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The Impact of Crude Oil Import Prices on Household Natural Gas Prices: The Case of Turkey

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ABSTRACT

This study examines the impact of crude oil import prices on household natural gas prices in Turkey. The household sector natural gas prices are chosen as a dependent variable while crude oil import price and real exchange rate are chosen as independent variables. The data for the period 1990-2016 for these variables are analyzed by the ARDL, causality test, variance decomposition and impulse-response functions. As a result of the ARDL, it was concluded that both short-run and long-run crude oil import prices affect natural gas prices positively while the real exchange rate affects it negatively. The results obtained from the impulse-response functions confirm the results of the ARDL model. According to the causality test result, there is not any causality between crude oil import prices and household natural gas prices. However, it has been concluded that there is unidirectional causality from the real exchange rate to the natural gas prices.

ملخص

تبحث هذه الدراسة في تأثير أسعار استيراد النفط الخام على أسعار الغاز الطبيعي للاستخدام المنزلي في تركيا. ويتم اختيار أسعار الغاز الطبيعي للقطاع المنزلي كمتغير تابع بينما يتم اختيار سعر استيراد النفط الخام وسعر الصرف الحقيقي كمتغيرات مستقلة. ويتم تحليل بيانات الفترة 1990-2016 لهذه المتغيرات بواسطة الانحدار الذاتي للابطاء الموزع ((ARDL، واختبار السببية، والتفكك التبايني ودالات الاستجابة للقوى الدافعة. وكنتيجة للانحدار الذاتي للابطاء الموزع، تم التوصل إلى أن أسعار استيراد النفط الخام على المدى القصير والطويل تؤثر بشكل إيجابي على أسعار الغاز الطبيعي بينما يؤثر سعر الصرف الحقيقي عليها بشكل سلبي. وتؤكد النتائج التي تم الحصول عليها من دالات الاستجابة للقوى الدافعة نتائج نموذج الانحدار الذاتي للابطاء الموزع.وبناء على نتيجة اختبار السببية، لا توجد علاقة سببية بين أسعار استيراد النفط الخام وأسعار الغاز الطبيعي المنزلي. ومع ذلك، فقد تم التوصل إلى أن هناك علاقة سببية أحادية الاتجاه من سعر الصرف الحقيقي إلى أسعار الغاز الطبيعي.

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ABSTRAITE

Cette étude examine l'impact des prix des importations de pétrole brut sur les prix du gaz naturel pour les ménages en Turquie. Le prix du gaz naturel dans le secteur des ménages est choisi comme variable dépendante, tandis que le prix des importations de pétrole brut et le taux de change réel sont choisis comme variables indépendantes. Les données de ces variables pour la période 1990-2016 sont analysées par l'ARDL, le test de causalité, la décomposition de la variance et les fonctions de réponse impulsionnelle. À la suite de l'ARDL, il a été conclu que les prix des importations de pétrole brut à court et à long terme ont une incidence positive sur les prix du gaz naturel, tandis que le taux de change réel a une incidence négative. Les résultats obtenus à partir des fonctions de réponse impulsionnelle confirment les résultats du modèle ARDL. Selon le résultat du test de causalité, il n'y a pas de lien de causalité entre les prix des importations de pétrole brut et les prix du gaz naturel pour les ménages. Cependant, il a été conclu qu'il existe une causalité unidirectionnelle entre le taux de change réel et les prix du gaz naturel.

Keywords: Household natural gas prices, crude oil import prices, natural gas prices in Turkey, real exchange rate, Autoregressive Distributed Lag (ARDL)

JEL Classification*:* C22, Q21

1. Introduction

The growing demand for energy causes a rapid increase in energy prices in both developed and developing countries. An increase in energy demand and fluctuations in energy prices may harm many economic indicators in energy importing countries. An increase in energy prices not only affects the production of goods and services negatively but also causes an increase in inflation by increasing the cost of production in a given economy. In an oil-exporting country, an increase in the price of oil have enhanced the exchange rate, while in an oil-importing country, a fall in oil price can decrease the value of the exchange rate (Reboredo et al., 2014:132).

International crude oil prices, which have an impact on the prices of several energy products, could also affect natural gas (here after gas) prices. Since oil and gas are substitute goods, gas prices are dependent on international crude oil prices in the world. But, in recent years, gas markets have been developed at different levels in the unregulated zones (Ji et al., 2014: 96). Therefore the gas prices are mostly determined locally, while the crude oil prices are determined on the world market. (Villar and Joutz, 2006: 2). Increases in oil prices can affect the gas market from different aspects. An increase in crude oil prices will encourage consumers to substitute gas for petroleum products. Increases in crude oil prices arising from the increase in crude oil demand may increase the production of gas, which is a by-product of petroleum. Hence, this will be in the tendency to reduce gas prices. The increase in crude oil prices due to the increase in crude oil demand may cause an increase in gas prices because it will increase gas production and development costs (Villar and Joutz, 2006: 4). Electricity producers and large-scale fuel consumers, such as iron and steel plants and paper mills can change the type of fuel depending on the cost of each fuel and the elasticity of substitution between fuels. When the cost of other fuels falls, a decrease in gas prices might reduce gas demand. When the cost of substitute fuels increases more than the cost of gas, substituting gas for these fuels can increase gas demand and prices consequently (Energy Information Administration-EIA, 2017). EIA (2017) stated that in 2016 most of the electricity was generated from gas for the first time and it was a breaking of a record. So that the largest source for the overall electricity generation has become gas.

According to Giziene and Zalgiryte (2015), gas price is a major political and economic problem. Therefore, gas prices do not only create additional costs for households and industries but also affect the corporate global competitive power. There are internal and external factors that are affecting gas prices. Internal factors include the costs of the depreciation of the gas infrastructure and the costs of the facilities including gas infrastructure development costs, as well as the purchase, transportation, warehousing, and production costs. External indicators include energy price, fuel, distillation, coal, and local resources (Giziene and Zalgiryte, 2015: 115). There are also other factors that affect gas prices. Brown and Yücel (2008) emphasize that variables such as weather, stocks, hurricanes, and other seasonal factors have a significant effect on the dynamic adjustment of prices in the short-run. In his study of how air shocks affect the US gas prices, Mu (2007) concludes that the weather has a significant impact on gas prices.

Since gas is more environment-friendly than other fossil fuels, it is preferred in the household sector in many countries. Turkey is one of the countries that has adopted such a preference. As of 2017, households living in 76 of the 81 Turkish cities are using gas. Moreover, the government plans to complete the infrastructure investments at the end of 2018 so that gas will be available for the households living in all 81 cities. The total amount of the investment (excluding operating expenses and VAT) made by the companies, which have a gas distribution license, has increased by 15.24% as of the end of 2017 when compared to the previous year and reached 15.119 million TRY (Energy Market Regulatory Authority-EMRA, 2018). In addition, the gas consumption of the consumers, who are the subscribers of these companies increased by 15.19% to 13,081.67 million cubic centimeters (cm^3) when compared to the previous year. These data demonstrate that gas consumption in the Turkish household sector has increased and will continue to increase in the following years. Turkey imports a significant portion of its gas. In 2017, 55.249,95 million cm3 of gas were imported and gas imports increased by 19.20% when compared to 2016 (EMRA, 2018). Since domestic gas production is at the negligible level in Turkey (0.4 bcm - Billion Cubic Meters), almost all of the gas supplied to the market (48.2 bcm) is imported (International Energy Agency -IEA, 2016). As being Turkey's main source of fuel, gas constitutes 30.2% of Turkey’s total primary energy supply. Also in 2017, 37% of the electricity generated in Turkey was produced from gas (Republic of Turkey Ministry of Energy and Natural Resources, 2018). Since the households are the significant consumers of gas and electricity in Turkey, an increase in the gas prices may affect them directly through gas consumption and indirectly by causing an increase in the electricity production costs. Because the significant portion of the gas used in Turkey is imported, foreign exchange rates, strategic trade agreements between countries, and international political events may affect gas prices. Turkey's closeness to the rich gas reserves such as the Middle East and Central Asia and gas transport investments in Turkey made by these regions have the potential to diminish the increase in gas prices. Turkey has made some reforms in the gas market in 2001. These reforms include the liberalization of imports and arrangements made for the domestic gas market. Within this framework, in 2016, some amendments were made in the Natural Gas Market Law, which was enacted in 2001.

In the world and Turkey, the factors affecting the gas prices, of which consumption has been ever-increasing, become crucial. Price is an important factor affecting energy demand. Since the middle class constitutes a significant portion of the Turkish population (Yıldız and Bas, 2017), the increase in gas prices can create negative impacts on the life of this class. Therefore, policymakers need to determine the factors influencing gas prices in making effective decisions. This study aims to determine the relationship between international crude oil prices and gas prices consumed in the Turkish housing sector using different econometric methods. In the first part following the introduction section of the study, the literature summary is given in the second part, while in the third part empirical analysis is carried out and the study is completed with the results and suggestions.

2. Literature Review

Nowadays, gas is used in several areas, such as the production of goods and services in the industrial sector and final consumption in the household sector. The changes in gas prices may produce impacts in several areas. When the literature is examined, it is seen that energy economists have recently been working on gas prices.

When the studies on the determinants of gas prices are examined, it is seen that many studies focus on the cointegration relationship between gas and crude oil markets (Brigida, 2014; Ramberg and Parsons, 2012; Panagiotidis and Rutledge, 2007; Bachmeier and Griffin, 2006). However, in recent years, there have also been studies showing that there is a gas market separated from the oil market (Batten et al., 2017, Caporin and Fontini, 2017, Nick and Thoenes, 2014). Therefore, Geng et al. (2017) emphasized that the dynamic relationship between gas and crude oil prices is very complicated due to fluctuations in their prices and that there are different linear and nonlinear causalities between oil and gas markets. Jadidzadeh and Serletis (2017) stated that a response of gas prices to an oil price shock depends on the source of a shock. Besides, Nick and Thoenes (2014) suggested that gas prices are mainly affected by both coal and crude oil prices. Bekheta et al. (2016) stated there are significant linear effects between gas prices and their determinants. Misund and Oglend (2016) investigate the dynamic relationship between daily shocks in gas demand and supply and gas spot price volatility in the United Kingdom. They found evidence that the daily deviations in total gas demand have significant influences on the volatility. Besides, they concluded that the decline in the volatility has been associated with a diminishing demand and a decline in the crude oil volatility.

Considering the literature in the world, it is seen that different samples, methods, and periods are discussed in studies on the relationship between oil and gas prices. In this context, studies in the literature on the issue are arranged in term, sample, method, and result and are presented in Table 1.

Table 1: Summary Literature Findings

Author(s)	Year	Country	Method	Result
Hartley and Medlock III (2014)	1995:1-2011:12	United States	ECM and Johansen cointegration	The exchange rate was decided to be an important determinant of the relative gas prices with respect to crude oil.
Ji et al. (2014)	1997:1-2011:8	North America, Europe and Asia	VAR	It was determined that the volatility in oil prices has a negative impact on regional gas prices.
Hulshof et al. (2016)	2011-2014	Netherlands	Linear regression model	It was determined that the oil price has little effect on the gas price and the coal price has no effect on the gas price.
Atil et al. (2014)	1997:1-2012:9	United States	NARDL	It has been found that oil prices affect gasoline prices and gas prices in an asymmetric and non-linear manner, and it is found that the price transmission mechanism is not the same.
Brigida (2014)	1997:6-2012:9	United States	Markov-switching cointegrating, ECM	It was determined that there is a significant relationship between oil prices and gas prices.
Ramberg and Parsons (2012)	1997:6-2010:12	United States	VECM and conditional ECM	It was determined that there was a cointegration relationship between gas and oil prices and this relationship changes over time. Also, it has been determined that oil prices positively affect gas prices in both the short-term and long-term.

Table 1: Summary Literature Findings(cond)				
Author(s)	**Year**	**Country**	Method	**Result**
Bachmeier and Griffin (2006)	1990:1-2008:8	United States	ECM	They found a very weak relationship between crude oil, coal, and gas markets.
Panagiotidis and Rutledge (2007)	1996-2003	United Kingdom	Johansen (1995) and Breitung (2002) cointegration test, ECM	They concluded that there is a long-term balance between gas and oil prices.
Jadidzadeh and Serletis (2017)	1976:1-2012:12	United States	VAR	Crude oil prices were found to be an important factor of gas prices.
Lin and Li (2015)	2008:1-2012:6	United States, Europe and Japan	VEC-MGARCH	European and Japanese gas prices are co-integrated with Brent oil prices, but the US gas price has been separated from the oil.
Nick and Thoenes (2014)	2008:1-2012:6	Germany	structural VAR	Gas prices are affected in the short-run by the shortcomings of temperature, storage, and supply, while in the long-run they are tightly coupled with both crude oil and coal prices.
Batten et al. (2017)	1994:1-2014:12	Russia	Causality test	It was specified that there is no evidence for a consistent relationship between oil and gas markets.
Caporin and Fontini (2017)	1997:1-2013:12	United States	VECM	They stated that it is certainly not possible to assess whether a new long-term relationship between oil and gas has been established.
Mohammadi (2009)	1960-2007	United States		There is an insignificant relationship between electricity and crude oil and gas prices in the long-run.
Méndez-Carbajo (2011)	1990-2008	Dominica	VECM	A bi-directional causality finding between gas prices and real exchange rate has been found.
Geng et al. (2017)	1997:1-2016:1	North America and Europe	EEMD, linear and nonlinear and GCT	It was determined that there is bidirectional nonlinear causality between oil and gas markets.
ECM: Error Correction Model; VAR: Vector Autoregressive Model; NARDL: Nonlinear Autoregressive Distributed Lag; VECM: Vector Error Correction Model; EEMD: Ensemble Empirical Model Decomposition Method; GC Test: Granger causality tests				

It is shown in Table 1 that different results have been obtained in empirical studies conducted on different countries with different methods on the subject. For example, in the studies carried out by Ji et al (2014), Hulshof et al. (2016), Atil et al. (2014), Brigida (2014), Ramberg and Parsons (2012), Jadidzadeh and Serletis (2017) and Mohammadi (2009), it has been found that there is a significant relationship between gas prices and oil prices. In some studies, it has been also found that there is a causal relationship between gas and oil prices (Méndez-Carbajo, 2011; Geng et al. 2017).

In Turkey, there is a very limited number of studies on the relationship between gas and oil prices. In their study, which examined the causal relationship between oil and gas prices in Turkey for the period 2000-2011 Akgül and Burucu (2013) concluded that there is a bidirectional causality relationship between oil prices and gas prices. The relationship between gas and oil price indices and Istanbul Stock Exchange industrial sector indices in Turkey for the period October 2005- September 2015 was tested in Eyüboğlu and Eyüboğlu (2016) via Johansen cointegration method, VECM, and GC test. It has been determined that there is a long-run relationship between existing indices and both gas and oil prices. On the other hand, there is not any study on the determinants of the gas prices in the household sector in Turkey.

3. Data and Methodology

3.1. Data

In this study, the impact of crude oil import prices and the real exchange rate on the household gas prices in Turkey was examined by using annual data for the period 1990-2016. The explanations for the variables and the sources from which the variables are obtained are given in Table 2. The relationship established between the dependent variable and the independent variables in the study was established in a logarithmic form and is presented in Equation 1.

$$\ln GP_t = \alpha_0 + \alpha_1 \ln OP_t + \alpha_2 \ln RER_t + u_t \qquad (1)$$

Here, ln*GP*, ln*OP*, and ln*RER* are the household sector gas price, crude oil import price, and real exchange rate respectively. ln*GP* was converted to real form by proportioning to the US GDP deflator. The real exchange rate was calculated by proportioning to the nominal exchange rate purchasing power parity (PPP).

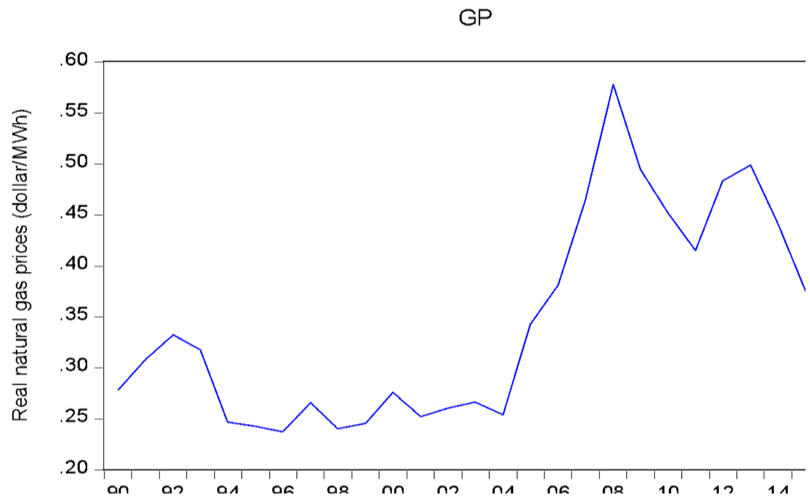
Table 2: Variables and Their Descriptions

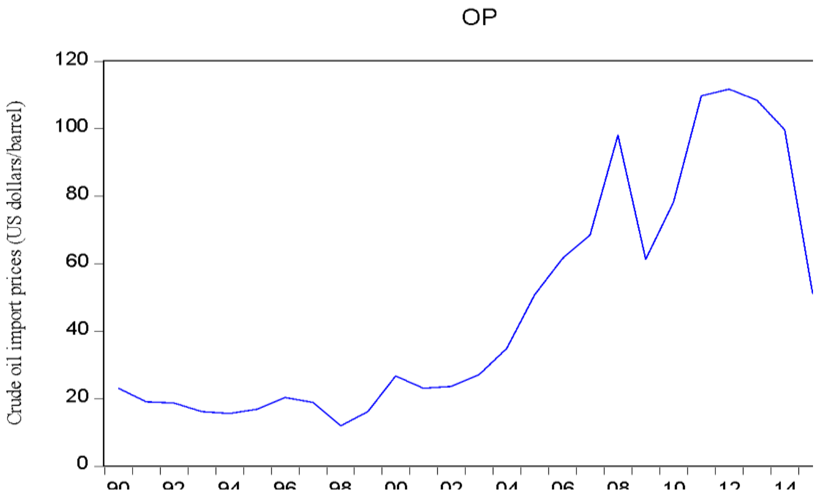
Variable	Description	Sources
ER	Exchange rate, national currency/USD	Penn World Table
PPP	GDP (LCU per international $)	World Bank Database
RER*	Exchange Rate/ Purchasing Power Parity	Penn World Table and World Bank Database
OP**	Crude oil import prices (US dollars/barrel)	OECD
GP***	gas prices for household (US dollar/MWh)**	IEA

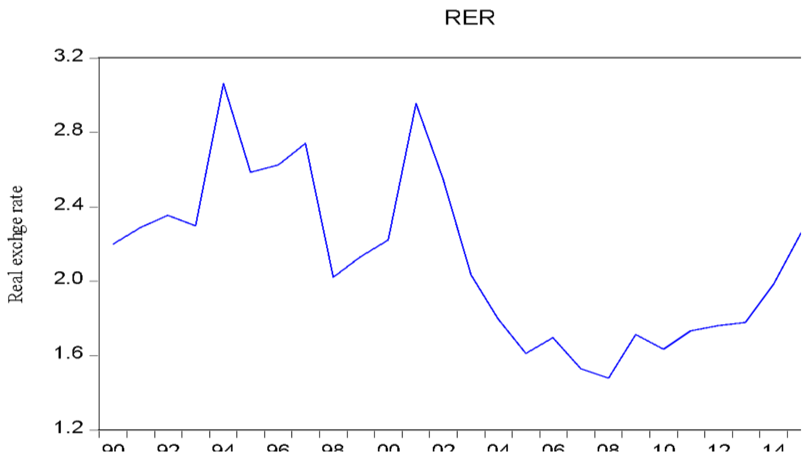
Note:* This variable was calculated by the authors. ** The Crude oil import price was calculated using the deflator for GDP at market prices and rebased with reference year 1970 = 100.
***deflated using the GDP deflator of the United States

The charts for time series of variables used in the study for Turkey are shown in Figure 1.

Figure 1: Charts of Time Series of Variables Used in the Study







According to the chart for the household gas prices, the household gas prices have remained at low levels from 1990 to 2005. However, after 2005, the price had increased and the household gas price peaked together with the 2008 global economic crisis while it had decreased after 2008 and hit rock bottom in the 2011-2012 period. Increasing prices in the period 2012-2014 have decreased after 2014. Crude oil import prices started to increase after 2002 and this trend came to an end with the peak of oil prices during the 2008 global economic crisis. Crude oil import oil price, which started to diminish after 2008, hit rock bottom in the period 2009-2010 and after that had increased until 2011. After 2012, crude oil import prices have declined. When the charts related to household gas prices and crude oil import prices are examined, it is seen that there has been parallelism with a one or two year lag between gas prices and oil prices after 2002. This implies that the relationship between gas and crude oil import prices has been increasing. In Turkey, the real exchange rate had increased during the times of local crisis (i.e. crisis in 1994, 1998-1999, and 2001) while the real exchange rate had decreased during the 2008 global economic crisis. However, after 2008, the real exchange rate has followed an increasing trend.

3.2. Estimation Techniques

The impacts of crude oil import price and real exchange rate on household gas prices have been examined via the ARDL method, GC test, impulse-response functions, and variance decomposition. First, variables were tested through unit root tests to examine the stationarity of the variables. Then the ARDL bounds test method was used to obtain co-integration and short and long-run coefficients. The GC test was applied to examine whether there is a causality between variables. Finally, the obtained results and evidence are tried to be verified by the impulse-response and variance decomposition methods.

Before the estimation of the model expressed by Equation (1), the stationary characteristics of the series of the variables in the model were examined. Augmented Dickey Fuller-ADF (1981) and Phillips and Perron-PP (1988) unit root tests were used to test the stationarity of the variables. The null hypothesis for these tests was that the series contain unit root whereas the alternative hypothesis was that the series does not contain the unit root.

Since a long-run relationship between household gas prices and the oil prices has been investigated, the stability of the series was examined by considering that there may be a structural break, via Zivot and Andrews-ZA (1992) test, which considers structural breaks. The ZA test is a test that pays regard to a single break and assumes a break period is determined internally in the model. If the t statistics calculated in the ZA test are larger than the table critical values of Zivot and Andrews (1992) in absolute value, the basic hypothesis of unit root is rejected. Perron (1989) has shown that standard ADF tests tend to non-rejection of the unit root hypothesis in the presence of structural variations since it can be misleading to decide whether variables are stationary based on standard unit root test results. Hence, the ZA unit root test was applied to all variables.

Since the ARDL bounds test approach, which is created by Pesaran et al. (2001), allows the cointegration method to be applied in series, which are stationary at different levels, it differs from Engle and Granger (1987) and Johansen and Juselius (1990) co-integration tests. When the data set is considered, the ARDL model used in the study for co-integration is presented in Equation (2).

$$\Delta \ln GP_t = \alpha_1 + \sum_{i=1}^{p1} \phi_{1i} \Delta \ln GP_{t-i} + \sum_{j=0}^{q1} \delta_{1j} \Delta \ln OP_{t-j} + \sum_{k=0}^{r1} \theta_{ik} \Delta \ln RER_{t-k} + \gamma_1 \ln GP_{t-1} + \gamma_2 \ln OP_{t-1} + \gamma_3 \ln RER_{t-1} + \varepsilon_{t1} \quad (2)$$

Here; Δ, is a difference operator; ε_t, is a term for standard error. Terms ϕ_1, ϕ_2, ϕ_3, indicates the short-run relationship while $\gamma_1, \gamma_2, \gamma_3$ state the long-run relationship. In the model, the relationship between the variables was investigated by using the above-mentioned unrestricted error correction model-VECM and with respect to the *F* statistics. Hypotheses regarding the *F* test statistics are given below.

$H_0 = \gamma_1 = \gamma_2 = \gamma_3 = 0$ (there is no cointegration)

$H_1 = \gamma_1 \neq \gamma_2 \neq \gamma_3 \neq 0$ (there is cointegration)

The appropriate lag length is determined by considering the information criterion of the Schwarz Bayesian Criterion (SBC). If the estimated *F-test* statistic is higher than the upper critical bound, the null hypothesis that there is no cointegration is rejected (i.e. there is co-integration) while the null hypothesis cannot be rejected if the estimated *F-test* statistic is under the lower critical bound (i.e. there is no cointegration). If the estimated *F-test* statistic is between the lower and upper limits, no definite comment can be made as to whether or not co-integration occurs.

If there is a long-run relationship (co-integration) between the variables, the long-run and the short-run models which are presented in Equation 3 and Equation 4, respectively, are estimated.

$$\ln GP_t = \alpha_2 + \sum_{i=1}^{p2} \phi_{2i} \Delta \ln GP_{t-i} + \sum_{j=0}^{q2} \delta_{2i} \Delta \ln OP_{t-j} + \sum_{k=0}^{r2} \theta_{2i} \Delta \ln RER_{t-k} + \varepsilon_{t2} \quad (3)$$

$$\Delta \ln GP_t = \alpha_3 + \sum_{i=1}^{p3} \phi_{3i} \Delta \ln GP_{t-i} + \sum_{j=0}^{q3} \delta_{3j} \Delta \ln OP_{t-j} + \sum_{k=0}^{r3} \theta_{3k} \Delta \ln RER_{t-k} + \varphi ECT_{t-1} + \varepsilon_{t3} \quad (4)$$

Here, φ is the coefficient of the error correction term. It indicates how swiftly the variables have reached equilibrium and should have a statistically significant and negative sign.

The GC test was performed to specify the causality between variables (Table 6). The GC test consists of estimating the following equations:

$$\Delta \ln GP_t = \vartheta_0 + \sum_{i=1}^{n} \vartheta_{1i} \Delta \ln GP_{t-i} + \sum_{i=1}^{n} \vartheta_{2i} \Delta \ln OP_{t-i} + \sum_{i=1}^{n} \vartheta_{3i} \Delta \ln RER_{t-i} + u_1 \quad (5)$$

$$\Delta \ln OP_t = \varphi_0 + \sum_{i=1}^{n} \vartheta_{1i} \Delta \ln OP_{t-i} + \sum_{i=1}^{n} \varphi_{2i} \Delta \ln GP_{t-i} + \sum_{i=1}^{n} \varphi_{3i} \Delta \ln RER_{t-i} + u_2 \quad (6)$$

$$\Delta \ln RER_t = \square_0 + \sum_{i=1}^{n} \vartheta_{1i} \Delta \ln RER_{t-i} + \sum_{i=1}^{n} \square_{2i} \Delta \ln GP_{t-i} + \sum_{i=1}^{n} \square_{3i} \Delta \ln OP_{t-i} + u_3 \quad (7)$$

In the above-mentioned equations; $\vartheta_i, \varphi_i, \square_i$ are coefficients, *n* is the optimum lag length, u_i is the error term, ln*GP*, ln*OP* and ln*RER* are the time series of which causality relationships are searched and Δ is a difference operator.

In order to evaluate the diagnostic test results of the model, the Breusch-Godfrey LM test for the auto-correlation test, the Jarque-Bera test for normality test, White test for heteroscedasticity test, and Ramsey Reset test for the correct use of the model were used. Then, CUSUM and CUSUMSQ graphs, which are developed by Brown et al. (1975) to test the stability of the long-run ARDL coefficients, were presented. After that, causality analysis developed by Granger (1969) was conducted to determine the direction of the relationship between the variables.

Finally, impulse-response functions and variance decomposition tools were used to interpret the dynamic structure of the model. Variance decomposition is an analysis technique that shows what percentage of change in any given variable is directly dependent on the variable itself, and what percentage depends on other variables. If a large part of the change in a variable arises from its shocks, this implies that such the variable acts exogenously. However, if the change in a variable arises from other variables in the model, it is indicated that the variable is endogenous (Enders, 1995: 311). The impulse-response analysis shows how and to what extent each variable in the model reacts to the shocks that occur in the error terms and as well as how and to what extent the other variables react. In other words, these functions show the own reaction of each variable to one unit shock or the reaction of other variables to such shock.

4. Empirical Results

4.1. Testing For Unit Roots

The results of the ADF and PP unit root tests are shown in Table 3. As a result of the ADF and PP unit root tests, it is concluded that all variables are non-stationary at the level values. However, when the first differences of these variables are taken, it is seen that the series becomes stationary, which is I (1).

Table 3: The Unit Root Test Results for Variables

Variables	ADF		PP	
	Constant	Constant and trend	Constant	Constant and trend
lnGP	-1.3323	-1.3710	-1.4722	-1.6437
	(0.5989)	(0.8455)	(0.5314)	(0.7469)
lnOP	-1.0297	-1.4863	-1.0297	-1.4863
	(0.7271)	(0.8082)	(0.7271)	(0.8082)
lnRER	-1.6813	-1.7971	-1.6917	-1.8644
	(0.4285)	(0.6769)	(0.4235)	(0.6437)
lnΔGP	-3.7469	-3.6800	-3.7613	-3.6966
	(0.0095)***	(0.0429)**	(0.0092)***	(0.0415)**
lnΔOP	-4.2201	-4.1772	-4.1835	-4.1333
	(0.0031)***	(0.0153)**	(0.0034)***	(0.0168)**
lnΔRER	-5.2601	-5.2079	-5.2610	-5.2097
	(0.0003)***	(0.0016)***	(0.0003)***	(0.0016)***

***1% significance level, **5% significance level

Note: Δ, indicates the first difference of the variables.

Gas prices, which are dependent variables in the model, are stationary at I (1) level in fixed and fixed and trending models. This indicates that the precondition of the ARDL model has been met.

The results of the Zivot-Andrews unit root test are presented in Table 4. Table 4 demonstrates the test statistics generated for the breaking in constant and constant and trending models of the series, the corresponding critical values, and structural break periods determined with respect to minimum *t* statistics.

Table 4: The Zivot-Andrews Unit Root Test

	Constant		Constant and trend	
Variables	**Min. t-Statistic**	**Break Period**	**Min. t-statistic**	**Break Period**
lnGP	-3.892 (1)	2005	-3.463 (1)	2007
lnOP	-2.236 (0)	2005	-3.267 (0)	2011
lnRER	-3.759 (0)	2003	-3.629 (0)	2003
Critical Values : 1% : -5.34 5% : -4.93			Critical Values : 1% : 5.57 5% : -5.08	

Note: Values in parentheses indicate the number of lags. Critical values of both models are taken as the Zivot and Andrews (1992: 258).

No variable can reject the null hypothesis that there is a structural breaking unit root for both fixed and fixed and trending models. Therefore, it is seen from the results of the Zivot-Andrews unit root test that structural breaks in the series do not significantly affect results of the traditional ADF unit root test and that all series are at I(1) level.

4.2. Co-integration And Short- And Long Term Results

The results of the cointegration test are given in Table 5. The estimated *F-test* statistic is greater than the upper critical value of both 5% and 10% significance level. Moreover, because the sample size is small, the *F-test* statistic is also higher than the upper critical value both at 5% and 10% significance level according to critical values suggested by Narayan (2005). For this reason, the hypothesis that there is no cointegration in the model (H_0) is rejected. Specifically, these results indicate that there is a long-run relationship between variables. This result is supported by the studies of Brigida (2014), Hartley and Medlock III (2014), Ramberg and Parsons (2012), Bachmeier and Griffin (2006), Panagiotidis and Rutledge (2007), and Lin and Li (2015). A common conclusion from these studies is that there is a relationship between gas prices and crude oil prices.

Table 5: The Conclusions of Cointegration tests

	F- statistic	**k**
	6.09	2
Critical Value Bounds		
Significance level	**I(0)**	**I(1)**
10 %	3.17	4.14
5 %	3.79	4.85
1 %	5.15	6.36
Narayan (2005)		
10%	3.43	4.47
5%	4.26	5.47
1%	6.18	7.87

Note: k, represents the number of independent variables.

The estimation results of the models that are expressed by Equations (3) and (4) are given in Table 6. In the model, the information criteria of Schwarz Bayesian Criterion (SBC) and 4 lags were taken into consideration in determining the lag lengths. Specifically, the short and long-run coefficients of the ARDL (1, 0, 0) model are tendered in Table 6.

The short- and long-run results from ARDL presented in Table 6. In the short-run, the coefficient for crude oil import prices was estimated at 0.10. As expected, this coefficient is positive and statistically significant at a 10% significance level. The 1% increase in crude oil import price, increases the household gas price by 0.10%. Also, the 1% increase in the real exchange rate reduces the household gas price by 0.33%. This coefficient is statistically significant at a 5% significance level. In the long run, the coefficient for crude oil import price is estimated at 0.22. The 1% increase in crude oil import price increases household gas prices by 0.22%. The 1% increase in the real exchange rate reduces the household gas price by 0.71% in the long run. Nonetheless, it was concluded that the positive impact of crude oil import prices on gas prices is more in the long-run when compared with the short-run. These results confirm the results of Ramberg and Parsons (2012), Panagiotidis, and Rutledge (2017). Here, *ECT*, which has a statistically significant coefficient with a negative sign (-0.47), demonstrates that about 47% of a deviation at time *t-1* will be corrected at time *t* (Table 6). That is to say, if in the short-run, there is a deviation from the long-run equilibrium, the system will reach the equilibrium in 2 quarters (1/0.47=2.12).

Table 6: Short- And Long-Term Coefficients

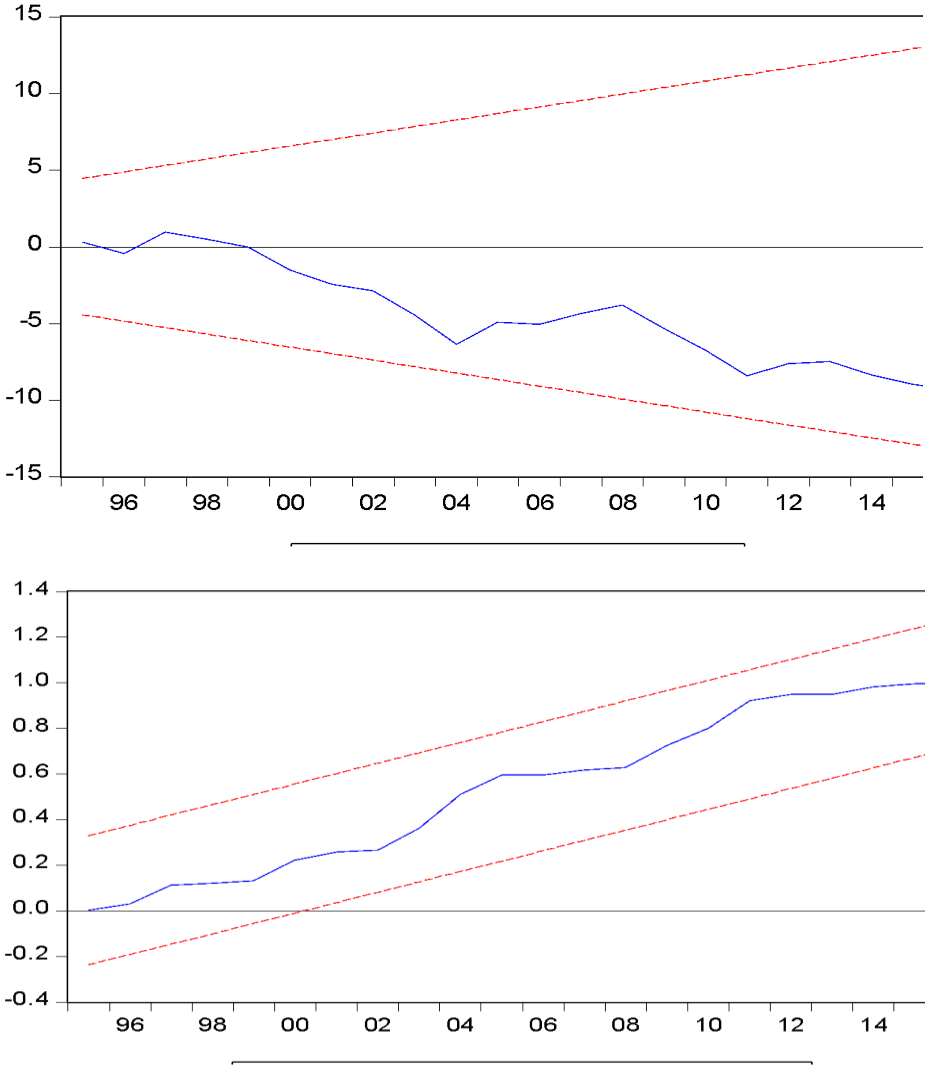
Short Term Coefficients			
Variables	**Coefficient**	**Std. error**	**t-Statistic**
Constant	-0.6541	0.3431	-1.9064*
lnGP(-1)	0.5277	0.1080	4.8837***
lnOP	0.1070	0.0526	2.0342*
lnRER	-0.3361	0.1338	-2.5105**
ECT(-1)	-0.4722	0.1080	-4.3706***
Long Term Coefficients			
Variables	**Coefficient**	**Std. error**	**t-Statistic**
Constant	-1.3851	0.5219	-2.6537**
ln*OP*	0.2266	0.0834	2.7144**
ln*RER*	-0.7116	0.3443	-2.0665*
R^2	0.9082		
Adj R^2	0.8957		
F-statistic	72.5883[a]		
DW	1.5993		
Diagnostic tests	**Statistic**	**Prob. value**	
χ^2 *NORMAL*	0.0843	0.9586	
χ^2 *SERIAL*	0.6830	0.5165	
χ^2 *WHITE*	0.4514	0.8861	
χ^2 *RESET*	0.2369	0.6314	

***1% significance level, **5% significance level, **10% significance level

Note: χ^2 NORMAL, the Jarque-Bera test for normality; χ^2 SERIAL, the Breusch-Godfrey Serial Correlation LM (autocorrelation) test; χ^2 WHITE, Heteroscedasticity test; χ^2 RESET, the Ramsey Reset test.

When the diagnostic test results of the model are evaluated, it is seen that there is no auto-correlation problem in the model according to the Breusch-Godfrey LM test results, the error term is normally distributed according to the Jarque-Bera test results, there is no variance problem in the model according to the White test results and the model was established with the right specifications according to the Ramsey Reset Test results. Therefore, these results support that the estimation results obtained are reliable. CUSUM and CUSUMSQ graphs, which are developed by Brown et al. (1975) to test the stability of the long-run ARDL coefficients, are presented in Figure 2.

Figure 2: CUSUM and CUSUMSQ



According to these tests, the calculated coefficients are stable because the curves, which are obtained as a result of test statistics for error terms, are between the critical limits at the level of 5% significance. Hence, the stability of long-run estimates has been confirmed.

4.3. Results of Causality Test Between Variables

The GC test was carried out to specify the direction of the relationship between variables. GC test result demonstrated in Table 7. According to the GC test results, there is no causality between the crude oil import prices and the household gas prices. However, there is unidirectional causality from the real exchange rate to the gas prices. Also, there is unidirectional causality from the real exchange rate to the crude oil import price at a 10% significance level. Méndez-Carbajo (2011) has concluded that there is a unidirectional causality between gas price and the real exchange rate. Wang and Wu (2012) found a unidirectional nonlinear causality from the exchange rate to the natural gas price. These results support the result obtained while do not support the result that there is a unidirectional linear causality from crude oil import prices to natural gas price and bi-directional non-linear causality between crude oil import prices and gas prices which are obtained by Geng et al. (2017).

Table 7: Findings of Causality Test Between Variables

Variables	lnGP	lnOP	lnRER
lnGP	-	1.4178 (0.2656)	4.9108** (0.0184)
lnOP	0.2644 (0.7703)	-	2.6006 (0.0991)*
lnRER	0.0283 (0.9721)	0.0804 (0.9230)	-

**5% significance level

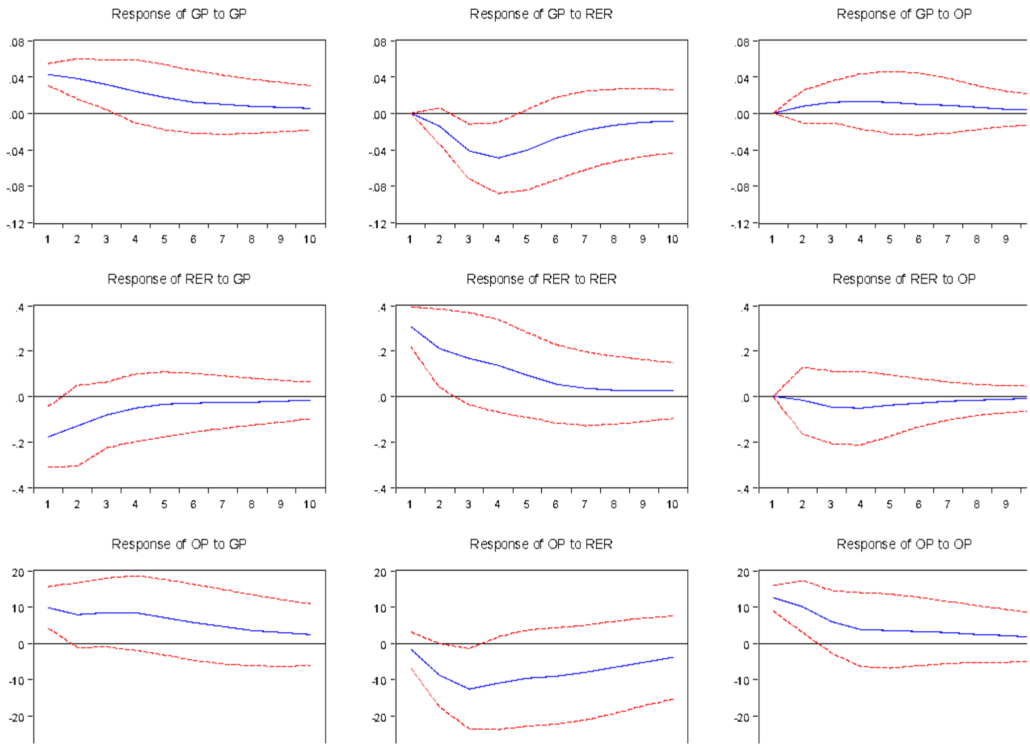
**10% significance level

Note: Expressions in parentheses indicate p-value (probability) value.

4.4. Results of Impulse-Response Functions and Variance Decomposition Analysis

The results of impulse-response functions and variance decomposition used for estimating the reaction of household gas prices to a shock in crude oil import price and in the real exchange rate are presented in Figure 3 and Table 8 respectively.

Figure 3: Impulse-Response Function



The findings obtained from the impulse-response functions affirms the results of the ARDL model. As a response to a standard error shock in crude oil import price (ln*OP*), the household gas price (ln*GP*) had given positive but increasing reaction until the middle of the fifth period. After this period, the reaction has continued to be positive but declining. On the other hand, as a response to a standard error shock in the real exchange rate (ln*RER*), the household gas price (ln*GP*) had given negative but the declining reaction until the middle of the fourth period. In the following periods, however, the reaction has been negative but increasing. Obtained impulse-response and variance decomposition results support the results of Ji et al. (2014). The variation in gas and oil prices affects investment decisions of the private firms in the production process while influencing the welfare level of the household in the consumption process. Therefore, as Atil et al. (2014) point out, the development of appropriate energy policies in the production and consumption stages requires the strategic development of alternative energy sources and the adjustment in oil and gas prices.

Table 8: Variance Decomposition (V.D.)

V.D. of GP					V.D. of RER				V.D. of OP			
	S.E.	GP	RER	OP	S.E.	GP	RER	OP	S.E.	GP	RER	OP
1	0.04	100.0	0.000	0.00	0.35	25.06	74.93	0.00	15.88	37.89	1.32	60.78
2	0.06	92.95	5.55	1.48	0.43	25.66	74.16	0.16	22.16	31.62	16.67	51.69
3	0.08	66.24	30.48	3.26	0.47	24.42	74.42	1.14	27.51	30.03	31.83	38.12
4	0.09	50.42	45.61	3.95	0.49	23.10	74.78	2.10	30.99	30.76	37.71	31.52
5	0.10	44.18	51.34	4.46	0.50	22.51	74.84	2.63	33.37	31.07	40.74	28.18
6	0.11	41.84	53.21	4.94	0.51	22.40	74.69	2.89	35.18	30.61	43.17	26.20
7	0.11	40.92	53.78	5.28	0.51	22.45	74.53	3.01	36.50	29.99	45.01	24.99
8	0.11	40.54	53.96	5.48	0.51	22.52	74.39	3.07	37.35	29.55	46.13	24.31
9	0.11	40.37	54.03	5.59	0.51	22.57	74.31	3.11	37.86	29.32	46.72	23.94
10	0.11	40.27	54.08	5.64	0.51	22.60	74.26	3.13	38.17	29.22	47.030	23.747

As a result of the variance decomposition analysis the household gas price is affected by its own lags at 100% in the first period while in the second period, it is affected by its own lags at 92.9%. Besides, in the second period, the household gas prices are affected by the real exchange rate at 5.5% and by crude oil import price at 1.48%. At the end of ten semesters, gas price is affected by their own lags at 40.2%, while it is affected by the real exchange rate at 54.08% and by crude oil import price at 5.64%. Meanwhile, the fact that most of the changes in the household gas price do not originate from the shocks of itself implies that household gas price moves intrinsically.

5. Conclusion

In this study, the impact of the crude oil import price on the gas price was examined. Besides, the effect of the real exchange rate on the gas price is taken into consideration as a control variable. The results of the study provide strong evidence to support the assertion that is linear in the relationship between oil and gas that is expressed in empirical studies.

The ARDL bounds test method was used to determine the short and long-run relationship between gas price and crude oil import price. As a result of this test, it is concluded that there is a long-run relationship between gas prices and crude oil import prices. Besides, in the short-run, it was determined that the crude oil import price has affected gas prices positively. The reason why crude oil prices positively affect household gas prices can be expressed as an increase in crude oil prices prompting end-users to substitute gas for petroleum products in consumption. The realization of this situation increases the demand and therefore the prices of gas. Increasing crude oil prices due to the increase in crude oil demand increases gas production and development costs (Villar and Joutz, 2006). This increase may also cause an increase in gas prices. The fact that the increase in oil prices puts gas prices on an upward trend puts pressure on the limited budget of the household. Therefore, changes in oil prices can change the policies of companies, economic policies of countries, and relations between countries. It is found in the study that the real exchange rate has a significant and negative impact on gas prices both in the short and the long-run. This result shows that gas prices are affected by the fluctuations in the real exchange rate.

Whether there is a causality between gas prices and crude oil import prices are tested by the GC test. As a result of this test, it is concluded that there is no causality between the crude oil import price and the gas price while there is unidirectional causality from the real exchange rate to the gas price. Results of impulse-response functions and variance decomposition, which are used to examine the dynamic impact of variations in the crude oil import price and the real exchange rate on the gas price, support the obtained results. According to the impulse-response functions, crude oil import price affects gas prices positively, while the real exchange rate affects it negatively. Variance decomposition results imply that household gas prices move intrinsically.

Gas and oil are two sources of energy that are extremely important for the economy of Turkey. The relationship between crude oil and gas prices seems to be strong and positive in Turkey. Turkey has a high degree of dependence on oil imports. Hence, because an increase in oil price increases the consumption of high-grade gas, this increase in demand will lead to an increase in household gas prices. From this point forth, Turkey should increase investments in gas projects corresponding to the increasing gas consumption. Also, to reduce the increasing effect of crude oil prices on gas prices, gas supply should be increased. The way to achieve this is to discover cheap gas resources in its geography and to make cheap gas agreements with the surrounding gas-rich countries. At the same time, since gas is a cleaner source of energy, it might be effective in reducing air pollution by increasing gas consumption through price.

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