

Varahrami, Vida; Haghighat, Mohammad Saeed

## Article

# The assessment of liquefied natural gas (LNG) demand reversibility in selected OECD countries

Energy Reports

**Provided in Cooperation with:**

Elsevier

*Suggested Citation:* Varahrami, Vida; Haghighat, Mohammad Saeed (2018) : The assessment of liquefied natural gas (LNG) demand reversibility in selected OECD countries, Energy Reports, ISSN 2352-4847, Elsevier, Amsterdam, Vol. 4, pp. 370-375, <https://doi.org/10.1016/j.egy.2018.05.006>

This Version is available at:

<https://hdl.handle.net/10419/187921>

### Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

### Terms of use:

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



<https://creativecommons.org/licenses/by-nc-nd/4.0/>



## Research paper

## The assessment of liquefied natural gas (LNG) demand reversibility in selected OECD countries

Vida Varahrami <sup>\*</sup>, Mohammad Saeed Haghighat

Shahid Beheshti University, Iran

## ARTICLE INFO

## Article history:

Received 3 February 2018

Received in revised form 26 April 2018

Accepted 30 May 2018

## JEL classification:

F14

Q37

Q41

R49

## Keywords:

LNG

Asymmetric effects

Reversibility

Dynamic panel

## ABSTRACT

Experience has shown that there is a relationship between demand and price, contrary to the short-term mode, which is expected to be inverted between price and value, and the effects of lowering and rising prices follow reverse. But symmetric results; in the long run, there may be unlawful reactions. It would seem that the effect of the price increase and its effect on the amount with its photo mode is not the effect of the price decline. To illustrate the effects of price symmetry, the price can be broken down into three parts, the maximum price, the lowering price, and the increasing price, according to the Getely method. The main objective of this paper is to investigate the effects of the LNG product in the OECD countries. The study uses seasonal data from 2011–2015 for selected countries (Japan, South Korea, United States, United Kingdom, and Spain). Dynamic panel method is also used to estimate the model of this research. According to research findings, long-term and short-term elasticities of effective factors on LNG demand in selected countries have been calculated. The results show that LNG demand in the selected importing countries is relatively reversible in the short and long-term.

© 2018 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## 1. Introduction

Natural gas is regarded as an important source of energy supplies in the new century. Today, many technologies have been developed for extracting, transporting, and utilizing gas resources. In addition, the rapid development of the gas industry has influenced some important technologies introduced since the mid-twentieth century. However, it has faced a lot of difficulties due to the nature of the natural gas transmission, and the pipeline has many problems at long distances even using the easiest means of transportation.

In those cases where short distances and markets are large, pipelines usually have the lowest cost for transporting natural gas without considering specific political and geographic locations. However, the factors considered as limiting gas pipelines include transferring distance, determining the pressure boost stations, marine and blue barriers, crossing populated areas, and environmental issues, and political problems.

In addition, more pipelines and pressure boost stations are required for longer transmission distance. Further, it is evident that this plays a significant role in increasing the price of the final product. Given the technology available to transport gas for

remote areas, the LNG method, as an economic method, can largely overcome the difficulties of carrying gas. In general, two separate markets are available for liquefied natural gas trading. First, the Atlantic market including the exports to Mediterranean markets, or Atlantic Mediterranean markets. Import markets include Europe, America, and the Caribbean, as well as Norway, Libya, Nigeria, Trinidad and Tobago and Egypt, with the largest share of LNG exports. Second, Asia Pacific market includes Japan, Korea, China and Taiwan as the importers of this market. Typically, the Asia Pacific market will take a larger share of international trade. The following factors are regarded as some of the most important factors in increasing the global LNG trade:

- Increased competition among suppliers of new LNG technologies
- Increased demand for LNG in importing countries and the addition of emerging markets to this market
- Scale-scale savings in designing new natural gas conversion facilities to LNGs
- Reducing LNG production costs due to the growth of technical progress in this area
- Enhancing global attention to environmental issues, reaching the proximity of the global carbon tax, and increasing in plant production costs, and enhancing the need for clean fuel
- High prices of natural gas and the willingness of gas producers to extract and produce even remote resources.

The present study aimed to evaluate the asymmetric effects of the price on LNG demand and its sub-target, as well as the

<sup>\*</sup> Corresponding author.

E-mail addresses: [Vida.varahrami@gmail.com](mailto:Vida.varahrami@gmail.com) (V. Varahrami), [haghighat@gmail.com](mailto:haghighat@gmail.com) (M.S. Haghighat).

short-term and long-term elasticities of other variables affecting the demand for liquefied natural gas in selected countries. In fact, it tries to analyze the variables affecting LNG imports in light of expanding this industry in the world. All data were seasoned to more assess the asymmetric effects of the price more accurately. Data related to LNG and gas prices through the pipeline were monthly and the data on national income, energy consumption, population and LNG demand were annual. To this aim, Japan, South Korea, Spain, the United Kingdom and the United States were selected. These countries are regarded as the only countries having the highest volume of LNG imports worldwide.<sup>1</sup>

Based on the literature review related to the LNG markets and the problems related to convergence in hydrocarbon reserves, those variables affecting the amount of LNG demand according to theoretical economic basis were taken into consideration. Then, the price of LNG in selected countries was analyzed by implementing Getely's method, using theoretical bases of the model, and finally estimating the model by using dynamic panel data. Finally, conclusions and policy recommendations were made.

## 2. Background of the study

So far, most of the studies conducted in this area have focused on examining the asymmetric effects of hydrocarbon reserves and relating the reversibility of hydrocarbon reserves to the oil price. However, less attention has been paid on other transmission energy, especially Olive. For example, some focused on studying the problems related to asymmetric effects with positive oil shocks in the early 1970's, followed by the recession in the world economy. In addition, the effects of oil shocks on the macroeconomic structure were evaluated in some other studies.

Alam et al. (2017) reviewed Australia's current gas reserve, industries, markets, and LNG production capabilities. Now, Australia is regarded as one of the world's major natural gas producers and exporters and is expected to continue a dominating role in the world gas market in future.

In another study, Varahrami et al. (2015) studied the asymmetric effects of natural gas prices on their consumption in the household sector by using the Cooke model during 1991–2012 and concluded that change in the effects of natural gas price on asymmetric household consumption. In addition, long and short-term gas price stretches, natural gas stretch, and short-term natural gas demand were evaluated in this study.

Regarding the future of LNG trade in the United States, Moryadee et al. (2014) has the potential of exporting LNG by the country by relying on significant reserves of unconventional gas in the US. In addition, its impact on LNG global trade was evaluated within the framework of a game theory model.

Further, Taklif (2013) examined the cooperation of the elected members in the Gas Exporting Countries Forum based on the game theory approach. First, an LNG shipping cost matrix was developed from the elected member states of the exporter in the LNG to the selected LNG countries by examining the structure of the LNG carriage cost and its global business model. Finally, this matrix was utilized to study the game theory approach in the selected countries.

Furthermore, regarding the LNG product, Mansurkiaee (2009) estimated the relationship between crude oil prices and LNG Liquefied Petroleum and recommended some appropriate strategies for exporting gas through LNG to Iran.

Getely and Hillard (2001), in another study, estimated three separate models for OECD and non-OECD oil and non-OECD high demand growth by implementing integrated data during 1971–1997. The results indicated that long-term tensions and long-term

earnings were  $-0.64$  and  $0.56$  for OECD countries, respectively,  $-0.17$  and  $0.68$ , respectively for non-OECD countries, and  $-0.12$  and  $0.95$ , respectively for non-OECD countries with high growth.

Regarding all the above-mentioned studies, most of the research on price symmetry highlighted the effects of price fluctuations on macroeconomic variables. In addition, a large number of studies were conducted on the asymmetric and reversible effects of the dependent variable in the market for exchange rate and deposit, investment and consumption issues. However, to the best of our knowledge, no research has been conducted on effects of assessing price symmetry in the global LNG market.

## 3. Methodology

In order to conduct the present study, the United States, Spain, Britain (Atlantic market), and Japan and Korea (Asian-Pacific market) were selected. To this end, the following variables were considered:

*Imported LNG Prices:* The price of LNG is considered as one of the most important factors affecting the level of imported LNG. According to demand law and the inverse relationship between price and quantity, an increase in LNG prices leads to a reduction in the amount of imported demand and a decrease in the price of LNG. In the economic term, assuming that other conditions are stable, an increase or decrease in price is regarded as the demand for the movement of the curve. In the demand side of hydrocarbon reserves, it seems that the effect of changing demand for these reserves such as oil on its demand in the long run is greater than its effects in the short term. For example, fuel consumers cannot quickly change their consumption habits through rising oil prices while it is possible in the long run (Mousavi et al., 2014).

*Asymmetric LNG Prices:* The effects of prices on energy demand behaviors are asymmetric due to the irreversible effects of technology improvement and demand-side management. Technology increases or equipment efficiency increases when the price of imported LNG increases in developed countries. In addition, this improvement is institutionalized in the industrial structure so that if a reduction in price occurs in the future, this effect is not reversible (Taghvi Nejad, 2006).

*GDP (or national income):* LNG imports are directly related to the level of industrial activity in the community, the amount of gas consumed in the domestic and commercial sectors, as well as the amount of agricultural production Arbox and Perobelli (2010).

*Gas pipeline price:* A pipeline can be used as a substitute for natural gas. For example, the price set for LNG in the Henry hub is closely related to the price of natural gas from the pipeline in the United States, which means that they are competing for successive commodities. As it was already mentioned, in order to determine the transmission path to transfer gas, different conditions such as the amount of transmission distance, the existence of sea, political-economic barriers, and the like should be considered. For example, South Korea and Japan are shipping all their gas through LNG due to the sea and high gas pipeline costs from the sea (Rahimi, 2007).

*Population growth:* Clearly, population growth results in increasing the demand for hydrocarbon reserves such as natural gas. In other words, the higher population leads to the greater demand for energy.

### 3.1. Imported LNG prices decomposition

In 1993, Mory divided the price changes of oil into two categories in order to examine the existence of a synonymous relationship between economic activity and oil prices. The sharp rise in oil prices in 1973 has had some implications for the world's

<sup>1</sup> BP Statistical Review of World Energy (2013).

energy economy. The demand structure of energy dramatically changed in the OECD countries, leading to some technological changes and an improvement inefficiency and change in energy consumption patterns. The LNG market experienced three types of price (increase, decrease, increase) during the time:

$$P_t = P_{\max,t} + P_{\text{cut},t} + P_{\text{rec},t} \quad (1)$$

where  $P_{\max,t}$  represents the maximum historical price,  $P_{\text{cut},t}$  indicates a cumulative series of decreasing prices, and  $P_{\text{rec},t}$  is considered as the cumulative series of price improvements. Thus, the following equations are obtained:

$$P_{\text{rec},t} = \text{Max} (P_0, P_1, \dots, P_t) \quad (2)$$

$$P_{\text{cut},t} = \sum_{i=0}^t \min\{0, (P_{\max(t-1)} - P_{t-1}) - (P_{\max t} - P_t)\} \quad (3)$$

$$P_{\max,t} = \sum_{i=0}^t \max\{0, (P_{\max(t-1)} - P_{t-1}) - (P_{\max t} - P_t)\}. \quad (4)$$

Regarding the history of price decomposition during the last decades in the oil market, oil price decay occurred after rising oil prices between 1973 and 1982. During these years, rising oil prices caused a maximum price change (maximum price). However, the price increase was not satisfactory to lead to a change in this maximum price (incremental price) after 1982. In addition, a decrease in oil prices resulted in reducing the prices in the oil market (falling prices).

Here, Eq. (1) indicates the highest and lowest price during a period and its value is always positive. Eq. (2) represents the cumulative amount of price reductions during a period so that the price difference between the current price changes with the maximum price and that of the previous period is calculated based on the maximum price of the previous period and is compared with zero. Then, the less number is selected between these two numbers and then the resulting number is added to the numbers of previous years obtained by the same method and the total reduction ( $P_{\text{cut}}$ ) is obtained. In addition, Eq. (3) addresses the incremental series of oil prices. Here, like  $P_{\text{cut}}$ , the difference in oil price and its maximum price for the years in question is calculated, and finally it is compared with zero, and each larger number is considered as the final number in the final cumulative relation. Finally, the cumulative gain is obtained ( $P_{\text{rec}}$ ), which represents an ascending graph and has a positive trend since it always considers only the price increases. Each year, the algebraic sum of these three numbers represents the actual price of oil in that year (Hamilton, 1983).

#### 4. Model of the study

In order to estimate the research pattern, the price decoupling method was used to obtain LNG and LNG price increases among the selected countries. Then, the data were used to estimate the model based on the dynamic panel method. Further, the price is regarded as the average price of imported LNG per country. Japan, South Korea, the United States, the United Kingdom and Spain were considered as the case study. These countries are the only countries with the highest share of LNG demand in the global market and accordingly are selected as the studied countries. The data were obtained from BP, EIA, and World Bank during 2011–2015.

##### 4.1. Price decomposition

In this section, the prices of imported LNGs are compared to  $P_{\max}$ ,  $P_{\text{cut}}$ ,  $P_{\text{rec}}$  in the selected countries according to the price analysis method used in the theoretical bases. The demand function is reversible if the  $P_{\max}$  and  $P_{\text{rec}}$  move towards each other. Otherwise, they are irreversible. Finally, the LNG import demand function can be largely predicted (see Tables 1–5).

**Table 1**  
LNG import price decomposition in Japan.

	$P_{\text{LNG}}$ (US dollar/Mbtu)	$LP_{\text{LNG}}$	$P_{\max}$	$P_{\text{cut}}$	$P_{\text{rec}}$
Q1 2011	14.73	2.690	2.69		
Q2 2011	15.195	2.721	2.721	0	0
Q3 2011	15.66	2.751	2.751	0	0
Q4 2011	16.125	2.780	2.78	0	0
Q1 2012	16.59	2.809	2.809	−0.001	0
Q2 2012	17.27	2.849	2.849	−0.001	0
Q3 2012	17.73	2.875	2.875	−0.001	0
Q4 2012	15.36	2.732	2.875	−0.144	0
Q1 2013	16.42	2.799	2.875	−0.144	0.067
Q2 2013	16.42	2.799	2.875	−0.144	0.067
Q3 2013	15.77	2.758	2.875	−0.184	0.067
Q4 2013	15.48	2.740	2.875	−0.203	0.067
Q1 2014	16.87	2.826	2.875	−0.203	0.173
Q2 2014	16.66	2.813	2.875	−0.216	0.173
Q3 2014	15.9	2.766	2.875	−0.263	0.173
Q4 2014	15.91	2.767	2.875	−0.263	0.174
Q1 2015	13.57	2.608	2.875	−0.422	0.174

**Table 2**  
LNG import price decomposition in South Korea.

	$P_{\text{LNG}}$ (US dollar/Mbtu)	$LP_{\text{LNG}}$	$P_{\max}$	$P_{\text{cut}}$	$P_{\text{rec}}$
Q1 2011	12.67	2.539	2.539		
Q2 2011	12.9775	2.563	2.563	0	0
Q3 2011	13.2775	2.586	2.586	0	0
Q4 2011	13.5775	2.608	2.608	0	0
Q1 2012	13.9	2.632	2.632	−0.001	0
Q2 2012	16.13	2.781	2.781	−0.001	0
Q3 2012	15.59	2.747	2.781	−0.0341	0
Q4 2012	13.73	2.620	2.781	−0.161	0
Q1 2013	15.23	2.723	2.781	−0.161	0.104
Q2 2013	14.83	2.697	2.781	−0.188	0.104
Q3 2013	15.07	2.713	2.781	−0.188	0.120
Q4 2013	14.76	2.692	2.781	−0.208	0.12
Q1 2014	16.46	2.801	2.801	−0.208	0.209
Q2 2014	16.76	2.819	2.819	−0.208	0.209
Q3 2014	16.61	2.810	2.819	−0.217	0.209
Q4 2014	16.29	2.791	2.819	−0.237	0.209
Q1 2015	13.79	2.624	2.819	−0.403	0.209

**Table 3**  
LNG import price decomposition in the UK.

	$P_{\text{LNG}}$ (US dollar/Mbtu)	$LP_{\text{LNG}}$	$P_{\max}$	$P_{\text{cut}}$	$P_{\text{rec}}$
Q1 2011	8.57	2.148	2.148		
Q2 2011	8.42	2.131	2.148	−0.018	0
Q3 2011	8.27	2.113	2.148	−0.036	0
Q4 2011	8.12	2.094	2.148	−0.054	0
Q1 2012	7.96	2.074	2.148	−0.074	0
Q2 2012	8.35	2.122	2.148	−0.074	0.048
Q3 2012	7.85	2.061	2.148	−0.136	0.048
Q4 2012	9.43	2.244	2.244	−0.136	0.135
Q1 2013	9.44	2.245	2.245	−0.136	0.135
Q2 2013	9.6	2.262	2.262	−0.136	0.135
Q3 2013	8.78	2.172	2.262	−0.225	0.135
Q4 2013	9.83	2.285	2.285	−0.225	0.225
Q1 2014	9.14	2.213	2.285	−0.298	0.225
Q2 2014	8.09	2.091	2.285	−0.420	0.225
Q3 2014	5.94	1.782	2.285	−0.729	0.225
Q4 2014	6.66	1.896	2.285	−0.729	0.339
Q1 2015	6.84	1.923	2.285	−0.729	0.366

##### 4.2. Presentation of the model

In this section, a model is introduced for assessing the relationship between the amounts of LNG demand, the price fluctuations of this commodity and other factors affecting the imports. According to the theoretical basis, such a function can be considered for LNG imports:

$$Q_{\text{LNG}} = f(P_{\text{LNG}}, P_{\text{pipeline}}, N_i, \text{population}, \text{consumption}, Q_{\text{LNG}(-1)}). \quad (5)$$

**Table 4**  
LNG import price decomposition in the United States.

	$P_{LNG}$ (US dollar/Mbtu)	$LP_{LNG}$	$P_{max}$	$P_{cut}$	$P_{rec}$
Q1 2011	5.47	1.699	1.699		
Q2 2011	5.0425	1.618	1.699	−0.081	0
Q3 2011	4.615	1.529	1.699	−0.170	0
Q4 2011	4.1875	1.432	1.699	−0.267	0
Q1 2012	3.76	1.324	1.699	−0.374	0
Q2 2012	3.41	1.227	1.699	−0.472	0
Q3 2012	4.03	1.394	1.699	−0.472	0.167
Q4 2012	5.1	1.629	1.699	−0.472	0.402
Q1 2013	5.67	1.735	1.735	−0.472	0.472
Q2 2013	5.9	1.775	1.775	−0.472	0.472
Q3 2013	7.18	1.971	1.971	−0.472	0.472
Q4 2013	6.26	1.834	1.971	−0.609	0.472
Q1 2014	8.69	2.162	2.162	−0.609	0.609
Q2 2014	10.74	2.374	2.374	−0.609	0.609
Q3 2014	8.85	2.180	2.374	−0.803	0.609
Q4 2014	5.92	1.778	2.374	−1.205	0.609
Q1 2015	9.19	2.218	2.374	−1.205	1.049

**Table 5**  
LNG import price decomposition in Spain.

	$P_{LNG}$ (US dollar/Mbtu)	$LP_{LNG}$	$P_{max}$	$P_{cut}$	$P_{rec}$
Q1 2011	9.08	2.206	2.206		
Q2 2011	9.3325	2.234	2.234	−0.001	0
Q3 2011	9.5825	2.260	2.26	−0.001	0
Q4 2011	9.8325	2.286	2.286	−0.001	0
Q1 2012	10.09	2.312	2.312	−0.001	0
Q2 2012	10.12	2.315	2.315	−0.001	0
Q3 2012	10.18	2.320	2.32	−0.001	0.001
Q4 2012	10.15	2.317	2.32	−0.004	0.001
Q1 2013	10.04	2.307	2.32	−0.015	0.001
Q2 2013	10.56	2.357	2.357	−0.015	0.014
Q3 2013	10.31	2.333	2.357	−0.039	0.014
Q4 2013	9.94	2.297	2.297	−0.039	0.037
Q1 2014	10.46	2.348	2.297	−0.039	0.088
Q2 2014	9.91	2.294	2.297	−0.093	0.088
Q3 2014	9.5	2.251	2.297	−0.135	0.088
Q4 2014	9.23	2.222	2.297	−0.164	0.088
Q1 2015	7.76	2.049	2.297	−0.338	0.088

Further, given the breakdown of the price we have before, the model is specified as follows:

$$Q_{LNG} = f(P_{max}, P_{cut}, P_{rec}, P_{pipeline}, Ni, population, consumption, Q_{LNG(-1)}) \quad (6)$$

where  $P_{max}$  represents the maximum price,  $P_{cut}$  indicates cumulative fallback price series,  $P_{rec}$  is considered as cumulative incremental price series, pipeline, the price of imported gas through the pipeline, and Ni describes the national income and the population of the population in the host country.

**Table 6**  
Reliability of the research variables.

Variable	Probability (Pesaran & Shin test)	Result
$P_{max}$	03309	Unstable
First order difference $P_{max}$	00794	Stable
$P_{cut}$	09999	Unstable
First order difference $P_{cut}$	00085	Stable
$P_{rec}$	10000	Unstable
First order difference $P_{rec}$	03322	Unstable
Second order difference $P_{rec}$	00001	Stable
$\log(P_{pipeline})$	05261	Unstable
First order difference $\log(P_{pipeline})$	00239	Stable
$\log(\text{consumption population})$	01397	Unstable
First order difference $\log(\text{consumption/population})$	01191	Unstable
Second order difference $\log(\text{consumption/population})$	00063	Stable
$\log(Ni/\text{population})$	09999	Unstable
First order difference $\log(Ni/\text{population})$	06623	Unstable
Second order difference $\log(Ni/\text{population})$	00038	Stable

**Table 7**  
Results of KAO test.

Test	t-statistics	Prob
ADF	−1.9371	0.0246

In addition, it is evident that the energy consumption in Iran is effective on the import of energy carriers. Thus, the consumption variable is added to the model. Further, the dependent variable is considered as one of the important explanatory variables in the model. Per capita is considered for avoiding the simultaneous occurrence of income and energy variables. In this regard, dynamic panel method is used to estimate the equation. The panel dataset contains the observations for several sections (households, firms, etc.) which have been collected during the time. Furthermore, a dynamic panel data model includes information in time and space which contains  $N$  components in  $T$  period. The estimated model is equal to:

$$\begin{aligned} \log(Q) = & \beta_1 + \beta_2 P_{max} + \beta_3 P_{cut} + \beta_4 P_{rec} + \beta_5 \log(P_{pipeline}) \\ & + \beta_6 \log(Ni/\text{population}) + \\ & \beta_7 \log(\text{consumption/population}) + \beta_8 Q_{(-1)} + \varepsilon_0 \end{aligned} \quad (7)$$

where  $\varepsilon_0$  represent a white noise property  $\varepsilon \sim NI(0, \delta^2)$ . Of course, in order to prevent from occurring the problem, the correlation and the interpretation of the coefficients as stretch are used in the logarithm of the variables in the equation.

Pesaran and Shin test was used to avoid false regression among variables. Table 6 indicates the results.

Based on the root test results, some variables are differentiated once and some twice at the confidence level of 95%. Now, as shown in Table 7, a long-term relationship was made among the variables through the KAO cointegration test.

As observed, the zero assumption of the absence of coexistence is rejected. Thus, a long-term relationship among the variables is confirmed.

## 5. Results

Based on  $F$  test, the model is estimated randomly, along with the width of the common origin and slope. Then, the number of regression residues is calculated and the model is bounded and assumed to be the width of the heterogeneous sources among the sections. The  $H_0$  hypothesis is based on the homogeneity of the sections and widths of the same origin if the  $F$  value calculated from  $F$  is greater than the specified degree of freedom. Therefore, the effects of the accepted group and the width of the various sources should be considered for estimating the model. As a result, a dynamic panel can be used for estimation. However, when the  $H_0$



**Table 8**  
Results of *F* Limer test.

Test effect	Statistics	Df	Prob
Cross-section Chi-square	6.6130	2	0.036

**Table 9**  
Results of Hausman test.

Test summary	Chi-sq statistic	Chi-sq d.f.	Prob
Cross-section random	12594	7	09895

**Table 10**  
Panel dynamic results with random effects.

Variables	Coefficients	<i>t</i> Statistics	Prob
$P_{max}$	04116	16713	0000
$P_{cut}$	01203	11406	0000
$P_{rec}$	02545	11089	0000
Pipeline	−07653	−1227	0000
L(NI Lconsumption)	1638	13665	0000
Lconsumption Lpopulation	04025	62573	0000
Lq (−1)	09484	95482	0000

DW = 2.090,  $R^2 = 0.973$ , *J*-Statistic = 0.1022.  
Prob *J*-Statistic = 0.749.

assumption is accepted, it means that the slopes are identical for different sections. Thus, the ability to combine the data and using the model of the consolidated data is statistically verified (Majidi and Ebrahimi, 2014).

As shown in Table 8, the assumption of zero on the use of least squares method with a 95% confidence level is rejected. In other words, dynamic panel model is used (fixed effect model or random effect).

Then, the Hausman test was used to determine the model of fixed effects or random effects. In this test, the hypothesis zero represents random effects and the opposite assumption, in contrast to the fixed effects (see Table 9).

Based on the result, the zero assumption of the use of the random effects model is not rejected. In fact, the use of the constant effects model is rejected at 95% confidence level. Model was estimated with dynamic panel and random effects. Table 10 indicates the results.

## 6. Discussion

As shown in Table 10, all coefficients are significant at 95% confidence level. Therefore, based on the results of model estimation of factors affecting LNG import level in selected countries, the following results are interpreted as follows:

First, the value of the  $R^2$  statistics indicates that 97% of the changes in the amount of imported natural gas in the selected countries are explained by the explanatory variables of the model. According to the econometric literature, this indicator reflects the good fit of the model for the indicator.

Second, Sargan test was used to validate the explanatory variables and the lack of self-correlation of these variables with the distorted terms of the estimated model. Based on zero assumption, there is no self-correlation between the independent variables of the model and the distorted sentences. As the probability is 0.749, the null hypothesis of this test is not rejected and the variables used in this estimation are valid.

Third, as shown in Table 10, the per capita consumption variable has a positive and significant effect on the amount of LNG demand in selected countries. In addition, 1% increase in per capita consumption leads to an increase of 0.402% in the amount of LNG imports. Further, per capita income has a positive and meaningful relationship with the amount of imported liquefied natural gas. In other words, 1% increase in per capita income leads to 16.38%,

**Table 11**  
Reviewing the decomposition price factors.

$\beta_2 P_{max}$	$\beta_4 P_{cut}$	$\beta_3 P_{rec}$
0411	0120	0254

increase in the amount of imports. Furthermore, the high rate of this factor indicates the high impact of the per capita income variable on the imports of LNG.

Fourth, In the case of the variable analysis of the gas pipeline price, as expected, a negative coefficient was obtained since the transfer of gas through the pipeline is a substitute commodity for LNG.

Fifth, all three coefficients ( $P_{max}$ ,  $P_{rec}$ , and  $P_{cut}$ ) obtained for price variables indicate a direct and significant relationship. Of course, the effect of the maximum price on the number of imports is greater than that of the other two explanatory variables. Based on the results, a 1% increase in the variables  $P_{max}$ ,  $P_{rec}$ ,  $P_{cut}$  results in increasing the import rate by 0.12, 0.411, and 0.25%, respectively.

Based on the gas price analysis, the following relations are established between the coefficients  $P_{max,t}$ ,  $P_{cut,t}$ ,  $P_{rec,t}$ .

Demand is certainly reversible  $\beta_2 = \beta_3 = \beta_4$   
Demand is relatively reversible  $\beta_2 > \beta_4 > \beta_3$   
The demand is irreversible  $\beta_3 > \beta_4 > \beta_2$

where  $\beta_2$  indicates the  $P_{max}$  coefficient,  $\beta_3$  represents the  $P_{cut}$  coefficient and  $\beta_4$  is regarded as the  $P_{rec}$  coefficient. In addition, the theory of irreversibility in that equation cannot be determined in the absence of any of the modes (see Table 11).

Based on the second state of gas price analysis, the demand for imported LNG in the selected importing countries is relatively reversible. In other words, there is a rather similar symmetry between rising and falling prices regarding the price change followed by a change in the amount of demand in the short run.

Sixth, it is also possible to calculate the long-term stretching coefficients of the import by using the import–import variable.

$$\beta_8 = 0.948 \rightarrow (1 - \beta_8) = 0.052.$$

The lag coefficient indicates the speed of re-matching the demand for LNG imports to exit the equilibrium. Thus, 0.948% of imbalance in the previous period is eliminated in the current period.

Long-term price elasticity:

- $e_{p_{max}} = (0.4110.052) = 7.9$
- $e_{p_{rec}} = (0.2540.052) = 4.88$
- $e_{p_{cut}} = (0.120.052) = 2.3.$

As shown, the symmetry conditions are applied like the case in short-term conditions.

Due to the higher magnitude of the  $P_{max}$  coefficient than the precision and the magnitude of both coefficients of  $P_{cut}$ , the same Getely theorem can be used, upon which the reversibility theory of imported LNG prices is fairly established in the importing countries. In addition, regarding long-term stretch amounts, the long-term demand for LNG is 2.3, 4.88, and 7.9%, respectively, with a 1% change in  $P_{max}$ ,  $P_{rec}$ ,  $P_{cut}$ . Further, in order to calculate long-term elasticity of other variables, the following equations are used:

- $e_{consumption} = (0.4020.052) = 7.73$
- $e_{Ni} = (16.380.052) = 315$
- $e_{pipeline} = (-0.7650.052) = -14.71.$

As observed, the trajectory of the explanatory variables is considerably higher in the long run while the income trajectory is higher than the other variables. Further, the impact of the economic

situation of the society on this issue is effective as the increase in income and economic growth in a society, as well as the increase in industrial activities and the development of the economy of society, plays a significant impact on the intensity of energy imports due to various industrial uses in Iran. Regarding an increase in the price elasticity of gas from the pipeline, it can be traced back to the basic principles of microeconomics. By increasing the time period, the importing country can function better for replacing the two goods. In fact, the importing country becomes more sensitive to the price change in the pipeline. Similarly, the import stretch of energy consumption in the long run is more sensitive to its short-term mode, maybe due to the type of inputs, machinery, and fuel products. In the long run, it is possible to use these types of capital and equipment, and the burning or efficiency of these devices is higher than that of the fuel. In addition, long-term elasticities can be interpreted as short-term. Thus, 1% change in per capita income, per capita consumption and gas price through the pipeline leads to the change of 315, 7.73 and –14.71% in the number of LNG imports during long term.

## 7. Conclusion

The present study aimed to evaluate the effects of asymmetric LNG shock shocks. Through estimating the model, the dynamic panel method was used to examine how the demand reversibility in response to price fluctuations in the selected countries was answered. Based on the results, Iran needs to expand its technology and capacity in the LNG industry as it is regarded as the holder of the second largest gas reserves in the world and in the pursuit of the 20-year vision of becoming the world's third-largest natural gas producer with 10% of global gas trade. Further, the growth of LNG demand in major markets such as Korea, Japan, Spain, as well as the emergence of new LNG like China and India, along with traditional natural gas markets such as the United States and Britain, should import LNG in order to replace their production decline. The prospects of LNG global demand are very clear and promising. Estimates and forecasts from the perspective of the future Global LNG demand have been made by various institutions, among which the largest and lowest estimates of future LNG demand were estimated at 500 and 250 million tones, respectively. According to the International Energy Agency, global LNG demand will reach 335 and 495 million tons in 2020 and 2030, respectively.

Furthermore, the development and commercialization of gas and LNG should be examined in a long-term perspective and it is worth noting that some factors affecting the price of gas are beyond the control of gas suppliers. Thus, it is suggested to highlight, gas trading economically and consider the export strategy as a national security tool.

In addition to the efforts of policymakers to reduce risk, the quest for entry and increased share in Asia-Pacific market as the largest market near Iran is necessary. Asia-Pacific region has a lot of potentials for LNG imports in the future, and it is expected that the competition between LNG producers will increase the supply in this region. Middle Eastern countries, especially Qatar, have developed large capacity development plans to export LNG to this market. Further, Russia opened its first liquefaction unit in Sakhalin. Iran and Yemen are seeking for entering this market. Given the enormous amount of LNG trade in the Asia-Pacific market and the expectations of unexpected demand for this market by overseas manufacturers, it is necessary to make productive and constructive decisions after conducting all the necessary studies to get more market share in the area, given the enormous gas supply in Iran and its neighborhood in this market.

## References

- Alam, F., Alam, Q., Reza, S., Khurshid-ul Alam, S.M., Saleque, Khondkar, Ahsan, Saifuddin, 2017. Liquefied natural gas (LNG) market and Australia. AIP Conf. Proc. 1851, 020107 <http://dx.doi.org/10.1063/1.4984736>.
- Arbex, Perobelli, 2010. Economic growth and energy consumption. *Energy Econ.* 32, 43–53.
- BP Statistical Review of World Energy, 2013.
- Getely, D., Hillard, G.H., 2001. The asymmetric effects of changes in price and income on energy and oil demand. *Energy J.* 23, 19–55.
- Hamilton, J.D., 1983. Oil prices as an indicator of global economic conditions. *Econ. Browser Blog Entry*.
- Majidi, Ebrahimi, 2014. *Applied Econometrics Panel Data*. Noor e Elm Publications.
- Mansurkiaee, Isaac, 2009. Estimation of the relationship between the price of crude oil and LNG using the error correction model. *J. Energy Econ.* 5 (18), 121–199.
- Moryadee, S., Steven, A., Gabriel, H., Avetisyan, G., 2014. Investigating the potential effect of US LNG exports on global natural, gas markets. *Energy Strategy Rev.* 2, 273–288.
- Mousavi, MirHossein, Bazazan, Fatemeh, Raghfar, Hossein, Ebrahimi, Masoumeh, 2014. Assessing the asymmetric effects of oil prices on demand in OECD countries using time series models. *J. Energy Econ. Stud.* 46, 27–60.
- Rahimi, Gh., 2007. *A Look At the LNG Industry in the World*, first ed. International Institute of Energy Studies, Tehran.
- Taghvi Nejad, Ehsan, 2006. Investigating the effect of high oil prices on global oil demand. *J. Energy Econ.* 3 (11), 43–62.
- Taklif, Atefeh, 2013. Cooperation of elected members of the assembly of gas exporting countries in exporting LNG, collaborative game theory approach. *Econ. Res.* 49 (4), 835–868.
- Varahrami, Vida, Moshrefi, Rassam, Layegh, Jaber, 2015. Investigating the asymmetric effects of natural gas prices on consumption in the household. *J. Econ. Model.* 4 (19 & 20), 1–27.