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Asymmetric Effects of Real Exchange Rate on Turkey's Imports: Threshold Value Regression Model

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ABSTRACT

Determinants of imports are one of the most discussed topics in the foreign trade literature. This study explores the asymmetric relationship between the real exchange rate and imports for Turkey example. The paper employs monthly data spanning from 2013:01 to 2023:06, estimating classical least square estimation and Threshold Regression Models, subsequently comparing their outcomes. The findings highlighted that the relations between imports and real exchange rate are asymmetric. According to the least square estimation model, it was noted that the real exchange rate had a negative impact on imports, aligning with anticipated outcomes. In the threshold regression model, it was seen that movements in the real exchange rate positively affected imports in the model below the threshold, while exerting a negative effect in the model above the threshold. This finding was interpreted as increasing imports by buying the expectation that the exchange rate increases, which are below the internalizable level, may increase further. It is considered essential for policymakers to take into account asymmetric relationships when analyzing the relationships between imports and the exchange rate.

Keywords
Turkey's Import, Asymmetric Effects of Real Exchange Rate, Threshold Value Regression Model

JEL Classification
E21, F14, F47

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Reel Döviz Kurunun Türkiye'nin İthalatı Üzerine Asimetrik Etkisi: Eşik Değer Regresyon Modeli

ÖZ

İthalatın belirleyicileri dış ticaret literatüründe en çok tartışılan konulardan biridir. Bu çalışma, Türkiye özelinde reel döviz kuru ile ithalat arasındaki asimetrik ilişkiyi araştırmaktadır. Makalede, 2013:01-2023:06 arası aylık verileri kullanılmış olup model klasik en küçük kareler yöntemi ve eşik değer regresyon modeli ile tahmin edildikten sonra sonuçlar karşılaştırılmıştır. Bulgular, ithalat ile reel döviz kuru arasındaki ilişkinin asimetrik olduğunu göstermektedir. En küçük kareler modeline göre, reel döviz kuru ithalatı olumsuz etkilemektedir. Eşik değer regresyon modeline göre ise reel döviz kurundaki hareketler, eşik altı modelde ithalatı pozitif yönde etkilerken, eşik üstü modelde negatif etkilemektedir. Sonuçlar, içselleştirilebilir seviyenin altında kalan reel döviz kuru artışlarının piyasada kurun daha da artabileceği beklentisi oluşturduğu ve bunun da ithalatın artmasına neden olduğunu göstermektedir. Bu nedenle de politika yapıcıların ithalat ile döviz kuru arasındaki ilişkileri analiz ederken asimetrik ilişkileri dikkate almaları önemli görülmektedir.

Anahtar Kelimeler
Türkiye İthalatı,
Reel Döviz Kurunun Asimetrik Etkisi,
Eşik Değer Regresyon Modeli

JEL Kodu
E21, F14, F47

1. Introduction

One of the most important items of macroeconomics, the current account balance sheet is one of the most critical problems of Turkish economy. Although the ratio of current account balance to gross domestic product in the period from 2000 to the present was positive in 2001 and 2019, it had negative values in all other years. The ratio of current account deficit to gross domestic product is lower than -5% in 12 of the 23-year period between 2000 and 2022. In particular, the current account balance gross domestic product ratio, which dropped to approximately as low as -9% in 2011, is an indication that the current account deficit problem has reached critical levels for the Turkish economy (Saraçoğlu et al. 2019).

The underlying reason behind the current account deficit of the Turkish economy is the foreign trade deficit. The fact that exports do not increase at the same level in the face of high import demand leads to the current account deficit problem. The Turkish economy has mostly had a foreign trade deficit during the 100-year period from the Republic to the present. The Turkish economy, which had a foreign trade deficit in the first years of the Republic, started to have a foreign trade surplus in 1930 with the support of industrialization moves (Akyıldız & Eroğlu,

2004). In the period from 1930 to 1946, except for 1938, there was a significant foreign trade surplus.

Adopting the liberal economic model after 1946, the Turkish economy started to have a foreign trade deficit and then had to impose import restrictions in the following years (Şenkardeşler, 2018). After 1960, the import substitution economic policy was implemented and the foreign trade deficit deepened (Bolat, 2020). In 1980, Türkiye took radical change decisions regarding economic policy. The import substitution policy was abandoned because of the foreign trade deficit, which became a significant problem due to the increase in imports, and an export-based growth model was adopted (Özsoylu, 2016). However, high import demand couldn't be prevented by means of this policy.

Signing the European Union Customs Union Agreement in 1996 became one of the most important turning points for Turkey's foreign trade. Although the Customs Union Agreement could not make the expected contribution to exports, it increased import demand rapidly. This situation negatively affected the foreign trade balance and therefore the current account balance. The Turkish economy, which entered a recovery trend after 2000, made significant strides in growth and exports. However, the increase in imports in the same period led the foreign trade deficit problem being unresolved. Import demand, which crashed sharply in 2009, the crisis period, followed a fluctuating course in the post-crisis period, but increased sharply in some years. Especially in 2022, imports, which were approximately 260 billion USD in the previous year, have increased significantly, exceeding the level of 342 billion USD.

Devaluation policies have been implemented at various times in Turkey in order to increase exports and reduce imports. The Turkish Lira was devalued in 1946, 1958, 1970, 1980, 1995 and 2000. Although devaluations were sometimes effective in reducing imports, it was observed that the exchange rate was mostly unable to prevent the increasing import demand. This issue shows that it is important to investigate the reaction of imports to exchange rate movements.

In this study, the relationship between Turkey's imports and the real exchange rate was investigated empirically with monthly data covering the period 2013:01 - 2023:06. Considering that the relationship between imports and real exchange rate may be asymmetrical, predictions were made with Threshold Regression Model (TRM). Thus, it was aimed to determine the heterogeneous responses of imports to the real exchange rate at different levels. While making

predictions, an import demand model was established and the effects of real exchange rate uncertainties were added to the model and taken under control.

The study is built on 5 chapters. In the second section, the literature review on the subject is summarized. In the third part; the data set, model and methodology are described. The fourth section includes empirical findings. In the fifth and final section, conclusions and recommendations are discussed.

2. Literature Review

Studies examining the effects of exchange rate and exchange rate volatility on foreign trade mostly focus on exports (Akpiliç & Yurdakul, 2022; Arize, 1995; Asteriou et al. 2016; Chowdhury, 1993; Doğanlar, 2002; Köse et al. 2008; Nazlıoglu, 2013; Saatcioğlu & Karaca, 2004; Solakoğlu, 2010; Thursby & Thursby, 1987; Vergil, 2002). It is possible to come across many studies in the literature that analyze the relationships between exchange rates and exchange rate uncertainties and imports. Kenen & Rodrik (1986) examined the relationship between imports of 11 developed countries and real exchange rate uncertainties with the help of monthly data covering the period 1973-1984. The findings of the analysis indicate that the increasing exchange rate risk negatively affects imports.

Koray & Lastrapes (1989) analyzed the relationship between US imports from 4 developed countries and real exchange rate uncertainties with monthly data for the period 1959-1985. The analysis results show that there is a negative, albeit weak, relationship between real exchange rate uncertainties and imports, and this effect increases as we move from fixed exchange rate to flexible exchange rate. Mzkeinze & Brooks (1997) analyzed the responses of bilateral trade between Germany and the USA to exchange rate changes for the period 1973:02 and 1992:09. The analyzes show that the nominal exchange rate and exchange rate uncertainties respectively affect trade in both directions negatively and positively. The authors point out that estimating exchange rate uncertainties from nominal or real rates does not affect the results.

Arize & Shwiff (1998) empirically investigated the effects of exchange rate fluctuations on the import volume of G-7 countries in the long term. In this study, using monthly frequency data for the period 1973:02 and 1995:01, it was concluded that Canada's imports were positively affected by real exchange rate uncertainties, while the imports of the other 6 countries included in the study were negatively affected. Picard (2003) empirically analyzed the relationship between

steel trade and exchange rate volatility between the USA, Mexico and Canada for the period 1996-2002. The analyses have shown that the impact of exchange rate volatility on trade flows is relatively small.

Yamak & Korkmaz (2005) examined the effects of the real exchange rate on the foreign trade balance in the case of Turkey. The data set is quarterly time series data covering the period 1995:1-2004:4. In this study, where no cointegration relationship could be determined between the variables, it was stated that the relationship between the real exchange rate and the foreign trade balance in the short term was shaped by capital goods trade. The authors stated that there is a vicious circle situation for the Turkish economy. Namely, they stated that the depreciation in TL would have positive effects on reducing the capital goods foreign trade deficit, but economic growth would be negatively affected in this scenario. Karagöz & Doğan (2005), who analyzed the relationship between exchange rate and foreign trade with monthly data covering the period 1995:01-2004:06 for the Turkish case, could not detect a cointegration relationship between the variables. However, they underlined that the devaluation in 2001 affected foreign trade flows.

Erden & Sağlam (2009) investigated the effects of exchange rate uncertainties on Turkey's total imports, imports of investment goods and consumer goods. In the study, monthly data were included for the period 1989:01-2008:10 and long and short-term forecasts were made with the ARDL model. The results show that Turkey's total imports and investment goods imports react negatively to increasing exchange rate uncertainties. Co-integration relationship could not be reached in the import demand model established with imports of consumer goods. Aktaş (2010) analyzed the effects of real exchange rate changes on Turkey's foreign trade for the period 1989Ç1-2008Ç4. The findings indicate that the real exchange rate does not have a significant effect on the foreign trade balance. In other words, it has been stated that the real exchange rate is not an effective instrument in ensuring the foreign trade balance. Sarı (2010) analyzed the relationship between exchange rates and Turkey's imports with the help of monthly data covering the period 1982:05-2006:12. Analyzes have shown that the exchange rate and exchange rate volatilities negatively affect Turkey's imports.

Kızıldere et al. (2014) analyzed the effects of the real exchange rate on Turkey's foreign trade with the help of 1980-2010 period data. The findings obtained indicate that Turkey's foreign trade is not affected by exchange rate movements. In the study of Kılıç & Yıldırım (2015), the

effects of sectoral real exchange rate and sectoral real exchange rate volatility on Turkey's imports were empirically investigated with quarterly data covering the period 2015:Q_1 : 2012Q_2. In the study using 22 manufacturing sub-industry sectors, it was found that the increase in the value of TL negatively affects imports, but increasing exchange rate uncertainties do not affect imports.

Uslu (2018) analyzed the effects of the exchange rate on Turkey's foreign trade with monthly data covering the period 1989:01-2018:06. In the study where predictions were made using the FMOLS method, it was concluded that exchange rate increases negatively affected Turkey's imports both in the short and long term. Moreover, according to the Granger Causality Test results, there is a one-way causality relationship from exchange rate to imports. Saraçoğlu et al. (2019), examined Turkey's mutual foreign trade with Germany for 10 different sectors according to SITC Rev. 3. In the study using monthly data for the period 2002-2015, it was found that real exchange rate and real exchange rate uncertainties were effective for Turkey's trade with Germany in sectors with high volume. Köse & Aslan (2020) estimated the effects of exchange rate and exchange rate uncertainty on Turkey's foreign trade with the help of monthly data from 2002:01 to 2017:12. According to the variance decomposition results of the study in which the structural VAR model was used, the real exchange rate was decisive on imports in the early periods. However, in the following periods, it was observed that the effect of real exchange rate on imports weakened and the effects of real exchange rate uncertainties were felt much more clearly. Acaravcı & Dağlı (2021), who studied the impact of exchange rate variability on Turkey's foreign trade using data from the 2002Q1:2020Q1 period, observed positive relationships between real exchange rate and imports and negative relationships between real exchange rate uncertainties and imports.

3.1. Model, Data Set and Methodology

3.1. Model

The study was based on the import demand model. Considering that uncertainties in the exchange rate may also affect imports, real exchange rate uncertainties estimated with moving average standard deviation were added to the model in order to control the uncertainties.

$$LR\dot{I}TH_t = \beta_0 + \beta_1 L\dot{I}G_t + \beta_2 LRDK_t + \beta_3 RVOL_t + \varepsilon_t \quad (1)$$

In equation number 1; $LR\dot{I}TH_t$ shows real imports with logarithmic transformation, $L\dot{I}G_t$ domestic income with logarithmic transformation, $LRDK_t$ real exchange rate with logarithmic

transformation, $RVOL_t$ real exchange rate uncertainties estimated with the moving average standard deviation method. and ε_t the error terms with white noise process.

Economic agents whose income increases with the rise in domestic income are expected to increase their demands and therefore their imports (Saraçoğlu et al. 2019; Köse & Aslan, 2020). The increase in the real exchange rate, that is, the depreciation of the local currency, makes imported goods more expensive and causes a decrease in import demand (Tapşın & Karabulut, 2013). Although there is no consensus in the literature on the effect of exchange rate uncertainty on trade flows, results have mostly been obtained indicating that exchange rate uncertainties negatively affect trade flows. In this respect, β_1 is expected to have a positive sign and β_2 and β_3 to have a negative sign.

3.2. Data Set

In this study, monthly Türkiye data between 2013:01 - 2023:06 were used. Real imports were obtained by dividing nominal import data by the import unit value index. Nominal import data were taken from the database of the Turkish Statistical Institute (TUIK) in Million US Dollars ($). Import unit value index was obtained from TUIK's database based on 2015=100. GDP is generally used in the literature for the income variable. Since GDP data are announced to the public quarterly, the industrial production index, which is announced to the public monthly, was used as a proxy for the income variable in this study. Turkey's 2015 = 100 based industrial production indexes was preferred for the domestic income variable. All data on income and import variables were taken as free from calendar and seasonal factors.

The real exchange rate series was obtained from EVDS, the Central Bank's database, based on 2003=100. Real exchange rate increases in the Central Bank's database indicate appreciations in the national currency. These series were added to the model by inverting and re-indexing with regard to multiplication. With this transformation, the increasing real exchange rate was enabled to express the depreciation of the domestic currency.

In the literature, exchange rate uncertainties are generally estimated with ARCH-GARCH models and moving average standard deviation methods. Arize (1995), Özbay (1999), Demirel and Erdem (2004), Türkyılmaz et al. (2007), Baum and Çağlayan (2009), Erden and Sağlam (2009), Sarı (2010), Hatırlı and Önder (2010), Sever (2012), Nazlioglu (2013), Çiftçi (2014), Çelik (2018), Dada (2021) and Dursun and Çelikkaya (2022) estimated the exchange rate uncertainty with

ARCH-GARCH approaches. On the other hand, Chowdhury (1993), Arize (1996), Doğanlar (2002), Vergil (2002), Kasman (2003), Buguk et al. (2003), Saatçioğlu and Karaca (2004), Kasman and Kasman (2005), Öztürk and Acaravcı (2006), Tarı and Yıldırım (2009), Öztürk and Kalyoncu (2009), Altıntaş et al. (2011), Esen (2012), Sarıoğlu (2013), Denaux and Falks (2013), Kılıç and Yıldırım (2015), Thuy and Thuy (2019), Tarasenko (2021) and Akpiliç and Yurdakul (2022) estimated exchange rate uncertainty with a moving average standard deviation. In this study, exchange rate uncertainties were estimated by the moving average standard deviation method applied to real exchange rate series. The equation in Equation (2) was used when estimating the moving average standard deviation approach.

$$V_t = \left[\left(\frac{1}{m}\right)\sum_{i=1}^{m}(LRDK_{t+i-1} - LRDK_{t+i-2})^2\right]^{0.5} \quad (2)$$

In Equation 2, *LRDK* is a logarithmically transformed real exchange rate series while *m* refers to the time dimension in which the moving average is taken, and it is taken as 12 since this study works with monthly data.

3.3. Methodology

Many methods and analyzes have been proposed in the economic literature to analyze nonlinear relationships. Granger & Andersen (1978)'s Bilinear Model, Hamilton (1989)'s Markov Transition Model and Tong (1978)'s Threshold Autoregression Model are a few of them. Tong (1978)'s Threshold Autoregression Model was preferred for this study. The basic idea underlying nonlinear models is that averages move nonlinearly with time (Tsay, 2010). Accordingly, nonlinearity is a result of breaks occurring in the averages of the series. In this context, regression models with threshold values have been developed to minimize deviations due to breaks. These models are nonlinear models developed in the studies of Tong (1978) and Tong (1983).

With TRM, nonlinearity is estimated piece by piece and dummy variables are defined for structural breaks. However, when determining the threshold value in TRM, the values of the explanatory variable whose effect is being investigated are taken as basis. Observations in the data set of the dummy variable take different values above and below a certain threshold value, and there is no systematic situation based on time that takes breaks into account.

The two basic concepts of TRM are threshold variable and threshold value. Threshold variable is one of the explanatory variables that adds the non-linear structure of the model to the

estimation process whereas the threshold value is the value of the threshold variable that is determined a priori or estimated later.

TRM is established with the division of the threshold variable by two by the threshold value. TRM defined by Tong (1978) is given in Equation (3) as a simple AR(1) process.

$$y_t = \begin{cases} \rho_{10} y_{t-1} + \varepsilon_{1t} & If\ y_{t-1} > \zeta \\ \rho_{20} y_{t-1} + \varepsilon_{2t} & If\ y_{t-1} < \zeta \end{cases} \quad (3)$$

In Equation (3), the threshold variable is y_{t-1} and the parameter ζ indicates the threshold value. Under the assumption var $(\varepsilon_{1t}) = var(\varepsilon_{2t})$, Equation (3) can be written as follows

$$I_t = \begin{cases} 1 & if\ y_{t-1} > \zeta \\ 0 & if\ y_{t-1} < \zeta \end{cases} \quad (4)$$

Under the knowledge of the piecewise function of Equation (4), with I_t as the threshold dummy, the model can be reduced to a single-equation model as in Equation (5).

$$y_t = \rho_{10} I_t y_{t-1} + \rho_{20}(1 - I_t) y_{t-1} \quad (5)$$

There are two different situations for the estimation of threshold regression models. The estimation process is shaped depending on whether the threshold value is known or not.

When the threshold value is known, the model is estimated with the Least Squares method (EKM). The point to be considered here is to shape the model using a dummy variable according to the threshold variable. Equation (6) shows the TRM to be estimated with OLS.

$$y_t = I_t\left[\beta_{10} + \sum_{i=1}^{p} \beta_{1i} y_{t-i}\right] + (1 - I_t)[\beta_{20} + \sum_{i=1}^{r} \beta_{2i} y_{t-i}] + \varepsilon_t \quad (6)$$

In practice, not knowing the threshold value is a more common situation. Chan (1993) suggested a solution to the issue (Enders, 2010: 446-447).

The process proposed by Chan (1993) is basically based on selecting the optimal model. This process consists of 3 stages.

Step 1: The threshold value of the threshold variable is between the largest and smallest values. Therefore, the threshold variable is arranged from smallest to largest. From the resulting new series, the smallest and largest 15% are discarded to create a series y^i with a total of T elements. Under these conditions, the smallest value of the series is y^i and the largest value is y^T.

Step 2: By taking the new derived series, the model is estimated T times as if each element were a threshold value, and T different threshold variables are obtained.

Step 3: The error sum of squares is calculated for each of the T estimated models. The threshold value in the model with the smallest square error is considered the optimal threshold value of the model.

4. Empirical Findings

In this section, first the stationarity of the variables included in the model was tested with unit root tests. Then, the import demand model was estimated and interpreted with OLS and TRM.

Structural breaks were also taken into account when performing unit root tests. According to the unit root test results summarized in Table 1, all variables are stationary at the 5% confidence level. The fact that the variables are stationary prevents the possible spurious regression problem.

Table 1

Unit Root Test Results with Structural Breaks

Variable		**Constant and Trend**	**Variable**		**Constant and Trend**
LRİTH	Test İst.	-4.90	ΔLRİTH	Test İst.	-14.38
	Tab.-d.(%5)	-4.85		Tab.-d.(%5)	-4.85
LİG	Test İst.	-10.38	ΔLİG	Test İst.	-14.36
	Tab.-d.(%5)	-4.85		Tab.-d.(%5)	-4.85
LRDK	Test İst.	-4.86	ΔRDK	Test İst.	-10.16
	Tab.-d.(%5)	-4.85		Tab.-d.(%5)	-4.85
RVOL	Test İst.	-8.23	RVOL	Test İst.	-15.67
	Tab.-d.(%5)	-4.85		Tab.-d.(%5)	-4.85

Notes. Trend specification was made with constant term and trend, break specification was made with only constant term, and structural break determination was made with Minimized Dickey Fuller T statistic. The maximum delay length was determined as 12 and the optimal delay length was determined by the Schwarz Criterion.

The estimation results made with OLS are shown in Table 2. According to Table 2, it can be seen that the model is significant. In order to prevent possible autocorrelation problems, one-period lagged values of real imports were also added to the model. The coefficient on the one-period lagged values of imports is statistically significant and positive. According to the results, increasing real domestic income increases import demand. A 1% increase in income increases imports by 0.5%. This result is consistent with expectations and the findings of similar studies in the literature (Acaravcı & Dağlı, 2021; Köse & Aslan, 2020). The coefficient on the real exchange

rate is negative and statistically significant. A 1% increase in the real exchange rate reduces imports by 0.12%. The negative relationship between exchange rate and imports is consistent with expectations and the findings of similar studies in the literature (Kılıç & Yıldırım, 2015). The coefficient on real exchange rate uncertainties is statistically insignificant. Although this finding is not consistent with expectations, there are studies in the literature that reach similar findings (Acaravcı & Dağlı, 2021; Aktaş, 2010; Bailey et al. 1986; Denaux & Falks, 2013).

The explanatory power of the model is quite high (90%). Ninety percent of the changes in the dependent variable are explained by changes in the independent variables. According to supplementary table 1 and supplementary table 3, the assumptions that the error terms of the model are not autocorrelated and that the squared variances of the errors are constant are met. According to supplementary figure 1, the errors are normally distributed. In summary, the import demand model established with OLS provides the necessary econometric assumptions.

Table 2

LCM Regression Results

Variable	**Coefficient**	**Standard Error**	**t Statistic**	**P Value**
Constant	1.10	0.63	1.74	0.09
LİG	0.51	0.08	6.16	0.00
LRDK	-0.12	0.04	2.73	0.01
RVOL	0.06	0.64	0.09	0.92
LRITH (-1)	0.67	0.05	12.99	0.00
R-squared	0.90	Dependent variable means	12.21	
Adjusted R-squared	0.90	Dependent variable standard deviation	0.16	
Standard Error of Regression	0.05	Akaike information criterion	-3.10	
Residual sum of squares	0.28	Schwarz criterion	-2.98	
Log likelihood	181.61	Hannan-Quinn criterion	-3.05	
F statistic	249.51	Durbin-Watson statistic	1.84	
Prob (F statistic)	0.00			

It is thought that the increase in the exchange rate, that is, the depreciation of the national currency, may affect imports in different ways after reaching a certain level, and that the relationship between these two variables may not be linear. Namely, it is a normal scenario that small exchange rate movements are not an important criterion, especially for large-scale commercial agreements. However, changes above a certain threshold value are expected to have

an impact on foreign trade volume by having an impact on commercial decisions. In this context, a threshold value regression model was established and compared with the results of the LCM model. In this respect, the import demand model was also estimated with TRM and reported in Table 3.

Table 3

TRM Regression Results

Variable	Coefficient	Standard error	t statistic	P value
LRDK < 4.24 -- 40 observation				
Constant	6.21	1.36	4.58	0.00
LIG	0.28	0.15	1.84	0.07
LRDK	0.44	0.14	-3.10	0.00
RVOL	1.10	0.96	1.15	0.25
LRITH (-1)	0.53	0.10	5.56	0.00
4.24 <= LRDK -- 74 observation				
Constant	1.06	0.94	1.13	0.26
LIG	0.63	0.09	7.20	0.00
LRDK	-0.26	0.05	5.10	0.00
RVOL	-0.47	0.75	-0.63	0.53
LRITH (-1)	0.57	0.08	7.28	0.00
R-squared	0.92	Dependent variable means	12.21	
Adjusted R-squared	0.92	Dependent variable standard deviation	0.16	
Standard error of regression	0.05	Akaike information criteria	-3.27	
Residual sum of squares	0.21	Schwarz criterion	-3.03	
Log likelihood	196.52	Hannan-Quinn criterion	-3.17	
F statistic	140.90	Durbin-Watson statistic	1.84	
Prob (F statistic)	0.00			

According to Table 3, the TRM model is statistically significant. In the model in which the logarithmic form of the real exchange rate is taken as the threshold variable, the threshold value is calculated as approximately 4.24. This means that the regression can be examined with two different models, one with 74 observations and one with 40 observations, depending on the cases where the real exchange rate is below or above 4.24. According to the below-threshold regression results, the income variable is statistically significant and positive. When the real exchange rate is below the threshold, a 1% increase in income increases imports by 0.28%. The coefficient of the real exchange rate is positive and statistically significant. In the below-threshold model, a 1%

increase in the real exchange rate increases imports by 0.44%. This finding is exactly opposite to expectations.

In the above-threshold model, increasing real income continues to have an increasing effect on real import volume, and a 1% income increase increases imports by 0.63%. The coefficient of the real exchange rate is negative and statistically significant. A 1% increase in the real exchange rate reduces real imports by 0.47%. As in the OLS model, the coefficients of the exchange rate uncertainty variable are statistically insignificant in both the below-threshold model and the above-threshold model. In other words, real exchange rate uncertainties do not affect real imports. Econometric assumptions are also provided in the TRM model (See Annex Table 2, Annex Table 4 and Annex Figure 2).

When the results of the OLS model and the TRM model are evaluated in general, the income variable is seen to be positive and statistically significant in both models. However, in the above-threshold model of TRM, the income elasticity of imports is higher than in the below-threshold model and the OLS model. It is plausible that the income levels of traders are more effective in the face of increasing import costs due to the increasing real exchange rate. This is because if the prices of imported products increase, companies and households will be able to take their income levels into account when deciding on import demands.

When analyzing the OLS and TRM models comparatively, the most striking difference is observed in the real exchange rate. The coefficient of real exchange rate uncertainty, which is positive and significant in the OLS model, consistent with expectations, is negative and significant in the below-threshold model, and positive and significant in the above-threshold model. This highlights the fact that asymmetric relations should be taken into consideration when analyzing the relations between exchange rate and imports. That the real exchange rate has a positive impact on import demand when it is below a certain value is explained by the fact that the importer increases his import demand by thinking that the exchange rate may increase further. That is to say, in cases where the exchange rate is below a certain threshold value, namely, an internalizable level, it is thought that the demand for imports is increased, considering the scenario that the increase in the exchange rate may continue. In the scenario where the exchange rate level rises above the threshold value, that is, the internalizable level, import demand decreases.

When the OLS and TRM models are compared, it has been seen that the TRM model was more successful. While the R square and Adjusted R square values of OLS are around 90%, the R square and Adjusted R square values of TRM are around 92%. While the Akaike information criterion, Schwarz criterion and Hannan-Quinn criterion values of OLS are -3.10, -2.98 and -3.05, respectively, the same values are -3.27, -3.03 and -3.17 in the TRM model. The residual sum of squares is 0.28 in the OLS model and 0.21 in the TRM model. In short, the TRM model is more successful than the OLS in terms of all criteria.

The results obtained emphasize the necessity of examining the changes in the exchange rate asymmetrically when analyzing the relationship between the exchange rate and imports. This study offers different perspectives to policy makers, considering the fact that imports react differently at different levels of the exchange rate. In addition, the income elasticity of imports varies at different exchange rate levels.

5. Conclusion

According to classical economic theory, imports are a decreasing function of the exchange rate. In other words, increases in exchange rates are expected to have a negative impact on imports. However, in studies investigating the effect of exchange rate on Turkey's imports, there are many studies that cannot reach meaningful relationships between the two variables. As a matter of fact, what motivates this study is such a situation.

The subject of this study is the effect of the exchange rate on Turkey's imports. The period between 2013:01 and 2023:06 was chosen and monthly frequency data were used. Threshold value regression model and OLS model were used as econometric methods. The purpose of using both models is to compare the results of the two models and to show the model that has high explanatory power and gives optimal results.

Econometric linear models have been mostly used in studies on the subject. In the research conducted, no studies were found, aiming to detect the asymmetric relationship between exchange rate and imports for the Turkish example. What is meant by an asymmetric relationship is that importers react differently depending on the relative magnitude of changes in the exchange rate.

In this context, while establishing the import demand function, real effective exchange rate, domestic income and real exchange rate uncertainty variables were included as independent

variables, inspired by similar studies in the literature. To avoid the potential autocorrelation problem, the first lag of imports, which is the dependent variable, was also incorporated into the model. Before proceeding with the analyses, the stationarity of the variables was tested. According to the structural break unit root test results, all variables were found to be stationary at level. For this reason, the analyzes were continued with the stationary states of the series.

First OLS and then TRM models were established within the scope of the study. According to the results, the domestic income variable has significant and positive effects on imports for all three models. The income elasticity of imports is higher than other models in the above-threshold model. This has been interpreted as meaning that when import costs are above the threshold value, income level becomes more important when deciding on import demand. The most interesting result of the study is the relationship between real exchange rate and imports. The exchange rate, which negatively affects imports consistent with expectations in the OLS model, is positive and significant in the below-threshold model, contrary to expectations. On the other hand, it is negative and significant in the above-threshold model, consistent with expectations. This finding suggests that exchange rate increases, which are below internalizable level, lead to increases in imports due to the expectation that exchanges rates may rise further. In other words, when the exchange rate increases to a certain value, traders can increase their import demands by bringing forward their import demands before the exchange rate level increases further. However, after the exchange rate level exceeds a certain threshold, traders can no longer internalize these cost increases and reduce their import demands. The coefficients of exchange rate uncertainties are statistically insignificant in both the OLS model and the TRM models.

The difference in the income and exchange rate elasticities of imports in the OLS and TRM models shows that the relationship between the real exchange rate and imports may be asymmetric. The fact that the TRM model has a higher explanatory power and lower deviation than the OLS supports this conclusion. OLS and TRM models provide econometric assumptions.

This study, which deals with the relationship between exchange rate and foreign trade, reveals the importance of asymmetric relations. However, it is thought that more empirical studies are needed to compare the findings. Accordingly, analyzes can be made with examples from different countries or on a sectoral basis.

References

Acaravcı, A., & Dağlı, Ö. (2021). Döviz kurundaki değişkenliğin Türkiye dış ticaretine etkisi. *Uluslararası Ekonomi ve Yenilik Dergisi, 7*(2), 213-232.

Akpiliç, F., & Yurdakul, F. (2022). Reel döviz kurunun Türkiye imalat sanayi ihracatı üzerine etkisi: Doğrusal olmayan panel ARDL yaklaşımı. *Maliye Dergisi, (182),* 1-29.

Aktaş, C. (2010). Türkiye'de reel döviz kuru ile ihracat ve ithalat arasındaki ilişkinin VAR tekniğiyle analizi. *Uluslararası Yönetim İktisat ve İşletme Dergisi, 6*(11), 123-140.

Akyıldız, H., & Eroğlu, Ö. (2004). Türkiye Cumhuriyeti dönemi uygulanan iktisat politikaları. *Süleyman Demirel Üniversitesi İİBF Dergisi, 9*(1), 43-62.

Altıntaş, H., Çetin, R., & Öz, B. (2011). The impact of exchange rate volatility on Turkish exports: 1993-2009. *South East European Journal of Economics and Business, 6*(2), 71-81.

Arize, A. C. (1995). The effects of exchange-rate volatility on US exports: An empirical investigation. *Southern Economic Journal, 62*, 34-43.

Arize, A. C. (1996). Real exchange-rate volatility and trade flows: The experience of eight European economies. *International Review of Economics and Finance, 5*, 187-205.

Arize, A. C., & Shwiff, S. S. (1998). Does exchange-rate volatility affect import flows in G-7 countries? Evidence from cointegration models. *Applied Economics, 30*(10), 1269-1276.

Asteriou, D., Masatcı, K., & Pilbeam, K. (2016). Exchange rate volatility and international trade: International evidence from the MINT countries. *Economic Modelling, 58*, 133-140.

Bailey, M. J., Tavlas, G. S., & Ulan, M. (1986). Exchange-rate variability and trade performance: Evidence for the big seven industrial countries. *Review of World Economics, 122*(3), 466-477.

Baum, C. F., & Çağlayan, M. (2009). The volatility of international trade flows and exchange rate uncertainty. *Boston College Department of Economics, Working Paper 695*.

Bolat, M. (2020). Sektör - ülke açısından ihracat çeşitlendirmesi ve ihracatı etkileyen faktörler: Türkiye üzerine bir uygulama (Yayımlanmamış Yüksek Lisans Tezi). Tarsus Üniversitesi Lisans Üstü Eğitim Enstitüsü.

Chan, K. S. (1993). Consistency and limiting distribution least square estimation of threshold autoregressive model. *The Annals of Statistics, 21*, 520-533.

Chowdhury, A. R. (1993). Does exchange rate volatility depress trade flows? Evidence from error-correction models. *The Review of Economics and Statistics, 75*, 700-706.

Çelik, R. (2018). The effect of exchange rate volatility on export: The case of Turkey (1995-2017). *Istanbul Journal of Economics, 181*, 181–220. https://doi.org/10.26650/istjecon404747

Çiftçi, N. (2014). Reel döviz kuru oynaklığının Türkiye'nin Avrupa Birliği'ne ihracatı üzerine etkisi: AR(1)-GARCH(1,1) ve ARDL tekniği ile analiz. *Sakarya İktisat Dergisi, 3*, 72-112.

Dada, J. T. (2021). Asymmetric effect of exchange rate volatility on trade in Sub-Saharan African countries. *Journal of Economic and Administrative Sciences, 37*(2), 149-162. https://doi.org/10.1108/jeas-09-2019-0101

Demirel, B., & Erdem, C. (2004). Döviz kurlarındaki dalgalanmaların ihracata etkileri Türkiye örneği. *İktisat İşletme ve Finans, 19*(223), 117-127.

Denaux, Z. S., & Falks, R. (2013). Exchange rate volatility and trade flows: The EU and Turkey. *Southwestern Economic Review, 40*, 113-121.

Doğanlar, M. (2002). Estimating the impact of exchange rate volatility on exports: Evidence from Asian countries. *Applied Economics Letters, 9*(13), 859-863.

Dursun, B., & Çelikkaya, S. (2022). Döviz kuru belirsizliğinin çelik sektörü ihracatı üzerine olan etkisi: Türkiye örneği. *Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 27*(1), 67-82.

Enders, W. (2010). *Applied econometric time series* (3rd ed.). John Wiley & Sons.

Erden, L., & Sağlam, G. (2009). Türkiye'de döviz kuru oynaklığının sektörel ithalata etkileri: Bir ARDL ithalat modeli analizi. *Hacettepe Üniversitesi İİBF Dergisi, 27*(2), 19-45.

Esen, Ö. (2012). Türkiye'de döviz kuru belirsizliğinin ihracat üzerine etkisi. *Finans Politik ve Ekonomik Yorumlar, 49*(568), 87-97.

Granger, C. W. J., & Andersen, A. (1978). On the inevitability of time series models. *North-Holland Publishing Company, 8*, 87-92.

Hamilton, J. D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica, 57*, 357-384.

Hatırlı, S. A., & Önder, K. (2010). Reel döviz kurundaki değişkenliğin Türkiye'nin tekstil ve konfeksiyon ihracatı üzerine etkisinin araştırılması. *Anadolu Üniversitesi Sosyal Bilimler Dergisi, 10*(2), 41-54.

Karagöz, M., & Doğan, Ç. (2005). Döviz kuru dış ticaret ilişkisi: Türkiye örneği. *Fırat Üniversitesi Sosyal Bilimler Dergisi, 15*(2), 219-228.

Kasman, A. (2003). Türkiye'de reel döviz kuru oynaklığı ve bunun ihracat üzerine etkisi: Sektörel bir analiz. *Uludağ Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 22*(2), 169-186.

Kasman, A., & Kasman, S. (2005). Exchange rate uncertainty in Turkey and its impact on export volume. *METU Studies in Development, 32*(1), 41-58.

Kenen, P. B., & Rodrik, D. (1986). Measuring and analyzing the effects of short-term volatility in real exchange rates. *The Review of Economics and Statistics, 68*, 311-315.

Kılıç, E., & Yıldırım, K. (2015). Sektörel reel döviz kuru oynaklığı ithalat hacmini etkiler mi? Türkiye üzerine bir uygulama. *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi, 43*, 192-199.

Kızıldere, C., Kabadayı, B., & Emsen, Ö. S. (2014). Dış ticaretin döviz kuru değişimlerine duyarlılığı: Türkiye üzerine bir inceleme. *Uluslararası İktisadi ve İdari İncelemeler Dergisi, (12)*, 39-54.

Köse, N., Ay, A., & Topallı, N. (2008). Döviz kuru oynaklığının ihracata etkisi Türkiye örneği (1995-2008). *Gazi Üniversitesi İİBF Dergisi, 10*(2), 25-45.

Köse, N., & Aslan, Ç. (2020). The effect of real exchange rate uncertainty on Turkey's foreign trade: New evidences from SVAR model. *Asia-Pacific Journal of Accounting and Economics, 1-15*.

McKenzie, M. D., & Brooks, R. D. (1997). The impact of exchange rate volatility on German-US trade flows. *Journal of International Financial Markets, Institutions and Money*, *7*(1), 73-87.

Nazlıoğlu, S. (2013). Exchange rate volatility and Turkish industry-level export: Panel cointegration analysis. *The Journal of International Trade and Economic Development, 22*(7), 1088-1107.

Özbay, P. (1999). *The effect of exchange rate uncertainty on exports: A case study for Turkey*. The Central Bank of the Republic of Turkey Discussion Paper, 1-14.

Özsoylu, A. F. (2016). *Türkiye ekonomisi*. Adana: Karahan Kitabevi.

Öztürk, İ., & Kalyoncu, H. (2009). Exchange rate volatility and trade: An empirical investigation from cross-country comparison. *African Development Review, 21*(3), 499-513. https://doi.org/10.1111/j.1467-8268.2009.00183.x

Öztürk, İ., & Acaravcı, A. (2006). Döviz kurundaki değişkenliğin Türkiye ihracatı üzerine etkisi: Ampirik bir çalışma. *Review of Social, Economic and Business Studies, 2*, 197-206.

Pickard, J. C. (2003). *Exchange rate volatility and bilateral trade flows: An analysis of US demand for certain steel products from Canada and Mexico* (Unpublished doctoral dissertation). Virginia Tech.

Saatçioğlu, C., & Karaca, O. (2004). Döviz kuru belirsizliğinin ihracata etkisi: Türkiye örneği. *Doğuş Üniversitesi Dergisi, 5*(2), 183–195.

Saraçoğlu, B., Açıkgöz, Ş., & Çatalbaş, K. G. (2018). Döviz kuru oynaklığının Türkiye'nin Almanya ile mal ticareti üzerine etkileri. *Anadolu Üniversitesi Sosyal Bilimler Dergisi, 18*, 39-58.

Sarıoğlu, S. E. (2013). Reel döviz kuru belirsizliğinin Türkiye'nin ihracatına etkisi: Farklı sektörler üzerine bir analiz. *Anadolu Üniversitesi Sosyal Bilimler Dergisi, 13*(1), 77-92.

Sarı, A. (2010). Döviz kuru oynaklığının ithalata etkileri: Türkiye örneği. *Istanbul University Econometrics & Statistics e-Journal, 11*(1), 31-44.

Sever, E. (2012). Döviz kuru dalgalanmalarının tarımsal dış ticarete etkisi: Türkiye örneği. *Akademik Araştırmalar ve Çalışmalar Dergisi (AKAD), 4*(7), 17-35.

Solakoğlu, M. N. (2010). Exchange rate exposure and real exports. *Applied Economics Letters, 17*(5), 457-462. https://doi.org/10.1080/13504850701701482

Şenkardeşler, R. A. (2018). Cumhuriyetten günümüze Türkiye'nin dış ticaret ve ekonomik büyüme ilişkisi üzerine nedensellik analizi. *Journal of Accounting, Finance and Auditing Studies, 4*(1), 108-129.

Tapşın, G., & Karabulut, A. T. (2013). Reel döviz kuru, ithalat ve ihracat arasındaki nedensellik ilişkisi: Türkiye örneği. *Akdeniz İİBF Dergisi, 26*, 190-205.

Tarasenko, I. (2021). The impact of exchange rate volatility on trade: The evidence from Russia. *Russian Journal of Economics, 7*(3), 213–232. https://doi.org/10.32609/j.ruje.7.57933

Tarı, R., & Yıldırım, D. Ç. (2009). Döviz kuru belirsizliğinin ihracata etkisi: Türkiye için bir uygulama. *Journal of Management and Economics, 16*(2), 95-105.

Thursby, J., & Thursby, M. (1987). Bilateral trade flows, the Linder hypothesis, and exchange risk. *The Review of Economics and Statistics, 69*, 488-495. https://doi.org/10.2307/1925017

Thuy, V. N., & Thuy, D. T. (2019). The impact of exchange rate volatility on exports in Vietnam: A bounds testing approach. *Journal of Risk and Financial Management, 12*(1), 6. https://doi.org/10.3390/jrfm12010006

Tong, H. (1978). On a threshold model. In C. H. Chen (Ed.), *Pattern recognition and signal processing* (pp. 1-16). Sijthoff & Noordhoff.

Tong, H. (1983). *Threshold models in nonlinear time series analysis*. Lecture Notes in Statistics. Springer-Verlag.

Tsay, S. R. (2010). *Analysis of financial time series*. Wiley.

Türkyılmaz, S., Özer, M., & Kutlu, E. (2007). Döviz kuru oynaklığı ile ithalat ve ihracat arasındaki ilişkilerin zaman serisi analizi. *Anadolu Üniversitesi Sosyal Bilimler Dergisi, 7*(2), 133-150.

Uslu, H. (2018). Türkiye'de döviz kuru ve faiz oranının dış ticaret üzerine etkileri: Yapısal kırılmalı bir analiz. *Ekonomi Politika ve Finans Araştırmaları Dergisi, 3*(3), 311-334.

Vergil, H. (2002). Exchange rate volatility in Turkey and its effect on trade flows. *Journal of Economic and Social Research, 4*(1), 83-99.

Yamak, R., & Korkmaz, A. (2005). Reel döviz kuru ve dış ticaret dengesi ilişkisi. *İstanbul Üniversitesi İktisat Fakültesi Ekonometri ve İstatistik Dergisi, 2*, 11-29.

APPENDIX

Chart of Residuals

Appendix Table 1

OLS Charelogram

	AC	PAC	Q-İst	P-variable
1	0.05	0.05	0.33	0.57
2	0.10	0.10	1.60	0.45
3	0.19	0.18	5.85	0.12
4	0.08	0.06	6.63	0.16
5	-0.05	-0.09	6.88	0.23
6	0.03	-0.02	6.97	0.32
7	0.00	-0.01	6.97	0.43
8	0.03	0.05	7.08	0.53
9	0.03	0.04	7.18	0.62
10	-0.04	-0.05	7.36	0.69
11	-0.07	-0.10	8.02	0.71
12	0.03	0.03	8.16	0.77

Appendix Table 2

TRM Charelogram

	AC	PAC	Q-İst	P-variable
1	0.06	0.06	0.39	0.53
2	0.10	0.10	1.52	0.47
3	0.22	0.22	7.48	0.06
4	0.09	0.07	8.46	0.08
5	-0.01	-0.06	8.48	0.13
6	0.09	0.03	9.44	0.15
7	0.06	0.03	9.82	0.20
8	0.08	0.09	10.64	0.22
9	-0.02	-0.06	10.70	0.30
10	-0.08	-0.13	11.48	0.32
11	-0.08	-0.11	12.20	0.35
12	0.02	0.05	12.23	0.43

Appendix Table 3

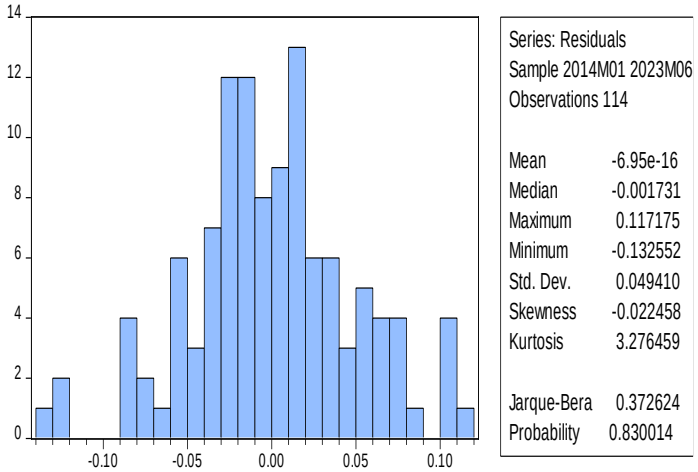
OLS Test Results

Heteroskedasticity Test: ARCH			
F-statistic	0.7065	Prob. F(5,183)	0.4024
Obs*R-squared	0.714681	Prob. Chi-Square(5)	0.3979

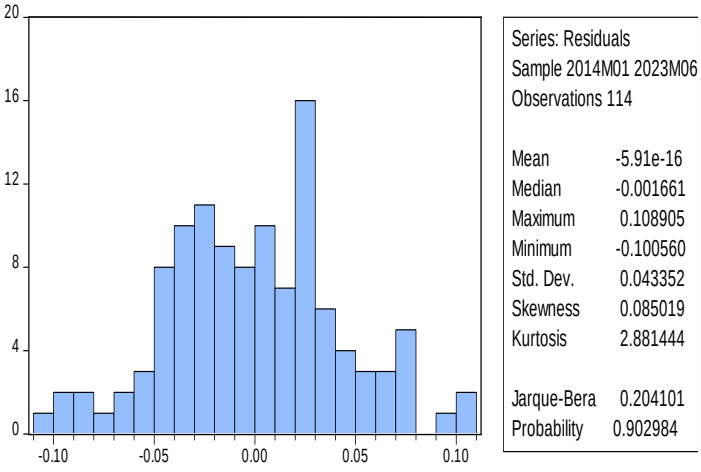
Appendix Table 4

TRM Test Results

Heteroskedasticity Test: ARCH			
F-statistic	0.012597	Prob. F(5,183)	0.9108
Obs*R-squared	0.012823	Prob. Chi-Square(5)	0.9098



Appendix Figure 1. OLS Normality Test Table



Appendix Figure 2: TRM Normality Test Table