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Investigating the Asymmetric Prices and the Role of Technology and Environmental Constraints in the Oil Demand Function of the Iran Oil Importing Countries

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ABSTRACT

The present study seeks to investigate the oil demand function reversibility of the Iran oil importing countries, taking into account the effect of technology and environmental constraints on the demand of the mentioned countries. In order to reach this goal, the present study evaluated two symmetrical and asymmetric adjustments for oil demand of Iran oil importing countries using data of 1970-2014 period for Iran oil importing countries including France, Germany, Greece, Italy, Japan, Poland, Spain, Turkey, the United Kingdom, South Korea, Czech Republic, the Netherlands and Belgium, Russia, South Africa, China and India. As there was a co-integrated relationship among the variables of mentioned cross-sections, Fully Modified Ordinary Least Squares (FMOLS) method of Panel data approach was applied. According to the results of this research, the oil price increase has a negative and significant effect and GDP has a positive and significant effect on the Iran oil importing countries in symmetric and asymmetric models. Through the application of FMOLS co-integrated panel data approach, oil demand of Iran oil importing countries is irreversible. Moreover, R&D as the technology indicator and lag of CO_2 as environmental constraints have a significant effect. In one hand, ignoring environmental considerations and pollution increasing in the mentioned countries will decrease the oil demand of Iran and on the other hand, technology indicator and applying modern ones will decrease the oil demand of Iran, too. According to the irreversibility for oil demand of Iran oil importing countries and Iran dependency on oil revenues, it should be attentive in selecting oil importing countries for sustainable source of revenue. The importance of environmental considerations and technological improvements of oil importing countries will be impressive for energy policy makers.

Keywords: Oil Demand Function, Oil Price, Irreversibility of Demand Function, Environmental Constraints, Technology Indicator

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1. INTRODUCTION

After the World War II, particular attention has been paid to studies on energy models in general and energy demand models, in particular.The time-based statistical models were used utilizing the time series in the 1950's. These models did not explicitly address causal relationships between energy demand and economic and technical variables and the forecast of energy consumption in subsequent periods was only obtained by calculating the average growth rate of energy consumption with the help of statistical data. Econometric methods in order for estimating energy demand were widely used in the 1960s. Investigating the relationship between various economic and energy variables by applying economic and statistical theories was the focus of these methods. The type and amount of energy demand is influenced by different factors that the effects of these factors on energy demand have not been the same over time, even at the time of increasing and decreasing energy prices. The major part of global energy demand, despite the growing trend of the use of new energies such as nuclear energy at the global level, is still supplied by fossil fuels such as crude oil as the most important of these resources. According to Basher and Sadorsky (2006), oil is the blood of modern economics. They believe that the oil prices will increase by increasing oil demand and at the same time, the constant supply of it. In their view, the supply and demand forces influence the oil price fluctuations. In 1973, after the rise in oil prices, the International Energy Agency (IEA), consisting of the United States, Japan and some European countries, was established to provide the arrangements for energy savings and replacing renewable with non-renewable resources. This led to the success of some of the above-mentioned countries in saving oil. For this reason, oil demand did not return to the pre-1973 oil price level after dropping in subsequent years; therefore, fundamentals on the oil demand reversibility and irreversibility was raised in different countries. Based on this hypothesis, the oil demand reaction is not the same against its increase and decrease. Wolffram (1971) was the first one who discusses about the asymmetry and decomposition of oil price. In another study, confirming Wolfram's result, Traill *et al.* (1978) concluded that the reaction to an increase or decrease in prices is equal to or less than the reaction to the maximum price. Mory (1993) also addressed the symmetry or asymmetry of economic activities relative to oil price changes. Several studies have also conducted in this field subsequently that addressed the reversibility test of the oil demand function in different countries as well as in various industries using different approaches. The effect of technological improvements on oil demand have been carried out in various studies, since 1971. In these studies, the price role and technological improvements are distinguished and they were looking for differentiating the effect of these two variables on energy demand.

The substantiation of development plans, in oil-dependent economies like Iran, requires accurate forecasting of the oil demand level in different countries and, consequently, in global markets, which can lead to more accurate forecasts of future oil prices. Hence, studying oil demand and demand reactions to price changes can be important; however, it can also be more important if the oil demand in different countries shows different reactions to the decrease or increase in oil prices. Accordingly, our main intention in the current study is estimating the oil demand pattern in Iran with two symmetric and asymmetric adjustments. This study was conducted in six sections as follows.

2. RESEARCH LITERATURE

After World War II, particular attention was paid to studies on energy models in general and energy demand patterns in particular. Trend extrapolation statistical models have been used by time series in the 1950s.The causal relationships between energy demand and economic and technical variables were not explicitly addressed in these models, and energy demand in upcoming years was only predicted by calculating the average growth rate of energy consumption with the help of statistical data. Econometric methods for estimating energy demand were widely used in the 1960s. Applying economics and statistical theories, these models tested the relationships between economic variables and energy demand growth. Using economics and statistical theories, these models test the relationships between economic variables and energy demand growth. The prediction of energy demand with the help of these models is based on the generalization of the past conditions to the future, because the parameters of these patterns are estimated based on historical or cross-sectional data. The type and amount of energy demand is influenced by different factors, which, over time and even at the time of increasing and decreasing in the price of energy, these factors had not have a similar effect on energy demand. The impact of technological improvements on oil demand has been studied since 1971, especially in OECD countries. The purpose of these studies, which distinguish between the role of prices and the improvement of technology, is to segregate the effect of these two variables on energy demand. As already mentioned, oil prices has experienced decreasing and increasing in the 1970s and 1980s, and these fluctuations had not the same effects on oil demand in different countries. This situation is interpreted as asymmetric reaction in the field of economic literature, like Walker and Wirl (1993), Gately and Huntington (2002), Ryan and Plourde (2002), and Dargay *et al.* (2007).

Two parts of the technical change rate, called pure technical changes and non-Neutral technical changes can be obtained by deriving the energy demand function to time. Pure technical changes are only dependent on time and non-Neutral technical changes are only dependent on changes in inputs over time and are defined as the substitution rate between the energy and other inputs. Technical changes can therefore be shown in the equation below:

$$E_t = \frac{\partial e_{it}}{\partial t} = \beta_t + \beta_{it} t + \sum \beta_{jt} x_{ijt} \quad (1)$$

The above equation represents the partial derivative of energy demand over the time. The pure technical changes can be considered as the result of promoting the technical knowledge level over time and the change in the amount or type of energy use is also known as non-neutral component.

The rate of change depends on the production agents and the relationship between energy and other inputs such that if the mentioned relationship is a complementary relationship, it will be specified with the positive sign and in case of substitution, it will be indicated by the negative sign. It is also possible to create non-neutral component as a result of lower costs due to the rise in energy prices. The growth of the scale of the economy, if we do not have any structural and technological changes in the economy, will lead to pollution and other environmental issues which is known as the scale effect. According to Kuznets' environmental curve theorists, product mix, technological changes, inputs combinations changes, environmental regulations, awareness and education can be influential through the environmental variable. These variables are expressed below in more details:

A) The production scale emphasizes the production increase at a certain level of input ratio, product mix, and technology level. It is generally assumed that a one percent increase in scale causes one percent increase of the pollution as there is no change in the ratio of output to input or technology.

B) In the early stages of development, the pollution increases during the transition from agriculture to heavy industries. While in the next stages, its' transition is from the heavy industry to the service and industry sector with less pollution.

C) Changing the inputs mix and the replacement of less polluting inputs; For example, the replacement of gas instead of coal.

(D) Improving the level of technology that causes increasing productivity and decreasing inputs used per unit of production and the use of less-polluting technologies in the production process.

The important point is that although any changes in pollution can be the result of one of the proxy variables, the variables that causes these changes has not the same effects at different levels of development. There are two-way limitations for energy-consuming countries. On the one hand, these countries need more energy in the production process by more economic growth, and on the other hand, environmental pollution is the results of increased energy consumption. Hence, such countries face environmental constraints. This has led some countries to apply less polluting energy in line with the pollution control; on the other hand, they seek to reduce energy consumption by supporting new technologies. Various adjustments have been made by various studies to model the irreversibility of oil demand or the asymmetry of oil demand. The present study emphasizes the models provided by Gately and Huntington (2002), Griffin and Schulman (2005) and Huntington (2009). Since Gately and Huntington (2002) have considered oil demand irreversibility caused by various reasons, they observed that oil demand has different reaction to the increase or decrease in oil prices in various countries like USA, China and Japan at different periods, and especially between 1970 and 1980.

In their Koyck model, Gately and Huntington (2002) presented a symmetric model for the energy demand of the industry based on natural logarithms as follows:

$$e_t = f\left[y_t,\ \gamma(L)p_t\right] \tag{2}$$

where e_t is the natural logarithm of energy demand, y is the natural logarithm of production, P is the energy price, and L is the interrupt operator. Equation (1) can be represented as follows in case that we as ume that the above model is super inear and can be used for the first interruption:

$$e_t = \alpha + \beta y_t + \frac{\lambda p_t}{1-\lambda L} + \mu_t \tag{3}$$

where, μ_t is a random error that has a normal distribution with mean zero and constant variance. By applying the interrupt operator we have:

$$e_t = \alpha^* + \beta\left(y_t - \lambda y_{t-1}\right) + \lambda p_t + \lambda e_{t-1} + \varepsilon_t \tag{4}$$

where, $\alpha^* = \alpha(1-\lambda)$ and $\varepsilon_t = \mu_t - \lambda\mu_t$. In order to investigate the energy demand asymmetric reaction to price, they segregated the energy prices as follows:

$$p_t = p_1 + p_{max,t} + p_{cut,t} + p_{rec,t} \tag{5}$$

where, p_1 is the oil price logarithm at the beginning of period 1, $p_{max,t}$ is the cumulative increase in Log of Maximum Historical Prices, $p_{cut,t}$ is the cumulative increase in log of oil price and $p_{rec,t}$ is the improved cumulative increase in the logarithm of the oil price.

Several studies have considered energy demand modeling, that in some of these studies such as Delavari and Baghbanzadeh (2007), Javaheri and Rezaei (2010), Ebrahimi (2014). The oil demand has been modeled and in some other studies, such as, Sadeghi (2013), Samimi (1995), Ang and Lee (1994), 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). Modeling the demand for other types of energy and examining the effect of different variables on the energy consumption of the researchers have been studied. The demand asymmetry and irreversibility hypothesis have been tested in different countries and for different energy commodities. Among these studies, we can mention the studies of Delavari and Baghbanzadeh (2007), Javaheri and Rezaei (2010) and Ebrahimi (2014) in Iran and Wolffram (1971), Traill *et al.* (1978), Bacon (1991), Manning (1991), Kirchgässner and Kübler (1992), Dargay and Gately (2007), Borenstein *et al.* (1997), Asplund *et al*. (2000), Godby *et al.* (2000) and Bettendorf *et al.* (2003). A review of the studies conducted in this area has been proposed in follow.

In a study by Gately and Huntington (2002), the impact of price and income changes on energy and oil demand in a number of countries has been estimated. Based on the results of this study, the demand response to oil prices for OECD countries is more than the oil prices drop. On the other hand, the demand response to income changes, according to the results achieved in many non-OECD countries, has not been necessarily symmetrical.

The demand asymmetric response has also been investigated in a study by Adeyemi and Hunt (2007). According to the results of this study, in the OECD countries, the energy demand of the industrial sector is an asymmetric response to price changes; while this result has not been observed for technical changes in energy saving.

The study of Wadud (2015) addresses the demand incomplete reversibility in air transport. In this study, an econometric model was used to test the reversibility hypothesis or demand irreversibility by decomposing fuel prices into three components. According to the results of this study, the demand for US air transport is asymmetrical, that indicates the potential for irreversibility of consumer behavior.

With the estimation of oil demand function in Japan, China, India and South Korea, the hypothesis of asymmetry in oil demand functions of these countries has been tested by Delavari and Baghbanzadeh (2007). Based on the results of model estimation, the hypothesis of asymmetry is confirmed in Japan, India and China. However, this hypothesis was not statistically confirmed in South Korea. Ebrahimi (2014) studied the factors affecting oil demand in the OECD countries. The results of the model estimation show the asymmetric demand response to the price changes and the demand is more sensitive to price increases.

3. THE RESEARCH ECONOMETRIC MODEL

Two econometrics models are generally considered in this research. Model (7) is a symmetric and (8) is an asymmetric model for oil demand for Iran oil importing countries:

$$ldemand_{it} = \beta_0 + \beta_1 lGDP_{it} + \beta_2 loilp_{it} + \beta_3 lTech_{it} + \beta_4 Environment_{it} + \varepsilon_{it} \quad (6)$$

$$ldemand_{ir} = \beta_0 + \beta_1 lGDP_{ir} + \beta_2 oilp_{max} + \beta_3 oilp_{cut} + \beta_4 oilp_{rec} + \beta_5 lTech_{ir} + \beta_6 Environment_{ir} + \varepsilon_{it} \quad (7)$$

In the above relationship, oil demand is the amount of oil demand, which is calculated from the oil consumption in terms of barrels as an indicator of oil demand according to previous studies such as Javaheri and Rezaei (2010), Delavari and Baghanzadeh (2007), Ebrahimi (2014), and Griffin and Schulman (2005). GDP represents the Gross domestic product in real prices; the oil price also represents the price of Brent crude oil per barrel in dollar. In the above-mentioned equations, tech is a symbol for the technology indicator and three variables of R&D expenditures, the industrial value added share of GDP (indvdr) and time (t) have been used as indicators of technology. Also, the environmental indicator indicates the environmental constraints that the carbon dioxide emission (CO_2) will be used as an indicator of environmental constraints in this study.

In the asymmetric model of oil demand in equation (6), price indicators are defined as the relation (7) according to previous studies of oil price differentiation:

$$\begin{aligned} p_{max,t} &= \max(p_0, p_1, \ldots, p_t) \\ p_{cut,t} &= \sum_{i=0}^{t} min\left\{0, \left(P_i - P_{i-1}\right) - \left(P_{\max,i} - P_{max\ i-}\right)\right\} \\ p_{rec,t} &= \sum_{i=0}^{t} max\left\{0, \left(P_i - P_{i-1}\right) - \left(P_{\max,i} - P_{max\ i-}\right)\right\} \end{aligned} \quad (8)$$

According to the above, the estimated models in the panel data-based method framework are as follows:

$$ldemand_{it} = \beta_0 + \beta_1 lGDP_{it} + \beta_2 loilp_{it} + \beta_3 indvd_{it} + \beta_4 CO_{2it} + \varepsilon_{it} \quad (9)$$

$$ldemand_{it} = \beta_0 + \beta_1 lGDP_{it} + \beta_2 loilp_{it} + \beta_3 R\&D_{it} + \beta_4 CO_{2it} + \varepsilon_{it} \quad (10)$$

$$ldemand_{it} = \beta_0 + \beta_1 lGDP_{it} + \beta_2 loilp_{it} + \beta_3 T_{it} + \beta_4 CO_{2it} + \varepsilon_{it} \quad (11)$$

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

$$ldemand_{ir} = \beta_0 + \beta_1 lGDP_{ir} + \beta_2 oilp_{max} + \beta_3 oilp_{cut} + \beta_4 oilp_{rec} + \beta_5 R\&D_{ir} + \beta_6 CO_{2ir} + \varepsilon_{it} \quad (13)$$

$$ldemand_{ir} = \beta_0 + \beta_1 lGDP_{ir} + \beta_2 oilp_{max} + \beta_3 oilp_{cut} + \beta_4 oilp_{rec} + \beta_5 T_{ir} + \beta_6 CO_{2ir} + \varepsilon_{it} \quad (14)$$

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

4. EXPERIMENTAL RESULTS

4.1 Variables Reliability Testing

The Panel Unit Root tests, Lewin, Lane, and Chu (LLC), and the Panel Unit Root Test of Im, Pesaran and Shin (IPS), have been used to validate the variables. The results of the reliability test of the values in the level and the results of the first-order difference values of the variables used in the research are presented in Tables 1 and 2, respectively. As can be seen, the values are not constant at the level based on both tests; however, the first order difference values of the variables are valid; such that as the nullhypothesis of the existence of a unit root for the values in the level is not rejected, but the first order difference values is reliable. So, it can be said that for Iran oil importing countries, the values at the level of variables are not reliable, but the first-order difference of these variables is reliable. Hence, it is necessary to examine the existence of a long-term relationship between variables in order to avoid falling into the trap of false regression.

Table 1. unit root test of the values at variables level for Iran oil importing countries

Variable	Unit root test	statistics	significance level
The oil demand logarithm	Lewin, Lane, and Chu	12/092	0/981
	Im, Pesaran, Shane	8/400	1/000
The GDP logarithm in fixed price	Lewin, Lane, and Chu	-1/744	0/040
	Im, Pesaran, Shane	2/388	0/ 991
Oil price logarithm	Lewin, Lane, and Chu	-0/667	0/252
	Im, Pesaran, Shane	2/149	0/984
Logarithm of the percentage of industry share	Lewin, Lane, and Chu	0/180	0/571
	Im, Pesaran, Shane	1/950	0/974
Logarithmic R & D expenditures	Lewin, Lane, and Chu	-0/561	0/287
	Im, Pesaran, Shane	2/712	0/996
CO2 emission logarithm	Lewin, Lane, and Chu	1/954	0/974
	Im, Pesaran, Shane	1/950	0/974
Logarithm for the maximum historical price of the period	Lewin, Lane, and Chu	0/908	0/818
	Im, Pesaran, Shane	4/703	1/000
Cumulative series logarithm of oil price rises	Lewin, Lane, and Chu	3/075	0/998
	Im, Pesaran, Shane	-0/463	0/321
The cumulative series logarithm of the fall in oil prices	Lewin, Lane, and Chu	6/296	1/000
	Im, Pesaran, Shane	-0/425	0/335

Source: Research data.

Table 2. Unit Root Test of the first-order difference values for Iran oil importing countries

Variable	Unit root test	statistics	significance level
The oil demand logarithm	Lewin, Lane, and Chu	-7/988	0/000
	Im, Pesaran, Shane	-6/665	0/000
The GDP logarithm in fixed price	Lewin, Lane, and Chu	-2/127	0/016
	Im, Pesaran, Shane	-3/500	0/000
Oil price logarithm	Lewin, Lane, and Chu	-10/460	0/000
	Im, Pesaran, Shane	-11/653	0/000
Logarithm of the percentage of industry share	Lewin, Lane, and Chu	-10/923	0/000
	Im, Pesaran, Shane	-11/496	0/000
Logarithmic R & D expenditures	Lewin, Lane, and Chu	-9/672	0/002
	Im, Pesaran, Shane	-8/597	0/000
CO2 emission logarithm	Lewin, Lane, and Chu	-10/059	0/000
	Im, Pesaran, Shane	-8/275	0/000
Logarithm for the maximum historical price of the period	Lewin, Lane, and Chu	-6/413	0/022
	Im, Pesaran, Shane	-2/700	0/000
Cumulative series logarithm of oil price rises	Lewin, Lane, and Chu	-11/247	0/000
	Im, Pesaran, Shane	-9/758	0/000
The cumulative series logarithm of the fall in oil prices	Lewin, Lane, and Chu	-3/795	0/000
	Im, Pesaran, Shane	-8/238	0/000

Source: Research data.

5.2 Co-integration Test among Variables

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

Generally, judging by the Pedroni co-integration test is based on the assumption that if four of the seven statistics of this test indicate a long-term relationship between variables, or, in other words, the co-integration between variables, the assumption of the absence of co-integration is rejected and the existence of a long-term relationship is confirmed. As it can be seen in the table, at least four pedroni statistics indicate a long-term relationship between variables for each of the six models. Therefore, it can be said that the variables of each model are co-integrated or, in other words, the long-term relationship is formed between the variables. Since the existence of a co-integration relationship between variables is confirmed for all models of Iran oil importing countries, the estimation of models will be used by Panel Fully Modified Least Squares (FMOLS).

5.3 Estimating the Symmetric Research Patterns

The results of estimating symmetric models for Iran oil importing countries by Fully Modified Least Squares (FMOLS) are shown in Table 4. T tests, as shown in Table 4, represent the meaningfulness of variables and models. The coefficient of determination also shows that more than 90 percent of the dependent variable variables are explained by independent variables for all three symmetric models. Hence, there are the necessary parameters to rely on the intended models.

Table 3. Pedroni Co-integration test results among variables for Iran oil importing countries

	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13
panel V Statistics	-0/549 (0/708)	-0/132 (0/552)	0/315 (0/376)	-2/256 (0/988)	-0/985 (0/837)	-0/358 (0/640)
panel R statistics	1/784 (0/962)	1/948 (0/974)	0/529 (0/701)	3/923 (1/000)	3/207 (0/999)	2/290 (0/989)
panel Pp statistics	-3/545 (0/000)	-1/806 (0/035)	-2/478 (0/006)	-2/476 (0/006)	-1/562 (0/059)	-1/861 (0/031)
panel ADF Statistics	-3/479 (0/000)	-1/616 (0/053)	-4/036 (0/000)	-4/762 (0/000)	-2/888 (0/001)	-3/721 (0/000)
Group R statistics	2/754 (0/997)	3/320 (0/999)	2/119 (0/983)	4/732 (1/000)	4/396 (1/000)	3/498 (0/999)
group Pp statistics	-3/532 (0/000)	-1/562 (0/059)	-2/289 (0/011)	-3/418 (0/000)	-1/995 (0/023)	-2/668 (0/003)
Group ADF statistics	-2/149 (0/015)	-1/435 (0/075)	-3/997 (0/000)	-3/722 (0/000)	-4/432 (0/000)	-6/024 (0/000)

Source: Research data.

Table 4. The results of the estimation of symmetric models for Iran oil importing countries by FMOLS method

The explanatory variables	Model 8	Model 9	Model 10
The GDP logarithm in fixed price	0/107 (0/000)	0/115 (0/000)	0/388 (0/000)
Oil price logarithm	-0/041 (0/014)	-0/049 (0/003)	-0/053 (0/000)
the percentage of industry share logarithm	0/108 (0/000)	-	-
Research and development expenditures	-	-0/028 (0/000)	-
Time	-	-	-0/008 (0/000)
CO_2 emission logarithm	0/806 (0/000)	0/820 (0/000)	0/464 (0/000)
The coefficient of determination	0/977	0/967	0/911

Source: research data.

The results of estimating symmetric models of the Fully Modified Least Squares method (FMOLS) are shown in Table 4. Gross domestic product, as shown in Table 4, has had a positive and significant impact on the oil demand of Iran oil importing countries, which means that the increase in Gross domestic product, and subsequently, the increase in energy demand, caused the increase in oil demand as one of the major sources of energy, and hence, there is a positive relationship. 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 of these coefficients are less than 0.05, which indicates that the negative effect of oil prices is statistically confirmed. According to the results of the model (8) the oil price coefficient is -0.041 and its' probability level is 0.014. in model (9), the price elasticity of oil demand is negative which indicates that with 1 percent increasing in oil price the demand of oil importing countries of Iran will significantly decrease by 0.049 percent and in model (10) the coefficient of oil price is -0.053. The environmental constraints index, which is carbon dioxide in this study, also shows a positive effect on oil demand and is statistically significant, and in this symmetric pattern, the research expenditures on oil demand are negative and significant for the importing countries.

Also, according to the results, oil demand is positively and significantly influenced by the technology index, which is measured in model 1 with the share of the industrial sector to gross domestic product. While, the elasticity of technology is significant and equal to 0.108 in such a way that with 1 percent increasing in industry sector portion of oil importing countries' economies, the oil demand of Iran will increase by 0.108 percent. The technology indicator in Model 2 has been measured by research and development expenditures. The results show that research and development expenditures have had a negative and significant effect on the oil demand of Iran oil importing countries. The elasticity of R&D is -0.028 which implies that with 1 percent decreasing in R&D, the oil demand will decrease by 0.028 percent. The time variable has also been defined for technology in model 3. Estimated results show the negative and significant effect of this variable on oil demand from the Iran oil importing countries. According to the results, the oil demand of Iran oil importing countries has declined over time, which can be attributed to the improvement of the level of technology and the use of higher-performance equipment in the use of energy in the mentioned countries.

5.4 Estimating the Research Asymmetric Patterns

The results of estimating asymmetric patterns are presented in Table 5. As can be seen in Table 5, the results do not change much relative to the previous model that indicates the stability of the estimated parameters. On the other hand, the determination coefficients also show the high power of explaining the asymmetric models of research.

The positive income elasticity of the oil demand of the mentioned countries is also confirmed by the results of the asymmetric model estimation. Other results also confirm the symmetric pattern results so that the oil demand increase significantly by the increased industry's share in the economy as a technology indicator. So, with 1 percent increasing in industry sector in oil importing countries of Iran, their oil demand increases by 0.164

Table 5. The results of estimating asymmetric patterns for Iran oil importing countries using the FMOLS method

The explanatory variables	Model 11	Model 12	Model 13
The GDP logarithm in fixed price	0/098 (0/000)	0/106 (0/000)	0/111 (0/000)
Logarithm for the maximum historical price of the period	-0/099 (0/000)	-0/097 (0/000)	-0/111 (0/000)
Cumulative series logarithm of oil price increases	-0/055 (0/769)	-0/039 (0/289)	-0/078 (0/161)
The cumulative series logarithm of the fall in oil prices	-0/056 (0/011)	-0/054 (0/16)	-0/056 (0/000)
Logarithm of the percentage of industry share	0/164 (0/000)	-	-
Research and development expenditures	-	-0/057 (0/000)	-
Time	-	-	-0/016 (0/000)
CO_2 emission logarithm	0/789 (0/000)	0/816 (0/000)	0/373 (0/000)
The coefficient of determination	0/978	0/977	0/923

Source: Research findings.

percent and 1 percent increasing in R&D decreases the oil demand by 0.057 percent. On the other hand, the increase in carbon dioxide emissions will also increase the oil demand in the Iran oil importing countries. So, it can be said that the demand for Iran oil importing countries can be decreases by the environmental constraints to reduce air pollution. The Table 5 also shows that the maximum historical price of the period, the cumulative series of oil price reductions have a negative and significant effect on the oil demand of the Iran oil importing countries. As in model (11), 1 percent increasing in the maximum historical price will decrease the oil demand by 0.055 percent and in model (12) and model (13) will decrease it by 0.039 and 0.078 percent, respectively. Moreover, 1 percent increasing in the cumulative series of oil price reductions will decrease oil demand in models (11), (12) and (13) by 0.056, 0.054 and 0.056 percent, respectively. the cumulative series of oil price increases will have no significant effect on oil demand. Therefore, the oil demand pattern of oil importing countries of Iran is asymmetric.

6. CONCLUSION

The present study seeks to estimate the oil demand function of the Iran oil importing countries based on two symmetric and asymmetric adjustments. To this end, the present study evaluated two symmetrical and asymmetric adjustments for oil demand of Iran oil importing countries using data of 1970-2014 period for Iran oil importing countries including France, Germany, Greece, Italy, Japan, Poland, Spain, Turkey, the United Kingdom, South Korea, Czech Republic, the Netherlands and Belgium, Russia, South Africa, China and India. According to the results of the unit root test of the research variables, the values are not constant at the level of variables for Iran oil importing countries; however, the first-order difference of these variables is reliable. So, in order to avoid falling into the trap of regression, it is necessary to examine the existence of a long-term relationship between variables. Pedroni co-integration test was used to examine the co-integration among variables. The results of this test showed that the variables of each of the six models are co-integrated or, in other words, long-term relationship exists between the variables. Since the co-integration relationship between variables is confirmed for all the intended models of Iran oil importing countries, hence the Panel Fully Modified Least Squares (FMOLS) method was used to estimate the models. According to the results of this research, the oil price increase has a negative and significant effect and GDP has a positive and significant effect on the Iran oil importing countries in symmetric and asymmetric models, according to expectations. On the other hand, as the results shows, CO_2 has a significant and positive effect of on oil demand from the studied countries that this issue can be resulted from the positive relationship between the oil consumption and CO_2 emission. Oil demand has significantly increased with increasing industry share in the economy as a technology indicator, and over time, oil demand of the Iran oil importing countries has decreased which can be attributed to improved technology and the use of higher-end equipment in utilizing energy in the above countries. According to the results, the research and development 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 of the technology level that could be due to increased research and development spending in these countries, significantly reduces oil demand. The results of estimating asymmetric patterns 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 have a negative and significant effect on oil demand for Iran oil importing countries. Since the value of the cumulative series variable of the fall in oil prices is considered negative in the model's estimation, the results can be interpreted as a further decrease in the price of oil relative to the maximum historic price, which increases the demand for oil if the further increase in demand for oil does not significantly affect it. The negative and significant effect of the maximum historical price on the oil demand of Iran oil importing countries has also confirmed by the results. It can be concluded that according to the findings of this study, the oil demand pattern for Iran oil importing countries is asymmetrical. The results of this study can more effectively guide economic policymakers to predict the oil demand of Iran oil importing countries, and therefore, it is suggested that economic policymakers consider asymmetric patterns in order to predict the oil demand. Therefore, according to the irreversibility for oil demand of Iran oil importing countries and Iran dependency on oil revenues, it should be attentive in selecting oil importing countries for sustainable source of revenue. The importance of environmental considerations and technological improvements of oil importing countries will be impressive for energy policy makers.

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