Evaluating the Asymmetric Causal Relationship between Hydrocarbon products Consumption and Economic Growth in Iran

Parastoo Boroomandfar[a], Alireza Baghighi Asli[b*] and Azadeh Mehrabian[c] Marjan Damankeshideh[d]

[a] *Ph.D. Candidate, Department of Economics, Central Tehran Branch, Islamic Azad University, Tehran, Iran, Email: p_boroomand@yahoo.com*

[b] *Assistant Professor, Department of Economics, Central Tehran Branch, Islamic Azad University, Tehran, Iran, Email: daghighiasli@gmail.com*

[c] *Assistant Professor, Department of Economics, Central Tehran Branch, Islamic Azad University, Tehran, Iran , Email:mehrabianazadeh@yahoo.com*

[d]*Assistant Professor, Department of Economics, Central Tehran Branch, Islamic Azad University, Tehran, Iran , Email: m.damankeshideh@yahoo.com*

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ABSTRACT

This paper analyzes the existence of an asymmetric causality relationship between the consumption of hydrocarbon products in four sectors: residential-commercial, manufacturing, agricultural, and transportation, and the economic growth of Iran during the years 1981-2017. To achieve this goal, the effect of positive and negative shocks of the mentioned variables is investigated using the asymmetric causality approach of Hatemi-J (2012). Research results suggest a two-way causal relationship between the positive shocks of economic growth and the consumption of carriers of hydrocarbons in all four residential-commercial, manufacturing, agricultural and transportation sectors. There is a two-way causal relationship between negative economic growth shocks and hydrocarbon carriers' consumption in agriculture and transportation, and a one-way causal relationship between hydrocarbon energy carriers' consumption and economic growth in the residential-commercial and industrial sectors. There is no causal relationship between non-directional shocks of hydrocarbon consumption and economic growth.

1. Introduction

The tendency of rising competition among developed and developing countries is widely understood via higher economic growth that often comes with massive usage of energy (Shahbaz et al, 2018). Energy is one of the major inputs for economic development of any country. In developing countries, the energy sector assumes a critical importance in view of the spiraling energy needs due to accelerated economic development. The energy

* Corresponding author

requirement of an economy is sensitive to the rate of economic growth and energy intensity of producing sectors. The energy intensity is the function of technological progress and it varies from sectors to sectors. All production and many consumption activities involve energy as an essential input. It is a very important and primary input in the aggregate production function. It is the key source of economic growth, industrialization and urbanization. Thus, energy consumption function as an engine of growth and fuelled the economic activities (Phukon and Konwar, 2019). Hydrocarbon Products is one of the vital sources of energy in developing and developed countries. In Iran, natural gas and oil include a major part of primary energy consumption. Primary energy consumption in Iran has increased rapidly during the past decade even as the sanction period when economic growth has declined. Indeed, Iran's primary energy consumption increased from 2006 to 2016 by around 40% (EIA, 2019). This Growing procedure emphasizes the need for research into the proportion of this consumption in each economic sector and its effects on economic growth. One way of evaluating the relationship between energy consumption and economic growth is through asymmetric causality testing. The current research considers this point and uses a test asymmetric Granger causality was explained by Hatemi-J (2012). The rest of the paper is organized as follows: First, the related literature and studies are reviewed in this regard. Data and methodology are then briefly explained. The empirical analysis and the discussion of the results are presented in the next section. The last section finally concludes.

2. Literature Review

After the energy crisis of the 1970s, Kraft & Kraft first discussed the relationship between economic growth and energy consumption. These researchers find energy consumption as a significant factor in the performance of production, such as capital and labor (Shahbaz et al. 2018). Four hypotheses have been studied to investigate the relationship between energy consumption and economic growth (Tuna & Tuna, 2019). Based on the first hypothesis (neutrality hypothesis), there isn’t any connection between these two variables. This hypothesis shows that conservative policies do not affect energy consumption, so there is no causal relationship between energy consumption and economic growth. The second hypothesis (growth hypothesis) refers to the influence of energy consumption on the developing countries. This hypothesis notes that a small decrease in energy consumption has a negative impact on growth. This hypothesis may have a destructive impact on oil-dependent countries' Gross Domestic Production because the required measures to save energy, such as energy prices or quotations, decrease energy consumption, and then decrease GDP development. The third hypothesis (protection hypothesis) explains a causality link between growth and energy consumption. According to this hypothesis, the development of countries is not affected by energy consumption limitation. Increasing economic growth can also increase energy request. The fourth hypothesis (feedback hypothesis) poses the causality relationship between energy consumption and economic growth. In this case, an increase (decrease) in energy consumption leads to an increase (decrease) in economic growth, and thus, a decrease (increase) of Growth in the economy leads to a decrease (increase) in energy consumption. This relationship points out that energy exploration policies should be a priority for policies on energy conservation, which prevents economic growth.

In performed researches in this field, the relation between energy consumption and economic growth has been taken from the production function. Zhixin (2011) uses the Cobb Douglas function to check the related energy consumption and economic growth. The production function includes only two factors, capital, and labor, but Zhixin introduces a specific model for examining the relationship between energy and economic growth:

$$Y = AK^{\alpha}L^{\beta}EC^{\gamma}e^{C+\mu} \quad (1)$$

$$\mathrm{Ln}Y = \mathrm{C} + \alpha\,\mathrm{Ln}K_t + \beta\,\mathrm{Ln}L_t + \gamma\,\mathrm{Ln}EC_t + \mu_t \quad (2)$$

In this function, K is capital assets, L is labor, EC is energy consumption, μ_t is part of the random error component and γ is the logarithmic coefficient of energy consumption which shows that if $\mathrm{Ln}EC_t$ increases by 1 percent, total production to the amount of γ % increases. Also, α and β show that increasing 1 percent in capital assets and manpower will increase β% and α%, respectively (Shahbaz et al. 2013), Moroney (1990), Lee (2005), Smyth and Nayaran (2008) and Payne and Apergis (2010) use the following production functions:

$$y_t = f(G_t.E_t.K_t.L_t) \quad (3)$$

Where y is the gross domestic product per capita at a fixed price of the year 2000 ($), G is natural gas consumption (per capita), E is real exports (per capita), K is real fixed domestic capital formation, and L, is the per capita labor power. (Shahbaz et al. 2013). Shahbaz (2013) also uses this production function as follows to shape its linear logarithmic form:

$$\ln y_t = \alpha_0 + \alpha_1 \ln G_t + \alpha_2 \ln E_t + \alpha_3 \ln K_t + \alpha_4 \ln L_t + \varepsilon_t \quad (4)$$

Also (Shahbaz et al. 2018) research the relationship between energy consumption and economic growth in the ten countries with the highest energy consumption rates. To investigate the relationship, they apply the QQ method. In this method we have:

$$EC_t = \beta^t(GDP_t) + u_t^\theta \quad (5)$$

Where 〖EC〗_t is per capita energy consumption over t time, 〖GDP〗_t is real pet capita GDP growth over t time, θ is the θth of the distribution of consumption in energy (per capita), 〖β〗^t is an unknown function because we don't have previous information about the related energy consumption and economic growth and u_t^θ is the remaining of the part that makes the remaining of θth zero.

3. Previous Studies

Many studies have been performed on the causality relationship between the consumption of hydrocarbon products and economic growth but in most cases, only one of the domestic economic sectors of the residential - commercial, industry, agriculture, and transportation has been studied. In Iran also, the causal relationship between the consumption of hydrocarbon products and economic growth has not been examined separately by economic sectors and by the asymmetric approach of Hatemi-J.

Amade et al. (2009) investigated the short and long-term relationship between the final energy consumption and various energy carriers such as: petroleum and gas products, economic growth and employment in different economic sectors in Iran from 1971 to 2003. The results show that there is a one-way short-term causal relationship between final electrical energy consumption and economic growth. And there is a short-term causal relationship between the final gas energy consumption and economic growth. Also, there is a one-way causal relationship between the final energy consumption in the industrial sector and the value-added growth. There is also a short-term and long-term causal relationship between the final electrical energy consumption in the agricultural sector and the growth of value-added in this sector.

Shakibaei and Ahmadlou (2011) investigated the relationship between the energy consumption carriers and the growth of economic sub-sectors in Iran from 1967 to 2007 by the method of integration and vector error correction. The results show that there is a long-term one-way relationship between electricity consumption of industrial and agricultural sectors according to the value added of industrial and agricultural sectors and also a long-term one-way relationship between gas consumption and the value added of this sector.

Fotros et al. (2014) used panel-integration and causality tests to study the relationship between renewable energy consumption and economic growth in different regions in the world in 1980-2009. The results show that in America, in short and long term, there is a one-way causal relationship between economic growth and renewable energy consumption. In middle east and Africa, there is a causal relationship between the renewable energy consumption and economic growth in short term and in Africa this is a two-way relationship. In Asia- pacific, there is a two-way causal relationship in long term and a causal relationship between economic growth and renewable energy consumption.

Lotf-Ali pours et al. (2016) studied the relationship between energy, economic growth and export in Iran manufacturing sector in 2001-2011 by Toda-Yamamoto method and vector error correction model. The results show that there was no causal relationship between exports, energy consumption and economic growth in short term. But in the other cases there is a strong and positive relationship between energy consumption, export and economic growth in short and long terms.

(Adams et al. 2016) analyzed the South Saharan African political regime, energy consumption and economic growth using VAR modeling in panel data. This study shows that the relationship between openness trade and the energy consumption is a one-way one. There is also a positive feedback relationship between economic growth and energy consumption and energy prices and economic growth.

In another study, Dastak (2016) explored the relationship between economic growth and natural gas in 26 countries that are members of The Organization for Economic Cooperation and Development (OECD). Regression of data in these countries using the modified least-squares method indicates a positive relationship between long-term economic growth and consumption of natural gas. Furthermore, Granger's causality test indicates that in the long-term, there is a two-way relationship between natural gas consumption and economic growth.

(Osman et al. 2016) investigated the electricity consumption and economic growth of the countries of the Persian Gulf Cooperation Council with panel data. The Hausman test had been used in this study to determine the appropriate model and decision. The findings showed that these countries have a two-way causality relationship between economic growth and electricity consumption.

(Bayat et al.2017) evaluated the causality relationship between energy consumption and economic growth in Turkey in the years 1967-2014. Results show that rising energy consumption does not raise economic growth, but reducing energy consumption decreases growth.

In another study, (Hatami et al. 2018) Evaluated the effect of insurance activity on economic performance by asymmetric causality in the G-7 countries in the years 1980-2014. Generally, the findings show that the two variables have a bidirectional causality but their intensity, direction, and significance are different. In economic performance, insurance operation has an important role. (Xu et al. 2018) studied the effect of coal consumption on economic growth in China through the Johansen co-integration test. This study shows that an increase in unit consumption of coal is increasing economic growth by 0.0252 units. They proposed that since population growth would increase the use of coal and lead to an increase in greenhouse gases, control of the population could partially regulate coal usage. They also propose to use renewable energy rather than coal.

Phukon & knowar (2019) used the Granger method to examine the relationship between energy consumption, fixed capital inventory, and India's economic growth in 1970–2002. The results indicate that there is a bidirectional causality relationship between energy consumption and economic growth, and a one-way relationship between energy consumption and the fixed capital inventory from energy consumption to fixed capital inventory.

(Fadiran et al, 2019) investigated the relationship between economic growth and gas consumption in ten European countries with the highest rate of panel convergence and vector error correction model in the European gas consumption market. Research results suggest that it is seen as a long-term relationship between the two variables, but in the short term there is no relationship between them.

(Baz et al, 2019) investigated the relationship between Pakistan's energy consumption, agriculture, economic growth, and capital during the years 1971-2014 with NARDL (nonlinear co-integration autoregressive distributed lag) model. The results demonstrate an asymmetric causality relationship from positive shocks of energy consumption to positive shocks of economic growth and it is seen a one-way causality relationship between positive and negative capital shocks and growth. Tuna & Tuna (2019) examined the asymmetric causality relationship between renewable and non-renewable energy consumption and economic growth in five Asian countries: Thailand, Indonesia, the Philippines, Malaysia and Singapore using Hacker and Hatemi-J (2006) and Hatemi-J (2012). The results of the research indicate that non-renewable energy consumption has a greater effect on those countries ' economic growth than renewable energy. They suggest that to determine the appropriate energy consumption strategy, positive and negative shocks should be considered separately. In order to reduce the dependence of economic growth on renewable energy consumption and provide the basis for effective economic growth, these countries need to change in non-renewable energy and more use of renewable.

Hatami (2019) investigated the asymmetric causality relationship between the impact of the capital market growth and the UAE's economic development. Study results show that financial sector activity has a positive effect on the country's economy's performance, and that impact is greater during a recession. Therefore, enhancing the financial sector will also be efficient in allocating scarce resources and increasing productivity to full effect.

Liddle and Sadorski (2020) answer the question of how much energy demand changes when energy prices and revenue show asymmetric effects, using panel data from 91 OECD and recently developed non-OECD countries. The result indicates that by a one percent increase in gross domestic product, energy consumption increases by %0.35, and when gross domestic product decreases by one percent, energy consumption decreases by %0.68. So, the impact of reducing gross domestic product on energy consumption is more than the effect of increasing gross domestic product on energy consumption.

4. Research Model and Estimation Method

Jixin,s model has been used in this study:

$$Y = AK^{\alpha}L^{\beta}EC^{\gamma}e^{C+\mu} \tag{6}$$

$$\mathrm{LnY} = \mathrm{C} + \alpha\,\mathrm{Ln}K_t + \beta\,\mathrm{Ln}L_t + \gamma\,\mathrm{Ln}EC_t \tag{7}$$

That it can be written that:

$$\mathrm{LnY} = \gamma\,\mathrm{Ln}EC_t + z \tag{8}$$

In this function, Y is the GDP growth, EC_t , consumption of hydrocarbon products, γ is the coefficient of LnEC_t , and shows what one percent of change in the logarithm of consumption of hydrocarbon products (LnEC_t) may influence on GDP growth, z, includes the other factors affecting the growth of GDP.

According to the opinion of Granger and Yoon (2002), the relationship between negative and positive shocks can differ from that of variables. They said the data had to change to negative and positive shocks first, and then test the long-term relationship between the shocks (Hatemi-J 2012). To achieve the positive and negative shocks of variables, Hatemi-J define the relationship between the two groups of variables $y_{1t}$and y_{2t} by a random step process as below;

$$\begin{aligned} y_{1t}{=}y_{1t-1} + \varepsilon_{1t} &= y_{1,0} + \sum_{i=1}^{t}\varepsilon_{1i} \\ y_{2t}{=}y_{1t-1} + \varepsilon_{2t} &= y_{2,0} + \sum_{i=1}^{t}\varepsilon_{2i} \end{aligned} \tag{9}$$

So that, T…… and 2 and t=1, the constant values of $y_{2,0}$ and $y_{1,0}$ are the primary values and ε_{2i} *and* ε_{1i} variables are used to show the distribution of white noise. Negative and positive shocks are defined as below:

$$\varepsilon_{2i}^{+} = \max(\varepsilon_{2i} and\ 0) \qquad \varepsilon_{1i}^{+} = \max(\varepsilon_{1i} and 0)$$

$$\varepsilon_{2i}^{-} = \min(\varepsilon_{2i}\ and\ 0) \qquad \varepsilon_{1i}^{-} = \min(\varepsilon_{1i} and\ 0)$$

Or are defined as $\varepsilon_{1i}^{-} + \varepsilon_{1i}^{+} = \varepsilon_{1i}$ and $\varepsilon_{2i}^{-} + \varepsilon_{2i}^{+} = \varepsilon_{2i}$

As we have:

$$y_{1t} = y_{1t-1} + \varepsilon_{1t} = y_{1,0} + \sum_{i=1}^{t}\varepsilon_{1i}^{+} + \sum_{i=1}^{t}\varepsilon_{1i}^{-} \tag{10}$$

And finally, negative and positive shocks of each variable can be summed up as below:

$$Y_{1i}^{+} = \sum_{i=1}^{t}\varepsilon_{1i}^{+} \qquad Y_{1i}^{-} = \sum_{i=1}^{t}\varepsilon_{1i}^{-} \tag{11}$$

To evaluate the asymmetric Granger causality relationship between the hydrocarbon product consumption and economic growth in Iran, time-series data obtained from the balance sheet of petroleum products and time-series data of the Central Bank have been used.

Figure (1) reveals economic growth data during the 1981–2017 period (time-series data of the Central Bank).

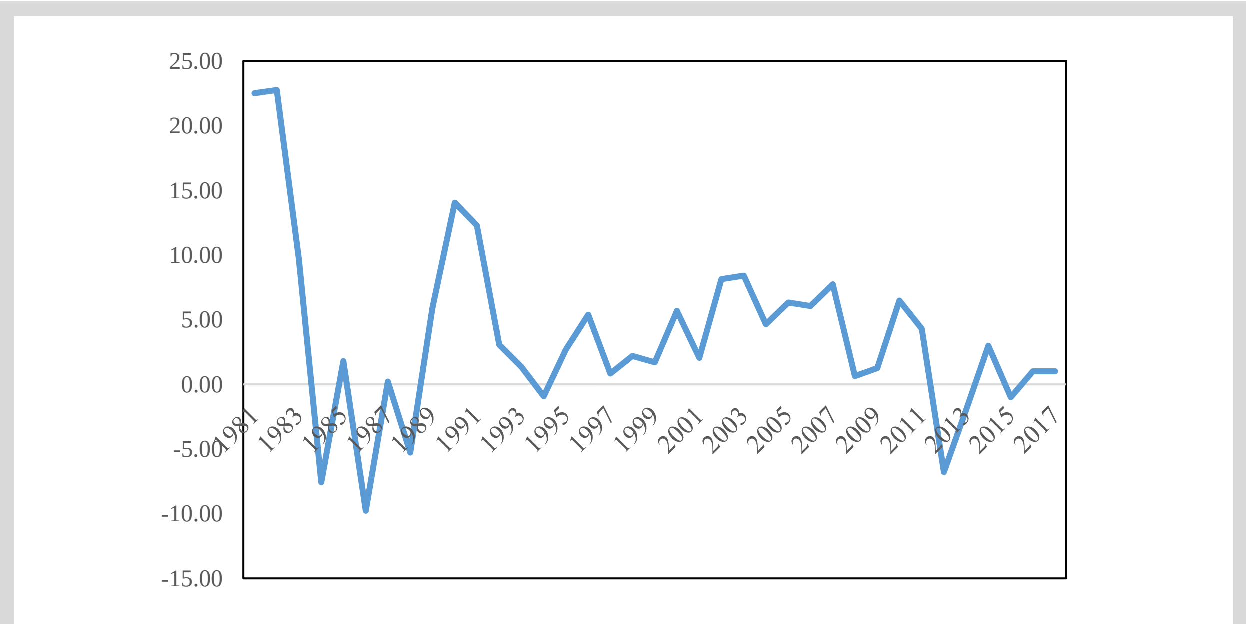

Figure 1. Economic growth.

Figures (2-5) reveal hydrocarbon products consumption data in four sectors (residential-commercial, manufacturing, agricultural, and transportation) during the 1981–2017 period (the balance sheet of petroleum products, 2007, 2016, 2017).

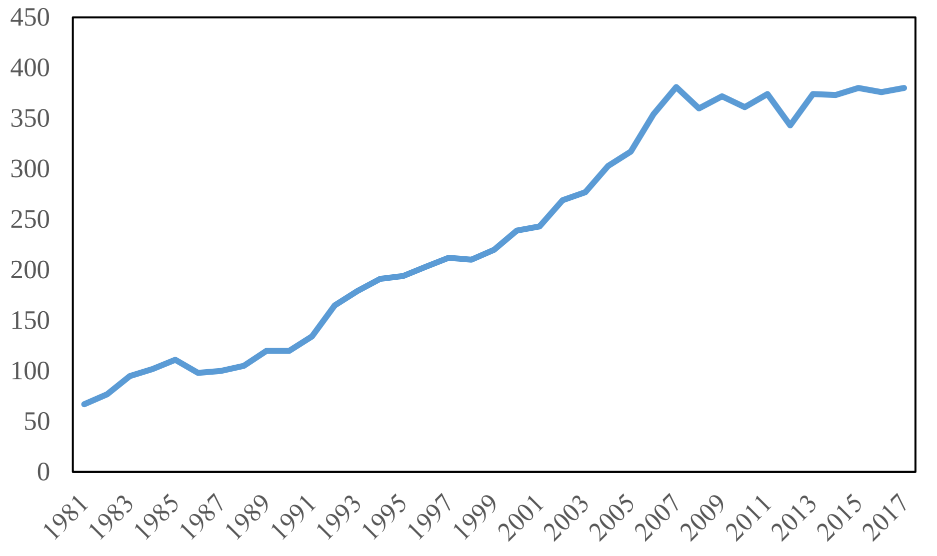

Figure 2. Residential-comemercial consumption.

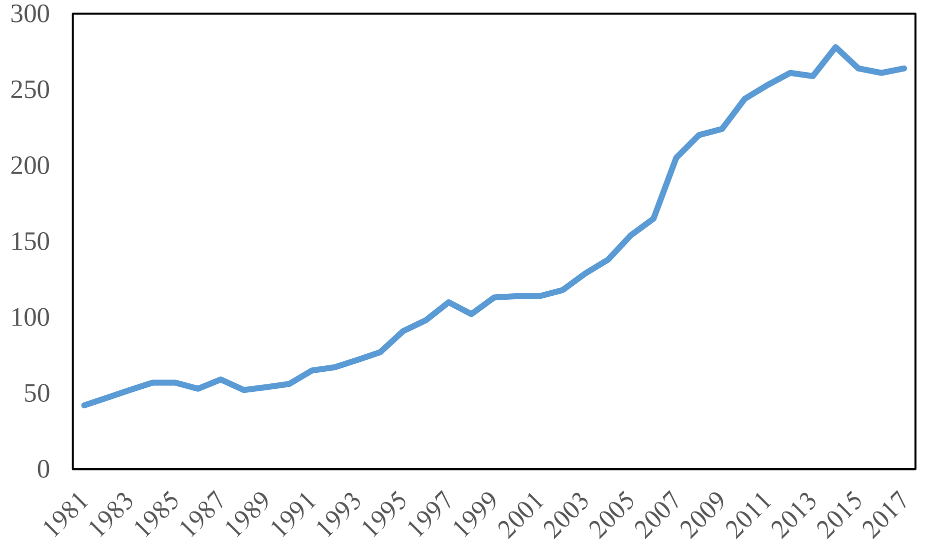

Figure 3. Manufacuring consumption.

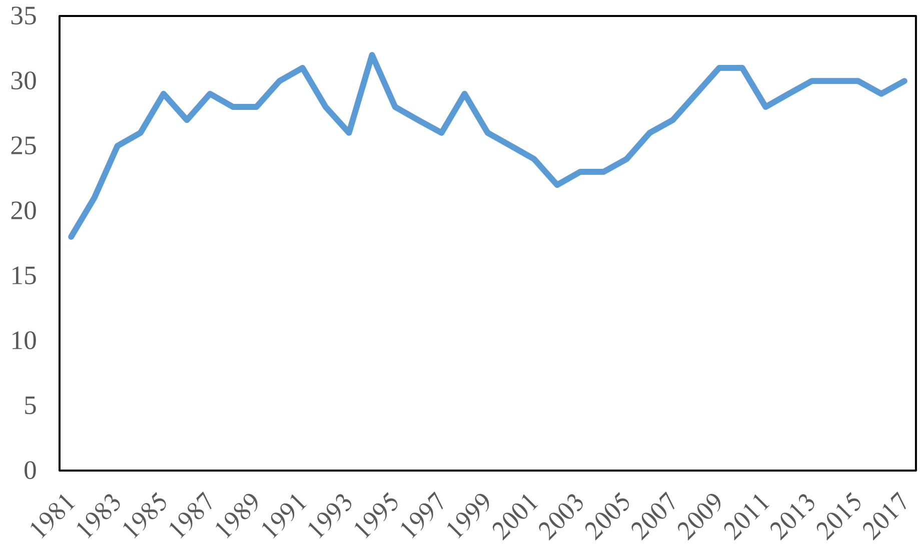

Figure 4. Agricultural consumption.

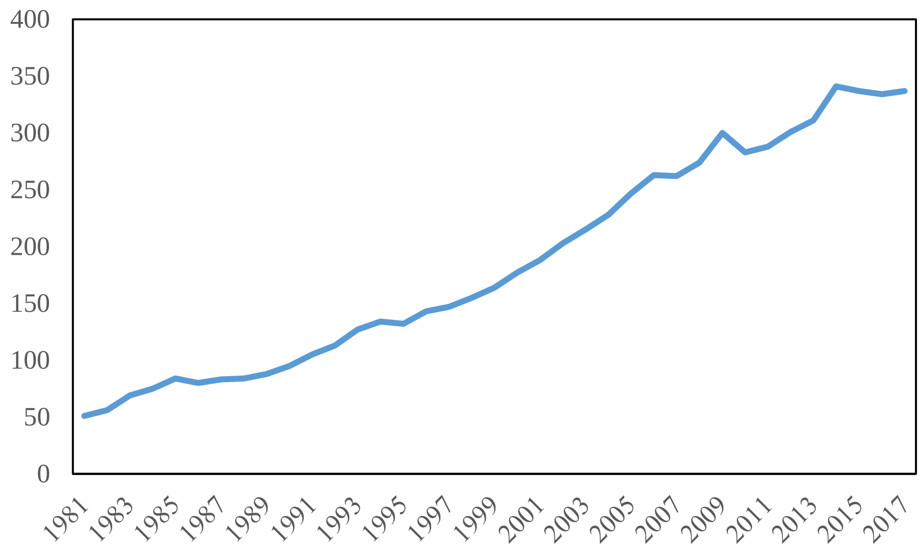

Figure 5. Transportation consumption.

The study of the final consumption of hydrocarbon products by sector in 2017 shows that the highest final consumption of petroleum products was 282.1 equivalent to one million barrels of crude oil in the transport sector and there was residential-commercial sector, respectively 36 equivalent to one million barrels of crude oil in the residential-commercial, 24.7 equivalent to one million barrels of crude oil in the industry sector and 21.8 equivalent to one million barrels of crude oil in the agriculture sector. In addition, the highest final consumption of natural gas this year was 345 million barrels of crude oil in the residential sector, 262.3 million barrels of crude oil in the industrial sector, 48.4 million barrels of crude oil in the transport sector, and 13.9 million barrels of crude oil in the agricultural sector (Iranian Petroleum Products Consumption Statistics, 2017, 113).

In the first step, the negative and positive shocks of each variable should be specified. Then, the resistance of shocks should be checked. Peron (1989) believes that if there is a structural break, the unit root test has an incorrect result (Chen and Lin, 2014). Failure to detect a structural break may lead a shock to have a permanent impact on time series (Ling et al, 2013). So in time series structural break is tested at the beginning. The research results shows, all of the variables have a structural break.

Table 1. Break year determination test (Bai-Perron test2003).

variable	break year	scald-f-statistic	f-statistic
growth^{-}	2007	30/616	30/616
growth+	1988	26401	26401
Ckh^{-}	2000	24/777	24/777
Ckh+	2000	19/363	19/363
Ck^{-}	2004	7/254	7/254
Ck+	1993	9/826	9/826
Cs^{-}	2014	6/155	6/155
Cs+	2006	6/897	6/897
Ch^{-}	2009	5/364	5/364
Ch+	1999	6/824	6/824

The critical values are based on Bai-Perron test (2003).

Resource: Research Findings

Considering that there is one break between all eight variables, the Dicky-Fuller method can be used to distinguish break in data. This method lets data be examined with a structural break (Sarfaraz & Zwick, 2016). The conclusions of the data stability examination are elaborated in Table (2):

Table 2. Unit root test with one structural break

variable	stationary	Break year	p-value	Critical value	t-statistic
growth^{-}	*	2007	0/000	-4/444	-5/193
growth+	*	1988	0/000	-5/176	-6/011
Ckh^{-}	*	2007	0/000	-4/859	-4/915
Ckh+	*	2000	0/000	-4/524	-6/306

variable	stationary	Break year	p-value	Critical value	t-statistic
Ck^{-}	*	2004	0/000	-4/524	-6/469
Ck+	*	1993	0/000	-4/859	-7/382
Cs^{-}	*	2014	0/000	-4/859	-5/264
Cs+	*	2006	0/000	-4/859	-6/109
Ch^{-}	*	2009	0/000	-4/444	-6/204
Ch+	*	1999	0/000	-4/524	-5/112

Resource: Research Findings

In this level, the causality relation test is performed between these components. In this step, we just concentrate on the positive cumulative shocks. By supposing

〖y^+〗 _t= (〖y^+〗 _2tand 〖 〖 y〗 ^+〗 _1t), the causality test can be done by using vector autoregressive model [var (p)] as follow:

$$y^{+}{}_{t} = v + A_1 y^{+}{}_{t-1} + \cdots + Ap\, y^{+}_{t-1} + u^{+}_{t} \qquad (12)$$

Where $y^{+}{}_{t}$ represents vector 2×1 of variables, v represents vector 2×1 of constant values and u^{+}_{t} is 1×2 vector of error components. Matrix A_r is 2×2 matrix for Delay parameter r(r=l, p). The following equation is used to determine the best delay period:

$$HJC = \mathrm{Ln}\left(\left|\widehat{\Omega}_j\right|\right) + j\left(\frac{n^2 \mathrm{LnT} + 2n^2\, \mathrm{Ln(LnT)}}{2\,\mathrm{T}}\right) \qquad (13)$$

j=0.1.2... p

As $\widehat{\Omega}_j|$ Estimated matrix determinants, the error term in the VAR model are based on the delay period j, n is the number of functions in the VAR model and T is the number of observations. After determining the optimal lag order, the null hypothesis which states that the Kth element of y^{+}_{t} is not the Granger causes of the ωTh element of y^{+}_{t} is surveyed. Hatamei-J defines the Wald test in a compressed form as follows:

$$Y := (y^{+}_{1} \ldots\ldots y^{+}_{T}) \qquad (14)$$

$(n \times T)$ matrix

$$D := (V, A_1, \ldots\ldots, A_p)$$

$(n_1\,(1 + np))$

$$Z_t := \begin{bmatrix} 1 \\ y^{+}_{t} \\ y^{+}_{t-1} \\ \vdots \\ y^{+}_{t-p-1} \end{bmatrix} t = 1, \ldots \ldots \ldots .. \mathrm{T}\ Z := \qquad (15)$$

$(Z_0\ , \ldots, Z_{T-1})\ 1 + np) \times T)\ matrix$

$\delta := (u^{+}_{1,\ldots\ldots\ldots}, u^{+}_{T})\ (n \times T) matrix$

The compressed VAR (P) model is defined as follows:

$$VAR(P) = DZ + \delta Y \qquad (16)$$

The null hypothesis of non-Granger causality $H_O: c_B = 0$ is tested as follows:

$$Wald = (c\beta)'\ [c((\acute{Z}z)^{-1} \otimes \mathrm{s_u})c'\,])^{-1}(c\beta) \qquad (17)$$

So that, $\beta =$ (D) vector, C, an index vector for × $n(\,1 + \,)\ n_p$ for a limited parameter, s_u the unlimited VAR variance matrix is $\mathrm{s_u} = \frac{\hat{\delta}\,\hat{\delta}'}{\mathrm{T-q}}$ so that q, define as the number of parameters in each function of VAR model. When the normalization hypothesis completed, the wald statistical test is performed with a distribution of χ^2 which has a degree of freedom equal to the number of model constraints. (Hatami- J2012). Also financial data are not normally distributed and there may be effects of autoregressive conditional heterogeneity variance.

This problem is resolved using bootstrapping technique (Chen and Lin, 2014). In this method, it is assumed that θ^ is an estimation of the θ parameter which can be obtained by the OLS method from a sample of a series of ns. For we can get a standard error that can be used as a confidence interval. A reliable confidence interval can be achieved with the use of several random samples. To do this, we consider a set of data from 1 to n and replace it by randomly extracting a collection of m of it. We now have a set of data derived from the original data. We can do it many times. In this way, we can calculate the value of which is obtained from the original data. We can do it many times.in this way, we can calculated the value of θ which is obtained from the original data. Now if we do this from series of b (1, 2, 3… m) and repeat it m times the $\hat{\theta}$ standard error which is derived from $\hat{\theta}^{(b)}$ is obtained (Wooldridge, 2009). For normalizing the data by the Bootstrapping technique, first by using the VAR model ($Y = DZ + \delta$), we estimate the regression. The next step is to generate bootstrap data Y^*in the form of regression $Y^* = \hat{D}Z + \delta^*$ by using the coefficients which are obtained from the VAR model. Error components Bootstrap data are randomly obtained from modified error components to show that the average value of error components at each sampling is zero. The bootstrap simulation is repeated 10,000 times, and each time the Wald test is estimated to distribute the test. Then, taking into account the ath upper quarter of the obtained distribution, the critical value of the distribution is obtained at the level of significance α. In the last step, the wald test on the primary data is calculated with the Bootstrap critical value obtained in the previous step. If the values of the statistical test are more than critical value at the α level of significance, the null hypothesis of the test based on the lack of the Granger relationship of causality is rejected (Hatemi-J2012). The result of the asymmetric Hatemi-J test is illustrated in Tables 3 and 4.

Table (3). Asymmetric causality test of positive and negative shocks of economic growth to Negative and positive shocks of hydrocarbon products consumption.

Null hypothesis	Test statistics	Critical value			Conclusion on H_0
		1%	5%	10%	
growth+ ≠> Ch⁻	0/157	7/733	4/240	2/907	Not rejected
growth+ ≠> Ch+	5/483	77/224	4/128	2/921	rejected
growth+ ≠> Ck⁻	0/043	7/625	4/172	2/936	Not rejected
growth+ ≠> Ck+	6/358	8/761	4/352	3/008	rejected
growth+ ≠> Ckh⁻	1/203	8/179	4/096	2/825	Not rejected
growth+ ≠> Ckh+	4/242	7/267	4/039	2/785	rejected
growth+ ≠> Cs⁻	2/107	8/058	4/233	2/888	Not rejected
growth+ ≠> Cs+	5/789	7/910	4/234	2/911	rejected
growth⁻ ≠> Ch⁻	7/337	8/767	4/512	3/100	rejected
growth⁻ ≠> Ch+	1/672	10/206	5/515	3/731	Not rejected
growth⁻ ≠> Ck⁻	5/247	8/557	4/685	3/254	rejected

Null hypothesis	Test statistics	Critical value			Conclusion on H_0
		1%	5%	10%	
growth⁻ ⇏ Ck+	1/743	9/942	5/675	4/015	Not rejected
growth⁻ ⇏ Ckh⁻	3/631	9/022	4/687	3/160	Not rejected
growth⁻ ⇏ Ckh+	1/764	10/821	5/645	3/906	Not rejected
growth⁻ ⇏ Cs⁻	0/145	8/658	4/598	3/060	Not rejected
growth⁻ ⇏ Cs+	0/284	8/325	4/931	3/758	Not rejected

Resource: Research Findings

According to Table 3, the statistical value of the wald test on the asymmetric causality hypothesis is based on the lack of a causality relationship from negative growth shocks to negative and positive hydrocarbon shocks Carriers consumption in transport, agriculture and residential-commercial and industrial sectors are 7/337, 1/672 ,5/247 , 1/743, 3/631, 1/764, 0/145 and 0/284 having regard to their critical value at the level of 1% and 5% and 10%, the hypothesis of zero asymmetric causality test that it does not represent a causal relationship between negative economic growth shocks and positive shocks in the consumption of hydrocarbon products in the transportation, agricultural, residential, commercial and industrial sectors is not rejected, respectively. Wald test statistical value with regard to the null hypothesis of asymmetric causality test that there is no causal relationship between positive economic shocks and negative and positive shocks of consumption of hydrocarbons products in transportation, residential-commercial and industrial sectors are 0/157, 5/483, 0/043, 6/358, 1/203, 4/242, 2/107 and 5/789 having regard to their crucial value of 1 % , 5% and 10%, the null hypothesis that there is no causality relationship between positive economic growth shocks and negative hydrocarbon shocks cannot be rejected, respectively, And the causal relation between the positive shocks of economic growth and the positive shocks of consumption of hydrocarbon products cannot be rejected.

Table 4. Asymmetric causality test for negative and positive shocks of Hydrocarbon products consumption to positive and negative shocks of economic growth.

Null hypothesis	Test statistics	Critical value			Conclusion on H_0
		1%	5%	10%	
Ch⁻ ⇏ growth+	0/365	7/094	3/511	2/376	Not rejected
Ch+ ⇏ growth+	4/519	6/841	3/961	2/730	rejected
Ck⁻ ⇏ growth+	0/425	7/191	3/916	2/676	Not rejected
Ck+ ⇏ growth+	7/351	9/475	5/931	4/585	rejected

Null hypothesis	Test statistics	Critical value			Conclusion on H_0
		1%	5%	10%	
Ckh⁻ ≠> growth+	0/501	7/305	3/714	2/593	Not rejected
Ckh+ ≠> growth+	7/859	8/524	7/362	5/964	rejected
Cs⁻ ≠> growth+	0/612	8/058	4/233	2/888	Not rejected
Cs+ ≠> growth+	6/854	8/201	6/591	3/574	rejected
Ch⁻ ≠> growth⁻	6/451	6/258	5/124	2/482	rejected
Ch+ ≠> growth⁻	0/246	8/541	7/412	4/481	Not rejected
Ck⁻ ≠> growth⁻	5/328	7/424	5/129	4/564	rejected
Ck+ ≠> growth⁻	0/215	9/157	7/354	5/249	Not rejected
Ckh⁻ ≠> growth⁻	7/476	8/248	6/429	3/120	rejected
Ckh+ ≠> growth⁻	1/335	9/428	7/319	4/852	Not rejected
Cs⁻ ≠> growth⁻	5/851	7/254	4/857	2/534	rejected
Cs+ ≠> growth⁻	0/624	5/429	3/245	2/485	Not rejected

Resource: Research Findings

According to Table (4), the value of the Wald test statistics with respect to the null hypothesis of the asymmetric causality test that there is no causal relationship between negative and positive shocks of consumption of hydrocarbon products in transport, agriculture, residential-commercial and industrial sectors with positive economic growth shocks, respectively are 0/365, 4/519, 0/425, 7/351, 0/501, 7/859, 0/612, 6/854 .The null hypothesis of asymmetric causality testing based on the lack of a causal relationship due to negative shocks in the consumption of hydrocarbon products in transport, agriculture, residential-commercial and industrial sectors cannot be rejected, respectively, by considering their critical value at the level of 1 % , 5% and 10%.However, the test's null hypothesis about the lack of a causal relationship from the positive shocks of hydrocarbon products consumption in all four sections to the positive shock of economic growth is rejected. Furthermore, the value of wald test statistics on the null hypothesis of an asymmetric causality test based on the lack of a causal relationship between negative and positive shocks in the consumption of hydrocarbon products in the transportation, agriculture, residential-commercial and industry sectors to negative shocks of economic growth are respectively, 6/451, 0/246, 5/328, 0/215, 7/476, 1/335, 5/851, 0,624. Consequently, the asymmetric causality test's null hypothesis that there is no causal relationship from the positive shocks of consumption of hydrocarbon products in the transportation , agriculture, residential-commercial, and industry sectors to negative economic growth shocks cannot be rejected. The null hypothesis is rejected in the case of negative shocks of the above-mentioned sections.

5. Conclusion

In this study, the asymmetric causality between the consumption of hydrocarbon products in four sectors is evaluated: residential-commercial, manufacturing, agricultural and transportation, and the economic growth of Iran in the period from 1981-2017. Research findings in residential-commercial, manufacturing, agricultural, and transportation sectors indicate a two-way causal relationship between positive shocks of economic growth and positive shocks of hydrocarbon consumption in all four sectors and a two-way causal relationship between negative shocks of economic growth and negative shocks of hydrocarbon consumption in agricultural, and transport sectors. Hence the feedback hypothesis about the causal relationship between positive shocks of economic growth and positive shocks of hydrocarbon consumption in all four sectors and the causal relationship between negative shocks of economic growth and negative shocks of hydrocarbon consumption in agricultural, and transport sectors is valid.

Also, there is no causal relationship between non-directional shocks (positive and negative) of economic growth and shocks (negative and positive) of consumption of hydrocarbon products in the residential-commercial, manufacturing, agricultural, and transportation sectors. The neutrality hypothesis is also valid regarding the causal relationship between non-directional shocks of economic growth and consumption of hydrocarbon products in all four sectors. The one-way causal relationship from negative shocks of hydrocarbon consumption in residential-commercial and manufacturing sectors to negative shocks of economic growth suggests a growth hypothesis.

According to the results of this study, it is suggested:

Because of the relationship between economic growth and consumption of hydrocarbon products, to increase output levels in the short term, by growing energy consumption in all four economic sectors, production growth can be provided, However, due to the limited hydrocarbon resources, the long-term implementation of this strategy is not cost-effective and, as a policy tool, would, in the long run, lose its effectiveness. On the other hand, given that the policy of limiting the consumption of hydrocarbon products with the stability of other conditions, including production-consumption technology will lead to a reduction in GDP, it should be considered in planning to determine the optimal consumption of these products.

Since the main aim of developing countries, including Iran, is to achieve economic growth and to achieve this goal requires increased energy consumption, which in turn will increase greenhouse gas emissions and CO2 emissions, Iran will have trouble fulfilling its emissions reduction commitments if energy consumption is not managed.

As we know, transport and manufacturing industries play a significant role in pollutant emission, so the use of natural gas as a renewable fuel for the transportation sector and power plants will play an important role in reducing pollution from the environment, and at the same time, they provide a source of economic development and growth. In this regard, applying policies to optimize energy consumption and increase energy efficiency and productivity in energy-consuming industries, along with other successful economic policies to stimulate and improve economic growth, using the experiences of some developed and developing countries, with this in view, the goal of achieving economic growth and regulating and reducing greenhouse gas emissions can be followed by the view that more efficient use of energy resources is likely to require greater economic growth.

Considering the relationship between economic growth and consumption of hydrocarbons in the industrial sector, giving priority to high-tech industries and replacing them with energy-intensive industries, and amending foreign trade regulations to prevent the importation of energy-based products, energy provides the basis for economic growth and development at the same time as demand management.

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