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Reversibility Test of Oil Demand Function of OECD Countries Importing Oil from Iran with an Emphasis on Technological and Environmental Considerations: Symmetric and Asymmetric Models

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ABSTRACT

The study aimed to estimate the oil demand function of the OECD countries importing oil from Iran based on symmetric and asymmetric specification. To estimate symmetric and asymmetric patterns in this study, data from 1970 to 2014 for OECD countries importing oil from Iran including France, Germany, Greece, Italy, Japan, Poland, Spain, Turkey, England, South Korea, Czech, Netherlands and Belgium were used. The results of the panel root test showed the first-order difference reliability of the variables and the co-integration test confirmed a long-term relationship between the variables. Therefore, the models were estimated using the fully modified ordinary least square method. The results of the model estimation indicated the irreversibility of the oil demand function of the OECD countries importing oil from Iran.

Keywords: Oil Demand Function Reversibility, OECD Countries, Modifiedordinary Least Square Method, Panel Co-integration Test
JEL Classifications: D43, E31, L71

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1. INTRODUCTION

Demand for energy whether in short or long term is affected by various variables. One of the processes that can affect energy demand either in terms of energy type or in terms of energy consumption is economic development. Economic development changes the demand for energy through increased income and improved technology level, and on the other hand, the change in technology can even affect the price of energy. Hence, identifying the effectiveness of each of the economic and non-economic variables on energy demand can help scholars to provide an appropriate pattern for energy and, consequently, micro and macro policies in the field of energy.

Despite the growing trend of using new energies such as nuclear energy globally, most of the world's energy demand is still supplied by fossil fuels, most notably of which is crude oil. Basher and Sadorsky (2006) consider oil as the blood of modern economics. They believe that if oil demand increases and no changes occur in their supply, oil prices will increase. In fact, they see supply and demand forces as effective in oil price changes. With the rise in oil prices in 1973, the International Energy Agency, composed of the United States, Japan and some European countries, was set up to provide the ground for energy efficiency and the replacement of renewable energy resources instead of non-renewable resources. This led some of the above-mentioned countries to succeed in saving oil. Thus, with the fall in oil prices in the following years, oil demand did not return to the state before the oil shock in 1973, and therefore the literature related to asymmetry and irreversibility of oil demand in different countrieswere presented. This hypothesis states that the reaction to oil demand and its increase and decrease is not the same.

Asymmetry and oil price decomposition were first proposed by Wolffram (1971). Traill et al. (1978) concluded in another study confirming Wolffram's conclusion that the response to a rise or fall in prices was equal to or less than the response to the maximum price. Mory (1993) also examined the symmetry and asymmetry of economic activities in relation to oil price changes. Several studies have also been carried out in this regard, each tried to test the reversibility of the oil demand function in different countries as well as in various industriesusing various approaches.

In oil-dependent economies, including Iran, the realization of development plans requires precise predictions of the oil demand in different countries and, consequently, in global markets, which can lead to more accurate forecasts in the field of future oil prices. Therefore, studying oil demand and demand responseto price changes can be important. Now, if oil demand in different countries shows different responses to oil price rise and fall, it will become even more important. The objective of this study is to estimate the oil demand function of the OECD countries importing oil from Iran based on symmetric and asymmetric specifications. Therefore, the present chapter is presented in six sections. In the second part, after the introduction, we will present the theoretical principles of the research as well as the reasons for the asymmetry of oil demand based on the literature. The third section reviews the previous studies in this field and the fourth section presents the models for the research as well as describing the research variables and methods used. In the fifth section, the results of estimating the research models are presented and in 6th section, we will present the conclusions and recommendations of the research.

2. THEORETICAL PRINCIPLES

Studies on energy models in general and energy demand patterns in particular were considered after World War II. In the 1950s, time-based statistical models (trend extrapolation) have been used. In these models, the causal relations between energy demand and economic and technical variables were not explicitly explored, and only by calculating the average growth rate of energy consumption, energy demand in the years to come was predictedwith the help of statistical data. In the 1960s, econometric methods were widely used to estimate energy demand. Using economic and statistical theories, these patterns have empirically tested the relationships between economic variables and energy demand growth. Since the parameters of these patterns are estimated based on historical or cross-sectional data, the forecast of energy demand with the help of these models is based on the generalization of past conditions on the future.

Different factors affect the type and amount of energy demand, which, over time and even during the rise and fall in energy prices, have not had the same effects on energy demand. Since 1971, various studies have been done on the effect of improving technology on oil demand, especially in OECD countries. These studies differentiated between the role of price and the improvement of technology and sought to separate the effect of these two on energy demand. As already stated, in the 1970s and 1980s oil prices were fluctuating such as fall and rise; these fluctuations did not have the same and symmetrical effects on the oil demand in different countries, which in the economic literature, it was referred to as an asymmetric response to oil price in studies such as Walker and Wirl (1993), Dargay and Gately (1997), Gately and Huntington (2002), Ryan and Plourde (2002), and Dargay et al. (2007).

Since the second half of the 1970s, technology-based models have become more prominent as they were able to study the effect of structural and technological changes on energy demand growth. The disadvantage of these models was that they did not explicitly consider the effect of changes in economic variables on energy demand. In these models, energy demand in an economic sub-sector was assumed asthe product of the level of the sub-section activity and the intensity of energy needed for that activity. As it was said, these models ignored the link between economic conditions and changes in it, with the technical factors affecting energy demand, thus they did not have the required efficiency in predicting future energy demand. Since the second half of the 1980s, this idea was strengthened that the energy modeling should be dealt with a systematic approach, which means that the effects of socio-economic variables and the effects of technical factors should be simultaneously considered in the estimation of energy demand. An example of such models is the MADE-II model (Model for Analysis of Demand for Energy) that developed in the second half of the 1980s. In this model, which is designed based on engineering principles, econometric and statistical methods were extensivelyused to estimate energy demand and the combined assessment of the effects of economic and technical variables. The structure of this model is based on the view that energy is a means by which the goods and services required by the community can be supplied. Therefore, at the time of using the model, the development study for needfor useful energy is considered and energy demand is examined based on economic and social development programs.

Various studies proposed various specifications for modeling the irreversibility of oil demand, or, in other words, the asymmetry of oil demand; in this study, more emphasis is placed on the models provided by Gately and Huntington (2002), Griffin and Schulman (2004) and Huntington (2009).

Since Gately and Huntington (2002) observed that in different periods, especially between 1970 and 1980, the demand for oil in different countries such as the United States, China and Japan responded differently regarding the increase or decrease in oil prices, they believed that oil demand irreversibility is due to several reasons:

1. With rising oil prices in the 1970s, efficiency in energy consumption and technology improved, but in the 1980s, when oil prices declined, improvement in energy efficiency grew more and as a result, the declined demand resulting from rising oil prices, did not increase as previous.
2. With rising oil prices, several policies were introduced to replace energies other than oil, including electricity, gas, non-fossil fuels, such as solar energy and nuclear energy, the policies continued with declining oil prices.
3. Energy consumptionoptimization policies have been taken by different firms, and firms did more efficiently in terms of energy consumption.

3. PREVIOUS STUDIES

Energy demand modeling has been considered in various studies both inside and outside the country. In some of these studies, such as Delavari and Baghbanzadeh (2007), Javaheri and Asadollah (2010), Gately and Huntington (2002), Griffin and Schulman (2005), Canyurt and Öztürk (2006) modeled oil demand, and some other studies Such as Abu Nuri and Shive (2003), Kiumars (2007), Ali-Morad et al. (2010), Sherafat Jahromi and Shakeri (2010), Ang and Lee (1994), Samimi (1995), Masih and Masih (1997), Adeyemi and Hunt (2007), Ünler (2008), Chi et al. (2009), Liu et al. (2011), Feng et al. (2013), Dergiades et al. (2013), Śmiech and Papież (2014), and Wadud (2015) modeled the demand for other types of energy and examined the effect of different variables on the various energy consumption studied by the researchers. The hypothesis of asymmetry and irreversibility of demand have been tested in different countries and for various energies, among which are studies by Delavari and Baghbanzadeh (2007), Javaheri and Asadollah (2010) and Ebrahimi (2014) in Iran and Wolffram (1971), Traill et al. (1978), Bacon (1991), Manning (1991), Kirchgässner and Kübler (1992), Dargay and Gatley (1997), Borenstein et al. (1997), Asplund et al. Godby et al. (2000), Bettendorf et al. (2003), Adeyemi et al. (2010), and Wadud (2015) outside of Iran. Here is a review of the studies done in this area.

Dermot and Huntington (2001) in a study estimated the price and income changes on energy and oil demand in a number of countries. In this study, data from 96 countries of the world's largest countries during 1971-1997 were used. In this study, the asymmetric effects of rise and fall in oil prices on demand, asymmetric effects of rise and fall of income on demand, and the rate of demand adjustment relative to price changes and income changes were examined. The results of this study showed that the OECD countries responded to the demand for rising oil prices more than the fall in oil prices. On the other hand, the results indicated that the demand response to income changes in many non-OECD countries was not necessarily symmetrical. They also found that the rate of demand adjustment was higher than changes in the income more than changes in price.

Griffin and Schulman (2005) studied the symmetry or asymmetry of demand for oil during 1971-1996. For this purpose, they used data from 1961-1999 for 16 OECD countries. The results of this study confirmed the existence of asymmetry of oil demand relative to price changes.

In order to estimate the demand for oil using a genetic algorithm optimization method, Canyurt and Öztürk (2006) aimed to estimate the future value of oil demand and presented a nonlinear model for oil demand in Turkey. The results of this study showed that among these three models, a model that used independent variables like population, gross domestic product, oil imports, and import and sales of the truck as an index of the plan parameters, with a lower error square, provides a better solution for data observation.

Adeyemi and Hunt (2007) studied the econometric modeling of energy demand in the industry sector of 15 OECD countries. In this study, data from 1962 to 2003 were used to access the research objectives and examined the asymmetric response of demand to price variations. The results of this study showed that the energy demand of the OECD countries' industry had asymmetric response to price changes, while this was not the case for economical energy saving changes.

Wadud (2015) in a study examined the incomplete reversibility of demand for air transport. In this study, US time series data were used and, by analyzing the fuel price into three components, an econometric model was extracted to test thedemand reversibility orirreversibility hypothesis. The results of this study showed that the demand for US air transport is asymmetrical, indicating the potentially irreversible nature of consumer behavior.

Chow et al. (2015) studied the energy demand under the environmental restrictions in China. In this study, they used a combination of economic-energy-environmental model. The results of their studies showed that the demand for primary energies in green development scenarios would reduce the pollution of the environment by 12.4 tons of coal equivalent to the primary model. They also showed that coal taxes are the best policy to reduce environmental pollution.

Delavari and Baghbanzadeh (2007) tested the asymmetry hypothesis in the oil demand function of these countries in a study by estimating the oil demand function in Japan, China, India and South Korea. The results of the model estimation showed that the asymmetry hypothesis was confirmed in Japan, India and China, but this hypothesis was not statistically confirmed in South Korea. The results of this study showed that oil demand in the above countries was inelastic and therefore they concluded that the increasing demand for oil in these countries continued at least in the short term.

Javaheri and Asadollah (2010) in a study examined the oil demand in India as one of the major buyers of Iranian crude oil. The results of this study showed that all the obtained coefficients had the expected mark in theories. They found that the price elasticity was0.09 and the incomeelasticity of oil demand was 1.8. Their results also showed that the variables of industry, transportation and consumptsion of oil in the previous period were also not significant.

Karimian (2013) in a study predicted the China's oil demand from Iran and OPEC. The results of this study showed that in the case of increasing growth of China economic growth, its oil demand from Iran and OPEC is increasing more intensively than before.

Ebrahimi (2014) studied the factors affecting oil demand in the OECD countries. In this study, using the structural time series method, oil demand was modeled in this group of countries for the period 1965-2012. The results of the model estimation showed that demand response to price changes wasasymmetric and the demand for price increase was more sensitive so that the demand response to price increase was more than its response to price decrease. The results also indicated that oil was considered a necessary normal commodity for OECD members in the short and long term, which in the long term, the effect of income rise on oil demand was more than the short term.

Review of previous studies in Iran shows that the reversibility of the oildemand function is less considered by the researchers, and the estimation of oil demand function with an emphasis on the role of technology and environmental constraints has not been considered by them. Therefore, the present study estimates the oil demand function in OECD countries importing oil from Iran based on the symmetric and asymmetric approach to oil demand, with an emphasis on the role of technology and environmental constraints.

4. SPECIFYING THE APPLIED MODEL AND METHODS

4.1. Presentation of the Model and Definition of Variables

In this study, we seek to estimate the symmetric and asymmetric model for oil demand of OECD countries importing oil from Iran. Therefore, a symmetric and an asymmetric model for the oil demand of the oil importer countries should be presented. This study tried to use the model presented in previous research. Gately and Huntington (2002) presented a symmetric model for the energy demand of the industry sector based on the natural logarithm as follows, based on the Koyck model:

$$e_t=f[y_t,\gamma(L)\ p_t] \quad (1)$$

In model (1), e_t is the natural logarithm of energy demand, y the natural logarithm of production, P the energy price, and L represents the operator of the interruption. If we suppose that the above model is linear and can be used for the first interruption, equation (1) can be represented as follows:

$$e_t=\alpha+\beta y_t+\frac{\lambda p_t}{1-\lambda L}+\mu_t \quad (2)$$

In equation (2), μ_t represents a random error that has a normal distribution with mean zero and constant variance. Withapplying interruption operator, we will have:

$$e_t=\alpha^*+\beta(y_t-\lambda y_{t-1})+\lambda p_t+\lambda e_{t-1}+\varepsilon_t \quad (3)$$

In (3), $\alpha^*=\alpha(1-\lambda)$ and $\varepsilon_t=\mu_t-\lambda\mu_t$. In their study, they separated the energy price as follows to examine the asymmetric response to energy demand:

$$p_t=p_1+p_{max,t}+p_{cut,t}+p_{rec,t} \quad (4)$$

In the above equation, p_1 is the logarithm of the oil price at the beginning of period 1, $p_{max,t}$ is the cumulative increase in the log of maximum historical price, $p_{cut,t}$ the cumulative decrease of in the log of oil price and $p_{rec,t}$ is the improved cumulative increase in the log of oil price.

In this study, there are two econometric models that the model (7) is symmetric pattern and model (8) is asymmetric patterns for oil demand of OECD countries importing oil from Iran:

$$ldemand_{it}=\beta_0+\beta 1\ lGDP_{it}+\beta_2\ loilp_{it}+\beta_3\ lTech_{it}+\beta_4\ Environment_{it}+\varepsilon_{it} \quad (5)$$

$$ldemand_{ir}=\beta_0+\beta_1 lGDP_{ir}+\beta_2 oilp_{max}+\beta_3 oilp_{cut}+\beta_4 oilp_{rec}+\beta_5 lTech_{ir}+\beta_6\ Environment_{ir}+\varepsilon_{it} \quad (6)$$

In the above equation, oil demand is the amount of oil demand, which according to previous studies such as Javaheri and Asadollah (2010), Delavari and Baghbanzadeh (2007), Ebrahimi (2014), Dermot and Huntington (2001), and Griffin and Schulman (2005), oil by barrel will be used as an indicator of oil demand. GDP represents the gross domestic production with real price, the oil price also represents the price per barrel of Brent crude oil in dollar. In the above equation, tech represents the indicator of technology that in this study, three variables of R & D expenditures, the industrial value added share of GDP (indvdr) and time (t) will be used as indicators of technology. Environment is also an indicator of the environmental constraints thatin this study, the carbon dioxide (CO_2) emissions will be used as an indicator of environmental constraints.

In Equation (6), which is an asymmetric pattern of oil demand, price indices are defined as equation (7) according to previous studies of oil price differentiation:

$$p_{max,t}=\max(p_0 p_1,\ldots,p_t)$$

$$p_{cut,t}=\sum_{i=0}^{t}\min\left\{0\ ,\ (P_i-P_{i-1})-(P_{max,\,i}-P_{max,i-1})\right\} \quad (7)$$

$$p_{rec,t}=\sum_{i=0}^{t}\max\left\{0\ ,(P_i-P_{i-1})-(P_{max,\,i}-P_{max,i-1})\right\}$$

According to the explanations, in the framework of the model based on panel data, the estimated models will be as follows:

$$ldemand_{it}=\beta_0+\beta_1 lGDP_{it}+\beta_2 loilp_{it}+\beta_3 indvd_{it}+\beta_4 CO2_{it}+\varepsilon_{it} \quad (8)$$

$$ldemand_{it}=\beta_0+\beta_1 lGDP_{it}+\beta_2 loilp_{it}+\beta_3 R\&D_{it}+\beta_4 CO2_{it}+\varepsilon_{it} \quad (9)$$

$$ldemand_{it}=\beta_0+\beta_1 lGDP_{it}+\beta_2 loilp_{it}+\beta_3 T_{it}+\beta_4 CO2_{it}+\varepsilon_{it} \quad (10)$$

$$ldemand_{ir}=\beta_0+\beta_1 lGDP_{ir}+\beta_2 oilp_{max}+\beta_3 oilp_{cut}+\beta_4 oilp_{rec}+\beta_5 indvd_{ir}+\beta_6 Environment_{ir}+\varepsilon_{it} \quad (11)$$

$$ldemand_{ir}=\beta_0+\beta_1 lGDP_{ir}+\beta_2 oilp_{max}+\beta_3 oilp_{cut}+\beta_4 oilp_{rec}+\beta_5 R\&D_{ir}+\beta_6 CO2_{ir}+\varepsilon_{it} \quad (12)$$

$$ldemand_{ir}=\beta_0+\beta_1 lGDP_{ir}+\beta_2 oilp_{max}+\beta_3 oilp_{cut}+\beta_4 oilp_{rec}+\beta_5 T_{ir}+\beta_6 CO2_{ir}+\varepsilon_{it} \quad (13)$$

In this study, using data from the variables mentioned in 1970 to 2014, for OECD countries importing oil from Iran including France, Germany, Greece, Italy, Japan, Poland, Spain, Turkey, England, South Korea, Czech, Netherlands and Belgium, the models (8) to (13) are estimated.

5. EXPERIMENTAL RESULTS

5.1. Reliability Testing of Variables

Panel unit root test of Levin, Lin, and Chu (LLC) and the panel unit root test of Im, Pesaran and Shin (IPS) are used for reliability of variables. Table 1 shows the results of testing reliability of the values in the level and Table 2 shows the results of the first-order difference values of the variables used in the research. As shown in Tables 1 and

2, based on both tests, the values are not reliable at the level of the variables, but the first-order difference values of variables is reliable; in the sense that the null hypothesis"the existence of a unit root for the values in their level" is not rejected, but for the first-order difference values are rejected. Therefore, for OECD countries importing oil from Iran, the amounts are not reliable at the level of variables, but the first-order difference of these variables is reliable. Therefore, to avoid falling into the trap of false regression, it is necessary to examine the existence of a long-term relationship between variables.

5.2. Testing Co-integration Between Variables

Since the results of the unit root test represents the reliability of the first-order difference of the variables, the next step is to examine the existence of a long-term relationship, or, in other words, the co-integration between the variables in each model. To test the co-integration between variables, the test presented by Pedroni (1999 and 2004) is used. The results of this Pedroni co-integration test for models 1 to 6 are presented in Table 3.

In Pedroni's panel co-integration test, it is usually judged that if four of the seven statistics of the test indicate a long-term relationship between variables, or, in other words, the co-integration between variables, the hypothesis of absence of co-integration is rejected and the existence of a long-term relationship is confirmed. As shown in the table, for each of the six models, at least four Pedroni statistics indicate a long-term relationship between variables. Therefore, it can be said that the variables of each model are co-integrated or, in other words, the long-term relationship between the variables is established. As the co-integration relationship between variables is confirmed for all models of OECD countries importing oil from Iran, therefore, the Panel Fully Modified Least Squares (FMOLS) will be used to estimate the models.

5.3. Estimation of Symmetric Research Models

Table 4 shows the results of estimating symmetric models for OECD countries importingoil from Iran using the FMOLSmethod. As shown in Table 4, t-tests represent tshe significance of variables

Table 1: Unit root test of values at variable level for OECD importing countries from Iran

Variable	Unit root test	Statistics	Significance level
Log of oil demand	Levin, Lin and Chu	−1.182	0.118
	Im, Pesaran and Shin	8.400	1.000
Log of GDP to fixed price	Levin, Lin and Chu	2.850	0.997
	Im, Pesaran and Shin	0.318	0.625
Log of oil price	Levin, Lin and Chu	0.529	0.701
	Im, Pesaran and Shin	2.215	0.986
Log of industry share percentage	Levin, Lin and Chu	−1.220	0.111
	Im, Pesaran and Shin	−1.077	0.140
Log of R&D expenditures	Levin, Lin and Chu	0.017	0.507
	Im, Pesaran and Shin	2.761	0.997
Log of carbon dioxide emission	Levin, Lin and Chu	3.626	0.999
	Im, Pesaran and Shin	4.003	1.000
Logof maximum historical price of the course	Levin, Lin and Chu	1.983	0.976
	Im, Pesaran and Shin	4.665	1.000
Log of cumulative series of the rising oil price	Levin, Lin and Chu	7.574	1.000
	Im, Pesaran and Shin	0.247	1.000
Log of cumulative series offalling oil prices	Levin, Lin and Chu	−1.420	0.077
	Im, Pesaran and Shin	1.716	0.956

Source: Research findings. GDP: Gross domestic product

Table 2: Unit root test of first-order difference values of variables for OECD countries importing oil from Iran

Variable	Unit root test	Statistics	Significance level
Log of oil demand	Levin, Lin and Chu	−9.999	0.000
	Im, Pesaran and Shin	−3.664	0.000
Log of GDP to fixed price	Levin, Lin and Chu	−5.945	0.000
	Im, Pesaran and Shin	−4.539	0.000
Log of oil price	Levin, Lin and Chu	9.620	0.000
	Im, Pesaran and Shin	−16.725	0.000
Log o industry share percentage	Levin, Lin and Chu	−8.134	0.000
	Im, Pesaran and Shin	−11.742	0.000
Log of R&D expenditures	Levin, Lin and Chu	−2.862	0.002
	Im, Pesaran and Shin	−5.997	0.000
Log of carbon dioxide emission	Levin, Lin and Chu	3.630	0.000
	Im, Pesaran and Shin	−6.726	0.000
Logof maximum historical price of the course	Levin, Lin and Chu	−2.013	0.022
	Im, Pesaran and Shin	−5.629	0.000
Log of cumulative series of the rising oil price	Levin, Lin and Chu	−12.427	0.000
	Im, Pesaran and Shin	11.515	0.000
Log of cumulative series offalling oil prices	Levin, Lin and Chu	−7.255	0.000
	Im, Pesaran and Shin	−18.160	0.000

Source: Research findings

and model. The coefficient of determination also shows that for all three symmetric models, more than 90% of the dependent variable changes are explained by the independent variables, therefore, there are the necessary indices to ensure the desired models.

On the other hand, the results in the table show that the oil price coefficient for all three models is negative and the probability level for these coefficients is obtained <0.05, which indicates that the negative effect of oil prices is statistically confirmed, so it can be said in line with the expectation, rising oil prices significantly and reverselyinfluences the demand for oil in the OECD countries importing oil from Iran. The coefficients of the GDP variable for all three models also show that, according to the expectation, this variable has a positive significant effect on the oil demand of the oil importing countries from Iran. On the other hand, the results show the positive significant effect of carbon dioxide on oil demand in the studied countries, this can be attributed to the positive relation between oil consumption and carbon dioxide emissions.

The results also show that the technology indicator, which was measured in model 1 with the industry share in GDP, positively and significantly affected the oil demand, which was in line with theexpectation and with increasing share of industry, demand for energy has increased. In model 2, the R&D expendituretechnologyindicator is considered; as shown in Table 4, in this symmetric model, R&D expenditure has not been able to significantly affect the demand for oil for importing countries. Therefore, according to the results of this model, it can be said that R&D expendituresas a technology indicator have no significant effect on oil demand of OECD countries importing oil from Iran. In model 3, the time-varying technology indicator is defined, which results of estimatingsymmetric model show a negative effect of time on oil demand. The results show that demand for oil in the OECD countries importing oil from Iran has decreased, which can be attributed to improved technology levels and the use of more efficient equipment in using energy in the above countries.

5.4. Estimation of Asymmetric Models of Research

Table 5 presents the results of estimating asymmetric models. As shown in Table 5, the results did not change much in relation to the previous model, indicating that the stability of the estimated parameters is established. On the other hand, the determination coefficients also show the high explanatory power of the asymmetric models.

As shown in the table, for all three asymmetric models in the study, the cumulative series of oil price rise did not have a significant effect on oil demand, while the cumulative series of oil price fall negatively and significantly affected the oil demand of OECD countries importing oil from Iran. Since the variable amount of cumulative series of the fall in oil prices is negatively included in the model estimation, the results can be interpreted as following: Further fall in the price of oil relative to the maximum historical price would increase the demand for oil, while its further risedon'tsignificantly affect the demand for oil.

Table 3: Results of Pedroni co-integration test among variables for OECD countries importing oil from Iran

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Vpanel statistics	2.087 (0.018)	1.961 (0.024)	1.824 (0.034)	1.783 (0.037)	−1.417 (0.921)	0.546 (0.294)
R panel statistics	−0.703 (0.241)	−0.256 (0.398)	−0.503 (0.307)	0.397 (0.398)	3.051 (0.998)	1.764 (0.961)
Pp panel statistics	−1.436 (0.075)	−1.659 (0.048)	−2.571 (0.005)	−1.430 (0.076)	−2.308 (0.010)	−2.010 (0.022)
ADF panel statistics	−2.074 (0.019)	−2.541 (0.005)	−2.297 (0.010)	−1.267 (0.102)	−2.023 (0.021)	−4.030 (0.005)
R groupstatistics	1.067 (0.857)	0.936 (0.825)	0.624 (0.739)	1.743 (0.825)	4.424 (1.000)	2.716 (0.996)
Pp groupstatistics	−1.718 (0.042)	−1.994 (0.023)	−2.385 (0.008)	−2.444 (0.007)	−6.430 (0.000)	−2.315 (0.010)
ADF groupstatistics	−1.582 (0.056)	−2.523 (0.005)	−2.059 (0.019)	−1.617 (0.052)	−1.784 (0.037)	−4.606 (0.000)

Source: Research findings

Table 4: Results of estimation of symmetric models for OECD countries importing oil from Iran by FMOLS method

Explanatory variables	Model 1	Model 2	Model 3
Log of GDP at constant prices	0.143 (0.000)	0.120 (0.000)	0.274 (0.000)
Log of oil price	−0.052 (0.014)	−0.040 (0.059)	−0.081 (0.014)
Logarithm of the percentage of each industry sector share	0.096 (0.000)	-	-
R&D expenditures	-	0.005 (0.431)	-
Time	-	-	−0.010 (0.000)
Log of carbon dioxide emission	0.808 (0.000)	0.772 (0.000)	0.778 (0.000)
Coefficient of determination	0.966	0.931	0.911

Source: Research findings. FMOLS: Fully modified ordinary least square method

Table 5: Results of estimation of asymmetric models for OECD countries importing oil from Iran by FMOLS method

Explanatory variables	Model 4	Model 5	Model 6
Log of GDP at constant prices	0.102 (0.000)	0.093 (0.000)	0.125 (0.071)
Log of maximum historical price of the course	−0.075 (0.000)	−0.079 (0.000)	−0.111 (0.000)
Log of cumulative series of the rising oil price	−0.034 (0.114)	−0.009 (0.841)	−0.040 (0.335)
Log of cumulative series of falling oil prices	−0.087 (0.070)	−0.061 (0.036)	−0.289 (0.000)
Log o industry share percentage	0.168 (0.000)	−0.019 (0.035)	−0.011 (0.000)
Log of carbon dioxide emission	0.755 (0.000)	0.719 (0.000)	0.772 (0.000)
Coefficient of determination	0.970	0.969	0.923

FMOLS: Fully modified ordinary least square method, GDP: Gross domestic product

The results also confirm that the maximum historical price had a negative significant effect on the oil demand of OECD countries importing oil from Iran, which is also expected. According to the above, it can be said that the oil demand model for the OECD countries importing oil from Iran is asymmetric. The results of the estimation of asymmetric model also confirmed the positive income elasticity of the above-mentioned countries' oil demand. On the other hand, the increase in carbon dioxide emissions will also significantly increase the demand for oil in the OECD countries importing oil from Iran. Therefore, it can be said that environmental restrictions can reduce the demand for oil in OECD countriesto reduce air pollution. The results of the asymmetric model somehow confirm the results of the symmetric model, as the demand for oil increases significantly with the increase in industry's share of the economy as an indicator of technology. On the other hand, the results show that demand for oil in the OECD countries importing oil from Iran has slowed down, which can be attributed to improved technology and the use of higher equipment in using energy inthe above countries; thisresult is also achieved for the symmetric model, indicating a drop in oil demand in the studied countries over time. The difference in results compared to the symmetric model in model 2 is that in the asymmetric model, R&D expenditures has a negative significant effect on the oil demand of OECD countries importing oil from Iran. The results show that the R&D expenditures in the studied countries have led to a significant decrease in demand for oil for these countries; therefore, it can be concluded that the improvement in the level of technology that could result from increased R&D expenditures in OECD countries, significantly decreaseoil demand.

6. CONCLUSION

The study aimed to estimate the oil demand function in the OECD countries importing oil from Iran based on symmetric and asymmetric specifications. Thus, two symmetric and asymmetric models for oil demand from OECD countries importing oil from Iran were estimated. To estimate the symmetric and asymmetric models in this study, data from 1970 to 2014, for OECD countries importing oil from Iran including France, Germany, Greece, Italy, Japan, Poland, Spain, Turkey, the United Kingdom, South Korea, Czech, Netherlands and Belgium were used. The unit root test results of the variables showed that the value in the level of variables was not reliable for OECD countries importing oil from Iran, but the first-order difference values of these variables were reliable. Therefore, to avoid falling into the trap of false regression, it is necessary to examine the long-term relation between the variables. To examine the co-integration between variables, the Pedroni's co-integration test was used. The results of this test showed that the variables of each six models were co-integrated, or in other words there was a long-term relation between variables. Since the presence of a co-integration relationship between variables is confirmed for all models of OECD countries importing oil from Iran, hence the FMOLS method was used to estimate the models.

The results of this study showed that in symmetric and asymmetric models, increase in oil price had a positive significant effect as expected and GDP had a positive significant effect on the oil demand of OECD countries importing oil from Iran. On the other hand, the results indicate a positive significant effect of carbon dioxide on oil demand in the studied countries, which can be attributed to the positive relation between oil consumption and carbon dioxide emissions. The increase in the industry's share of the economy as an indicator of technology has significantly increased the demand for oil, and demand for oil in the OECD countries importing oil from Iran has slowed down over time, which can be attributed to improved technology and the use of higher-performance equipment in use of energy in the above countries. The difference in results compared to symmetric model is that in asymmetric models, R&D expenditures has a negative and significant effect on oil demand of OECD countries importing oil from Iran. The results show that the R&D expenditures in the studied countries have led to a significant decrease in oil demand for these countries; therefore, it can be concluded that the improved level of technology that could result from increased R&D expendituresin OECD countries, significantly reduce theoil demand.

The results of estimating asymmetric models for all three asymmetric models in the research showed that the cumulative series of oil price increases did not have a significant effect on oil demand, while the cumulative series of oil price decreases had a negative significant effect on oil demand in OECD countries importing oil from Iran. Since the cumulative series variable value of the fall in oil prices is negatively included in the model's estimation, the results can be interpreted as follows: A further decrease in the price of oil relative to the maximum historical price would increase the oil demand, while its further increase won't affect the oil demand significantly. The results also confirm that the maximum historical price has a negative significant effect on the oil demand of OECD countries importing oil from Iran, which is also expected. According to the above, it can be said that the oil demand model for the OECD countries importing oil from Iranis asymmetric.

The results of this study can lead economic policymakers more effectively to predict oil demand of oil-importing countries from Iran, and therefore the economic policymakers arerecommended to consider asymmetric models to predict oil demand.

REFERENCES

Abu, N.A., Shive, H. (2003), The gasoline consumption function of the country according to the data of years 1347 to1969. Economic Research, 22, 205-228.

Adeyemi, O.I., Hunt, L.C. (s2007), Modelling OECD industrial energy demand: Asymmetric price responses and energy-saving technical change. Energy Economics, 29(4), 693-709.

Ali-Morad, S., Karim, A., Iraj, K., Abuzar, S. (2010), Dynamic demand analysis of energy input in Iran's industrial industries. Quarterly Journal of Economic Modeling, 1, 77-105.

Ang, B., Lee, S. (1994), Decomposition of industrial energy consumption: Some methodological and application issues. Energy Economics, 16(2), 83-92.

Asplund, M., Eriksson, R., Friberg, R. (2000), Price adjustments by a gasoline retail chain. The Scandinavian Journal of Economics, 102(1), 101-121.

Bacon, R.W. (1991), Rockets and feathers: The asymmetric speed of adjustment of UK retail gasoline prices to cost changes. Energy Economics, 13(3), 211-218.

Basher, S.A., Sadorsky, P. (2006), Oil price risk and emerging stock markets. Global Finance Journal, 17(2), 224-251.

Bettendorf, L., Van der Geest, S.A., Varkevisser, M. (2003), Price asymmetry in the Dutch retail gasoline market. Energy Economics, 25(6), 669-689.

Borenstein, S., Cameron, A.C., Gilbert, R. (1997), Do gasoline prices respond asymmetrically to crude oil price changes? The Quarterly Journal of Economics, 112(1), 305-339.

Canyurt, O.E., Öztürk, H.K. (2006), Three different applications of genetic algorithm (GA) search techniques on oil demand estimation. Energy Conversion and Management, 47(18), 3138-3148.

Chi, K.C., Nuttall, W.J., Reiner, D.M. (2009), Dynamics of the UK natural gas industry: System dynamics modelling and long-term energy policy analysis. Technological Forecasting and Social Change, 76(3), 339-357.

Dargay, J., Gately, D. (1997), The demand for transportation fuels: Imperfect price-reversibility? Transportation Research Part B: Methodological, 31(1), 71-82.

Dargay, J.M., Gately, D., Huntington, H.G. (2007), Price and Income Responsiveness of World Oil Demand, by Product. Paper presented at the Energy Modeling Forum Working Paper EMF OP.

Delavari, M., Baghbanzadeh, F. (2007), Evaluation of symmetric and asymmetric patterns of oil demand in major oil importing countries from Iran. Journal of Energy Economics Studies, 14, 953-962.

Dergiades, T., Martinopoulos, G., Tsoulfidis, L. (2013), Energy consumption and economic growth: Parametric and non-parametric causality testing for the case of Greece. Energy Economics, 36, 686-697.

Dermot, G., Hillard, G.H. (2001), The Asymmetric Effects of Changes in Price and Income on Energy and Oil Demand. California: Energy Modeling Forum Stanford University Stanford. pOP50.

Ebrahimi, S.K. (2014), The relationship between profit management and information Asymmetry under uncertainty conditions. Accounting Knowledge, 3, 12.

Feng, Y., Chen, S., Zhang, L. (2013), System dynamics modeling for urban energy consumption and CO 2 emissions: A case study of Beijing, China. Ecological Modelling, 252, 44-52.

Gately, D., Huntington, H.G. (2002), The asymmetric effects of changes in price and income on energy and oil demand. The Energy Journal, 23(1), 19-55.

Gately, D., Huntington, H.G. (2002), The asymmetric effects of changes in price and income on energy and oil demand. The Energy Journal, 23(1), 19-55.

Godby, R., Lintner, A.M., Stengos, T., Wandschneider, B. (2000), Testing for asymmetric pricing in the Canadian retail gasoline market. Energy Economics, 22(3), 349-368.

Griffin, J.M., Schulman, C.T. (2005), Price asymmetry in energy demand models: A proxy for energy-saving technical change? The Energy Journal, 26(2), 1-21.

Huntington, H.G. (2009), Oil Demand and Technical Progress, Energy Modeling Forum. Stanford, CA: Stanford University. p94305-4026.

Javaheri, B., Asadollah, R. (2010), Investigating factors affecting oil demand in developing countries (case study: India) and short-term forecast of Iranian oil sales to India (1970-2005). Journal of Science and Development, 34, 51-68.

Karimian, A.A. (2013), Forecast China's Demand for OPEC and Iran oil, Bahonar University of Kerman, Master's Project.

Kirchgässner, G., Kübler, K. (1992), Symmetric or asymmetric price adjustments in the oil market: An empirical analysis of the relations between international and domestic prices in the Federal Republic of Germany, 1972-1989. Energy Economics, 14(3), 171-185.

Kiumars, S. (2007), Demand patterns and dynamic energy demand analysis in Iran. Quarterly Journal of Economic Research, 2, 67-79.

Liu, G., Yang, Z., Chen, B., Zhang, L. (2011), Emergy-based multiple spatial scale analysis framework combining resources and emissions impact for urban ecological economic evaluation. Entropy, 13(3), 720-743.

Manning, D. (1991), Petrol prices, oil price rises and oil price falls: Some evidence for the UK since 1972. Applied Economics, 23(9), 1535-1541.

Masih, A.M., Masih, R. (1997), On the temporal causal relationship between energy consumption, real income, and prices: Some new evidence from Asian-energy dependent NICs based on a multivariate cointegration/vector error-correction approach. Journal of Policy Modeling, 19(4), 417-440.

Mory, J.F. (1993), Oil prices and economic activity: Is the relationship symmetric? The Energy Journal, 14(4), 151-161.

Olutomi, I.A., David, C.B., Mona, C., Lester, C.H., Guy, J. (2010), Asymmetric price responses and the underlying energy demand trend: Are they substitutes or complements? Evidence from modelling OECD aggregate energy demand. Energy Economics, 32(5), 1157-1164.

Ryan, D.L., Plourde, A. (2002), Smaller and smaller? The price responsiveness of nontransport oil demand. The Quarterly Review of Economics and Finance, 42(2), 285-317.

Sadeghi, K. (2002), A Study of the Causal Relation between Energy Consumption and GDP in MENA Countries. Macroeconomic Research, 17, 121-140.

Samimi, R. (1995), Road transport energy demand in Australia a cointegration approach. Energy Economics, 17(4), 329-339.

Śmiech, S., Papież, M. (2014), Energy consumption and economic growth in the light of meeting the targets of energy policy in the EU: The bootstrap panel Granger causality approach. Energy Policy, 71, 118-129.

Traill, B., Colman, D., Young, T. (1978), Estimating irreversible supply functions. American Journal of Agricultural Economics, 60(3), 528-531.

Wadud, Z. (2015), Imperfect reversibility of air transport demand: Effects of air fare, fuel prices and price transmission. Transportation Research Part A: Policy and Practice, 72, 16-26.

Walker, I.O., Wirl, F. (1993), Irreversible price-induced efficiency improvements: Theory and empirical application to road transportation. The Energy Journal, 183-205.

Wolffram, R. (1971), Positivistic measures of aggregate supply elasticities: Some new approaches: Some critical notes. American Journal of Agricultural Economics, 53(2), 356-359.

Ünler, A. (2008), Improvement of energy demand forecasts using swarm intelligence: The case of Turkey with projections to 2025. Energy Policy, 36(6), 1937-1944.