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THE EFFECTS OF GASOLINE PRICE, REAL EXCHANGE RATE AND FOOD PRICE ON VEGETABLE AND FRUIT EXPORT

Gürkan BOZMA1[1], İlyas Kays İMAMOĞLU[2]

Abstract

This study examines the effects of gasoline prices, fluctuations in the actual exchange rate, and food prices on the export of vegetables and fruits from Turkey. In this study, the Nonlinear Autoregressive Distributed Lag (NARDL) approach was utilized to examine the factors influencing the exports of vegetables and fruits from 2003:1 to 2019:12. The analysis was conducted with the assumption that the relationships between gasoline, actual exchange rates, and food prices are nonlinear. The objective of the study was to ascertain the asymmetric effects of gasoline, real exchange rate, and food prices on the exportation of vegetables and fruits. The findings of the NARDL model suggest that there is a significant relationship between long-term fluctuations in gasoline prices and the export of fruits and vegetables of different magnitudes. On the other hand, it has been observed that vegetable exports experience linear effects over an extended period in relation to the real exchange rate. On the other hand, it has been observed that fruit exports are susceptible to asymmetric effects. The present study suggests that fluctuations in food prices have diverse effects on vegetable exports.

Keywords: *Agricultural Export, Food Price, Gasoline Price, Real Exchange Rate*
JEL Classification: *C32, D82, F14*

BENZİN FİYATI, REEL DÖVİZ KURU VE GIDA FİYATININ SEBZE VE MEYVE İHRACATI ÜZERİNDEKİ ETKİLERİ

Öz

Bu araştırma, benzin fiyatları, döviz kurundaki güncel dalgalanmalar ve gıda fiyatlarının Türkiye'den sebze ve meyve ihracatı üzerindeki etkisini araştırmaktadır. Doğrusal Olmayan ARDL (NARDL) yaklaşımı uygulanarak, benzin, reel döviz kuru ve gıda fiyatlarındaki hareketlerin doğrusal olmadığı varsayımı altında, 2003:1'den 2019:12'ye kadar olan dönemde sebze ve meyve ihracatının belirleyicileri bulunmaya çalışılmıştır. Çalışma, benzin, reel döviz kuru ve gıda fiyatlarının sebze ve meyve ihracatı üzerindeki asimetrik etkilerini belirlemeyi amaçlamıştır. NARDL modelinin sonuçları, benzin fiyatlarındaki uzun vadeli dalgalanmaların farklı büyüklükteki meyve ve sebzelerin ihracatını etkilediğini göstermektedir. Buna karşılık, sebze ihracatının reel döviz kuru açısından uzun vadede doğrusal etkilere maruz kaldığı kaydedilmiştir. Buna karşın, meyve ihracatının asimetrik etkilere maruz kaldığı tespit edilmiştir. Mevcut yayın, gıda fiyatlarındaki dalgalanmaların sebze ihracatı üzerinde farklı etkileri olduğunu göstermektedir.

Anahtar Kelimeler: *Gıda Fiyatı, Petrol Fiyatı, Reel Döviz Kuru, Tarımsal İhracat*
JEL Sınıflandırması: *C32, D82, F14*

[1] *Doç. Dr., Iğdır Üniversitesi, gurkan.bozma@igdir.edu.tr, ORCID:0000-0003-4047-9012*
[2] *Dr. Öğr. Üyesi, Bayburt Üniversitesi, imamoglu@bayburt.edu.tr, ORCID: 0000-0002-7732-4148*

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1. Introduction

Developing countries such as Turkey aim to increase export potential to achieve rapid economic growth. The fact that export-based growth policies have been adopted as a monetary policy in the Turkish economy since the 1980s gives important meanings to the concept of export. This transformation in the Turkish economy reveals the need to create policies for developing exports and export-related sectors. In addition to the acceptance of exports as the pioneer of the growth and development processes of countries (Balassa, 1978; Tyler 1981; Ram, 1985; Doraisami 1996; Mesike, 2006; Yapraklı, 2007; Sandalcılar 2012; Sandalcılar et al., 2022), this statement posits that the introduction of novel technologies has the potential to stimulate demand, incentivize savings, and facilitate capital accumulation. (Gururaj et al., 2016) as well as being a foreign exchange earning transaction, it is suggested that it can contribute to the sustainable growth targets of countries (Frankel and Romer, 1999; Chenery and Strout, 1966; Atif et al., 2017). In addition, exports are an important instrument for underdeveloped and developing countries to close their balance of payments deficits and increase their foreign exchange reserves. For this reason, exports can guide the design stages of the economic policies of the countries economies. In the last 50 years, international trade has gained an impressive momentum. The global trade volume of goods has grown by 17 times, increasing approximately three times more than the economic growth in the world. One of the factors affecting this situation is the reduction of average customs tariffs on manufacturing industry products from 40 per cent to 4 per cent with the General Agreement on Tariffs and Trade (GATT) negotiations. On the other hand, in the last 50 years, agricultural trade has grown only as much as the global economic output rate. The main reason for this is that agriculture is not fully included in the multilateral trade negotiations under the GATT, which has been very successful in reducing industrial tariffs (FAO, 2003).

The agricultural sector and trade of agricultural products were not incorporated into the tariff reduction negotiations according to the General Agreement on Tariffs and Trade (GATT). It was not until the Agriculture Agreement was signed within the World Trade Organization (WTO) framework, which succeeded the GATT after the Uruguay Round, and became effective on 01 January 1995 that these matters were addressed. Disregarding appropriate laws is observed. The Agriculture Agreement has led to the heightened significance of the agricultural industry and its foreign trade regulations. The liberalization of agricultural product trade presents a favourable prospect for nations possessing agricultural production potential and fertile agricultural lands to expand their market share in global trade and augment their export capacities. Because in economies where fertile agricultural areas and agricultural production are intense, agriculture has a high importance not only to feed the population but also in terms of export potential. Agricultural exports have an important place in the development of exports for countries that do not have the necessary infrastructure and investments for innovation and have fertile lands. The objective of this research is to analyze the asymmetric impacts of oil prices, real exchange rate, and food prices on the export of vegetables and fruits in Turkey.

2. Agricultural Export, Food Price and Oil Price in Turkey

Due to its favorable climatic and ecological conditions, as well as its extensive agricultural lands, Turkey stands out as one of the few countries capable of cultivating both yearly and perennial crops. Additionally, the country's abundant and cost-effective labor resources further enhance its competitive advantage in the agricultural production sector (Akbay et al., 2005; Bayramoğlu et al., 2009; Niyaz and Demirbaş, 2011). Presently, Turkey is among the leading countries globally in terms of producing numerous agricultural commodities. Turkey has an important position in the global competition in the many fruits and vegetables trade. It ranks first in the world in the production of tomatoes, dried fruits, apricots, hazelnuts, cherries, quince and figs, and has an important position in the trade of specially dried and dried fruits, fruit and vegetables suitable for processing (Ataseven and Güneş, 2008; Bayramoğlu et al., 2009). When the country's economy is examined since the date of the Republic, it is understood that agriculture is one of the critical development sectors. Turkey is in a position to meet its own needs in terms of agricultural production at a high rate. In addition, since agriculture and agro-industrial goods have a great place in exports, foreign agricultural trade is of great importance for Turkey. For this reason, in Figure 1 and Figure 2, the developments in agricultural exports and vegetable and fruit exports in Turkey between 2003 and 2019 are examined. Figure 1 shows Turkey's percentage change in total exports and agricultural exports between 2003-2019. The change in total exports and the change in agricultural exports show similar trends since 2006. This situation reveals the importance of agricultural exports for total exports in the Turkish economy. In addition to the data in the figure, the share of agricultural exports in total exports is between 12 and 14%, according to TUIK data (TUIK, 2020).

Figure 1: **Time-varying Total Export and Agricultural Export in Turkey (2003-2019)**

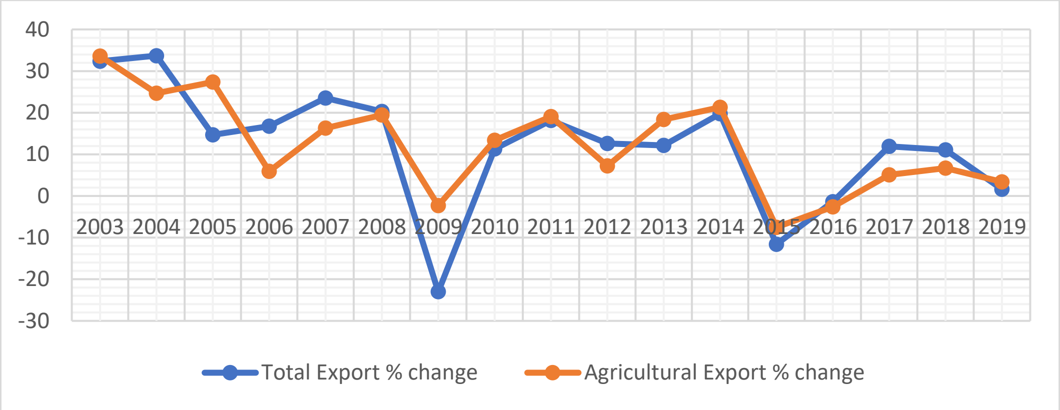
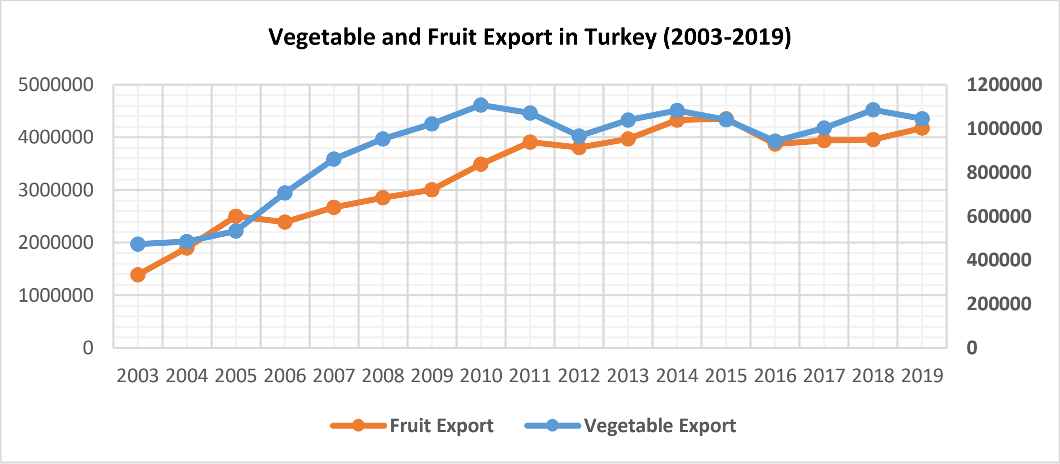


Figure 2 shows the changes in vegetable and fruit exports in Turkey between 2003 and 2019. Fruit exports in 2019 have approximately seven times the value of vegetable exports. In addition, according to the 2019 data from the Turkish Exporters Assembly (TIM), the export of fresh vegetables and fruits and vegetable and fruit products constitutes approximately 30% of the total agricultural exports. For this reason, it can be said that the export of vegetables and fruits is important for the Turkish economy. Fluctuations in production due to climatic conditions, production costs, exchange rates and relations with exporting countries, etc.; it is understood that there are periodic fluctuations in the export of vegetables and fruits due to the changes.

Figure 2: **Time-varying Vegetable Export and Fruit Export in Turkey (2003-2019)**



Moreover, Figure 3, constructed from TCMB data, shows the percentage changes in oil prices in Turkey.

Figure 3: **Time-varying Oil Price in Turkey (2003-2022)**

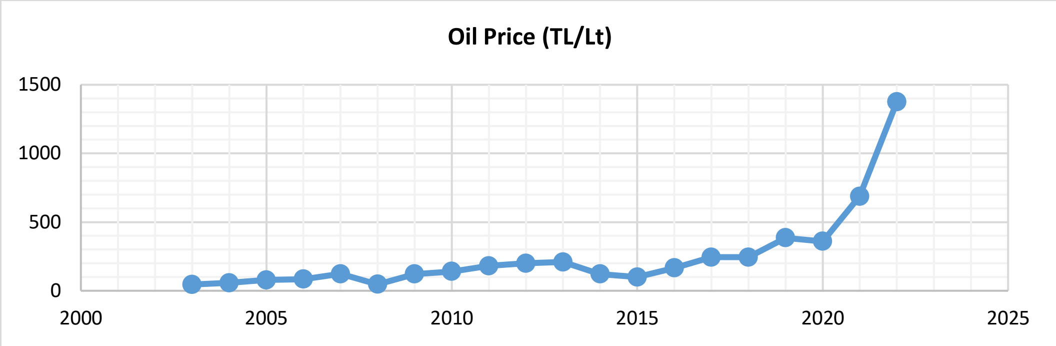


Figure 3 the percentage change values provide insight into the comparative fluctuations of oil prices between consecutive years. In the year 2014, a notable decline of approximately 42.18% was observed in comparison to the price recorded in the preceding year. This represents a significant decrease in the price of oil, characterized by a notable decline. In contrast, there was a significant surge of approximately 99.88% in the price observed in 2022 compared to the previous year, representing one of the most notable increments. The oil prices have witnessed significant fluctuations over the years.

As can be understood from the explanations about agricultural exports above, it is understood that agricultural exports are an essential export item for increasing exports and reducing the current account deficit in developing countries such as Turkey with suitable agricultural areas. Therefore, this study examines the asymmetric effects of gasoline prices, actual exchange rates and food prices on Turkey's agricultural product exports.

3. Motivation and Literature Review

According to Anderson (2010), agribusiness is an instance of economic trade which includes providing agricultural products or other goods to importing nations and generating export revenues for producing countries. The prices per unit of agricultural commodities have exhibited an increasing trend recently. The rise in the cost per unit can be attributed to the input factors involved in agricultural production, as Gündüz et al. (2017:806) stated. Researchers have suggested that the escalation in agricultural commodity prices could be mainly attributed to three factors: a surplus of demand, swings in exchange rates, and the interplay among energy costs and agricultural products. This viewpoint has been supported by various studies conducted by Abbott et al. (2008), Nazlıoğlu and Soytaş (2011), and Yahya et al. (2019). The exponential growth of the global population has resulted in a corresponding surge in the demand for goods that can sufficiently satisfy the nutritional requirements of the populace. Additionally, the volatility of oil prices has led to the farming of corn and soybean in agricultural regions, primarily for ethanol production from biomass and biodiesel. This is due to the limited availability of agricultural land for cultivation purposes. According to Hanson et al. (1993) and Nazlıoğlu and Soytaş (2011), this circumstance has the potential to result in a reduction in the production of other agriculture producers and a subsequent increase in their prices. Furthermore, the literature consensus acknowledges a causal relationship between oil prices and agricultural prices and a causal connection with exchange rates (Nazlioglu and Soytas, 2011; Harri et al., 2009). Currently, oil serves as a significant energy source that exerts substantial impacts on the economy. Arshad and Hameed (2009) suggest that the agricultural sector may be affected by oil price fluctuations, which is an essential component of the industry. The fluctuations in oil prices directly impact the costs of food production, which in turn affects the prices of food. This is due to the influence of oil prices on transportation costs and energy-intensive inputs like fertilizer and fuel. Several studies have explored this relationship, including Bastianin et al. (2014), Baumeister and Kilian (2014), Gardebroek and Hernandez (2013), Nazlıoğlu and Soytaş (2011), and Sarwar et al. (2020). Thirdly, it is worth noting that oil trading is primarily conducted in US dollars. Consequently, oil price fluctuations can significantly affect all nations' domestic currencies. The fluctuation of the domestic currency influences the local prices of agricultural emitters. In contrast, the export of agricultural products is impacted by variations in the exchange rate due to the need for imported items like fertilizers and seeds by producers (Engin-Öztürk and Kırışkan, 2019:104; Gündüz et al., 2017:806; Harri et al., 2009; Karadaş and Koşarlığlu, 2020:516).

Price levels of agricultural commodities are a vital factor affecting the competitive advantage of producing countries in international trade. From this point of view, the main variables that affect the prices of agricultural commodities are oil prices and changes in exchange rates (Çıplak and Yücel, 2004; Arshad and Hameed, 2009; Saghaian, 2010; Chen et al., 2010; Nazlıoğlu and Soytaş, 2012; Pala, 2013; Gogoi, 2014; Rezitis, 2015). ; Kapusuzoglu and Karacaer Ulusoy, 2015; Nwoko et al., 2016; Tay Bayramoğlu and Koç Yurtkur, 2016; Zafeiriou et al., 2018; Živkov et al., 2019; Aye and Odhiambo, 2021; Gökçe, 2021). It is thought that changes in oil prices and exchange rates, which are effective on agricultural prices, may also affect agricultural exports.

The studies conducted in the literature to determine the effect of changes in oil prices and exchange rates on agricultural exports are shown in Table 1. The extant literature on agricultural trade reveals a paucity of studies that investigate the effect of fluctuations in exchange rates and oil prices. For this reason, it is thought that the determination of this relationship can guide the policymaker.

Table 1: **Literature Review**

Author/ Date	Countr(ies)y	Methodology	Result(s)
Fidan (2006)	Turkiye	VAR	According to the study's results, it can be inferred that the agricultural exports of Turkey remain unaffected by variations in the real effective exchange rate.
Mesike et al. (2008)	Nigeria	Multiple Regression Analysis	The primary factors influencing rubber exports were identified as the exchange rate and domestic production.
Hatab et al. (2010)	Egypt	Gravity model	The study found that the devaluation of the Egyptian Pound vis-à-vis the currencies of Egypt's trade allies had a positive impact on the country's agricultural exports.
Abolagba et al. (2010)	Nigeria	OLS	The study has established that the rubber exports are affected by the exchange rate.
Sever (2012)	Turkiye	Cointegration and Error correction model (ECM)	The fluctuation of the real exchange rate has a detrimental impact on the agricultural exports of Turkey.
Maugu et al. (2013)	Kenya	OLS	Researchers showed at their findings that the real exchange rate performed a crucial role in determining the exports of tea, pyrethrum, and horticultural products. Nevertheless, it did not exhibit a significant impact on the exports of coffee.
Yanıkkaya et al. (2013)	Turkiye	Poisson Pseudo-Maximum-Likelihood (PPML)	The study concluded that the devaluation of the Turkish Lira had a positive impact on the exports of grapes and hazelnuts.
Kingu (2014)	Tanzania	Cointegration and Error correction model (ECM)	The study's findings show that there exists a positive relationship between the export earnings of lint in Tanzania and both the real exchange rate and agricultural productivity.

Table 1(Continued): **Literature Review**

Author/ Date	Countr(ies)y	Methodology	Result(s)
Adama and Ohwofasa (2015)	Nigeria	VAR	The study revealed that the exchange rate is a significant factor in illustrating fluctuations in agricultural export revenues.
Sertoğlu and Doğan (2016)	Turkiye	ARDL	The study demonstrated that the real exchange rate displays a significant and adverse impact on the estimation of trade in agricultural products balances within the Turkish context.
Atif et al. (2017)	64 country	Stochastic Frontier Model (SFM)	The bilaterally agricultural exports are impacted by the foreign exchange rate.
Gündüz et al. (2017)	Turkiye	VAR	The international trade of agricultural commodities from Turkey is impacted by the influence of both oil prices and exchange rates.
Şimşek (2017)	Turkiye	Cointegration and Error correction model (ECM)	The researchers have determined that despite the existence of a prolonged association, there is no visible causal linkage among the exchange rate and exports of agriculture.
Braha et al. (2017)	Albania	Poisson Pseudo-Maximum-Likelihood (PPML)	The findings indicate that agricultural exports encounter a positive impact as a result of fluctuations in exchange rates.
Bereket (2020)	Ethiopia	Cointegration and Error correction model (ECM)	The findings indicate that while the short-term impact exists, there is no endure connection between exports of agriculture and the real rate of exchange.
Eshetu et al. (2020)	Ethiopia	GMM	Exchange rate is one of the determinants of agricultural exports.
Oyetade et al. (2020)	Nigeria	ARDL	Empirical evidence suggests an interesting connection among exports of agriculture and the foreign currency rate, while no such relationship has been observed in the context of crude oil prices.

4. Data and Empirical Methodology

4.1. Data

This study uses the monthly time series for Turkey for 2003-2019 to estimate the asymmetric effects of the food price index, real exchange rate and gasoline price on vegetable and fruit exports. The CPI-based real effective exchange rate index calculated according to the IMF definition for 19 countries is taken from the CBRT for the real effective exchange rate variable. The real effective exchange rate is set as cool 2003 = 100 for the period considered. An increase in the index indicates a genuine appreciation of the TL. The data used in the study are obtained from the TUIK database and analyzed by taking their natural logarithms.

Table 2: **Descriptive Statistics**

	LNVEGEX	LNFRUEX	LNFOODIN	LNOIL	LNREELEX
	Value	Value	Index	Value	Index
Mean	11.139	12.423	5.318	1.316	4.637
Standard Deviation	0.440	0.492	0.478	0.380	0.142
Skewness	-0.077	-0.654	0.181	-0.440	-1.153
Kurtosis	2.117	3.720	1.985	2.446	4.086
Jarque-Bera	6.834	18.962	9.873	9.177	55.214
(Prob)	(0.033)	(0.000)	(0.007)	(0.010)	(0.000)
Obs.	204	204	204	204	204

Table 2 presents several descriptive statistics relating to the series. Notably, fruit exports have the highest mean and uncertainty among the series. Skewness and kurtosis values of the series show that the series is not normally distributed. The rejection of the null hypothesis of the Jarque-Bera statistic at the 5% significance level confirms the skewness and kurtosis statistics. Stationarity analysis of the series was tested using ADF and KPSS unit root tests. As a result of the analysis, it was found that the series is not integrated at the I(0) level, but at the I(1) level, the variables are integrated. According to this result, it is seen that the NARDL model can be used to reveal the long and short relationships between variables.

4.2. Empirical Methodology

Time series analysis in the NARDL model estimates the short and long-run asymmetric effects of gasoline prices, real exchange rate and food prices. The NARDL model proposed by Shin et al. (2014) can reveal the impact of positive and negative shocks in the independent variables on the dependent variable compared to the ARDL model. In this way, asymmetric effects can be detected, as shown by recent empirical studies in the economics literature. The basic model used for the analysis is as follows:

$$Y = \alpha_0 + \alpha_1 Oil_t + \alpha_2 Real\ Exchange + \alpha_3 Food\ index + \varepsilon_t \quad (1)$$

In equation (4.1), Y stands for exports of vegetables and fruits; Oil shows for gasoline price, Real Exchange represents the absolute exchange rate index, and Food index stands for food price index.

The main reason for using the Shin et al. (2014) NARDL model, which is an improved version of the Pesaran et al. (2001) -ARDL model, in this study is that the existence of a cointegration relationship between the variables can be investigated regardless of whether they are all I(0) and I(1) or whether they are all mutually cointegrated I(1), except that the variables in the model are I(2). The second main factor is that the short and long-run asymmetries between variables can be taken into account, and the effects of "negative" and "positive" changes in the explanatory variables on the dependent variable can be determined. Thus, the hidden cointegration relationships between positive and negative shocks of variables that do not have a long-run relationship between them can be detected (Shin vd., 2014: 285-286, 288-289).

In NARDL, unlike the ARDL test, the cumulative sums of positive and negative shocks of the independent variable are used, and the long-run asymmetric relationship is shown in equation (2) below.

$$\begin{bmatrix} Lnvegex_t \\ Lnfruex_t \end{bmatrix} = a_0 + \beta_t^+ Lnoil_t^+ + \beta_t^- Lnoil_t^- + \chi_t^+ Lnreelex_t^+ + \chi_t^- Lnreelex_t^- + \varphi_t^+ Lnfoodin_t^+ + \varphi_t^- Lnfoodin_t^- + \varepsilon_t \quad (2)$$

In Equation (2), Lnvegex, Lnfruex, Lnoil, Lnreelex and Lnfoodin denote stationary variables at the [I(1)] level, with positive and negative shocks, respectively. Positive and negative changes are calculated by taking cumulative sums as follows:

$$x_t^+ = \sum_{i=1}^{t} \Delta x_i^t = \sum_{i=1}^{t} \max(\Delta x_i, 0)$$
$$x_t^- = \sum_{i=1}^{t} \Delta x_i^t = \sum_{i=1}^{t} \min(\Delta x_i, 0)$$

The adapted version of the NARDL model proposed by Shin et al (2014) can be written as follows:

$$\begin{aligned}\begin{bmatrix} \Delta Lnvegex_t \\ \Delta Lnfruex_t \end{bmatrix} &= a_0 + \eta_{1i} \begin{bmatrix} Lnvegex_{t-1} \\ Lnfruex_{t-1} \end{bmatrix} + \beta_1^+ Lnoil_{t-1}^+ + \beta_2^- Lnoil_t^- + \chi_1^+ Lnreelex_{t-1}^+ + \chi_2^- Lnreelex_{t-1}^- + \varphi_1^+ Lnfoodin_{t-1}^+ + \varphi_2^- Lnfoodin_{t-1}^- \\ &+ \sum_{i=1}^{q} v_i \begin{bmatrix} \Delta Lnvegex_{t-i} \\ \Delta Lnfruex_{t-i} \end{bmatrix} + \sum_{i=0}^{j} (\upsilon_i \Delta Lnoil_{t-i}^+ + \sigma_i \Delta Lnoil_{t-i}^-) \\ &+ \sum_{i=0}^{k} (\varsigma_i \Delta Lnreelex_{t-i}^+ + \tau_i \Delta Lnreelex_{t-i}^-) + \sum_{i=0}^{k} (\omega_i \Delta Lnfoodin_{t-i}^+ + \psi_i \Delta Lnfoodin_{t-i}^-) + \varepsilon_t\end{aligned}$$

According to the above equation, a0 is the constant term, $\eta_{1i}, \beta_1^+, \beta_2^-, \chi_1^+, \chi_2^-, \varphi_1^+, \varphi_2^-$ are long-run coefficients and $v_i, \upsilon_i, \sigma_i, \varsigma_i, \tau_i, \omega_i$ and ψ_i short-run coefficients. In order to determine the optimal lag length of Equation (3), information criteria (Akaike, Schwarz, Hannan-Quinn, FPE) as well as the general-to-specific approach have been widely used in the literature. In this study, the general-to-specific approach is used. In this approach, models are estimated starting from a maximum lag length of 12 and statistically insignificant variables are excluded from the model and new estimates are made. In the models determined in this way, whether the series are cointegrated or not is tested under the null hypotheses $t_{BMD} : u = 0$ and $F_{PSS} : \eta_1 = \beta_1^+ = \beta_2^- = \chi_1^+ = \chi_2^- = \varphi_1^+ = \varphi_2^- = 0$. The test statistics obtained as a result of the tests are compared with the table values taken from Pesaran et al. (2001) and it is decided whether the series are cointegrated or not. However, since the number of regressors in the NARDL model is uncertain, the cautious approach in Shin et al. (2014) is followed and critical values based on k = 3 are used.

5. Results and Discussion

This study analyses the non-linear effects of gasoline, real exchange rate and food price index on vegetable and fruit exports. Firstly, the unit root test was applied to the series, and it was found that none of the series was stationary at the I(2) level, and it was determined that there was no problem in the NARDL model. Table 3 shows the results of the NARDL model. First of all, the error terms obtained from the models are tested for variance and autocorrelation using the White and LM tests, respectively. According to the results of the White test applied to the error terms obtained from the models for vegetable and fruit exports, the null hypothesis (There is no varying variance) cannot be rejected at 1%, 5% and 10% significance levels. It is determined that there is no varying variance problem in the error terms. Similarly, as a result of the LM test applied to the error terms in the model for vegetable exports, the null hypothesis (There is no sequential dependence between error terms) cannot be rejected at 1%, 5% and 10% significance levels and it is seen that there is no autocorrelation problem. On the other hand, it is noteworthy that the error terms of the model for fruit exports are autocorrelated. According to the NARDL models for vegetable and fruit exports, FPSS and tBDM tests revealed that there is a long-run relationship between the variables. The fact that the FPSS value is greater than the upper limit value of the table for both models indicates that there is a long-run relationship between the variables. tBDM test confirms the FPSS test. According to the Cusum and Cusum squared tests, the coefficients obtained from the model established for vegetable exports are stable. Still, the coefficients of the model established for fruit exports are unstable in the Cusum squared test.

Tablo 3: **Results of NARDL Models**

Vegetables Export		**Fruit Export**	
Constant	7.214 (0.792)	*Constant*	6.731 (0.808)
$Lnvebex_{t-1}$	-0.649 (0.072)	$Lnfruex_{t-1}$	-0.537 (0.065)
$Lnoil_{t-1}^+$	0.407 (0.219)	$Lnoil_{t-1}^+$	-0.002 (0.207)
$Lnoil_{t-1}^-$	-0.713 (0.221)	$Lnoil_{t-1}^-$	-0.056 (0.186)
$Lnreelex_{t-1}^+$	-0.618 (0.280)	$Lnreelex_{t-1}^+$	-0.581 (0.259)
$Lnreelex_{t-1}^-$	-1.264 (0.281)	$Lnreelex_{t-1}^-$	-0.905 (0.258)
$Lnfoodin_{t-1}^+$	-0.930 (0.386)	$Lnfoodin_{t-1}^+$	-0.019 (0.344)

Tablo 3 (Continued): **Results of NARDL Models**

Vegetables Export		Fruit Export	
$Lnfoodin^{-}_{t-1}$	0.240 (0.413)	$Lnfoodin^{-}_{t-1}$	-0.269 (0.353)
$\Delta Lnvebex_{t-1}$	0.258 (0.049)	$\Delta Lnfruex_{t-3}$	-0.078 (0.041)
$\Delta Lnvebex_{t-2}$	0.17 (0.051)	$\Delta Lnfruex_{t-4}$	-0.148 (0.043)
$\Delta Lnvebex_{t-7}$	-0.200 (0.046)	$\Delta Lnfruex_{t-5}$	-0.122 (0.048)
$\Delta Lnvebex_{t-8}$	-0.178 (0.046)	$\Delta Lnfruex_{t-6}$	-0.193 (0.047)
$\Delta Lnvebex_{t-9}$	-0.178 (0.048)	$\Delta Lnfruex_{t-7}$	-0.236 (0.051)
$\Delta Lnvebex_{t-10}$	-0.291 (0.049)	$\Delta Lnfruex_{t-8}$	-0.3 (0.053)
$\Delta Lnvebex_{t-11}$	-0.164 (0.055)	$\Delta Lnfruex_{t-9}$	-0.249 (0.055)
$\Delta Lnvebex_{t-12}$	0.272 (0.056)	$\Delta Lnfruex_{t-10}$	-0.43 (0.057)
$\Delta Lnoil^{-}_{t}$	-2.182 (0.753)	$\Delta Lnfruex_{t-11}$	-0.259 (0.063)
$\Delta Lnoil^{+}_{t-12}$	-1.352 (0.608)	$\Delta Lnoil^{+}_{t}$	-1.21 (0.604)
$\Delta Lnfoodin^{-}_{t-1}$	2.961 (1.399)	$\Delta Lnoil^{+}_{t-4}$	-1.426 (0.573)
$\Delta Lnfoodin^{+}_{t}$	-1.964 (0.832)	$\Delta Lnfoodin^{-}_{t}$	-1.719 (0.517)
$\Delta Lnfoodin^{+}_{t-1}$	2.778 (0.845)	$\Delta Lnfoodin^{-}_{t-4}$	-2.589 (1.136)
$\Delta Lnfoodin^{+}_{t-2}$	2.292 (0.819)	$\Delta Lnreelex^{-}_{t-2}$	1.598 (0.514)
$\Delta Lnfoodin^{+}_{t-3}$	2.144 (0.829)	$\Delta Lnreelex^{-}_{t-7}$	0.959 (0.502)
$\Delta Lnfoodin^{+}_{t-7}$	1.578 (0.796)	$\Delta Lnreelex^{+}_{t-10}$	-2.341 (0.64)
$\Delta Lnreelex^{-}_{t}$	-1.583 (0.572)	$\Delta Lnreelex^{+}_{t-11}$	2.354 (0.645)
$\Delta Lnreelex^{-}_{t-4}$	1.66 (0.56)		
$\Delta Lnreelex^{+}_{t}$	-1.947 (0.798)		
L^{+}_{oil}	**0.626* (0.330)**	L^{+}_{oil}	-0.004 (0.385)
L^{-}_{oil}	**-1.098*** (0.333)**	L^{-}_{oil}	-0.104 (0.346)
L^{+}_{rexer}	**-0.952*** (0.421)**	L^{+}_{rexer}	**-1.081*** (0.477)**
L^{-}_{rexer}	**-1.946*** (0.423)**	L^{-}_{rexer}	**-1.686*** (0.474)**
L^{+}_{foodin}	**-1.433*** (0.612)**	L^{+}_{foodin}	-0.036 (0.642)
L^{-}_{foodin}	0.370 (0.628)	L^{-}_{foodin}	-0.501 (0.660)
χ^2SC	0.140 [0.707]	χ^2SC	14.073 [0.000]

Tablo 3 (Continued): **Results of NARDL Models**

Vegetables Export		Fruit Export	
χ^2_{HET}	32.783 [0.204]	χ^2_{HET}	22.752 [0.592]
F_{PSS}	12.509	F_{PSS}	10.381
t_{BDM}	-9.048	t_{BDM}	-8.241
Cusum	s	*Cusum*	s
Cusum2	s	*Cusum2*	us

***Not**: *, ** and *** indicate that the null hypothesis is rejected at 1%, 5% and 10% significance levels, respectively. The symbol Δ denotes the first difference of the variables; those in parentheses denote standard errors and those in square brackets denote probability values. χ^2_{SC} and χ^2_{HET} denote LM and White tests, respectively.*

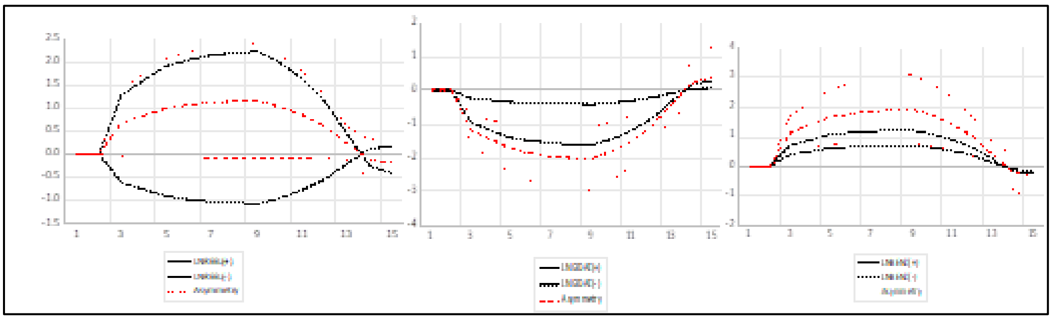
As can be seen in Table 3, a 1% positive increase in gasoline prices increases vegetable exports by 0.62% ($L^+_{oil} = 0.626$). Fossil fuels (gasoline and diesel) are essential inputs for agricultural production. Positive increases in fossil fuels lead to a rise in input prices and put upward pressure on producer prices. The increase in producer prices is directly reflected in consumer prices and increases the product prices. Countries' exports vary indirectly depending on the real exchange rate and the income level of their trading partners. Provided that the amount of vegetables that Turkey exports to other countries is constant, an increase in the price of the product will lead to an increase in volume, so the finding obtained here can be stated to be directly proportional to the theoretical. On the other hand, the increase in oil prices leads to increased demand for crops used in biofuel production, thus putting upward pressure on biofuel prices. Therefore, a close relationship exists between the biofuel sector and crude oil prices (Lajdoca et al., 2017; Galtier, 2022). A positive increase in oil prices increases both producer and consumer-based crop exports. A 1% negative increase in gasoline prices increases vegetable exports by 1.09% ($L^-_{oil} = -1.098$). The fact that oil is an important input for agricultural production and that its prices have fallen can be expressed as a positive situation for producers and consumers. A downward movement in input prices would push producer and consumer prices downwards, leading to higher demand. At the same time, a fall in oil prices may lead to reduced costs in the most important part of the supply chain, such as transportation, making agricultural exports more competitive (Puspitasari, 2018). Gündüz et al. (2017) and Bozma et al. (2023) stated that oil price uncertainties would significantly affect the prices and volatility of agricultural products. Especially Urak (2018) emphasized that positive and negative increases in gasoline prices will have different effects on the prices of agricultural products. Likewise, Table 4 shows that the alternative hypothesis that positive and negative increases in gasoline prices have different effects on vegetable exports is accepted at a 1% significance level (Wald test= 10.286). Graph 3 also shows the asymmetric effects of gasoline prices on vegetable exports.

Table 4: **Long-run and Short-Run Asymmetric Tests**

	Long-Run Asymmetric			**Short-Run Asymmetric**		
	W_{LR} (Oil)	**W_{LR} (ReelEx)**	**W_{LR} (Food)**	**W_{SR} (Oil)**	**W_{SR} (ReelEx)**	**W_{SR} (Food)**
Vegatable Export	**10.286** **[0.001]**	2.108 [0.146]	**24.486** **[0.000]**	0.350 [0.553]	2.390 [0.122]	1.945 [0.163]
Fruit Export	0.027 [0.867]	**24.959** **[0.000]**	1.481 [0.476]	**9.099** **[0.002]**	0.412 [0.520]	**5.194** **[0.022]**

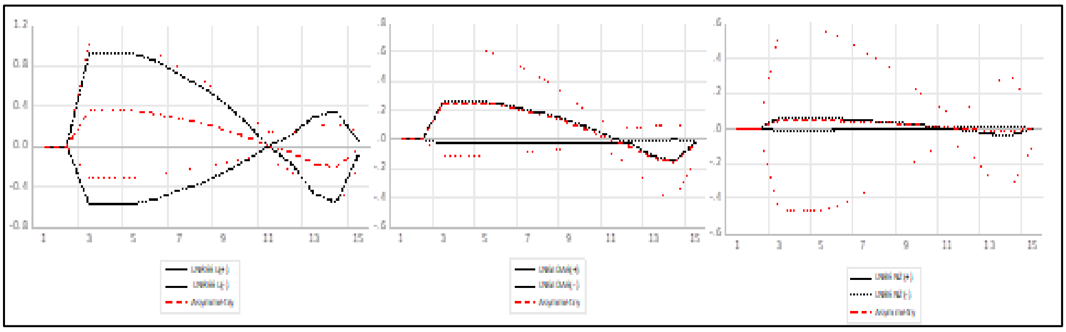
On the other hand, positive and negative increases in the real exchange rate have different effects on vegetable exports. However, as seen in Table 4, the null hypothesis of no asymmetric impact of the real exchange rate on vegetable exports cannot be rejected in the long run. In their study for Turkey, Sertoğlu and Doğan (2016) find that the real exchange rate has significant effects on agricultural exports, while Fidan (2006) considers that there is no relationship between the real exchange rate and agricultural exports in the long run. Finally, a 1% increase in the food price index is found to decrease vegetable exports by 1.433%. An increase in food prices means reduced purchasing power in the consumer context and less quantity of products sold. In terms of global competition, the fact that the prices of their products become more expensive may adversely affect competition and lead to a decrease in exports (Bahmani-Oskooee, 2009).

Figure 3: **Real Exchange, Gasoline and Food Price vs Vegetable Export Dynamic Multipliers (Long-Run and Short-Run Asymmetric)**



Considering that the autocorrelation problem in the model for fruit exports may cause inferences to be erroneous, positive and negative increases in gasoline prices do not have a statistically significant effect. On the other hand, positive and negative increases in the real exchange rate have a different and statistically significant impact on fruit and vegetable exports. However, Table 4 shows that, unlike vegetable exports, the real exchange rate has asymmetric effects on fruit exports in the long run. Bereket (2020); Şimşek (2017); Eshetu et al. (2020); Kingu (2014); Sever (2012) find that the real exchange rate has both positive and negative effects on agricultural exports. Uncertainty in the real exchange rate increases uncertainty about firms' profits in total and agricultural exports. This may significantly negatively affect exports in both the short and long run. Finally, the asymmetric effect of the real exchange rate on fruit exports may vary depending on various factors such as fruit type, country and market conditions (Shane, 2008).

Figure 4: **Real Exchange, Gasoline and Food Price vs Fruit Export Dynamic Multipliers (Long-Run and Short-Run Asymmetric)**



6. Conclusion

The present research examines the non-symmetrical impacts of crude oil prices, actual exchange rates, and food prices on the exportation of vegetables and fruits. The NARDL model's empirical evaluation results provide important insights into the agricultural sector's global trade dynamics. They further demonstrate the significance of considering the non-linear relationships among these variables. The outcomes of our analysis indicate that changes in the oil price, whether positive or negative, significantly influence the exportation of fruits and vegetables. Specifically, a rise in oil prices has a comparatively less favourable effect on the export of vegetables than a decline in prices. The previously mentioned research implies that the competitiveness for export of the agricultural industry is unequally impacted by the augmented transportation expenses linked with elevated oil prices. Additionally, it discloses that agricultural products and oil prices can influence one another owing to their interdependent complementarity and substitution relationships. Conversely, empirical evidence suggests that the impact of the real exchange rate on vegetable exports is not asymmetric. Instead, it shows a linear relationship over the long term. Consequently, as a policy recommendation, devaluing the Turkish lira could potentially enhance the competitive advantage of agricultural products in global markets, leading to a surge in export volumes and a favourable impact on the industry's trade balance. This, in turn, could positively influence the current account balance. Finally, this study investigates the effects of food prices on fruit and vegetable exports. The findings show that changes in food prices have an asymmetric impact. Empirically, it is observed that an increase in food prices has a more significant negative impact on export volumes than a decrease in prices. This finding suggests that rising food prices reduce the feasibility and competitiveness of agricultural commodities in the international market, thereby constraining export expansion.

It is recommended that governments offer financial assistance to farmers in the form of subsidies to mitigate the impact of escalating expenses associated with gasoline and other inputs. This measure could mitigate production costs and enhance farmers' profitability in exporting their commodities. Moreover, governments allocate resources towards research and development efforts to produce novel cultivars of fruits and vegetables that exhibit enhanced resistance to pests and diseases. Implementing this measure could mitigate the likelihood of loss of agricultural yield and guarantee a consistent flow of exported goods. It is recommended that governments facilitate trade agreements aimed at expanding the exportation of vegetables and fruits by accessing untapped markets. This measure could stimulate demand for said products and enhance export revenue. This study has some limitations. The research solely examined the impacts of gasoline prices, real exchange rate, and food price index on exporting fruits and vegetables in Turkey. The generalizability of the findings to other countries is uncertain. This factor poses a challenge in establishing a causal link between the variables. The study failed to account for additional variables that may impact the export of fruits and vegetables, such as climatic conditions, governmental regulations, and consumer preferences.

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