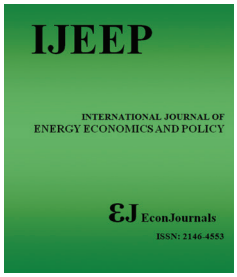

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2015, 5(2), 402-407.

Re-examining of the Turkish Crude Oil Import Demand with Multi-structural Breaks Analysis in the Long Run Period

Sevda Yaprakli[1], Fatih Kaplan[2]*

[1]Department of Economics, Ataturk University, Erzurum, 25240, Turkey, [2]Department of International Trade and Logistics, Mersin University, Mersin, 33420, Turkey. *Email: fatihkaplan@mersin.edu.tr

ABSTRACT

This study examines the Turkish crude oil import demand for the period of 1970-2013. Unlike earlier studies on Turkey, we tested the income and price elasticities of crude oil demand with structual breaks. In emprical analysis, the income and the price of crude oil used as a function of crude oil import demand. We employed Carrion-i-Silvestre et al. (2009) test for testing unit root, Maki (2012) cointegration test employed for testing for the existence of relationships. Dynamic ordinary least squares estimation employed for the estimating the long-run income and price elasticities. The empirical results show that the partial elasticities of crude oil import demand; income is (0.18) and crude oil is (−0.25). In the light of these results, it is said that income and price elasticities of demand for crude oil import in the long-run are inelastic. Furthermore, we used dummy varibale for testing internal and external crisses affetct. We conlcuded that the external crises had major impact on import oil demand on the contrary to internal crises in the long run.

Keywords: Income Elasticity, Price Elasticicy, Structual Breaks
JEL Classifications: C22, F10, F14

1. INTRODUCTION

The demand for energy is constantly increasing with population growth and economic development. As the importance of energy has increased in all fields, importance of crude oil demand has increased too. This study is focused on the demand for import crude oil which is one of the main energy sources and also has a leading role in the economic development of Turkey. The crude oil is not just directly consumed, on the other hand its derivatives are consumed more. These derivatives are used in electricity generation, heating, transportation vehicles (fuel), chemicals, plastics, pharmaceuticals and other industries. Crude oil that is used for a wide range of purposes has been critically significant, especially for those countries in which energy resources are limited and the domestic demand must be met by import. These countries have encountered serious economic problems when their crude oil demands have not been met.

The requirement of energy has increased in all fields because energy is one of the fundamental inputs for economic growth and development. Conversely, energy consumption is permanently rising as the population increases and techology advances. The crude oil consumption in Turkey has risen rapidly as a result of social and economic development. The share of crude oil in Turkey's total energy consumption was 33% in 2011. Approximately 75% of the oil products production related to crude oil processing in Turkey is performed in four refineries that belong to the Tüpras Co.

Recoverable oil reserves in the year 2011 are 294.8 million barrels (43.2 million tons), and in the absence of new discoveries, total domestic crude oil reserves with the current production level have a life expectancy of 18.5 years. Turkey's own oil reserves are very limited. In the last ten years, the share of domestic production has decreased by 15%, due to the depletion of resources. The ratio of production to consumption is approximately 7.5%. Therefore, the crude oil is almost met by foreign suppliers.[1] The examined this relationship and concluded that Turkey is a net importer of

1 91% of the domestic crude oil demand is met through import. See Turkish Petroleum Corporation (2012).

crude oil. Therefore, Turkey is becoming vulnerable to supply risks. To reduce supply risks, Turkey is resorting to risk mitigation methods[2].

Along with the movements of the log of crude oil import, the log of gross domestic product (GDP) and the log of nominal price of oil per ton, period under investigation, shows in Figure 1.

As seen in Figure 1 all series has a general upward trend. One of them, (lnQ), despite major breaks in this trend, at the 1970s, 1994 and in 2009, the upward trend of crude oil import demand has continued over time. There were a few events that caused breaks in crude oil import demand. The fisrt event, in 1970s, it was a Cyprus issue[3] (in 1974) and a rapid increase in the price of imported oil, with the effect of additional oil shocks (the first oil shock in 1974 and the second oil shock in 1979). The second event is the economic contraction, which occured in world countries affected by the global financial crisis experienced in 2008-2009. Furthermore, Turkey experienced four economic crises during 1970-2013, which occurred: in 1980, 1994, 2001 and 2009. There were three major national economic crises experienced, occuring in the years of 1980, 1994 and 2001. There was a relatively small economic downturn in 2009, due to the global financial crisis that emerged by the end of 2008. The oil demand in Turkey experienced breaks in the periods of economic crisis.

The GDP (lnY) shows an upward trend in general, except for 1980, 1994, 2001 and 2009. Despite the crises, the GDP was on the growth path, and economic growth quickened after each crisis. The nominal price of imported oil (lnPR) was high in 1974-1975 and in 1979-1980, the following the first and second oil shocks. After 2000, lnPR has increased rapidly, except for the short-term jumps during the global crises.

This study examines the turkish crude oil import demand for the period of 1970-2013. Structure of this paper is as follows: the literature review will be in Section 2. The model specification, data and econometric methodology will be introduced in Section 3. The findings will be presented in Section 4. The paper will end up with the concluding remarks.

2. LITERATURE REVIEW

The crude oil demand has been tested empirically in a limited number of studies for many specific country or country groups. To determine the factors affecting the demand for crude oil, the price and income elasticities of crude oil import must be known[4]. Limited previous studies such as Ghouri (2001), Krichene (2002), Gately and Huntington (2002), Cooper (2003), Dees et al. (2007), Narayan and Smyth (2007), Dargay et al. (2007), Altinay (2007), Xiong and Wu (2008), Ghosh (2009), Ziramba (2010), Tsirimokos (2011) and Stambuli (2013). Table 1 represents an overview of the literature on elasticities of crude oil import demand.

According to Table 1, the price elasticity of the demand for crude oil is extremely low in the long run period. The income and price elasticities of import demand for crude oil are found to be mostly inelastic. These results are consistent with the economics literature.

3. ECONOMETRIC METHODOLOGY

3.1. Model

The model based on earlier papers. The model specifies the quantity demand of imported crude oil as a function of the nominal price of oil in US dollars and GDP in millions of US dollars. In

2 Such as diversifying import sources and supplies, investing in domestic renewable energy sources and developing oil projects abroad.

3 Turkey has conflicted with Cyprus Greek.

4 See Bose and Shukla (1999), Narayan and Smyth (2005).

Figure 1: Plot of the log of crude oil import, the log of gross domestic product and the log of nominal price of oil per ton

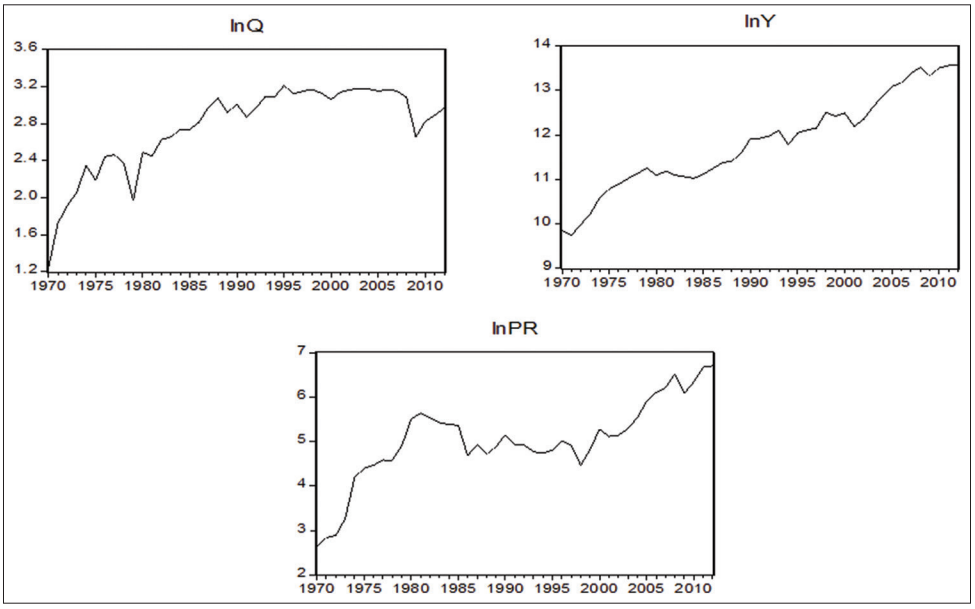

Table 1: Summary of the literature on elasticities of crude oil import demand

Authors	Period/Country	Methodology	Income elasticity	Price elasticity
			LR	LR
Ghouri (2001)	1980-1999/USA,	Almon polynominal distributed	USA 0.98	USA 0.05
	Canada, Mexico	lag model	Canada 1.08	-
			Mexico 0.84	-
Krichene (2002)	1918-1999/World	Two stage OLS; ECM	0.60	−0.05
Gately and	1971-1997/OECD and 66	Pooled cross section; panel data	OECD 0.56;	OECD −0.64;
Huntington (2002)	non-OECD countries	analysis	Non-OECD 0.53	Non-OECD −0.18
Cooper (2003)	1979-2000/23 countries	Nerlove's partial adjustment model	-	From 0.04 to −0.57
Dees et al. (2007)	1995q1-2000q3/Some	Dynamic OLS; ECM	From 0.17 to 0.98	-
	developed countries			
Narayan and Smyth (2007)	1970-2002/Middle east	Panel data analysis	From 0.20 to 1.82	From −0.07 to −0.02
Dargay et al. (2007)	1971-2006/OEDC,	Pooled cross section	OECD 0.88;	OECD −0.55;
	G-7 OECD		G-7 OECD -0.91	G-7 OECD −0.39
Altinay (2007)	1980-2005/Turkey	ARDL cointegration	0.61	−0.18
Ghosh (2009)	1970-71 to 2005-2006/India	ARDL cointegration	1.97	-
Xiong and Wu (2008)	1979-2004/China	JJ cointegration, ECM	0.65	−0.37
Ziramba (2010)	1980-2006/South Africa	JJ cointegration, ECM	0.43	−0.15
Tsirimokos (2011)	1980-2009/Ten IEA countries	Nerlove's partial adjustment model	$e_y \geq 0$	$e_p < 1$
Stambuli (2013)	1972-2010/Tanzania	Nerlove's partial adjustment model	1.750	−0.012

LR: Long-run, ARDL: Autoregressive distributed lag, OLS: Ordinary least squares, ECM: Error correction model, JJ: Johansen-Juselius, IEA: International Energy Agency, e_y: Income elasticity, e_p: Price elasticity

addition, dummy variable(s) that captures the stuctural break(s) (representing the impact of economic crises) is added to the model for the long-run relationship between the series.

$$Q_t = f(Y, PR, D) \quad (1)$$

In log-linear form the model (Equation 1) is specified as follows:

$$\ln Q_t = \beta_0 + \beta_1 \ln Y_t + \beta_2 \ln PR_t + \beta_3 D_t + u_t \quad (2)$$

where Q is the value of the quantity of crude oil imported, Y is representing the GDP in millions of US dollars, PR is the value of the nominal price of the crude oil per ton in US dollars, D is the dummy variable(s) is the impact of the economic crises. The expected signs for parameters are such that $1 > \beta_1 > 0$, $0 < \beta_2 < 1$ and β_3 is unclear.

3.2. Data

To investigate the turkish crude oil import demand, the models specified in Eq. (1) is estimated for the available time period for 1970-2013. The quantities of imported crude oil in millions of tons were obtained from the Turkish Statistical Institute. The nominal prices of crude oil per ton (in US dollars) were obtained from International Energy Agency websites. The current GDP (in millions of US dollars) data were obtained from the Central Bank of Turkey. The dummy variable(s) describing as structural break(s) points are defined by emprical test.

3.3. Methods

Co-integration methods have been used in some recently energy demand studies[5]. The empirical analysis is performed in three steps. The first step is to testing root root. The traditional unit root tests may be suspect when the sample under analysis includes major events (economic crisis, war, civil inorder, etc.). These major events likely to create structural breaks in the series. These methods have been criticised, as their explanatory powers are low in exist structual breaks.

In view of the fact that, we employ Carrion-i-Silvestre et al. (2009) test which allow for multi structural breaks under the endogenous structural breaks assumptions. Carrion-i-Silvestre et al. (2009) propose these equations for unit root test[6].

$$P_T(\lambda^0) = \left\{ S(\bar{\alpha}, \lambda^0) - \bar{\alpha} S(1, \lambda^0) \right\} / s^2(\lambda^0) \quad (3)$$

$$MP_T(\lambda^0) = \left[c^{-2} T^{-2} \sum_{t=1}^{T} \tilde{y}_{t-1}^2 + (1 - \bar{c}) T^{-1} \tilde{y}_T^2 \right] / s(\lambda^0)^2 \quad (4)$$

$$MZ_\alpha(\lambda^0) = T^{-1} \tilde{y}_T^2 - s(\lambda^0)^2 \left(2T^{-2} \sum_{t=1}^{T} \tilde{y}_{t-1}^2 \right)^{-1} \quad (5)$$

$$MSB(\lambda^0) = \left(s(\lambda^0)^{-2} T^{-2} \sum_{t=1}^{T} \tilde{y}_{t-1}^2 \right)^{\frac{1}{2}} \quad (6)$$

$$MZ_t(\lambda^0) = T^{-1} \tilde{y}_T^2 - s(\lambda^0)^2 \left(4 s(\lambda^0)^2 T^{-2} \sum_{t=1}^{T} \tilde{y}_{t-1}^2 \right)^{-\frac{1}{2}} \quad (7)$$

The second step involves testing for cointegration estimations. After verifying that the series are I(1), we analyse the cointegration relationship between variables. Accoring to Gregory and Hansen (1996), at the using the standard cointegration test, breaks may cause spurious unit root behavior in the cointegating relationship. Beacause of this reason, we employ the methodology proposed by Maki (2012).

5 See, Alves and Bueno (2003), Hondroyiannis (2004), Xiong and Wu (2008), Wadud et al. (2009), Ziramba (2010) and Maden and Baykul (2012).

6 Elliott et al. (1996), Ng and Perron (2001) and Perron and Rodrı´guez (2003) studies have benefited.

$$y_t = \mu + \sum_{i=1}^{k} \mu_i K_{i,t} + \beta X_t + u_t \quad (8)$$

$$y_t = \mu + \sum_{i=1}^{k} \mu_i K_{i,t} + \beta X_t + \sum_{i=1}^{k} \beta_i x_t K_{i,t} + u_t \quad (9)$$

$$y_t = \mu + \sum_{i=1}^{k} \mu_i K_{i,t} + \gamma t + \beta X_t + \sum_{i=1}^{k} \beta_i x_t K_{i,t} + u_t \quad (10)$$

$$y_t = \mu + \sum_{i=1}^{k} \mu_i K_{i,t} + \gamma t + \sum_{i=1}^{k} \gamma_i t K_{i,t} + \beta X_t + \sum_{i=1}^{k} \beta_i x_t K_{i,t} + u_t \quad (11)$$

The third step involves utilising of the dynamic ordinary least squares (DOLS) estimations. This approach, has involve advantages of the OLS and the maximum likelihood procedures, has been proposed by (Stock and Watson, 1993).

$$Q_t = B'X_t + \sum_{p=-P}^{p=P} \eta_k \Delta Y_{t-k} + \sum_{p=-L}^{p=L} \lambda_k \Delta \mathrm{PR}_{t-k} + u_t \quad (12)$$

Where B = [c, a, β] and [X = 1, Y_t, PR_t] and, P and L are the lengths of leads and lags of the regressors. The DOLS procedure which basically involves regressing in the differrent or the same integration level of variables and leads and lags of the first differences of any I(1) variables (Masiha and Masih, 1996).

4. EMPIRICAL FINDINGS

In estimating the long-run parameters analyses require investigating unit root properties of the series. The Multiple breaks test suggested by Carrion-i-Silvestre et al. (2009) is utilised to test stationary. Table 2 presents the Unit root test with multiple breaks test results.

The unit root test results show that all variables are integrated of order one, I (1). Because all variables included in the model are I (1), a co-integration test can be performed, as proposed by the Maki (2012) technique. Table 3 presents the co-integration test results for the model along with their 5% critical values to provide further evidence on the rank determination.

According to Maki (2012) cointegration test results which allows more than 3 structural breaks, reflection of endogenously determined several structural breaks dates. The cointegration test results supports the long-run cointegration relationship. In estimating the long-run parameters of the demand function, we

Table 2: Unit root test with multiple breaks

Var.	PT	MPT	MZA	MSB	MZT	Break dates
Breaks in slope of time trend at level						
lnQ	11.272373	11.587575	−21.343542	0.14902266	−3.1806714	1974
	(7.2479220)	(7.2479220)	(−32.247339)	(0.12502691)	(−4.0073205)	1995
						2011
lnY	11.002144	11.350692	−21.532498	0.14697329	−3.1647019	1979
	(6.9872779)	(6.9872779)	(−31.886212)	(0.12563297)	(−3.9941928)	2001
						2011
lnPR	11.334471	11.721255	−21.468650	0.14785131	−3.1741680	1980
	(7.1071480)	(7.1071480)	(−32.592040)	(0.12433845)	(−4.0385019)	1998
						2011
Breaks in level and slope of time trend at level						
lnQ	10.781624	11.114496	−21.157182	0.14647195	−3.0989336	1974
	(6.5019204)	(6.5019204)	(−32.116951)	(0.12642264)	(−3.9998030)	1994
						2009
lnY	12.765429	12.927712	−21.534089	0.14221030	−3.0623692	1979
	(7.3278460)	(7.3278460)	(−33.213019)	(0.12266794)	(−4.0736660)	2000
						2009
lnPR	13.493597	13.633562	−21.333331	0.14325219	−3.0560463	1980
	(7.5552827)	(7.5552827)	(−34.046976)	(0.12118612)	(−4.1241044)	1994
						2009
Breaks in slope of time trend at first difference						
ΔlnQ	-	-	-	-	-	
ΔlnY	5.1505484	5.1505484	−29.411416	0.13551414	−3.8088774	
	(7.8345453)	(7.6489553)	(−21.084185)	(0.15376199)	(−3.2419462)	
ΔlnPR	6.1833375	6.1833375	−33.041928	0.12493038	−4.0549499	
	(10.686448)	(9.9106453)	(−21.228802)	(0.15322472)	(−3.2527773)	
Breaks in level and slope of time trend at first difference						
ΔlnQ	6.9596812	6.9596812	−30.457841	0.12805622	−3.8978090	
	(13.072919)	(10.930011)	(−19.704809)	(0.15783350)	(−3.1100789)	
ΔlnY	8.2226972	8.2226972	−36.406872	0.11663881	−4.2450237	
	(14.653163)	(14.195649)	(−21.224905)	(0.15223092)	(−3.2310869)	
ΔlnPR	7.5824014	7.5824014	−33.830876	0.12136814	−4.1001117	
	(14.200049)	(12.409176)	(−20.615921)	(0.15562110)	(−3.2082723)	

Values inside the parentheses are statistical significance at 5% level of significance. Critical values are based on bootstrap. Δ denotes the first difference

Table 3: Maki cointegration tests results

	Statistic	1%	5%	10%	Break dates
Model 0	−5.671**	−5.943	−5.392	−5.125	1983/1999/2012
Model 1	−5.725**	−6.169	−5.691	−5.408	1982/1999/2007
Model 2	−7.296***	−7.031	−6.516	−6.210	2003/1984/2007
Model 3	−8.495***	−7.673	−7.145	−6.873	1981/2008/1990

Critical values are taken from Maki (2012), **: 5%, ***: 10%

Table 4: DOLS estimation results

Variables	Coefficient	SE	t statistic	*P*
Constant	12.38867***	1.394993	8.880816	0.0000
Y	0.183907***	0.059536	3.089028	0.0054
PR	−0.257378***	0.070233	−3.664611	0.0014
D1974	0.358725***	0.104208	3.442408	0.0023
D1979	0.309489**	0.121838	2.540159	0.0187
D1980	0.290769**	0.122928	2.365360	0.0272
D1994	0.062047	0.068144	0.910517	0.3724
D1999	−0.021970	0.092588	−0.237282	0.8146
D2001	0.049425	0.125775	0.392966	0.6981
D2009	−0.214368*	0.113481	−1.889023	0.0721

The number of leads and lags was determined by the AIC. The bandwidth was selected by Newey-West estimator using the Bartlett kernel. ***, ** and * denote statistical significance at the 1%, 5% and 10% level. R^2=0.90. DOLS: Dynamic ordinary least squares, SE: Standard error

adopt DOLS estimation. Table 4 presents DOLS Estimation results for the full sample period.

Based on the results given above, Equation 1 represents the long-run relationship among the variables. According to estimation, all variables have expected signs; in other words, they are consistent with economic theory. The major long-run determinants of crude oil import in Turkey are GDP and crude oil price. The partial elasticities of crude oil import demand with respect to income and price are 0.18 and −0.25, respectively, and denote statistical significance at the 1% level. In the light of these results, it is said that income and price elasticities of demand for crude oil import in the long-run are inelastic ($e_Y < 1$, $e_p < 1$). Accordingly, 1% increases in either GDP or crude oil price causes a 0.18% increase or a 0.25% decrease in crude oil import demand in the long-run, resppectively. Furthermore, abroad crises (1974, 1980, 1980 and 2009) had major impact on import oil demand on the contrary to domestic crises (1994,1999 and 2001) in the long run.

5. CONCLUSIONS

This study analyzed long-run elasticities of Turkish crude oil import demand for the period of 1970-2013. Unlike earlier studies on Turkey, we tested the income and price elasticities of crude oil demand with structual breaks. For this porpuse, we employ Carrion-i-Silvestre et al. (2009) unit root test, Maki (2012) cointegration test and DOLS estimation.

To analyse the properties of the time series data, the unit root test results confirm that all series have a unit root and the unit root test supports strong evidence of breaks. The cointegration test results supports the long-run cointegration relationship with strong evidence of breaks. DOLS estimation employed for the estimate to the long-run income and price elasticities. The empirical results show that the partial elasticities of crude oil import demand; income is (0.18) and crude oil is (−0.25). In the light of these results, it is said that income and price elasticities of demand for crude oil import in the long-run are inelastic. Furthermore, we used dummy varibale for testing internal and external crisis affetcts. We conlcuded that the external crises had major impact on import oil demand on the contrary to internal crises in the long run. This study provides some practical information. It is believed that the elasticities and the comments presented in the study will be beneficial for policy makers in determining future energy policies in Turkey.

REFERENCES

Altinay, G. (2007), Short-run and long-run elasticities of import demand for crude oil in Turkey. Energy Policy, 35(11), 5829-5835.

Alves, D.C.O., Bueno, R.L.S. (2003), Short-run, long-run and cross elasticities of gasoline demand in Brazil. Energy Economics, 25, 191-199.

Bose, R.K., Shukla, M. (1999), Elasticities of electricity demand in India. Energy Policy, 27, 137-146.

Carrion-İ-Silvestre, J.L., Kim, D., Perron, P. (2009), Gls-based unit root tests with multiple structural breaks under both the null and the alternative hypotheses. Econometric Theory, 25(06), 1754-1792.

Cooper, J.C.B. (2003), Price elasticity of demand for crude oil: estimates for 23 countries. OPEC Review, 27, 1-8.

Dargay, J.M., Gately, D., Huntington, H.G. (2007), Price and income responsiveness of world oil demand: by Product. Mimeo NYU.

Dees, S., Karadeloglou, P., Kaufmann, R.K., Sanchez, M. (2007), Modelling the world oil market: assessment of a quarterly econometric model. Energy Policy, 35(1), 178-195.

Elliott, G., Thomas J., Rothenberg, T.J., Stock, J.H. (1996), Efficient tests for an autoregressive unit root. Econometrica, 64, 813-836.

Gately, D., Huntington, H.G. (2002), The asymmetric effects of changes in price and income on energy and oil demand. The Energy Journal, 23, 19-55.

Ghosh, S. (2009), Import demand of crude oil and economic growth: evidence from India. Energy Policy, 37(2), 699-702.

Ghouri, S.S. (2001), Oil demand in North America: 1980-2020. OPEC Review, 25(4), 339-355.

Gregory, A.W., Hansen, B.E. (1996), Residual-based tests for cointegration in models with regime shifts. Joumal of Econometrics, 70, 99-126.

Krichene, N. (2002), World crude oil and natural gas: a demand and supply model. Energy Economics, 24(6), 557-576.

Maki, D. (2012), Tests for cointegration allowing for an unknown number of breaks. Economic Modelling, 29(5), 1-5.

Masih, R., Masih, A.M.M. (1996), Stock-Watson dynamic OLS (DOLS) and error-correction modelling approaches to estimating long- and short-run elasticities in a demand function: new evidence and methodological implications from an application to the demand for coal in Mainland China. Energy Economics, 20, 315-334.

Narayan, P.K., Smyth, R. (2005), The residential demand for electricity in Australia: an application of the bounds testing approach to cointegration. Energy Policy, 33, 467-474.

Narayan, P.K., Smyth, R. (2007), A panel cointegration analysis of the demand for oil in the Middle East. Energy Policy, 35(12), 6258-6265.

Stambuli, B.B. (2013), Price and income elasticities of oil Demand in Tanzania: an autoregressive approach. Business Management Dynamics, 3(1), 75-83.

Stock, J.,Watson, M.W. (1993), A simple estimator of cointegrating vectors in higher order ıntegrated systems. Econometrica, 61(4), 783-820.

Tsirimokos, C. (2011), Price and income elasticities of crude oil demand: the case of ten IEA countries. Swedish University of Agricultural

Sciences Faculty of Natural Resources and Agricultural Sciences Department of Economics, Master Thesis No 705.

Turkish Petroleum Corporation. (2012), Crude Oil and Natural Gas Sector Report for 2011. Turkish Petroleum Corporation, Republic of Turkey Ministry of Energy and Natural Resources.

Xiong, J., Wu, P. (2008), An analysis of forecasting model of crude oil demand based on cointegration and vector error correction model (VEC). In: Proceedings of the International Seminar on Business and Information Management, IEEE Computer Society.

Ziramba, E. (2010), Price and income elasticities of crude oil import demand in South Africa: a cointegration analysis. Energy Policy, 38(12), 7844-7849.