



AN EMPIRICAL STUDY ON THE RELATIONSHIP BETWEEN CRUDE OIL PRICES AND CURRENT ACCOUNT DEFICIT IN TURKEY

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ABSTRACT

The foreign trade balance of countries such as Turkey which import energy is considerably responsive to energy prices and especially to crude oil prices. Considering the increase in crude oil prices in the last 15 or 20 years, this situation is presumed to be affecting negatively the current accounts balance. Increase in crude oil prices affect enterprises in Turkey as well, because crude oil prices appear to be the factor directly affecting the costs of enterprises.

In this study, it is aimed to determine how the fluctuations in oil prices which have various influence on Turkish economy effect Turkish current account deficit in the 1998Q1-2015Q3 period using time sequence method. In this framework, stationarity of series concerning the variables of Brent crude prices and of the ratio between Turkey's current account deficit and GDP is examined using Augmented Dickey Fuller (ADF), Phillips Perron (PP), Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests and it is confirmed that difference value of series is stable. Then, the co-integration relation between the series which are stable in the same level is examined with the method of ARDL (Autoregressive Distributed Lag) Border Test by which it is deduced that there is a co-integration relation between the series. Along with that, by obtaining long term and short term coefficients the effect of crude oil prices on current account deficit of Turkey is presented numerically. Finally using Granger Causality Test to determine the direction of the relation, it is found that there is one sided causality from crude oil prices to current account deficit of Turkey. All these results indicate that crude oil prices in the world has a permanent and important impact on Turkey's current account deficit.

Keywords: Current Account Deficit, Crude Oil Price, ARDL

JEL: C22, Q43



Türkiye’de Ham Petrol Fiyatları - Cari Açık İlişkisi Üzerine Ampirik Bir Çalışma

ÖZET

Türkiye gibi net enerji ithalatçısı ülkelerin dış ticaret dengeleri enerji fiyatlarına, özellikle de ham petrol fiyatlarına oldukça duyarlıdır. Son 15-20 yılda petrol fiyatlarındaki yükseliş dikkate alındığında, Türkiye’de cari işlemler dengesinde görülen olumsuzluklarda bu durumun etkisi önem kazanmaktadır. Bunun paralelinde Türkiye’nin enerji açığı nedeniyle petrol ithalatı ve dolayısıyla petrol fiyatlarındaki yükseliş, Türkiye’deki işletmeleri de etkilemektedir. Petrol özellikle sanayi üretimi yapan işletmelerin de doğrudan ve dolaylı olarak üretim faaliyetlerini sürdürebilmeleri için kritik bir öneme sahiptir.

Dolayısıyla bu çalışmada, Türkiye ekonomisi üzerinde çeşitli etkileri söz konusu olan petrol fiyatlarındaki oynaklık 1998Q1 – 2015Q3 dönemi itibariyle zaman serisi yöntemleri kullanılarak Türkiye’nin cari işlemler açığına etkisi belirlenmeye gayret edilmiştir. Bu çerçevede Brent türü ham petrol fiyatları ile Türkiye’nin cari açığının GSYİH’na oranı değişkenlerine ait serilerin durağanlıkları Augmented Dickey Fuller (ADF), Phillips Perron (PP) ve Kwiatkowski-Phillips-Schmidt-Shin (KPSS) birim kök testleri ile incelenmiş ve serilerin fark değerinde durağan olduğu saptanmıştır. Sonrasında aynı mertebeden durağan olduğu belirlenen seriler arasındaki eş-bütünleşme ilişkisi ARDL (Autoregressive Distributed Lag) Sınır Testi yaklaşımıyla incelenmiş, seriler arasında eş-bütünleşme ilişkisi olduğu sonucuna varılmış, uzun dönem ve kısa dönem katsayıları elde edilerek ham petrol fiyatlarındaki değişimin Türkiye’nin cari açığı üzerindeki etkisi sayısal olarak ortaya konmuştur. Son olarak Granger Nedensellik Testi ile ilişkinin yönü saptanmış, ham petrol fiyatlarından Türkiye’nin cari açığına doğru tek yönlü bir nedensellik ilişkisi tespit edilmiştir. Tüm bu sonuçlar dünyadaki ham petrol fiyatlarının, Türkiye’nin cari açığı üzerinde kalıcı ve önemli bir etkiye sahip olduğunu göstermektedir.

Anahtar Kelimeler: Cari İşlemler Açığı, Ham Petrol Fiyatları, ARDL

1. INTRODUCTION

Crude oil costs are significant factors affecting the macroeconomic variables, including the foreign trade and current account deficit. The relationship between energy consumption, economic growth and current account deficit was raised as an issue with the advent of the oil crisis in the 1970s. The increasing oil and other energy prices after these crises led to emergence of a series of crisis in the countries that were dependent on oil-imports for their industrial sectors. The energy consumption, the engine of development factor, had a deteriorating impact upon current account deficit because of the increasing crude oil prices.

The vast majority of the transactions in the category of current account include commodity trade, the import and export of the movable goods via transfer or purchase between the settled and unsettled parties of a country. Because



commodity export creates an outflow from a country, it is recorded as receivable in the balance of payments whereas import of goods leads to inflow to a country, a record of debt is made for this account.

The current account deficit in Turkey is being exacerbated. The primary reason for the increasing deficit in current account stems from the foreign trade. The reason for the growth in the foreign trade deficit is that the imports are greater than exports.

The increase in the current account deficit in parallel to the economic growth in Turkish economy shows that the production in Turkey is dependent upon imported goods (Erdoğan and Bozkurt, 2009:142).

Therefore, Turkish economic growth also leads to growth in imports. On the other hand, the export of some products also increases the imports because intermediate goods are imported for their production. The rise in the prices of intermediate goods such as oil, iron, aluminum, copper and cotton which form a large part of Turkey's import is also increasing the import bill at the same rate. Likewise, even though it is not directly raw material, plastic and fertilizers affect the prices and amount of the imports due to their content of oil and its derivatives. A review of Turkey's spending on the crude oil in recent years reveals that the amount of foreign currency paid to crude oil increases in parallel to the crude oil prices. According to the report by the World Energy Council, the crude oil bill of Turkey in 2012 increased by threefold compared to 2002, reaching to 18,5 billion dollars (WEC, 2014:106).

The increase in crude oil prices leads to increase in the volume of imports and also makes the exported goods more expensive due to the increased costs. In addition, the high crude oil prices disallow devising pricing policies that would increase volume of foreign trade.

On the other hand, oil prices began to fall rapidly since the second half of 2014 and this decline continued in 2015. It is envisaged that while countries which are highly sensitive to oil revenues will be affected from this duration, decline in oil prices will positively effect to external balance of oil importing countries as Turkey.

The purpose of this study is to investigate the impact of the volatility in the crude oil prices upon the current account deficit in Turkey and to analyze the short and long term relationship between these two variables. The second part of the study focuses on the literature review whereas the third section deals with an empirical analysis. The fourth part offers the final results and the economic interpretations based on the findings of the empirical analysis.

2. LITERATURE REVIEW

By using the annual data of the period of 1984-2008, Demirbaş, Türkay and Türkoğlu (2009) analyze the relationship between current account deficit and crude oil prices in Turkey in which, they detect long term relationship between the variables by using the co-integration tests. It is seen that the relationship between these two variables is positive and significant indicating that the increase in crude oil prices also leads to increase in the



current account deficit. In addition, the coefficient of the error correction model is found to be negative and significant. This conclusion demonstrates that the error correction mechanism works and that the deviances between the current account deficit in Turkey and the crude oil prices will be balanced. In other words, the increase in crude oil prices will lead to increase in the amount of payment Turkey will have to make for the crude oil imports and in the current account deficit.

Yanar and Kerimoğlu (2011), in their study on the relationship between energy consumption, economic growth and current account deficit, conclude that the GDP is strongly affected by the increase in the consumption of energy and that as the energy consumption increases there will also be increase in the growth rate. In addition, it is also found that there is weak but two-way causality between current account deficit and the GDP. In other words, this means that the energy consumption leads to increase in growth rate; growth rate increases current account deficit and vice versa.

Demirci and Er (2007), using the monthly data of the current account deficit and crude oil prices during the period 1991: 12-2006: 12, analyze the impact of the crude oil prices upon the current account deficit in Turkey via the ARMAX, VAR and co-integration analysis. They find long term relationship between crude oil prices and current account deficit.

Özlale and Pekkurnaz (2010) analyze the impact of the crude oil price shocks upon the current account deficit in Turkey by using structural VAR approach. The analysis reveals that the crude oil price shocks increase the current account deficit in the first three months but decline it in the aftermath. In addition, even though the other factors are controlled, it is found that the crude oil prices are still an important determinant of the current account deficit of Turkey.

Peker and Hotunluoğlu (2009), analyze the reasons for the current account deficit in Turkey via econometric models and conclude that the current account deficit and crude oil import price interact with each other.

Mucuk, Gerçeker and Ay (2013), investigate the causal relationship between international crude oil prices and current account deficit for Turkey using Johansen co-integration and causality tests. The empirical findings show that there is a relationship between two variables in the long term.

In the studies where the relationship between crude oil prices and Turkey's current account deficit is analyzed, the standard unit root tests and standard co-integration tests as well as VAR analysis are used. In this study, standart unit root tests are used in the analysis of the stability of the series. In addition, in the investigation of the long and short term relationship between the variables, the ARDL limit test is preferred because of its comparative advantage to the other alternative co-integration tests.



3. MODEL, METHOD AND APPLICATION RESULTS

Quarterly data between the periods of 1998Q1-2015Q3 are used in the empirical study focusing on the relationship between crude oil prices and the current account deficit in Turkey. In the study, the ratio of the current transaction balance to the GDP is used to indicate current account deficit and average prices for Europe Brent Spot Price in US dollars per barrel are used as benchmark for crude oil prices.

The current account balance as a % of GDP data are retrieved from the “OECD.Stat” section of the official website of the Organisation for Economic Co-Operation and Development (OECD). The reason why this variable is expressed in ratio to the GDP in the analysis is that the potential inflationist impact would be eliminated and the relationship between the variables would be analyzed more properly.

The crude oil barrel prices are retrieved from the website of the U.S. Energy Information Administration (EIA). Daily spot quotations are used to convert to quarterly frequency.

The natural logarithm of the crude oil barrel price series is used in the analysis. However, because there are negative values in the current transaction balance data, the logarithm of the series of the ratio of the current transactions to the GDP is not taken.

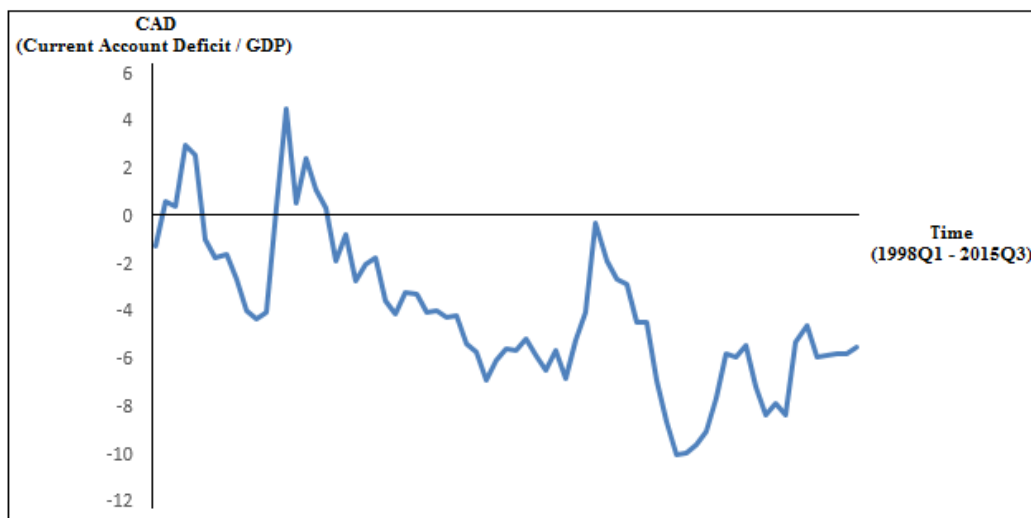
In this study, the following model is used to analyze the relationship between the current account deficit and the crude oil price:

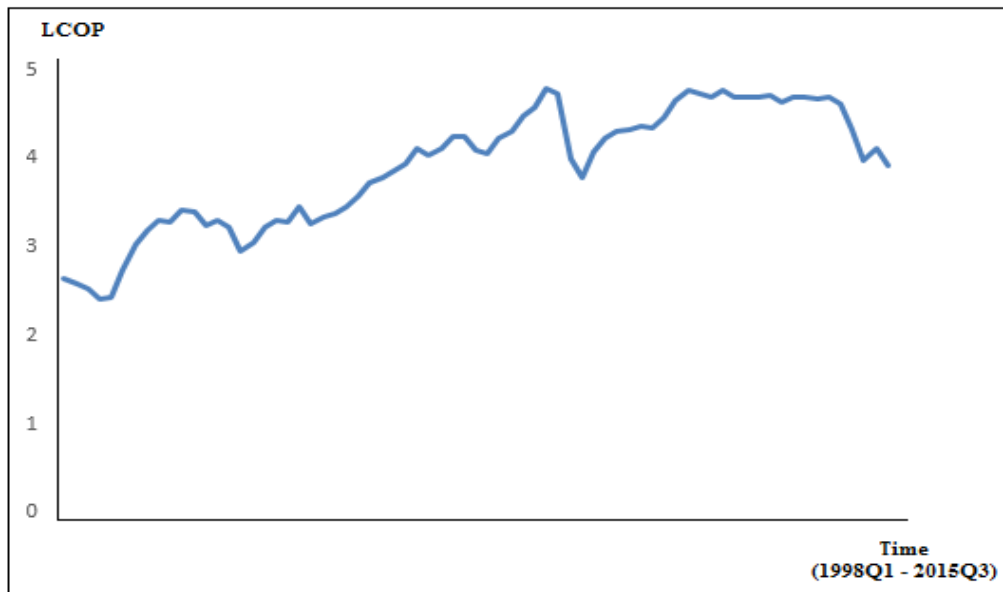
$$CAD_t = \alpha_0 + \alpha_1 LCOP_t + e_t \quad (1)$$

In this model, CAD represents the ratio of the current account deficits to the GDP and LCOP refers to the logarithmic form of the crude oil price series. The graphs of these series are provided in Fig. 1 and Fig. 2.

In the application, Eviews 8.0, Microfit 5.0 and WinRats 7.0 package software are used.

Figure 1. Ratio of Current Account deficit to GDP



**Figure 2. Logarithmic form of Crude oil Prices**

A review of the CAD and LCOP series in Figure 1 and Figure 2 shows that both series display non-stable features. For this reason, the stability of the series are reviewed by using the stability of the series.

In order to test the co-integration concept, Engle-Granger and Johansen co-integration tests are used in the literature. However, in these tests, it is assumed that the series are stable at the same level. In the ARDL limit test developed by Pesaran and Pesaran (1997) and Pesaran et al (2001) the condition that the series should be at the same level is not sought. However, it is still necessary to analyze the stability levels of the series to be included in the analysis because the critical values in Pesaran et al (2001) are categorized in accordance with the stationary of the variables at level ($I(0)$) or in first difference ($I(1)$). Therefore, the series of the variables whose co-integration relationship will be reviewed should not be stable at second degree ($I(2)$).

Another advantage associated with the ARDL limit test is that since unrestricted error correction model is used in this approach, it displays better statistical features compared to the Engle-Granger test; and in more limited cases, it provides more reliable results than the results of Johansen and Engle-Granger tests (Narayan and Narayan, 2005:429).

For the reasons specified above, the stationary of the series is analyzed without application of limit test. To this end, Augmented Dickey Fuller (ADF), Phillips Perron (PP), Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests is applied. The relevant results are shown in Table 1.



Table 1. ADF, PP and KPSS Unit Root Test Results

			CAD	ΔCAD	LCOP	ΔLCOP
ADF Unit Root Test	ADF Test Statistics		-2,1145 (0)	-8,2286* (0)	-1,8626 (0)	-6,0945* (0)
	Critical Values	% 5	-2,9035	-1,9455	-2,9035	-1,9455
		% 10	-2,5892	-1,6137	-2,5892	-1,6137
	Model		Model-1	Model-3	Model-1	Model-3
PP Unit Root Test	PP Test Statistics		-2,1670 (1)	-8,2287* (2)	-1,8733 (3)	-5,9009* (5)
	Critical Values	% 5	-2,9035	-1,9455	-2,9035	-1,9455
		% 10	-2,5892	-1,6137	-2,5892	-1,6137
	Model		Model-1	Model-3	Model-1	Model-3
KPSS Unit Root Test	KPSS Test Statistics		0,8266 (6)	0,0376* (2)	0,9780 (6)	0,2437* (2)
	Critical Values	% 5	0,4630	0,4630	0,4630	0,4630
		% 10	0,3470	0,3470	0,3470	0,3470
	Model		Model-1	Model-1	Model-1	Model-1

- The values in parentheses refer to the optimal lag lengths. They are identified in the ADF test in accordance with the Akaike Information Criteria (AIC) and in accordance with the Newey-West Bandwidth in the PP test.
- Δ refers to the first order difference of the relevant series
- (*) denotes stationary at the 5-percent significance level
- Model-1: fixed model, Model-2 : trend-fixed model, Model-3 : none model

The test statistics are compared with MacKinnon critical values to test the null hypothesis (the variable has a unit root and hence not stationary) against alternative hypothesis (having no unit root). If ADF test result is bigger than the critical value then the null hypothesis is rejected and concluded that unit root not existed. Test results show that the current account deficit/GDP variable and the crude oil price variable is stationary after differencing once.

To identify the co-integration relationship between the current account deficit/GDP series and crude oil price series, the following unrestricted error correction model is formed.

$$\Delta CAD_t = \sum_{i=1}^m \alpha_{1i} \Delta CAD_{t-i} + \sum_{i=0}^m \alpha_{2i} \Delta LCOP_{t-i} + \alpha_3 CAD_{t-1} + \alpha_4 LCOP_{t-1} + u_t \quad (2)$$

The main hypothesis tested by using the standard F statistics is as follows:

$$H_0 : \alpha_3 = \alpha_4 = 0$$

The F statistics is compared to the critical values in Pesaran et al (2001). If the F statistics is greater than the upper limit of the critical values, the main hypothesis showing that there is no co-integration relationship between variables is rejected and if it is greater than the bottom limit, the main hypothesis showing that there is not such a relationship is rejected. If the F statistics is in between the upper and bottom limit, no comment is being made on the presence of the co-integration relationship between the variables under the limit test and the other co-integration tests are being used.

Because F test used for the limit test is sensitive to the lag length, it is first necessary to determine the lag lengths of the variables. To this end, Akaike (AIC) and Schwarz (SIC) information criteria are used in the literature. At



this stage, as maximum length of lags, 4 lags were picked following Narayan and Smyth (2006) because the data was quarterly and to pick the proper lag length, Akaike information criteria were selected. ARDL (1, 2) was determined as the proper model. The test results are shown in Table 2.

Table 2. ARDL Limit Test Prediction Results

F Statistics	Critical values at %5 significance level	
	Lower Bound	Upper Bound
4,3801	3,2279	4,2365

The F statistics is greater than the upper critical value. For this reason, the null hypothesis that there is no relationship of co-integration between the variables is rejected. This means that there is co-integration relationship between the variables. Therefore, it is possible to move to the second stage. In the second stage, the long term relationship between the current account deficit and crude oil prices is analyzed by using the long term ARDL model.

$$CAD_t = \sum_{i=1}^m \alpha_{1i} CAD_{t-i} + \sum_{i=0}^m \alpha_{2i} LCOP_{t-i} + u_t \quad (3)$$

Table 3. ARDL (1, 2) Long Term Coefficients

Variables	Coefficients	Standard Error	t-statistics values	Probability values
LCOP	-1,1176	0,21749	-5,1384	0,000

The long term coefficient shown in Table 3 is statistically significant and according to this coefficient, a 1 pct. of increase in crude oil prices will increase the current account deficit by 1,12 pct in the long term. The coefficient obtained in the test is -1,1176. In other words, it is negative. Therefore, the negative move of the current account deficit means that it is increasing.

Considering the fact that crude oil accounts for more than half of Turkey's total energy imports, and also that energy imports represent around a quarter of the country's total imports, this result is not surprising.

In the third stage, the short term relationship between current account deficit and crude oil prices is reviewed by ARDL-based error correction model as follows:

$$\Delta CAD_t = \sum_{i=1}^m \alpha_{1i} \Delta CAD_{t-i} + \sum_{i=0}^m \alpha_{2i} \Delta LCOP_{t-i} + \beta ecm_{t-1} + u_t \quad (4)$$

The variable referred to as *ecm* in Model 4 is error correction term. If the error correction term coefficient is between 0 and -1 or between -1 and -2, the error correction mechanism is working and different comments can be made depending on the sign and size of this coefficient. If this coefficient is between 0 and -1, the unbalances in the short term is nearing to the balance in the long term and if it is between -1 and -2, the long term balance reaches to the balance via fluctuations. If this is positive or less than -2, it could be inferred that we are moving away from



the balance in short and long term. The predicted results of the short term ARDL (1, 2) model based on the error correction model are shown in Table 4.

Table 4. Error Correction Model Estimation Results at ARDL (1, 2) Model

Variables	Coefficients	Standard error	t-statistical values	Probability values
$\Delta LCOP$	-2,4640	1,0538	-2,3383	0,023
ecm(-1)	-0,18886	0,063812	-2,9596	0,004

According to the results at Table 4, it is seen that the first degree difference of crude oil price is statistically significant. The results show that the increase in the crude oil prices negatively affects the current account deficit in the short term relationship as well. An increase by 1 pct. in the crude oil prices will lead to 2,46 pct. increase in the current account deficit.

Because error correction coefficient is between 0 and -1 (-0,18886) and because it is statistically significant, error correction mechanism works and the relationship between these two variables will come to balance in the long term. Since our data is quarterly, balance will be achieved in 16 months. This reveals that the imbalances that could occur in the short term could be corrected in the long term. In other words, in the long term, the deviations in the short term between the moving series disappear and the series come closer to the long term values.

From an economic perspective, it should be expected that the world crude oil prices will have impact upon the foreign trade deficit and current account deficit of Turkey as it is an importer of crude oil in large amounts and that Turkey's current account deficit cannot be expected to influence the global crude oil prices. To this end, the consistency of the model and the economic interpretations will be reviewed by Granger Causality Test calculated for four lags.

Table 5. Granger Causality Test Results

Main hypothesis:	F-statistics	Probability
$\Delta LCOP$ is not Granger Cause of CAD	3,09653	0,0224
CAD is not Granger Cause of $\Delta LCOP$	0,66774	0,6170

According to the Granger causality test results, because of the probability of the hypothesis, "crude oil prices do not granger cause current account deficit" is rejected. The Granger Causality Test has also revealed that there is a unidirectional causality relationship from crude oil prices to Turkey's current account deficit.

On the other hand, the current account deficit does not Granger cause the crude oil prices, as expected.



3. CONCLUSION

The emergence of the current account deficit problem in Turkey is frequently associated with the crude oil prices. However, number of studies investigating the relationship between these variables for Turkish economy is relatively few. This study seeks to make contribution to the literature and to analyze the impact of the crude oil prices upon the current account deficit in Turkey.

From an economic perspective, the increase in the global crude oil prices will lead to an increase in the amount of money Turkey will have to pay for the energy supplies because of its dependency on external resources. As a result this will lead to an increase in its current account deficit. The findings in this study support this argument. Previous literature accounts including Demirbaş, Türkay and Türkoğlu (2009), Demirci and Er (2007), Peker and Hotunluoğlu (2009) also have similar conclusions whereas the findings of the present study do not support the findings of Özlale and Pekkurnaz (2010).

The series of the crude oil prices and the series of the ratio of current account deficit to GDP of Turkey during the period between 1998Q1-2015Q3 are used in this study. First, the stationarity of both time series is analyzed; it is seen that the crude oil price series and current account deficit/GDP series are not stationary, are stationary after differencing once. Using these two time series which are stationary at same levels, the relationship between them is analyzed by utilizing the ARDL limit test. In the analysis of the co-integration performed with the limit test for Turkey, significant relationship between the global crude oil prices and the current account deficit of Turkey in both short and long run is found. The results show that the increase in the crude oil prices in the long term leads to increase in the current account deficit in Turkey, that the error correction mechanism works and that in the short run, the process converges to the long term balance value. In addition, in the Granger Causality Test, it becomes clear that there is one-way causality relationship from crude oil prices to the current account deficit of Turkey.

These results show that the global crude oil prices have lasting and significant impacts upon Turkey's current account deficit.



REFERENCES

- Demirbaş, M., Türkay, H. and Türkoğlu, M. (2009). Petrol Fiyatlarındaki Gelişmelerin Türkiye'nin Cari Açığı Üzerindeki Etkisinin Analizi [Petrol Price Developments In The Analysis Of The Effects Of Turkey's Current Account Deficit], *Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 14(3), 289-299
- Demirci, E. and Er, Ş. (2007). Ham Petrol Fiyatlarının Türkiye'deki Cari Açığa Etkisinin İncelenmesi [The Analysis Of The Effect Of Crude Oil Price To Turkey's Current Account Deficit], *8. Türkiye Ekonometri ve İstatistik Ulusal Kongresi Bildiriler Kitabı*, 24-25 Mayıs 2007, İnönü Üniversitesi/Malatya/Türkiye, 1-12.
- Erdoğan, S. and Bozkurt H. (2009). Türkiye'de Cari Açığın Belirleyicileri: Mgarch Modelleri İle Bir İnceleme [The Determinants Of Current Account Deficit In Turkey: A Study With Mgarch Models]. *Maliye Finans Yazıları*, 23(84), 135-172
- Mucuk, M., Gerçek, M. and Ay, A. (2013). The Relationship between International Oil Prices and Current Account Deficit: The Case of Turkey. *Session 1A: Energy, International Conference on Eurasian Economies, St. Petersburg, Russia (September 2013)*, 24-31
- Narayan, P. K. and Narayan S. (2005). Estimating Income and Price Elasticities of Imports For Fiji In a cointegration Framework. *Economic Modelling*, 22 (3), 423-438.
- Narayan, P.K. and Smyth, R. (2006). What Determines Migration Flows From Low-Income to High-Income Countries? An Empirical Investigation of Fiji-U.S. Migration 1972-2001. *Contemporary Economic Policy*, 24 (2), 332-342.
- Özlale, Ü. and Pekkurnaz, D. (2010). Oil Prices and Current Account: A Structural Analysis For The Turkish Economy. *Energy Policy*, 38(8), 4489-4496
- Peker, O. and Hotunluoğlu, H. (2009). Türkiye'de Cari Açığın Nedenlerinin Ekonometrik Analizi [Econometric Analysis Of The Reasons Of Current Account Deficit In Turkey]. *Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi*, 23(3), 221-237
- Pesaran, M. H. and Pesaran, B. (1997). *Working with Microfit 4.0: Interactive Econometric Analysis*, Oxford, United Kingdom: Oxford University Press.
- Pesaran, M. H., Shin, Y. and Smith R.J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics*, 16 (3), 289-326.
- World Energy Council (2013). *World Energy Resources 2013 Survey*
- Yanar, R. and Kerimoğlu, G. (2011). Türkiye'de Enerji Tüketimi, Ekonomik Büyüme ve Cari Açık İlişkisi [Energy Consumption, Economic Growth And Current Account Deficit Relations In Turkey]. *Ekonomi Bilimleri Dergisi*, 3(2), 191-201