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The effect of real exchange rate uncertainty on Turkey's foreign trade: new evidences from SVAR model

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ABSTRACT

In this study, the relationship between exchange rate uncertainty and Turkey's foreign trade performance is analyzed using monthly data from 2002:01 to 2017:12 via Structural VAR (SVAR) model. The empirical results indicate that domestic income and import have more impact on Turkey's export. Moreover, domestic income, exchange rate and exchange rate uncertainty are effective on Turkey's import. These results imply that Turkey's export is dependent on imported inputs more than the exchange rate and exchange rate uncertainties.

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SVAR model; exchange rate Volatility; macroeconomic policy

1. Introduction

After collapsing Bretton Woods System in 1973, the fixed exchange rate regime has begun to be abandoned and instead of that flexible exchange rate regime has taken into practice by industrialized and developing countries including Turkey. The effect of the exchange rate uncertainties, which is the result of flexible exchange rate regime, on trade flows has become an important subject to focus on for researchers.

Exchange rate fluctuation effects on international trade have been studied generally for the export demand model but there have been also studies for the import demand model. Although the relationship between exchange rate uncertainties and international trade has been analyzed both theoretically and empirically, common agreement on this issue has not been reached. In theory, different opinions have been suggested for the relation between foreign trade and the volatility of the exchange rate. Depending on this information, it can be inferred that exchange rate volatility may have negative or positive effects on the foreign trade level. Therefore, the effect of exchange rate volatility on foreign trade is a subject worth studying. This relationship has been examined empirically by a lot of econometric studies.

McKenzie (1999) and Bahmani-Oskooee and Hegerty (2007) provide a detailed theoretical and empirical review of the impact of exchange rate volatility on trade flows. They declare that the effect of exchange rate volatility on trade flows may change according to studied country or country group, applied econometric method, and used time interval. The majority of empirical studies have found a negative relationship between exchange rate volatility and international trade flows (Chowdhury 1993; Arize 1997a). On the other hand, a positive relationship between exchange rate volatility and trade is found in some papers like De Grauwe (1988), Asseery and Peel (1991), Viaene and Devries (1992), Franke (1991) and Sercu and Vanhulle (1992). Additionally, Gotur

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(1985) and Bailey, Tavlas, and Ulan (1986) conclude that exchange rate volatility has not any effect on foreign trade.

The effects of real exchange rate uncertainty on Turkey's export and import have been examined by using different econometric methods. In literature, mostly cointegration and error correction models have been employed for discovering short-term and long-term effects. Additionally, other methods like Vector Autoregression (VAR) and Gravity Models are also seen in the literature. However, literature survey carried out for Turkey demonstrated that the relationship between exchange rate volatility and international trade has not been analyzed by Structural Vector Autoregressive (SVAR) model.

In this study, the relationship between exchange uncertainty and Turkey's export and import performance is analyzed with the SVAR model. This paper is separated from others not only by using the SVAR model, but it differs that export and import in the SVAR model are analyzed together. In other words, unlike other studies, which estimate export and import demand models separately, all variables in the system are taken together. In this paper analyzing foreign trade, by using the SVAR model, by taking export and import together, we get a chance to discover more complicated and more realistic results. To extend this, contrary to most of the similar papers, that reached generally negative exchange rate uncertainty effects on export flows, it is found that export demand is determined with respect to dependent import structure more than exchange rate volatility. On the other hand, for the import demand model, thanks to the SVAR model's variance decomposition new kinds of evidences are obtained. In such a way that, while in early periods, exchange rate is more effective than exchange rate volatility on import level, after a while exchange rate volatilities become more effective. In literature as far as we search there is no kind of this type of analysis for export and import demand models. In addition to them, for determining restrictions of the SVAR model are determined not only considering economic theory but also current economic conditions are also taken into consideration. With these restrictions, import-dependent export case, which is one of the most fundamental economic problems for developing countries, is also examined empirically.

This paper consists of four sections including the introduction part. The literature survey is given in Section 2, Section 3 presents the empirical results, and concluding remarks are offered in Section 4.

2. Literature survey

In the theoretical literature, the model of Clark (1973) and Hooper and Kohlhagen (1978) claims that exchange rate volatility has a negative effect on the volume of trade. Another group of theoretical models indicates that exchange rate volatility has an unclear impact on trade, sometimes positive and other times negative (Franke 1991; Sercu and Vanhulle 1992; De Grauwe 1988). On the empirical side, the literature provides mixed findings, depending on the econometric methods, sample periods, a proxy of trade used, other macroeconomic indicators included, and methods of measuring the exchange rate volatility. For instance, Arize (1996) investigates that increasing exchange rate risks have unfavorable impacts on export, and Mckenzie and Brooks (1997) report that exchange rate uncertainties cause to increase trade level. Additionally, Kılıç and Yıldırım (2015b) do not establish any connection between them. In the study of Baum and Caglayan (2009), they come up with mixed results.

Effects of exchange rate volatilities on bilateral trade between the United States and Germany are searched empirically by Akhtar and Hilton (1984). It is obtained that trade flows between these countries are adversely affected by exchange rate volatility. In the study of Kenen and Rodrik (1986), relation between exchange rate fluctuations and import of the USA, Canada, Japan, Belgium, France, Germany, Italy, Netherlands, Sweden, Switzerland and the United Kingdom is analyzed. In this paper, it is stated that increasing exchange rate risks reduce the volume of international trade. Thursby and Thursby (1987) examine the effects of increasing exchange rate changes on the

exports of 17 countries. According to the empirical results, foreign trade is usually negatively affected by increasing exchange rate risks. Koray and Lastrapes (1989) have found that exchange rate volatilities have a little and negative impact on USA import. Lastrapes and Koray (1990) analyze the relationship between USA trade and real exchange rate uncertainties. The study indicates that exchange rate uncertainty's effect is lower than the other variables in the model. Chowdhury (1993) analyzes the relationship between real exchange rate uncertainty and export of G-7 countries. Empirical analyses show negative and statistically significant coefficients for all countries. In the study of Mc Kenzie and Brooks (1997), the effect of exchange rate volatilities on trade between Germany and the USA is searched. The trade in both ways is significantly and positively influenced by exchange rate volatility.

Arize (1997a), (1997b) and (1996) have constructed export models for 7 industrial, G-7 and 8 EU countries, respectively. Depending on the analysis, the result is that exchange rate volatility affects the export of the countries involved in these studies in a negative direction. Arize (1995) also has come to a similar conclusion that the US export is adversely affected by volatility.

The effects of the expected and unexpected exchange rate volatility on the steel trade between the US, Canada and Mexico are examined by Picard (2003). Empirical results point out that the exchange rate volatility impact on steel trade volume is relatively small. Baum and Caglayan (2009) stress on mutual trade of 13 countries bilateral trade and they have reached mostly insignificant coefficients. Byrne, Darby, and Macdonald (2008) investigate the effect of exchange rate volatility on bilateral trade flows of the US and six countries in the European Union region for 22 different sectors. They mention that exchange rate uncertainty negatively affects trading volume.

In the study of Olayungbo, Yinusa, and Akinlo (2011), the response of foreign trade performance to exchange rate uncertainties for 40 sub-Saharan African countries is analyzed. Findings reveal that the total trade level is affected positively by exchange rate volatility. The exchange rate volatility effects on trade flows between the US and South Korea are examined on a sectoral basis by Bahmani-Oskooee, Harvey, and Hegerty (2012) and they come up with mixed results. Additionally, Bahmani-Oskooe, Harvey and Hegerty (2015) study on the relationship between exchange rate volatilities and trade volume. Although volatility coefficients have positive and negative signs, it is generally found that coefficients of volatility are statistically insignificant.

There are also lots of studies for Turkey's international trade. Özbay (1999) analyzes the effect of real exchange rate uncertainty on Turkey's export and import. Ordinary least square regression results indicate that the real exchange rate volatility negatively affects the exports of Turkey and it does not affect the import level. The effect of real exchange rate uncertainty on the export of Turkey, Pakistan, Indonesia, Malaysia and South Korea is investigated by Doğanlar (2002) by using Engle-Granger cointegration and error correction models. Empirical findings show that the volatilities of exchange rate series reduce trade volume. Vergil (2002) investigated the impact of real exchange rate volatility on the export flows of Turkey to the United States and its three major trading partners in the European Union by using a cointegrating model. The results indicated that the real exchange rate volatility has a significant negative effect on real exports.

To investigate the relationship between uncertainties of the exchange rate and Turkey's export level, Kasman (2003) studied both in the sectoral and total base. The analysis is performed by Johansen cointegration and error correction models. While the total export impact of the real exchange rate uncertainty is negative, on the sectoral basis positive effect on export has been observed. The analysis is done by Saatcioğlu and Karaca (2004) with the help of Johansen cointegration and error correction models on exchange rate uncertainty, show a negative coefficient on Turkey's export level for both short and long term. Kasman and Kasman (2005) examine the export level of Turkey for the short and long term. To examine the relationship between exchange rate volatility and export level, Johansen cointegration and error correction models are employed. Their findings reveal that exchange rate volatility is beneficial for export. Tunçsiper and Öksüzler (2006) model the export of Turkey by using cointegration and error correction models. They observe unfavorable volatility influence on both total and sectoral bases. According to cointegration

model analyses' outputs done by Ozturk and Acaravci (2006), although exchange rate volatilities decrease export level in short term, in the long term, export volume does not get affected by uncertainties.

Köse, Ay, and Topallı (2008) examined the impact of reel exchange rate volatility on the export of Turkey by using Johansen cointegration and error correction models. The results indicate that exchange rate volatility affects exports negatively both in the short and long run. In addition, the results obtained from the variance decomposition for real export show that real exchange rate volatility has more effect than relative price and foreign real income on the real export of Turkey. Tarı and Yıldırım (2009) empirically investigate the relationship between Turkey's export and the real exchange rate uncertainty. According to Johansen cointegration and error correction models findings, volatility is not effective on the export volume in the short term, but it is observed that there is a negative relation between exchange rate uncertainty and export in the long run. Sari (2010) estimates Turkey's import by using the ordinary least square method and he has found a statistically significant negative coefficient for the exchange rate volatility.

On the other hand, Solakoglu (2010) studies on the export level of Turkey for company based. Panel data results indicate that exchange rate volatility negatively affects the real export level for Turkey example. In Esen's (2012) study, it is aimed to reveal the exchange impact on Turkey's export volume by using Johansen cointegration and error correction models. Findings show that while in short term coefficient of volatility is statistically insignificant, for the long term it becomes negative and statistically significant.

Recently there have been some studies focusing on avoiding aggregation deviation. For this purpose, instead of taking total import or export, some particular countries and sectors are chosen for Turkey. For example, Doğru and Uysal (2013) search Turkey's export to 12 countries in the EU region by using the ARDL bound testing approach. They got negligible negative and positive coefficients of exchange rate volatility for short term and long term, respectively. Besides that Nazlioglu (2013) examines Turkey's export performance by taking 20 different countries and 20 different sectors. Panel cointegration results point out that different sectors are influenced in different ways from the exchange rate volatility. The effects of exchange rate uncertainties on Turkey's agricultural (dry fig, hazelnut, citrus fruits, wet and unprocessed tobacco) export to 46 countries are analyzed by Yanıkkaya, Kaya, and Kocturk (2013). Gravity model results show generally insignificant exchange rate volatility effects on agricultural exports. Çiftçi (2014) analyzes Turkey's export to EU-27 countries by ARDL bound testing approach. Findings indicate that the exchange rate depresses export level for both the short and long run. In the studies of Kılıç, Yıldırım (2015a) and Kılıç, Yıldırım (2015b), the relationship between export and import of 22 manufacturing industry sectors and sectoral real effective exchange rate volatility is searched empirically. Findings of Panel Data analyses show that import volume is not affected by volatility, whereas export level increases when sectoral exchange rate uncertainties increase.

Asteriou, Masatci, and Pilbeam (2016) examine the exchange rate volatility effects on international trade volumes for Mexico, Indonesia, Nigeria, and Turkey (MINT countries). For long-term relationship, ARDL bound testing approach and for short term, Granger causality models are employed. The results point out that, in the long term, there is no relation between exchange rate volatility and international trade performance except for Turkey. In the short term, from exchange rate volatility to export/import significant casual relation is found for Indonesia and Mexico.

3. Empirical results

3.1 Data

The variable of real export is obtained by dividing the nominal export, which is taken as millions of US Dollars and seasonally-calendar adjusted, into the seasonally-calendar adjusted export unit value index which is 2010 = 100 base. The real import variable has been derived by dividing

seasonally calendar-adjusted nominal import, taken as millions of dollars, into seasonally calendar-adjusted and 2010 = 100 basis import unit value index. In the literature usually, both domestic income and external income are represented by GDP published quarterly period. However, in this study, instead of GDP, the industrial production index is taken, since it is published monthly. In this context, for internal income, 2010 = 100 based and seasonally adjusted Turkey's industrial production index, for external income, 2010 = 100 based and seasonally-calendar adjusted 27 EU Members' industrial production index is used.

For the exchange rate, the real effective exchange rate series based on CPI and 2003 = 100 are taken. At this stage, it is better to remember that the real effective exchange rate series are calculated with a different method for Turkey. For this reason, increasing the real effective exchange rate implies appreciation of Turkish Lira vice versa, decreasing real effective exchange rate implies deprecation of Turkish Lira. In that case, contrary to the economic theory negative relationship is expected between the export and the real exchange rate and a positive relationship is expected between the import and the real exchange rate. The exchange rate volatility variable is calculated by taking the square root of the conditional variances calculated from the GARCH (1,1) model of the logarithmic real effective exchange rate. Analyses are made by taking the logarithms of the variables except for exchange rate volatility.

Dataset, having the monthly period and covering 2002:01–2017:12 timeline, are taken from the database of the Turkish Statistical Institute, the Electronic Data Delivery System (EDDS) of the Turkish Central Bank and the database of Eurostat.

3.2 Unit root test

All data are in logarithmic form except exchange rate volatility. Real export, real import, domestic income, external income and real exchange rate are represented by LX, LM, LDY, LEY and LR, respectively.

In order to test whether the series contain unit root, augmented Dickey–Fuller (ADF, Dickey and Fuller 1981) unit root test is used. ADF unit root tests' results are reported in Table 1. According to Table 1, the integrated order of each variable is one. These results show that all series are stationary in the first difference.

3.3 Estimating volatility

To estimate exchange rate volatility various statistical methods have been used. Akhtar and Hilton (1984), Koray and Lastrapes (1989), Chowdhury (1993), Arize (1996), Kasman (2003), Tarı and Yıldırım (2009) and Davis (2014) implement moving sample standard deviation. On the other hand, Arize (1995), Mc Kenzie and Brooks (1997), Özbay (1999), Baum and Caglayan (2009), Nazlioglu (2013), Bahmani-Oskooee, Harvey, and Hegerty (2015) use ARCH/GARCH models.

Table 1. ADF unit root results.

Variable	Lag operator	ADF test stat.	Critical value (5%)	P value
LX	2	−2.9450	−3.4338	0.1511
ΔLX	3	−9.6818	−3.4340	0.0000
LM	3	−2.9216	−3.4339	0.1581
ΔLM	2	−8.1379	−3.4339	0.0000
LDY	1	−2.4011	−3.4337	0.3778
ΔLDY	0	−17.1839	−3.4337	0.0000
LEY	3	−2.9074	−3.4339	0.1626
ΔLEY	2	−4.1789	−3.4339	0.0058
LR	4	−1.8467	−3.4340	0.6779
ΔLR	11	−6.0362	−3.4351	0.0000

* The ADF includes constant term and trend from the deterministic components. The optimum lag length is selected with AIC with a maximum lag of 12.

Smallwood (2019) calculates volatility using a multivariate dynamic conditional correlation GARCH approach. Additionally, few studies are using more specific calculations to estimate volatility. Kılıç, Yıldırım (2015a) and Kılıç, Yıldırım (2015b) estimate exchange volatility in sectoral basis. Binding and Dibiasi (2017) have derived the firm-level exchange rate uncertainty variable from a survey question designed to measure felt uncertainty effects. Ismailov and Rossi (2018) have constructed exchange rate volatility data based on fixed horizon forecast errors from surveys, performed by Consensus Economics, by using average forecasts of approximately 250 professional forecasters. However, generally moving sample standard deviation and ARCH/GARCH models are preferred in papers especially focusing on discovering the relationship between exchange rate volatility and foreign trade. Doorodian (1999) indicates that the ARCH/GARCH procedure allows to capture time-varying conditional variance as a parameter. Therefore, it is more appropriate to generate exchange rate volatility than moving standard deviation. In this paper, since it is commonly used and it is suitable for our case, the ARCH/GARCH model is decided to use.

To be able to estimate volatility with the ARCH/GARCH model, a series that contains ARCH effects are required. The ARCH effect is tested by the ARCH-LM method. The test statistic equals 17.98, greater than the critical value which is approximately equal to 3.89. H_0, indicating no ARCH effect in the series, can be rejected at 5% significance level. From another point of view, since p-value, which is equal to 0.0000, is lower than 0.05, H_0 can be rejected, and consequently, it can be said that the exchange rate series contain ARCH effect. For this purpose, AR(1) model has been used as the mean equation. To sum up, we come up with the result that ARCH/GARCH models can be used to predict exchange rate volatility.

In this paper, real exchange rate volatility is estimated by GARCH(1,1) model. Lag length is decided based on explanation power (adjusted R squared value) of models. The output of this model is given in Table 2. As it is mentioned that exchange rate volatility is estimated by taking the square root of the conditional variances calculated from the GARCH (1,1). After that ARCH effect is tested again. According to the ARCH-LM test results, the ARCH effect disappears. Because the test statistic of ARCH-LM is 1.22, lower than the critical value that is 3.88. $H_{0,}$ which says that the ARCH effect does not exist, is not rejected at 5% significance level. In addition to this, stationarity of exchange rate volatility is tested by the ADF unit root test. It is found stationary at 5% significance level.

3.4 SVAR model

The SVAR model not only offers to analyze all variables together, but it also provides an opportunity to determine restrictions consistent with economic theory and current conditions. With this aspect, it assists to reach more robust and logical findings. Especially in our current case, this method helps us to discover new insights and new evidences. While constructing the SVAR model, the proxy of exchange rate volatility is estimated from pre-constructed GARCH model instead of using endogen uncertainty measure. In this way, the biasness problem is dismissed (Carriero et al. 2015).

The SVAR model equation is

Table 2. GARCH (1,1) results.

Variable	Coefficient	Std. error	z-Statistic	Prob.
C	−0.000511	0.002162	−0.236541	0.8130
AR(1)	0.263938	0.072817	3.624668	0.0003
Variance equation				
C	0.000146	0.0000841	1.737004	0.0824
RESID(−1)^2	0.112141	0.056107	1.998693	0.0456
GARCH(−1)^2	0.70006	0.135485	5.16707	0.0000
R^2 = 0.079773	D.W = 1.84503			F = 408.1238 (p = 0.0000)

$$A\left(I_k - A_1L - A_2L^2 - \cdots\cdots\cdots A_pL^p\right)y_t = Ae_t = Bu_t$$

where

L: Lag operator,

e_t: Error terms of Standard VAR Model,

ε_t: Error terms of Structural VAR Model,

k: Number of variables in the model,

A and **B**: Restriction matrices.

External income is not affected contemporaneously by the shocks of other variables in the system. Despite that, external income shock affects export shocks and domestic income shocks contemporaneously. The restriction of the contemporaneous effect of foreign income on export is consistent with economic theory. However, the restriction of foreign income effects on domestic income is determined under the current economic conditions. The integration among the economies in the globalizing world is getting stronger day by day. The most explicit example is that the global crisis beginning in the USA in 2008 spread all over the world in a short period and felt deeply. Hence, it is likely that Turkey's economy would be affected negatively by the economic troubles that are seen in its major trade partners.

Real exchange rate shock is not affected contemporaneously by the shocks of other variables while it affects all variables' shocks except external income shock.

Real exchange rate uncertainty shock is only affected by the real exchange rate. This shock is effective on domestic income, real export and real import contemporaneously. The relationship between exchange rate volatility and international trade performance is already the main subject of this paper.

Domestic income shock is effective on real import and real export shocks contemporaneously whereas it is affected by real exchange rate, real exchange rate, uncertainty and external income shocks.

Real import shock just affects real export shock but it is affected by domestic income, real exchange rate and real exchange rate volatility shocks contemporaneously. Real export shock does not affect any of the variables, on the other hand, all variables' shocks affect real export contemporaneously.

Restrictions of external income and real exchange rate effects on export are determined by considering economic theory, whereas restrictions of import and domestic income effects on export are determined by taking into consideration Turkey's economic production structure. Turkey's production structure is mostly imported dependent like other emerging market economies. In addition to importing intermediate inputs used for production, energy, which is another fundamental item for production, is also imported from other countries. On the other side, the industrial production index, taken as a proxy of domestic income variable, is a kind of source of importation finance. Consequently, in Turkey to sustain production, imported inputs are required. Moreover, the industrial production index is an indicator of the production level of Turkey. Therefore, it is assumed that the shocks of import and domestic income influence the level of export contemporaneously.

Under these restrictions, the structural VAR model with A and B matrices can be specified as below.

$$\begin{bmatrix} \begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} & a_{15} & a_{16} \\ 0 & 1 & a_{23} & 0 & a_{25} & a_{26} \\ 0 & 0 & 1 & a_{34} & a_{35} & a_{36} \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & a_{56} \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \end{bmatrix} \begin{bmatrix} e_t^{LX} \\ e_t^{LM} \\ e_t^{LDY} \\ e_t^{LEY} \\ e_t^{vol} \\ e_t^{LR} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{23} & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{55} & a_{56} \\ 0 & 0 & 0 & 0 & 0 & b_{66} \end{bmatrix} \begin{bmatrix} u_t^{LX} \\ u_t^{LM} \\ u_t^{LDY} \\ u_t^{LEY} \\ u_t^{vol} \\ u_t^{LR} \end{bmatrix}$$

The optimal lag operator of the VAR model is determined as 1 by using Schwarz information criteria. Before constructing the SVAR model, identification needs to be checked. There are six variables in our SVAR model. To satisfy exact identification, $2K^2 - \frac{1}{2}K(K+1) = 51$ restrictions are needed, where K is the number of variables. However, for this study, there are 54 restrictions. This shows that the SVAR model has overidentification problem and the availability of overidentification for this model must be controlled. According to the likelihood ratio test, the p-value is found 0.4407 greater than 0.05. H_0, which indicates that overidentification is valid, is not rejected at 5% level. This result means that overidentification is not a problem for the model.

3.5 Variance decomposition and impulse response functions

Variance decomposition outputs of real export for Turkey are given in Table 3. In the first period export is mostly explained by domestic income shock and the explanation power of domestic income for export is approximately 7% while other shocks' rates are lower than 1%. This rate almost doubled in the second period that is 13.4%. Despite, the increasing rate is getting slow for domestic income shock, this increment lasts until the 24th period and it becomes over 45%. After the first period beside domestic income shock, import shock, which has the second highest rate, begins to be effective on Turkey's export. While other variables' rates are lower than 1%, import shocks' explanation power equals to approximately 2.5% in the second period. From the second period to the third period import shock's explanation rate rises sharply. The explanation percentage of import shock on export shock increases smoothly and it becomes over 20% in the 24th period. The third effective variable on export is exchange rate volatility. Especially after the 6th month, the exchange rate volatility effect on export can be detected more precisely. This rate also increases smoothly and it equals almost 7.5% in the 24th period. In addition to them, the explanation rate of external shock on export shock stays lower levels. This effect is under 1% level until the 15th period. From the 16th period to the 24th period, the external income effect is greater than 1% and it is about 3% in the 24th period. The reason behind this result can be explained as, external income shock effects on the export level are quite low when it is compared to domestic income, import and exchange rate volatility shocks. The explanation percentage of real exchange

Table 3. Variance decomposition of real export (%).

Period	LX	LM	LDY	LEY	VOL	LR
1	92.8474	0.0144	7.0158	0.0630	0.0077	0.0517
2	83.8463	2.4792	13.4725	0.0444	0.1185	0.0391
3	74.1100	5.4180	20.2801	0.0382	0.1130	0.0407
4	65.5436	8.0046	26.2364	0.0395	0.1359	0.0400
5	58.4644	10.1325	30.9656	0.0487	0.3523	0.0365
6	52.6886	11.8715	34.5407	0.0683	0.7983	0.0326
7	47.9603	13.3030	37.1818	0.1011	1.4238	0.0300
8	44.0595	14.4906	39.1182	0.1496	2.1524	0.0297
9	40.8151	15.4817	40.5417	0.2156	2.9136	0.0322
10	38.0952	16.3124	41.5992	0.3000	3.6554	0.0377
11	35.7981	17.0108	42.3973	0.4035	4.3441	0.0462
12	33.8443	17.5990	43.0118	0.5257	4.9615	0.0577
13	32.1712	18.0952	43.4954	0.6663	5.4998	0.0722
14	30.7292	18.5138	43.8846	0.8242	5.9587	0.0895
15	29.4787	18.8667	44.2047	0.9985	6.3418	0.1096
16	28.3878	19.1636	44.4729	1.1878	6.6555	0.1324
17	27.4309	19.4126	44.7013	1.3906	6.9067	0.1579
18	26.5870	19.6204	44.8980	1.6057	7.1031	0.1858
19	25.8391	19.7925	45.0691	1.8314	7.2517	0.2162
20	25.1730	19.9337	45.2186	2.0664	7.3593	0.2490
21	24.5772	20.0482	45.3496	2.3092	7.4319	0.2840
22	24.0420	20.1392	45.4643	2.5584	7.4751	0.3211
23	23.5592	20.2098	45.5644	2.8128	7.4935	0.3603
24	23.1222	20.2626	45.6514	3.0711	7.4913	0.4014

Table 4. Variance decomposition of real import (%).

Period	LX	LM	LDY	LEY	VOL	LR
1	0.0000	88.3958	4.6764	0.2587	1.2766	5.3925
2	0.0568	77.4709	12.3527	0.5692	4.3200	5.2304
3	0.1610	68.2456	18.5950	0.7313	7.3667	4.9005
4	0.2882	61.4187	23.0245	0.7689	9.9273	4.5724
5	0.4265	56.4549	26.1338	0.7368	11.9656	4.2823
6	0.5710	52.7835	28.3835	0.6753	13.5566	4.0300
7	0.7198	49.9957	30.0821	0.6088	14.7849	3.8088
8	0.8722	47.8206	31.4212	0.5514	15.7223	3.6124
9	1.0280	46.0801	32.5186	0.5112	16.4264	3.4358
10	1.1867	44.6553	33.4477	0.4926	16.9425	3.2754
11	1.3480	43.4645	34.2548	0.4976	17.3066	3.1285
12	1.5116	42.4507	34.9699	0.5270	17.5475	2.9932
13	1.6769	41.5730	35.6128	0.5806	17.6886	2.8681
14	1.8434	40.8014	36.1970	0.6575	17.7486	2.7520
15	2.0106	40.1139	36.7318	0.7566	17.7430	2.6441
16	2.1779	39.4936	37.2238	0.8764	17.6846	2.5437
17	2.3448	38.9279	37.6778	1.0152	17.5839	2.4504
18	2.5109	38.4068	38.0976	1.1715	17.4495	2.3638
19	2.6755	37.9229	38.4861	1.3434	17.2886	2.2835
20	2.8385	37.4701	38.8457	1.5293	17.1071	2.2093
21	2.9992	37.0439	39.1785	1.7274	16.9101	2.1409
22	3.1575	36.6403	39.4861	1.9363	16.7016	2.0781
23	3.3130	36.2566	39.7703	2.1542	16.4851	2.0208
24	3.4655	35.8904	40.0324	2.3798	16.2632	1.9688

rate on export volume has the lowest rate for all periods and this rate is under 0.5% in the 24th period.

In Table 4 real import's variance decomposition results are summarized. In the first period, the most effective shocks on import level are exchange rate, domestic income and exchange rate volatility. Their rates are 5.4%, 4.7% and 1.3%, respectively. The explanation rate of domestic income rises until the 24th month. With the 2nd period, domestic income effect on import level takes the leadership and this situation lasts until the 24th period that is the end of research time. In the 24th period, the explanation rate of domestic income shock on import shock is about 40%. Although the exchange rate volatility effect on import volume is lower than the exchange rate effect in the first and second periods, with the third period its effect on import level becomes greater than the exchange rate effect and it lasts until the 24th period. The rate of exchange rate shock diminishes gradually, whereas the rate of exchange rate volatility shock increases. The exchange rate effect on import volume is about 2% towards the last periods. On the other hand, the exchange rate volatility percentage rises to 17.7% in the 14th period. After that, this percentage slightly decreases and the explanation percentage of exchange rate volatility on import volume becomes 16.2% in the 24th period.

In Figures 1 and 2, impulse response function of real export and real import is shown. According to the ADF unit root test results, the integrated order of each variable is one. These results show that all series are not stationary in their level. Confidence intervals are calculated with the bootstrap simulation method since the SVAR model is established with level forms of variables.

According to Figure 1, the explanation of export by itself decreases gradually. Import and domestic income shocks affect export level positively while shocks of external income, exchange rate and exchange rate volatility does not affect export volume. Figure 2 indicates that import shocks have favorable effects by itself. However, the explanation of import shocks by its own shocks getting diminishes. Moreover, it is seen that there is a potentially positive effect of domestic income shock on imports as well as on exports. Exchange rate volatility shocks have unfavorable effects on import volume. Despite that exchange rate shocks have positive effects on the import shocks for the first two periods, with the third period, exchange rate shock effect vanishes.

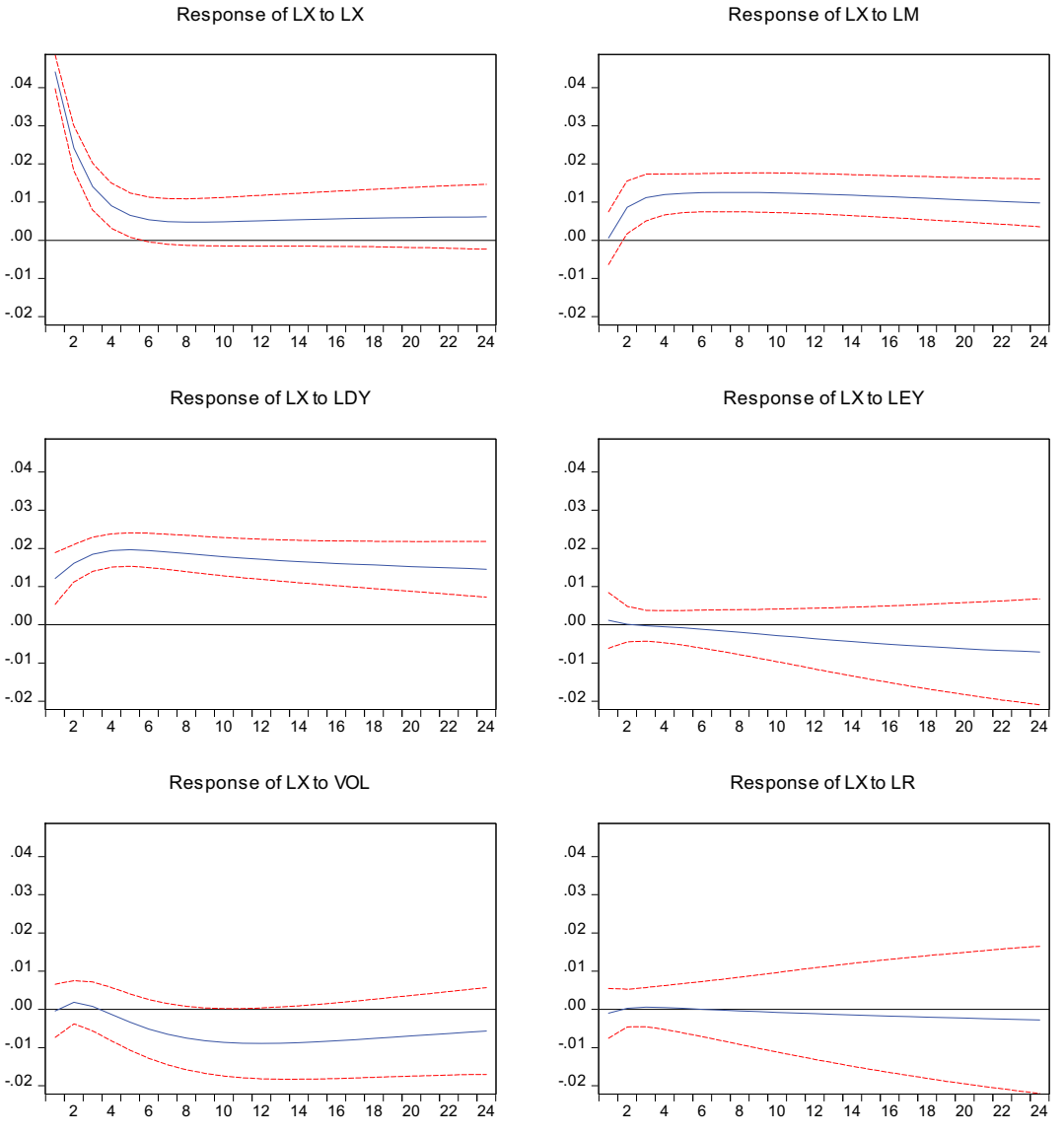

Figure 1. Impulse response functions of real export.

When the results of variance decomposition and impulse response functions related to export are analyzed, it is detected that domestic income shock is the most fundamental variable and import shock is the second most fundamental variable to explain export shock. Moreover, shocks of exchange rate volatility have been felt on the export flows of Turkey in the last periods. On the other hand, it is seen that Turkey's export is not affected by the exchange rate and external income shocks. Findings from this study for Turkey's export do not completely match with economic theory. According to the theory, export would be most influenced by foreign income and the real exchange rate. Nevertheless, results taken from this paper indicate that domestic income and import are more important than other variables for Turkey's export. This result can be shown as evidence that Turkey's export is dependent on import. According to the broad economic classification (BEC), the fact that Turkey's export is based largely on imported intermediate goods supports this opinion. In other words, as in other emerging market economies, significant inputs to keep

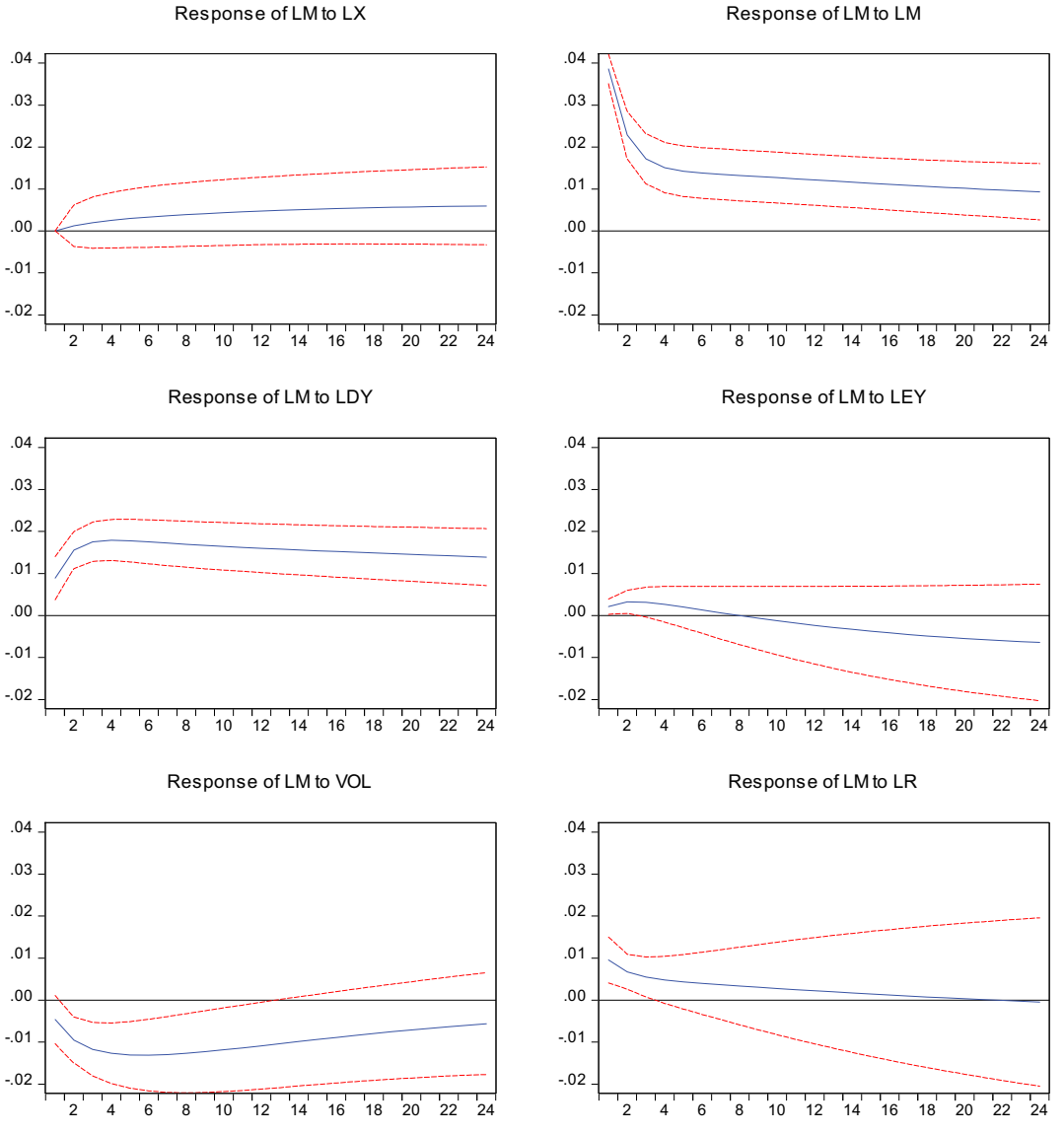

Figure 2. Impulse response functions of real import.

production are imported from other countries for Turkey market either. Besides, being an energy importer causes Turkey to increase external dependency. Under these circumstances, a certain amount of intermediate imported inputs is required to sustain production. Moreover, there are also two fundamental evidences proving the dependent production structure. Firstly, in the crisis periods, Turkey's international trade volume declines depending on both export and import. With another expression, while import volume declines due to economic recession, the export level decreases comparatively as being dependent on import. Additionally, it is observed that the international trade deficit decreases in Turkey, at crisis periods. Secondly, it is seen that the foreign trade deficit of Turkey is increasing in periods, in which economic growth is high for Turkey. Despite in times of economic growth export volume expands, increasing import performance becomes larger than export performance. This causes to increase the foreign trade deficit. The reason why export is highly affected by domestic income can be signified by two explanations. First

of all, import which is the source of export is financed by domestic income. Secondly, the industrial production index that represents domestic income is already an indicator of the production data of Turkey. This situation also confirms the import dependency of export for Turkey. To sum up, it can be inferred that the international trade deficit becomes structural for Turkey.

Furthermore, since a significant proportion of import is the source of export, the influence of domestic income on import stronger than the real exchange rate. At this point, another important question that may come up to mind is that in an import-dependent economy, why the export level is not affected while import level is affected by real exchange rates and exchange rate uncertainties. This question can be answered by considering local producers. Although domestic producers do export, they allocate a significant share of their production to meet domestic demand. It is a normal situation for domestic producers, who produce with imported inputs or import directly consumer product to work with the local market, to be affected by exchange rate movements. Because domestic demand may shrink due to the increased inflation rate which is caused by the exchange rate and exchange volatility. In another case, the profit level may be reduced if rising costs are not fully reflected in prices, depending on the exchange rate index and volatility. In both cases, the domestic producer would be affected adversely. But local enterprises, who do import in order to export, would not consider exchange rate movements since their both incomes and expenses are in foreign currency. Most probably they would focus on financing of imported inputs instead of exchange rate movements. In summary, while the import level is affected by exchange rate variables, the export level is not affected by them. Because export is mostly dependent on import more than exchange rate and exchange rate volatilities.

From a different point of view, this study provides new evidences to the literature. Our findings show that contrary to most of the similar studies focusing on detecting exchange rate volatility effects on Turkey's export volume, there is no negative relation. In other words, since they do not take into consideration the import-dependent production type of Turkey, they fail to discover the real relationship between these variables. They may have reached unfavorable effects of exchange rate uncertainty on import level that is transmitted to export level with dependent production structure. From this aspect, this study brings a new perspective and new evidences to analyze for exchange rate volatility effects on export flows. For the import side although mixed results are obtained in the literature, again negative relations are more dominated. However, the outputs of our study show differentiation from other similar studies in the literature. Thanks to the variance decomposition function, it is able to analyze exchange rate volatility effects on import volume period by period. By this way, the short-term dominated exchange rate effect and the long-term dominated exchange rate uncertainty effect on import volume are figured out. As far as we search, this is the unique finding with the way of method and outputs.

4. Conclusion

In this study, the relationship between exchange rate uncertainty and Turkey's foreign trade performance is analyzed using monthly data from 2002:01 to 2017:12. The SVAR model is preferred as an econometric method. Besides import, export and exchange rate volatility; domestic income, external income and exchange rate are also included in the model. The real exchange rate uncertainty is estimated by the GARCH (1,1) model using the CPI-based real exchange rate series.

Variance decomposition outputs and impulse response functions show that domestic income, exchange rate uncertainty and exchange rate shocks are effective on the import of Turkey. Variance decomposition outputs state that import is mostly affected by domestic income after the first month. Impulse response functions reveal that domestic income has favorable effects on import level as consistent with economic theory. For exchange rate and exchange rate volatility shocks on import flows, interesting results are observed. In the beginning months, the exchange rate impact is dominant, but during the following periods, the picture has changed dramatically. Shocks of exchange rate volatility impact have been started to be felt more deeply on Turkey's import flow

with the third period. This situation can also be observed from impulse response functions. Exchange rate volatility has negative effects while the exchange rate has positive effects on import flows for Turkey as expected. Exchange rate volatility shock is insignificant in the first period and it becomes significant in the second period. This significance lasts until the 14th period. On the other hand, the exchange rate effect on import volume becomes insignificant after the third period. In light of these findings, it can be told that importers in Turkey take into account the exchange rate in the short term but they decide to make importation by analyzing exchange rate uncertainties in the long term.

The results obtained imply that production in Turkey is dependent on imports. Therefore, it can be said that exporters in Turkey focus on imported intermediate goods rather than economic policies. Rely largely on the inward processing regime of Turkey's foreign trade can be shown another proof of this judgment. Besides this, it can be deduced that the domestic producers attach importance to the financing of imports needed for production.

This paper has reached new findings. For the export side, our findings imply that unlike most of the other studies, Turkey's export is not directly negatively affected by exchange rate volatility. The reason for obtaining negative relationship in most of the studies would be the imported intermediated inputs, which are negatively affected by exchange rate volatility used to manufacture for export products. That is to say, in most of the studies, export demand models are established without import and internal income by ignoring dependent production structure, they may have failed to extract real relations. The findings of this paper are consistent with the findings of Clark (1973) study. Clark (1973) mentions that the effect of increasing exchange rate risk on production volume will be lower if the amount of imported input used in the export product is higher. In other words, the exchange rate risk diminishes if the export product consists of largely imported inputs.

Under these scenarios, the necessary amount of importation should be allowed to sustain production in short term. In this direction, stabilizing economic policies must be implemented in order to ensure that import is not negatively affected, as well as the financing of import. For the production not to be adversely affected the importation of the inputs needed should be facilitated with different ways such as government incentives and tax reductions. However, the policies in this direction should be as short as possible. In the middle and long term, intermediate goods that are already imported should be manufactured within the borders of the country with local sources. So that, Turkey's import level would decrease gradually. Moreover, focusing on areas where the sustainability of production can be achieved, such as the industrial sector rather than the construction sector, the production of high value–added products may increase the export volume of Turkey. Should the mentioned precautions are taken, apart from the closure of the foreign trade deficit, unemployment problem, which is a candidate to be a problem for in the future of Turkey's economy, could also be alleviated.

In addition, it is critically important to increase investments in the fields of education and innovation to realize the medium-term and long-term solutions. As a result, to overcome Turkey's international deficit problem, in other words, to provide economic sustainability, policies to eliminate the dependence of production on import should be implemented rather than focusing on exchange rate policies.

Disclosure statement

No potential conflict of interest was reported by the authors.

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