent Variable -GTB)	ITA-TUR (Dependent Variable -ITB)
C(1)	7.01867*** (1.706) [0.0000]	-0.855363 (1.073) [0.4260]	0.680766 (0.9612) [0.4800]	3.31313*** (1.144) [0.0040]
C(2)	4.72679*** (1.659) [0.0005]	7.32898*** (2.195) [0.0010]	2.78849 (3.991) [0.4860]	10.5071*** (4.494) [0.0020]
RERV(1)	-119.061*** (34.97) [0.0001]	-36.6198 (23.27) [0.1170]	-64.4968*** (17.38) [0.0000]	-69.8081** (32.93) [0.0350]
RERV(2)	-32.8366 (82.30) [0.6900]	13.9641 (75.73) [0.8540]	-56.6774 (51.29) [0.2710]	-331.102** (127.6) [0.0100]

Model Parameters	BEL-TUR (Dependent Variable -BTB)	FRA-TUR (Dependent Variable -FTB)	GER-TUR (Dependent Variable -GTB)	ITA-TUR (Dependent Variable -ITB)
lnBIPI(1)	-1.22005** (0.5343) [0.0240]	-	-	-
lnBIPI(2)	0.342447 (0.6611) [0.6050]	-	-	-
lnFIPI(1)	-	1.00167*** (0.2262) [0.0000]	-	-
lnFIPI(2)	-	-0.527638 (0.3987) [0.1870]	-	-
lnGIPI(1)	-	-	0.614589** (0.2456) [0.0130]	-
lnGIPI(2)	-	-	0.228059 (0.6931) [0.7420]	-
lnIIPI(1)	-	-	-	-0.145564 (0.1982) [0.4640]
lnIIPI(2)	-	-	-	-1.00990 (0.7501) [0.1800]
lnTIPI(1)	-0.0114390 (0.1905) [0.9520]	-0.559914*** (0.05691) [0.0000]	-0.438165*** (0.06669) [0.0000]	-0.288322** (0.08264) [0.0010]
lnTIPI(2)	-0.992177*** (0.3449) [0.0040]	-0.736355*** (0.1118) [0.0000]	-0.449249* (0.2672) [0.0940]	-0.789398** (0.3235) [0.0160]
Sigma(1)	0.184006*** (0.01324) [0.0000]	0.114957*** (0.01129) [0.0000]	0.147490*** (0.01027) [0.0000]	0.182878*** (0.01643) [0.0000]
Sigma(2)	0.233851*** (0.01758) [0.0000]	0.198105*** (0.01216) [0.0000]	0.203532*** (0.01926) [0.0000]	0.316525*** (0.02326) [0.0000]

Model Parameters	BEL-TUR (Dependent Variable -BTB)	FRA-TUR (Dependent Variable -FTB)	GER-TUR (Dependent Variable -GTB)	ITA-TUR (Dependent Variable -ITB)
LR χ^2 Test	61.290*** [0.0000]	75.737*** [0.0000]	51.371*** [0.0000]	101.68*** [0.0000]
Davies Test Prob. Val.	0.0000***	0.0000***	0.0000***	0.0000***
Autocorrelation χ^2 Test Statistics	16.130 [0.3055]	11.016 [0.6848]	46.771*** [0.0000]	27.100** [0.0187]
Normality Test χ^2 Statistics	0.50376 [0.7773]	16.348*** [0.0003]	0.56476 [0.7540]	8.5137** [0.0142]
ARCH Test F Statistics	0.79841 [0.8068]	0.32120 [1.0000]	1.3304 [0.1189]	0.72691 [0.8908]

***, ** and * represent significance at 1%, 5% and 10% significance levels, respectively. BEL represents Belgium, FRA France, GER Germany, ITA, Italy, NLD Netherlands, POL Poland, ROU Romania, ESP Spain and TUR Turkey. ( ) denotes standard errors and [ ] p denotes probability values, LR χ^2 test statistics denote the linearity structures of models, and F statistics for ARCH test denote the values at the 50th lag. RERV denotes the volatility in the exchange rate, lnBIPI represents the natural logarithmic industrial production index series for Belgium, lnFIPI for France, lnGIPI for Germany, lnIIPI for Italy, lnNIPI for the Netherlands, lnPIPI for Poland, lnRIPI for Romania, lnSIPI for Spain and lnTIPI for Turkey. In addition, BTB, FTB, GTB, ITB, NTB, PTB, RTB and STB are Turkey's bilateral trade (balance of trade) series with Belgium, France, Germany, Italy, Netherlands, Poland, Romania and Spain, respectively.

When Table 7a is examined, it is seen that the sigma values obtained for both regimes in all the models and the LR test statistics are significant at 1% significance level, which shows that the models are not linear and that the model findings are correct and consistent. When the normality statistics and ARCH test results are considered, it can be said that the model residuals are normally distributed, and the problem of varying variance in the model residuals is resolved. In Table 7a, regime 1 represents the low volatility regime (bull market-expansion period of the economy), and regime 2 represents the high volatility regime (bear market-contraction period of the economy). When the findings are evaluated, it is seen that according to the model established for BEL-TUR and GER-TUR, the effect of real exchange rate volatility on bilateral trade between Turkey, Belgium, and Germany in regime 1 is statistically significant at the 1% significance level and negative. In other words, an increase in real exchange rate volatility reduces bilateral trade between Turkey, Belgium and Germany during periods of economic expansion. However, Table 7a shows that the negative correlation between Turkey and Belgium and between Turkey and Germany is not statistically significant during periods of economic contraction (according to regime 2). When the model findings for POL-TUR are examined, it is seen that the effect of real exchange rate volatility on bilateral trade between Turkey and Poland according to regime 2 is statistically significant at the 5% significance level and negative. In other words, an increase in real exchange rate volatility reduces bilateral trade between Turkey and Poland during periods of economic contraction. However, it can be said, according to Table 7b, that the negative correlation in the expansion periods of the economy is not statistically significant. According to the model findings for ITA-TUR, the correlation between the series is statistically significant at the 5% significance level and negative in both regimes. In other words, an increase in real exchange rate volatility in both expansion and contraction periods of the economy reduces the bilateral trade between Turkey and Italy.

Similarly, according to the model findings obtained for ROU-TUR, the correlation between the series is statistically significant at the 10% level and negative in both regimes. In other words, an increase in real exchange rate volatility in both expansion and contraction periods of the economy adversely affects bilateral trade between Turkey and Italy. However, according to the findings obtained for FRA-TUR, NLD-TUR and ESP-TUR, the real exchange rate volatility effect on bilateral trade between Turkey and France, Turkey and the Netherlands, and Turkey and Spain is not statistically significant in both regimes.

Table 7b. Markov Regime Switching Model Estimation Results (Netherlands, Poland, Romania and Spain, respectively)

Model Parameters	NLD-TUR (Dependent Variable -NTB)	POL-TUR (Dependent Variable -PTB)	ROU-TUR (Dependent Variable -RTB)	ESP-TUR (Dependent Variable -STB)
C(1)	1.82051 (1.744) [0.2980]	3.79743*** 0.2899 [0.0000]	2.60056*** (0.4703) [0.0000]	8.14629*** (1.231) [0.0000]
C(2)	1.90271 (3.568) [0.5940]	6.77224*** (0.6556) [0.0000]	2.56278*** (0.6990) [0.0000]	20.1375*** (1.068) [0.0000]
RERV(1)	-23.2363 (24.11) [0.3360]	-31.8751 (26.41)[0.2290]	-40.0315* (21.60) [0.0650]	-41.6598 (33.49) [0.2150]
RERV(2)	35.3433 (110.2) [0.7490]	-318.120** (160.6) [0.0490]	-89.2399* (48.82) [0.0690]	-67.9115 (54.96) [0.2180]

lnNIPI(1)	0.149010 (0.3796) [0.6950]	-	-	-
lnNIPI(2)	0.518281 (0.7707) [0.5020]	-	-	-
lnPIPI(1)	-	-0.825249** (0.3396) [0.0160]	-	-
lnPIPI(2)	-	-0.679861 (1.213) [0.5760]	-	-
lnRIPI(1)	-	-	-0.0763165 (0.1932) [0.6930]	-
lnRIPI(2)	-	-	-1.05674** (0.4917) [0.0330]	-
lnSIPI(1)	-	-	-	-0.336946 (0.2217) [0.1300]
lnSIPI(2)	-	-	-	-2.64376*** (0.1720) [0.0000]
lnTIPI(1)	-0.347059*** (0.04511) [0.0000]	0.256866 (0.3508) [0.4650]	-0.282254** (0.1397) [0.0450]	-1.16878*** (0.09412) [0.0000]
lnTIPI(2)	-0.663835*** (0.1337) [0.0000]	-0.349242 (1.195) [0.7700]	0.789456* (0.4373) [0.0730]	-1.37715*** (0.08069) [0.0000]
Sigma(1)	0.135178*** (0.008804) [0.0000]	0.145471*** (0.01455) [0.0000]	0.133772*** (0.009362) [0.0000]	0.169201*** (0.01625) [0.0000]
Sigma(2)	0.183705*** (0.01503) [0.0000]	0.259722*** (0.01785) [0.0000]	0.193710*** (0.01453) [0.0000]	0.164218*** (0.01005) [0.0000]
LR χ^2 Test	102.92*** [0.0000]	110.81*** [0.0000]	122.81*** [0.0000]	115.13*** [0.0000]
Davies Test Prob. Val.	0.0000***	0.0000***	0.0000***	0.0000***
Autocorrelation χ^2 Test Statistics	36.173*** [0.0010]	36.671*** [0.0008]	19.500 [0.1467]	33.923** [0.0021]

Normality Test χ^2 Statistics	1.8755 [0.3915]	4.4960 [0.1056]	0.49257 [0.7817]	1.9879 [0.3701]
ARCH Test F Statistics	0.97889 [0.5244]	1.2224 [0.2019]	0.70505 [0.9112]	0.97980 [0.5229]

***, ** and * represent significance at 1%, 5% and 10% significance levels, respectively. BEL represents Belgium, FRA France, GER Germany, ITA, Italy, NLD Netherlands, POL Poland, ROU Romania, ESP Spain and TUR Turkey. ( ) denotes standard errors and [ ] p denotes probability values, LR χ^2 test statistics denote the linearity structures of models, and F statistics for ARCH test denote the values at the 50th lag. RERV denotes the volatility in the exchange rate, lnBIPI represents the natural logarithmic industrial production index series for Belgium, lnFIPI for France, lnGIPI for Germany, lnIIPI for Italy, lnNIPI for the Netherlands, lnPIPI for Poland, lnRIPI for Romania, lnSIPI for Spain and lnTIPI for Turkey. In addition, BTB, FTB, GTB, ITB, NTB, PTB, RTB and STB are Turkey's bilateral trade (balance of trade) series with Belgium, France, Germany, Italy, Netherlands, Poland, Romania and Spain, respectively.

According to other findings, the increase in Belgium's industrial production (income) reduces the bilateral trade between Turkey and Belgium during the expansion periods of the economy, while the increase in Turkey's industrial production decreases during the contraction periods of the economy. It was determined that while the industrial production of Germany and France affects the bilateral trade with Turkey positively during the expansion periods of the economy, an increase in Turkey's industrial production decreases the bilateral trade between Turkey and Germany and France in both regimes.

While the increase in Turkey's industrial production decreases the bilateral trade between Turkey and Italy and the Netherlands in both regimes, no significant findings could be obtained in both regimes regarding the effect of an increase in the industrial production of Italy and the Netherlands. In addition, while the increase in Poland's industrial production during the expansion periods of the economy negatively affected the bilateral trade between Turkey and Poland, no significant findings were obtained regarding the effect of Turkey's industrial production in both regimes. During the contraction periods of the economy, the increase in Romania's industrial production negatively affects bilateral trade between Turkey and Romania.

While the increase in Turkey's industrial production decreases the bilateral trade between Turkey and Romania during the expansion periods of the economy, it increases it during the contraction periods of the economy. Similarly, while the increase in Spain's industrial production during economic contraction periods reduces bilateral trade between Turkey and Spain, the increase in Turkey's industrial production has a reducing effect in both regimes.

Table 8. Transition Probability Matrices and Duration of Stay in the Regime

Models	Regimes	Markov Transition Probabilities		Mean Duration of Stay in the Regime	
		Regimes			
		Regime 1	Regime 2	Regime 1	Regime 2
BEL-TUR	Regime 1	0.96968	0.025717	35.00	32.67
	Regime 2	0.030324	0.97428		
FRA-TUR	Regime 1	0.90502	0.046437	11.33	27.00
	Regime 2	0.094977	0.95356		
GER-TUR	Regime 1	0.95452	0.075509	25.60	18.75
	Regime 2	0.045481	0.92449		
ITA-TUR	Regime 1	0.92179	0.080028	12.88	14.29
	Regime 2	0.078206	0.91997		
NLD-TUR	Regime 1	0.97171	0.043215	31.25	26.00
	Regime 2	0.028292	0.95678		
POL-TUR	Regime 1	0.93084	0.046564	13.50	24.40
	Regime 2	0.069160	0.95344		
ROU-TUR	Regime 1	0.98963	0.022550	55.00	46.50
	Regime 2	0.010366	0.97745		
ESP-TUR	Regime 1	0.95484	0.016073	28.50	48.67
	Regime 2	0.045155	0.98393		

BEL represents Belgium, FRA France, GER Germany, ITA Italy, NLD Netherlands, POL Poland, ROU Romania, ESP Spain and TUR Turkey.

When the findings on the transition probabilities matrices are examined, it is seen that the probability of the economy staying in the same regime when it is in regime 1 is 96.96%, and the probability of remaining in the same regime when it is in regime 2 is 97.42%, according to the BEL-TUR model. In addition, according to Table 8, it can be said that the probability of transition to regime 2 when the economy is in regime 1 is 2.57%, and the probability of transition to regime 1 when in regime 2 is 3.03%. According to the FRA-TUR model, it can be said that the probability of remaining in the same regime when the economy is in regime 1 is 90.50%, and the probability of remaining in the same regime when it is in regime 2 is 95.35%. In addition, Table 8 shows that the probability of the economy transitioning to regime 2 when in regime 1 is 4.64% and that the probability of transition to regime 1 when in regime 2 is 9.49%. According to the GER-TUR model, it is seen that the probability of remaining in the same regime when the economy is in regime 1 is 95.45%, and the probability of remaining in the same regime when it is in regime 2 is 92.44%. In addition, it can be said, according to Table 8, that the probability of the economy transitioning to regime 2 when in regime 1 is 7.55%, and the probability of transition to regime 1 when in regime 2 is 4.54%. According to the ITA-TUR model, it can be said that the probability of remaining in the same regime when the economy is in regime 1 is 92.17%, and the probability of remaining in the same regime when it is in regime 2 is 91.99%. In addition, Table 8 shows that when the economy is in regime 1, the probability of transition to regime 2 is 8.00%, while in regime 2, the probability of transition to regime 1 is 7.82%.

Similarly, according to the NLD-TUR model, it is seen that the probability of remaining in the same regime when the economy is in regime 1 is 97.17%, and the probability of remaining in the same regime when it is in regime 2 is 95.67%. In addition, according to Table 8, it can be said that the probability of transitioning to regime 2 when in regime 1 is 4.32% and that the probability of transitioning to regime 1 when in regime 2 is 2.82%. According to the POL-TUR model, it can be said that the probability of remaining in the same regime when the economy is in regime 1 is 93.08%, and the probability of remaining in the same regime when it is in regime 2 is 95.34%. In addition, according to Table 8, it can be said that the probability of transitioning to regime 2 when in regime 1 is 4.65% and that the probability of transitioning to regime 1 when in regime 2 is 6.91%. According to the ROU-TUR model, it is seen that the probability of remaining in the same regime when the economy is in regime 1 is 98.96%, and the probability of remaining in the same regime when it is in regime 2 is 97.74%. In addition, according to Table 8, it can be said that the probability of transitioning to regime 2 when in regime 1 is 2.25% and that the probability of transitioning to regime 1 when in regime 2 is 1.03%. Finally, according to the ESP-TUR model, it can be said that the probability of remaining in the same regime when the economy is in regime 1 is 95.48%, and the probability of remaining in the same regime when it is in regime 2 is 98.39%. In addition, according to Table 8, it can be said that the probability of transitioning to regime 2 when in regime 1 is 1.60% and that the probability of transitioning to regime 1 when in regime 2 is 4.51%.

When the duration of stay in the regime in Table 8 is examined, it is seen that the mean duration of stay in the first regime is 35 months, 11.33 months and 25.60 months, and the mean duration of stay in the second regime is 32.67 months, 27 months and 18.75 months respectively, according to the BEL-TUR, FRA-TUR and GER-TUR models. Similarly, according to the ITA-TUR, NLD-TUR, and POL-TUR models, the mean duration of stay in the first regime is 12.88, 31.25, and 13.50 months, and the mean duration of stay in the second regime is 14.29 months, 26 months, and 24.40 months, respectively. Finally, Table 8 shows that the mean duration of stay in the first regime is 55 months and 28.50 months, and the mean duration of stay in the second regime is 46.50 months and 48.67 months, respectively, according to the ROU-TUR and ESP-TUR models.

Conclusion and Evaluation

Since the end of the Bretton Woods system, the effects of floating exchange rates on international trade and the general economy have become an essential area of research. Especially in 1973, the transition of the international monetary system from fixed exchange rates to relatively more flexible ones created a debate on whether flexible rates would make the trade environment and financing uncertain and ultimately lead to a decline in international trade. The proponents of floating exchange rates have developed arguments and models that predict that flexible exchange rates will increase trade. As a matter of fact, empirical studies conducted in the past 48 years have supported both views. As a result, determining the sensitivity of trade between countries to real exchange rate volatility is of great importance for policymakers, especially in this period of global imbalances.

The current study aimed to investigate the asymmetric effect of real exchange rate volatility on bilateral trade between Turkey and 8 EU member countries for the period 2005:1-2021:12 under different economic cycles. In this connection, firstly, real exchange rate volatility series was created, and conditional variance series were obtained from the most suitable volatility models determined under different distributions (GARCH(1,1) for Belgium, Netherlands, France, Italy, Spain and Poland, GJR-GARCH(1,1) models for Germany and Romania). Then, the research hypothesis was tested with Markov regime switching regression models. The findings revealed that an increase in real exchange rate volatility reduces bilateral trade between Turkey and Belgium, and Germany during periods of economic expansion. However, it was determined that the negative effect is not statistically significant during the contraction periods of the economy. The findings for Germany in the current study differ from those obtained in the study of Yildirim and Saraç (2022). In the study of Yildirim and Saraç (2022), they found that the increase in real exchange rate volatility increases the bilateral trade between Turkey and Germany during the expansion periods of the economy. In the study, it was also determined that an increase in the real exchange rate volatility during the contraction periods of the economy decreases the bilateral trade between Turkey and Poland, while the negative correlation in the expansion periods of the economy is not statistically significant. It was also found that an increase in real exchange rate volatility reduces bilateral trade between Turkey, Italy, and Romania during both expansion and contraction periods of the economy. The findings show that the Turkish lira is the main determinant of the trade cycle in international trade, depreciation in Turkey's local currency due to the increase in the prices of trade goods between Turkey-Belgium, Turkey-Germany, Turkey-Poland, Turkey-Italy, and Turkey-Romania, means a decrease in trade volume. Finally, in the study, no significant findings were obtained regarding the effect of real exchange rate volatility on bilateral trade between Turkey and France, Turkey and the Netherlands, and Turkey and Spain in both economic periods.

Although according to Marshall-Lerner and J-curve hypotheses, an improvement in the trade balance is expected after the depreciation of the local currency, the economic, health, and energy crises, political, military, and political events and domestic factors in the sampling period upset the world balances. Particularly, the difficulty of accessing the inputs used in the production of high-value-added products, the increase in input and energy costs made the production, investment, import, and export processes difficult, narrowed the movement mechanism of countries, and had a negative impact on the economies of developing countries such as Turkey. The macroeconomic factor most affected by this process was the real exchange rate volatility. Therefore, since the volatility of the fundamentals may cause the volatility of the real exchange rate, policies should be developed to help reduce the underlying sources of volatile exchange rates, such as a stable monetary policy. In order to protect them from exchange rate risk, futures markets should be developed, and companies engaged in international trade should be encouraged to trade in futures markets. In this way, the effect of exchange rate volatility can be minimized through financial markets. In addition, in countries where dollarization and asymmetric information are dominant, the exchange rate does not reflect the value it should be and presents misleading information, reducing the public's trust in the economy. For this reason, the public should be made aware of the problem of dollarization and asymmetric information, and policies encouraging the use of Turkish Lira should be brought to the fore. In this way, social awareness can increase monetary value and monetary value can increase commercial welfare.

As a result, the study findings show that the effect of real exchange rate volatility depends on the domestic demand structure, inflation level, monetary stability, competitive advantage in industrial products, and the structural economic situation reflecting the dependence of exports on imports and that the J-curve effect and Marshall-Lerner condition are not valid in Turkey's trade with the relevant countries. In the study, the effect of real exchange rate volatility was investigated on the basis of the collective trade flow with 8 EU member states, which are among the first 20 countries that Turkey imports and exports the most. Therefore, in future research, it will be helpful to emphasize the importance of trade flows with the European Union or other country groups at the sector level to determine each sector's response to exchange rate volatility.

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