Available online at www.elixirpublishers.com (Elixir International Journal)

Social Studies

Elixir Social Studies 126 (2019) 52504-52513

ISSN: 2229-712X

American New Sanction against Iran: Challenges for Economic Growth

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ARTICLE INFO

Article history:
Received: 18 December 2018;
Received in revised form:
01 January 2019;
Accepted: 11 January 2019;

Keywords
Hydrocarbons,
Production,
Consumption,
Exports,
Imports,
Statistical model,
Correlation.

ABSTRACT
The article is dedicated to investigation of two basic problems: (i) would bring the U.S. sanctions imposed on Iran to minimizing and even to cancelling the oil exports from this country? (ii) what impact would have those sanctions on the country's economic growth? For the survey we have used two methods. Primo, we have explored oil export structure from Iran and have studied oil import organization of the major commercial counterpart states trying to clarify if they would be able to substitute oil imports from Iran by alternative sources. And, secundo, we have drawn a statistical model, which links Iranian GDP with oil exports. Such a model was necessary for investigating probable undulations in the Iran GDP due to changing volume of exporting oil. Investigation results are important and may have huge geopolitical corollaries as follows: (i) In medium-term run President Trump's administration measures to cause serious economic obstacles for economic development of Iran will be unsuccessful. (ii) USA has no means and geopolitical instruments to bring oil exports from Iran to zero. (iii) Hence, even if it is done, these measures will cause difficult but not dramatic consequences for economic life of this Islamic country, which would create complications for development of civil society in Iran. Moreover, the desire of President Rouhani to modernize the Iranian society will fail, and Islamic Revolutionary Guard Corps, weakened under the Rouhani's presidency, will regain momentum. (iv) Thus, President Trump's measures will cause just the back effect than the target he wanted to reach, and (v) The sole possibility to provoke democratic movements within the Iranian society is to imply the country into international energy projects, in which Rule of Law is governing partnership relations.

Introduction

From the very beginning U.S. sanctions against Iran referred to an embargo on dealings with Iran by the United States, and a ban on selling aircraft and repair parts to Iranian aviation companies [1]. However, after signing on 14 July 2015 the Iran Nuclear Deal or the Joint Comprehensive Plan of Action (JCPOA), these sanctions were cancelled [2]. In August 2018 President Trump restored these sanctions and imposed penalties on companies, which tried to avoid them [3]. Moreover, U.S. administration aimed to reduce Iranian oil exports to zero [4]. In response, the United Nations International Court of Justice ordered the United States to stop the sanctions, based on the 1955 U.S.-Iran Friendship Treaty that was signed with the government overthrown by the 1979 Islamic Revolution [5]. Hence, United States withdrew from both international agreements [6]. It is true that the European Union tried to convince European companies to continue dealing with Iran [7], and is trying now to protect them against the U.S. sanctions [8], hence, the largest European corporations, which are active on the U.S. markets, had to follow President Trump's policy.

In this relation, two problems may be discussed. Firstly, would bring the U.S. sanctions imposed on Iran to minimizing and even to cancelling the oil exports from this country? And, secondly, what impact would have those sanctions on the country's economic growth?
This article is committed for answering both questions.

For the survey we have used two methods. Primo, we have explored oil export structure from Iran and have studied oil import organization of the major commercial counterpart states trying to clarify if they would be able to substitute oil imports from Iran by alternative sources.

And, secundo, we have drawn a statistical model, which links Iranian GDP with oil exports. Such a model was necessary for investigating probable undulations in the Iran GDP due to changing volume of exporting oil.
Below both problems are discussed.

Iranian Oil Export Structure and Main Oil Importer Countries

Table 1. Exports Value of Commodities and Goods from Iran in 2017.

Commodity & good	Exports value, US$ million	Share in total exports, %
Mineral fuels including oil	48,700.0	77.92
Plastics, plastic articles	3,000.0	4.80
Ores, slag, ash	2,200.0	3.52
Organic chemicals	1,800.0	2.88
Iron, steel	1,400.0	2.24
Fruits, nuts	934.8	1.50
Fertilizers	681.8	1.09
Salt, sulfur, stone, cement	561.3	0.90
Copper	386.2	0.62
Aluminum	305.4	0.49
Subtotal	59,969.5	95.95
Total	62,500.0	100.00

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In 2017 the overall value of commodities and goods exported from Iran equaled US$ 62.5 billion, and 95.95% of exports were covered by ten top items shown in Table 1 [9]. It may be seen that the lion's share in the export structure belongs to hydrocarbons and fuels exports.

For determining the share of crude oil in Iranian exports structure we have performed the following simple calculations.

As far as from 2008 storage capacity of the Strategic Petroleum Reserve has not changed in Iran and equals to 10 million barrels or to 1,598,000 m^3 [10, 11], annual value of crude oil exports was calculated as:

$$V = E.P_A = (C_P - C_C).P_A, \quad (1)$$

Where: V = annual crude oil exports value, US$, E = crude oil annual exports volume, t, P_A = average annual world oil price, US$ per t, C_P = annual crude oil production volume, t, C_C = annual crude oil consumption volume, t. According to the BP statistical review of world energy [12], in 2017 Iran produced 234.2 million t of crude oil, consumed – 81.0 million tons, and, therefore, exported 153.2 million tons. In 2017 average annual crude oil price was US$ 42.74 per barrel or US$ 313.28 per t [13]. Therefore, this year crude oil exports value was US$ 47.99 billion or 76.79% of total exports value and 98.55% of Mineral fuels including oil exports.

Table 2 demonstrates crude oil exports by volume and assessed value by destination in top 10 countries [11, 14], which covered 77.35% of the total oil exports from Iran.

It could be seen that the main Iranian crude oil consumer countries are those, which, firstly, maintain their own energy security policy and are slightly dependent on the U.S. "orders", and, secondo, may propose alternative currency for oil trade, namely Euro.

Let consider now the crude oil imports structure in countries – Iranian strategic partners in oil trade.

Fig. 1 contains information on top 15 crude oil suppliers to China in 2017. Imports volume was calculated via dividing imports value [15] by average annual crude oil price [13]. It may be seen that Iran has the sixth rank after Russia, Saudi Arabia, Angola, Iraq, and Oman.

Table 2. Iranian Crude Oil Exports in Top 10 Countries in 2017.

Iranian oil main importer countries	Oil exports		
	Barrel per day	Million tons per year	Value, US$ billion
China	648,080	32.27	10.11
India	501,982	25.00	7.83
South Korea	313,646	15.62	4.89
Turkey	165,207	8.23	2.58
Italy	154,813	7.71	2.42
Japan	137,541	6.85	2.15
U.A.E.	127,215	6.33	1.98
Spain	113,941	5.67	1.78
France	109,396	5.45	1.71
Greece	77,138	3.84	1.20
Subtotal	2,348,959	116.97	36.64

Now, Oman's exports to China comprises 81.81% of its annual crude oil production, Angola's - 77.26%, and the rest – almost entirely is shipped to the USA. As well, Saudi Arabia and Iraq are among the basic oil suppliers to the USA, and difficultly could increase their oil exports to China (please, compare the USA oil imports statistics [16] with oil production volume in the mentioned countries [12]). Thus, China would have troubles to find additional source for more than 30 million tons of crude oil at admissible prices to substitute Iranian oil. In addition, China never jointed international sanctions against Iran, and, within the framework of the USA-China trade war, which has impact on both economies [17], declared in August 2018 that business in Iran will continue [18].

Fig. 2 displays oil imports in India in 2017 [19] by main 15 suppliers. The chart bears information on both the slightly corrected by us imports values by destinations borrowed from the source cited above and on imports volumes calculated by us.

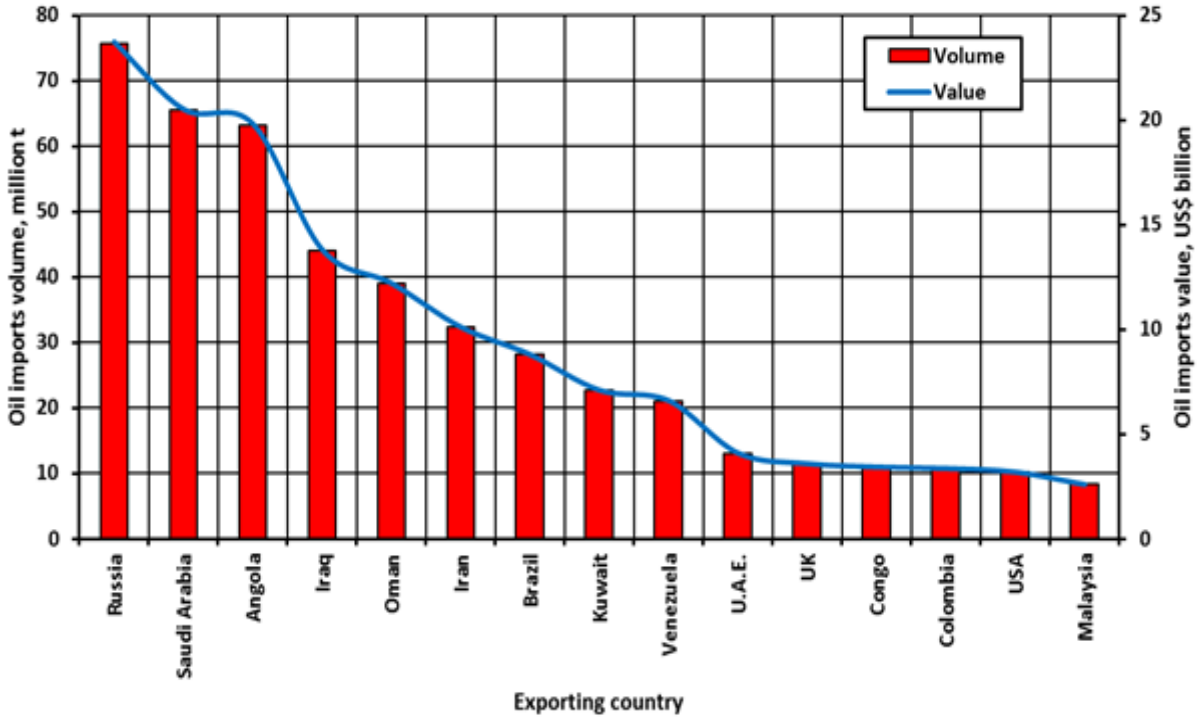

Figure 1 .Top 15 Crude Oil Suppliers to China in 2017.

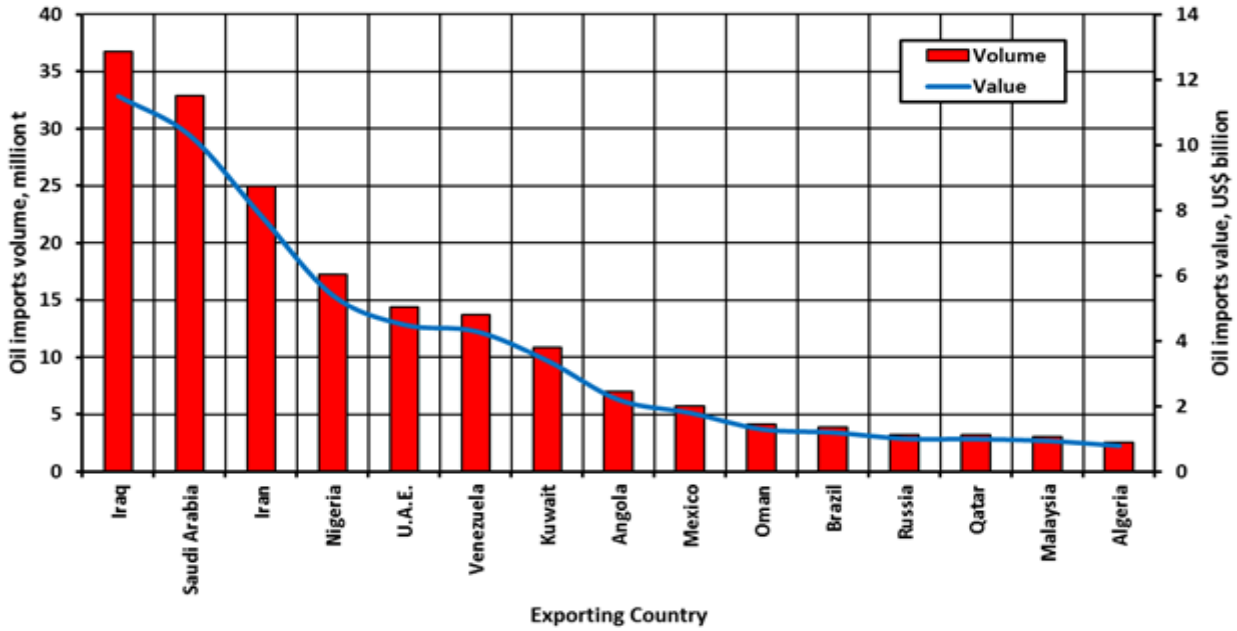

Figure 2. Top 15 Crude Oil Suppliers to India in 2017.

Iran has the third rank among basic oil suppliers to India, after Iraq and Saudi Arabia. Thorough analysis of oil production and exports by other destinations in top oil suppliers has revealed that India will have serious troubles to substitute Iran, and will be able in near future only to diminish imports to about 16-18 million tons but in no way to deteriorate it to zero.

At least, Fig. 3 provides the same information for the South Korea. As in previous cases, import volume was calculated from its value [20]. South Korea, according to the information cited above, has 30 oil suppliers, however, imports from countries, which are not shown on Fig. 3 (Brunei, Philippines, Vietnam, Kazakhstan, Malaysia, Bahrain, Bangladesh, Singapore, Thailand, Myanmar, Angola, Nigeria, Algeria, Congo, and Chad) is today very low. Thus, at our opinion, South Korea would be able to easily substitute oil imports from Iran only slightly increasing imports from above mentioned countries.

It is true that the U.S. administration has approved sales from its Strategic Petroleum Reserve to substitute exports from Iran [21], hence, this measure has a political either an economic importance. For proving this simple reality let analyze dynamics of the end-of-year volume of the U.S. Strategic Petroleum Reserve as it is released by the U.S. Energy Information Administration [22] and shown on Fig. 4. It may be seen that since 2009 volume of the Reserve is step-by-step diminishing from 726.6 million barrels in December 2009 to 662.8 million barrels in December 2017. In September 2018 it equaled 660.0 million barrels or 90.04 million tons. In other worlds, even if the USA entirely sells it Strategic Petroleum Reserve, such sales would cover only 58.77% of annual oil exports from Iran.

Now, it is highly unlikely that such countries like Turkey, Japan and European states will follow the U.S. sanction against Iran. Understanding this reality very well, the U.S. administration has exempted eight countries (Japan, China, India, Italy, Greece, South Korea, Taiwan, and Turkey) from sanctions for importing oil from Iran [23].

Thus, the wordings that "U.S. ready to drive Iranian oil exports to zero" [see 4] is a political declaration, which has no economic basement. The maximum effect that could be achieved, is reducing oil exports by 25-30 million t a year or by 16.32-19.58%.

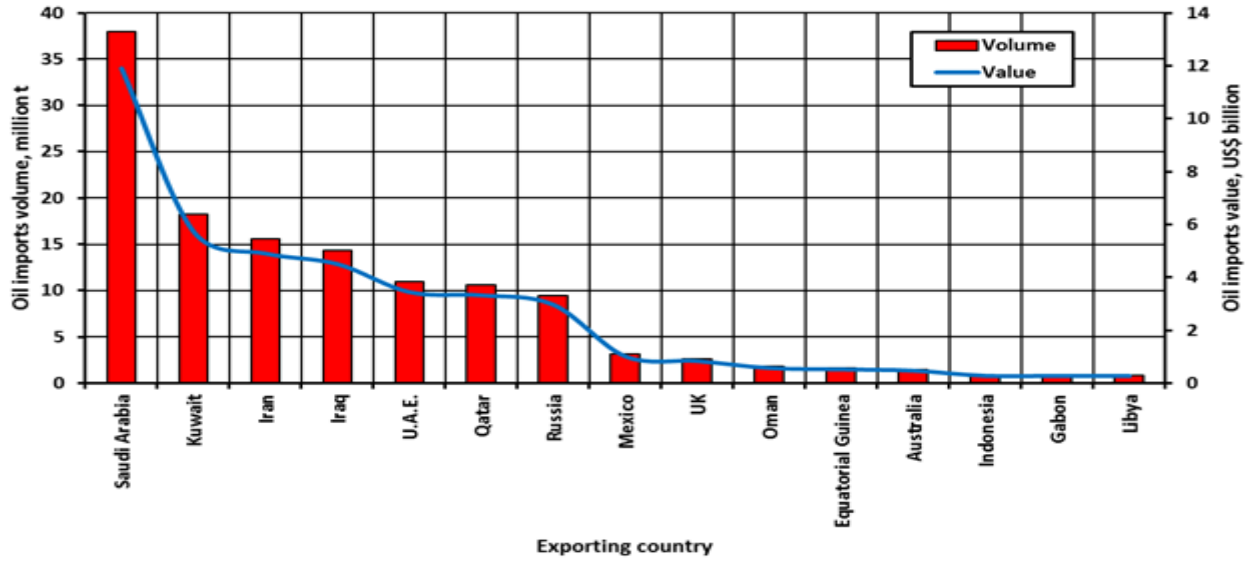

Figure 3. Crude Oil Suppliers to South Korea.

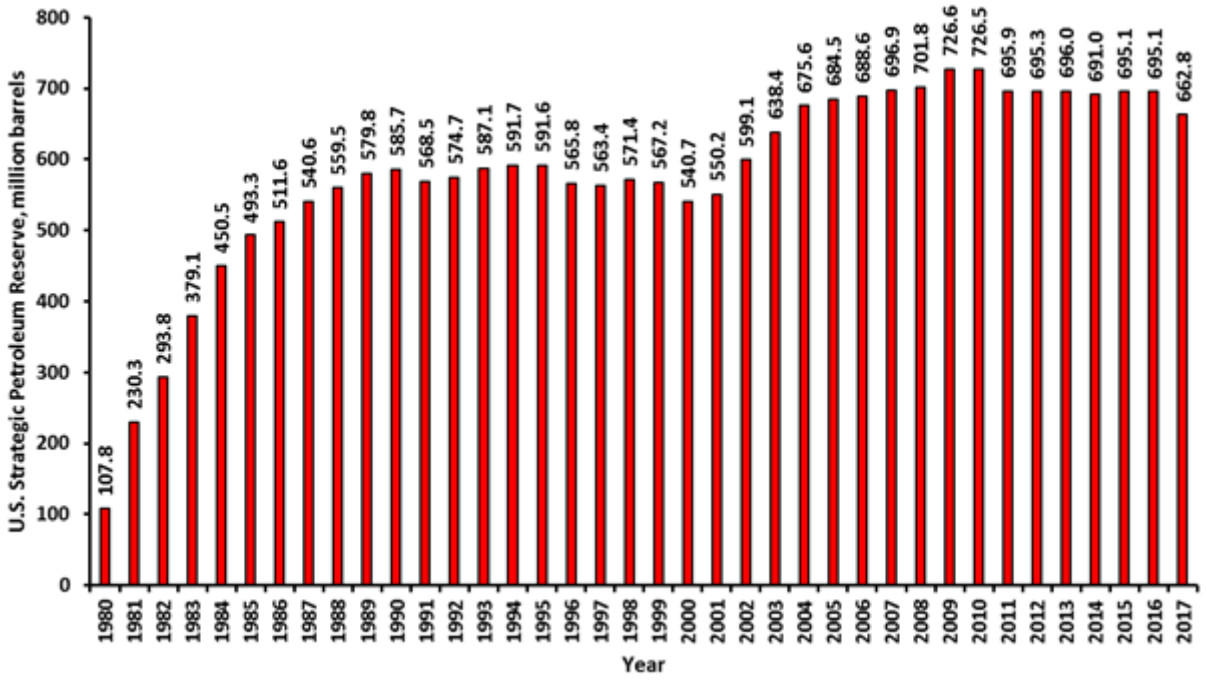

Figure 4. End-of-Year Volume of the U.S. Strategic Petroleum Reserve.

Interdependence between Oil Exports and the Gross Domestic Product of Iran: A Statistical Model

According to the available information [24], Iran is producing about 30 primary energy and mineral commodities and in addition such commodities, which represent products of their downstream processing like steal, alumina, slab zinc, gold and silver bars, wire copper, etc. However, 10 of them are of predominant importance. Table 3 provides share of their value or production volume multiplied by average annual world price, as defined earlier [25].

It may be seen from this table that the predominant share belongs to oil and gas production, and the hydrocarbon sector is as high as 96.57% in production value of 10 basic primary commodities. That is why, first of all, we have investigated a statistical interdependence between oil and gas production and GDP of Iran.

For analyzing impact of oil and gas production on the country's Gross Domestic Product (GDP), one of co-authors has elaborated a specific statistical modelling method [26], slightly updated recently [27].

Table 3. Average Weighted Basic Commodity Production in Iran in 1980-2016.

Primary commodity	Share in commodity value model, %
Oil	71.42
Gas	25.15
Aluminum	0.39
Iron ore	2.02
Copper	0.79
Lead	0.06
Zinc	0.14
Gold	0.02
Silver	0.02
Total	100.00

According to this method GDP, which represents sum of the finished products' added value [28], may be described in commodity terms [29]:

$$GDP = \sum_i \left(P_i S_i\right) + \sum_i \left(P_i^n F_n\right) + A_s \,, \qquad (2)$$

Where *GDP* = Gross Domestic Product, P_i = average weighted annual market price of the i^{th} commodity, S_i = annual volume of the produced commodity, P_i^n = price of the i^{th} commodity processed up to the finished product *n*, F_n = volume of sold n^{th} product, A_s = added value of all services (governmental, insurance, bank, education, etc.).

For the statistical modeling, first of all, correlation between GDP and value of both oil and gas production and oil exports shall be studied [29]. If the correlation factor is significant and strong, interrelation between two variables may be analyzed by the regression method [30]:

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + ... + \beta_p x_{ip} + \varepsilon_i \,, \qquad (3)$$

Where ε_i = residual of equation (4):

$$\vec{x} = \begin{pmatrix} x_{11} & \dots & x_{1p} \\ \dots & \dots & \dots \\ x_{n1} & \dots & x_{np} \end{pmatrix}, \qquad (4)$$

and coefficient β is determined by last squares method meaning that deviation of squares of points $(\bar{x}_i, \bar{y}_i)$ should be minimum. It is reached by an extremum [30]:

$$F(\vec{\beta}_n) = \sum_{n=1}^{p} [\bar{y}_n - B(\bar{x}_n, \vec{\beta}_n]^2 \,. \qquad (5)$$

In none-linear cases it is possible to compute the values of coefficients, standard errors and residue ε_i. To do so, we need to know mean values of $\bar{x}$ and $\bar{y}$, the standard deviation of *x*, the standard deviation of *y*, and the correlation between them. Such computation was realized in the SPSS computer system using ANOVA (analysis of variance) technology [30].

For statistical modelling the following sources were used:

1.Annual yearbooks "BP Statistical Review of World Energy" [12] and the statistical Excel file released by BP [31] – for oil and gas production and consumption data

2.World Development Indicators from the World Bank Group data bank [32] – for GDP data by years

3.Countryeconomy.com data for [33] – GDP data for the years 1990-1991 absent in the World Bank Group data bank

4. IMF primary commodity prices [34]

Data bank for statistical modelling based on oil and gas production is given in Table 4, and based on oil exports – in Table 5.

Fig. 5 demonstrates interrelation between Iranian GDP and oil and gas production value. Extremely high correlation factor (r) modulus allows performing statistical modelling of interrelation between GDP and hydrocarbon production. Graph of the quadratic equation is given on Fig. 6, whereas equation parameters and coefficients – in Tables 6 and 7.

Table 4. Data Bank on Oil and Gas Production in Iran.

Year	GDP, US$ billion	Oil production, million t	Gas production, billion m^3	Oil price, US$ per t	Gas price, US$ per 1000 m^3	Oil and gas production value, US$ billion
1980	94.36	74.2	4.73	274.29	63.57	20.64
1981	100.50	66.2	5.14	262.05	70.63	17.70
1982	125.95	120.1	7.04	233.31	88.29	28.64
1983	156.37	122.8	8.04	213.16	84.76	26.86
1984	162.28	102.5	9.36	210.74	84.76	22.40
1985	180.18	110.4	10.10	197.32	88.29	22.67
1986	209.09	102.7	9.70	105.85	63.57	11.49
1987	134.01	116.7	11.88	130.11	67.10	15.98
1988	123.06	117.4	12.90	109.00	88.00	13.93
1989	120.50	143.8	16.29	134.36	89.00	20.78
1990	124.81	162.8	25.78	169.98	104.23	30.36
1991	79.33	174.4	30.45	148.07	117.64	29.40
1992	49.27	175.7	32.23	141.10	93.56	27.80
1993	63.74	184.3	17.22	122.78	98.93	24.33
1994	71.84	185.0	27.36	114.79	89.43	23.68
1995	96.42	185.5	33.23	122.78	94.73	25.92
1996	120.40	186.6	39.09	149.97	119.11	32.65
1997	113.92	187.0	41.07	136.63	105.85	29.89
1998	110.28	190.8	46.38	87.30	84.37	20.57
1999	113.85	178.1	55.25	121.38	88.22	26.50
2000	109.59	191.7	58.75	200.77	154.72	47.58
2001	126.88	189.8	65.29	168.59	148.83	41.72
2002	128.63	179.1	77.64	167.20	124.45	39.62
2003	153.54	202.1	81.44	202.97	166.22	54.56
2004	190.04	208.9	94.94	276.05	185.17	75.24
2005	226.45	207.9	100.76	366.79	259.64	102.42
2006	266.30	210.7	109.79	427.34	273.84	120.10
2007	349.88	213.3	123.07	470.59	280.11	134.87
2008	406.07	215.6	128.87	670.55	399.84	196.07
2009	414.06	207.4	141.56	392.01	241.56	115.49
2010	487.07	212.3	150.08	521.97	261.82	150.08
2011	583.50	213.0	157.46	638.00	358.92	192.40
2012	598.85	180.7	163.67	633.75	391.43	178.61
2013	467.41	169.9	164.28	668.28	383.97	176.59
2014	434.47	174.3	183.05	627.45	378.95	178.71
2015	385.87	180.5	191.42	304.78	247.99	102.47
2016	418.98	216.8	203.16	252.08	134.08	81.89
2017	439.51	234.2	223.89	313.28	177.63	113.14

Table 5. Data Bank for Oil Exports from Iran.

Year	GDP, US$ billion	Oil production, million t	Oil consump-tion, million t	Oil exports, million t	Oil price		Value, US$ billion	
					US$ per barrel	US$ per t	Production	Exports
1980	94.36	74.2	27.9	46.28	37.42	274.29	20.34	12.70
1981	100.50	66.2	27.7	38.42	35.75	262.05	17.34	10.07
1982	125.95	120.1	30.2	89.92	31.83	233.31	28.02	20.98
1983	156.37	122.8	36.7	86.16	29.08	213.16	26.18	18.37
1984	162.28	102.5	39.7	62.81	28.75	210.74	21.60	13.24
1985	180.18	110.4	43.6	66.73	26.92	197.32	21.77	13.17
1986	209.09	102.7	40.3	62.42	14.44	105.85	10.87	6.61
1987	134.01	116.7	42.0	74.72	17.75	130.11	15.19	9.72
1988	123.06	117.4	44.3	73.12	14.87	109.00	12.79	7.97
1989	120.50	143.8	47.5	96.32	18.33	134.36	19.33	12.94
1990	124.81	162.8	49.3	113.53	23.19	169.98	27.67	19.30
1991	79.33	174.4	52.3	122.11	20.20	148.07	25.82	18.08
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2000	109.59	191.7	67.7	124.05	27.39	200.77	38.49	24.91
2001	126.88	189.8	68.1	121.68	23.00	168.59	32.00	20.51
2002	128.63	179.1	68.4	110.71	22.81	167.20	29.95	18.51
2003	153.54	202.1	69.2	132.96	27.69	202.97	41.02	26.99
2004	190.04	208.9	71.2	137.68	37.66	276.05	57.66	38.01
2005	226.45	207.9	78.6	129.34	50.04	366.79	76.26	47.44
2006	266.30	210.7	85.7	125.01	58.30	427.34	90.03	53.42
2007	349.88	213.3	87.9	125.46	64.20	470.59	100.39	59.04
2008	406.07	215.6	91.9	123.67	91.48	670.55	144.55	82.93
2009	414.06	207.4	90.9	116.46	53.48	392.01	81.30	45.65
2010	487.07	212.3	82.5	129.75	71.21	521.97	110.79	67.73
2011	583.50	213.0	84.0	129.00	87.04	638.00	135.88	82.30
2012	598.85	180.7	85.5	95.24	86.46	633.75	114.54	60.36
2013	467.41	169.9	93.4	76.44	91.17	668.28	113.52	51.08
2014	434.47	174.3	90.2	84.08	85.60	627.45	109.35	52.75
2015	385.87	180.5	80.3	100.15	41.58	304.78	55.00	30.52
2016	418.98	216.8	77.3	139.52	34.39	252.08	54.65	35.17
2017	439.51	234.2	81.0	153.23	42.74	313.28	73.37	48.00

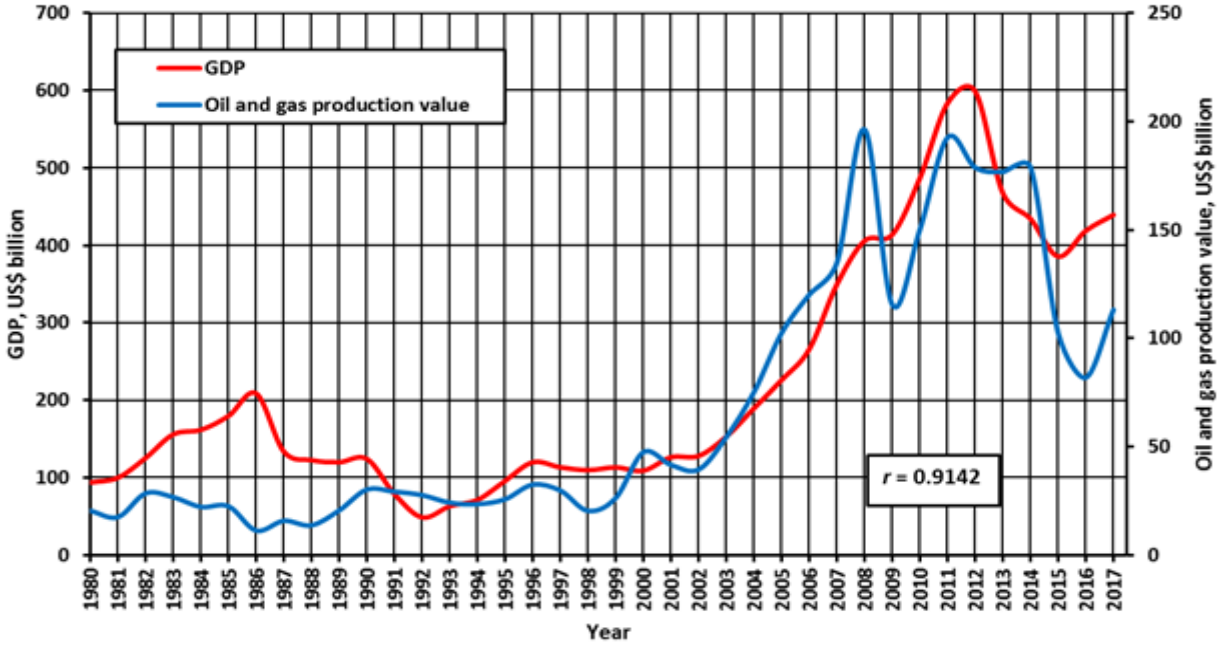

Figure 5. Interrelation Between Iran's GDP and Oil and Gas Production Value in 1980-2017.

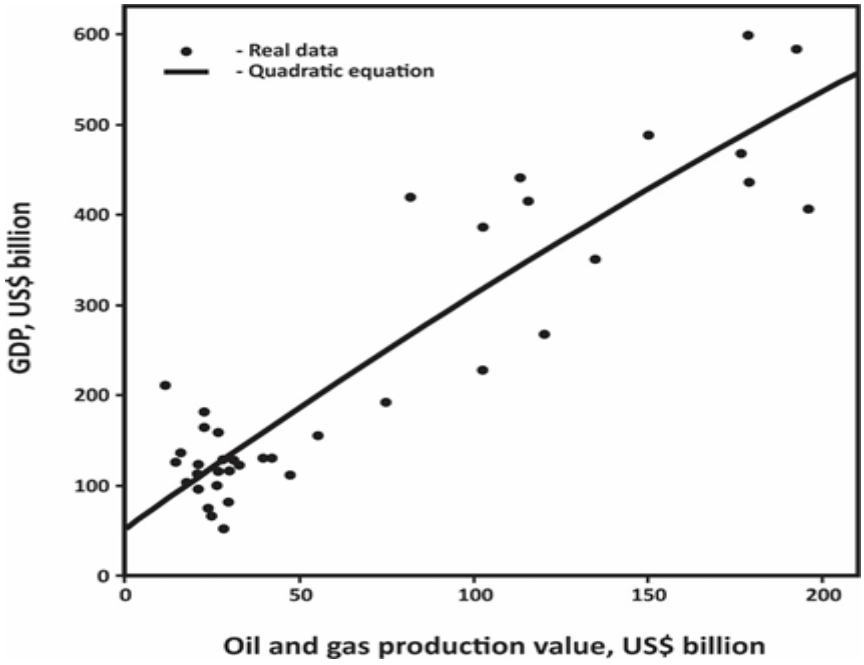

Figure 6. Model of Interdependence Between Iran's GDP and Oil and Gas Production Value.

Table 6. Regression Equation Parameters for Oil and Gas Production Model.

Equation parameters	Sum of squares	*dF*	Mean square	*F*	$\mathcal{E}$
Regression	780,749.53	2	390,374.76	89.545	0
Residual	152,583.27	35	4,359.52		
Total	933,332.80	37			

Table 7. Regression Equation Coefficients for Oil and Gas Production Model.

Coefficients	B	Std. Error	β	*t*	$\mathcal{E}$
Oil and gas production value	2.768	0.835	1.038	3.317	0.002
Oil and gas production value^2	-0.002	0.004	-0.126	-0.404	0.688
(Constant)	50.904	26.769		1.902	0.065

It could be seen that the equation describes the interrelation between Iran's GDP and oil and gas production value with an acceptable accuracy of ± 5%. This statement becomes extremely clear when the real GDP is compared with the model one, computed from oil and gas production value (Fig. 7).

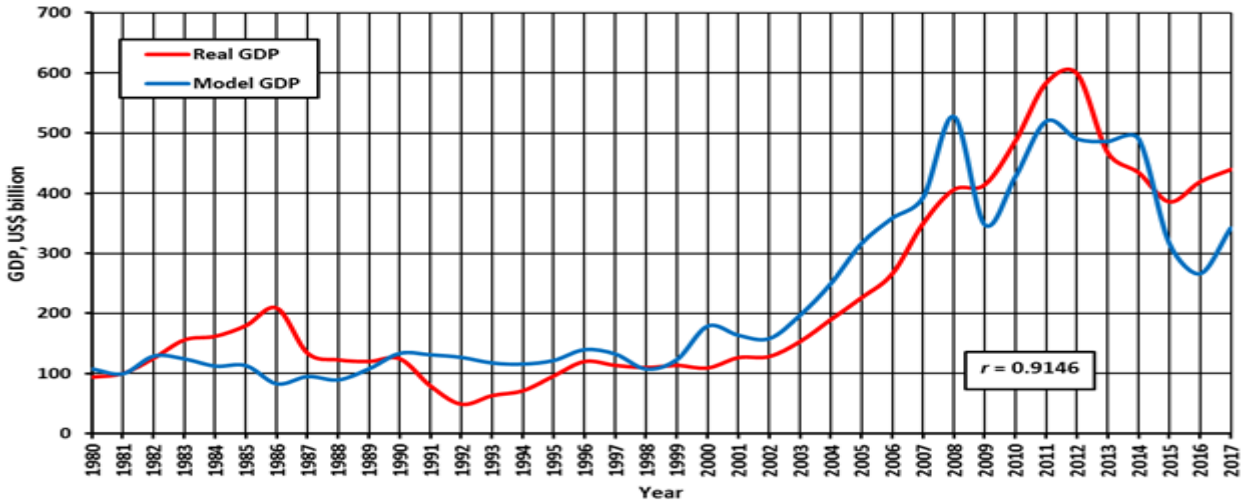

Figure 7. Comparison of Iran's Real GDP with the Model One Computed from Oil and Gas Production Value.

Thus, Iran's economic development is predominantly determined by the hydrocarbon production.

Now, Fig. 8 describes both oil and gas production and oil exports as a share of Iran's GDP. It may be observed that by the end of the recent century the lion's share of the added value in hydrocarbon sector was determined by oil exports. However, in the new millennium the difference between values of hydrocarbon production and oil exports is being increased, and today oil exports have a share of 10% of GDP.

Fig. 9 investigates statistical interdependence between Iran's GDP and oil exports value. It may be seen that at the background of a positive and strong (but weaker than in the previous model) correlation factor huge undulations in oil exports cause only small changes in GDP. Quadratic equation is shown on Fig. 10 and their parameters and coefficients – in Tables 8 and 9.

It may be seen that in this case the equation has much more uncertainty that in the previous model: standard error is by 3.18 order of magnitude higher (compare Tables 7 and 9).

Comparison of the real and the model GDP (Fig. 11) indicates that changes in oil exports by 36% will cause only 2% variations of GDP.

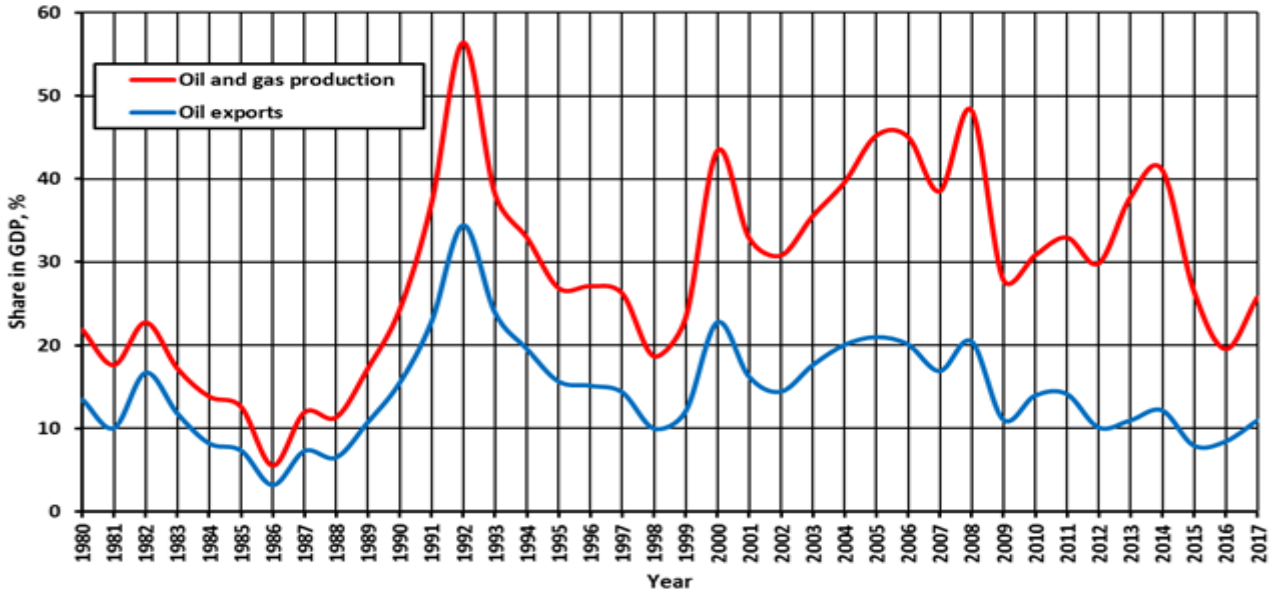

Figure 8. Oil and Gas Production and Oil Exports as a Share of Iran's GDP.

Table 8. Regression Equation Parameters for Oil Exports Model.

Equation parameters	Sum of squares	*dF*	Mean square	*F*	$\mathcal{E}$
Regression	696,385.77	1	348,192.89	51.432	0
Residual	236,947.02	36	6,769.91		
Total	933,332.80	37			

Table 9. Regression Equation Coefficients for Oil Export Model.

Coefficients	B	Std. Error	β	*t*	$\mathcal{E}$
Oil exports value	8.569	2.662	1.148	3.22	0.003
Oil exports value^2	-0.026	0.032	-0.295	-0.829	0.413
(Constant)	4.979	41.709		0.119	0.906

In other words, unlike other oil exporter countries, for instance, Saudi Arabia or Russia [see 27], Iranian economy is not entirely determined by oil exports. It is true that, as it has been shown above, the hydrocarbon sector is the main branch of the country's economy, hence, downstream processing of oil, production of fuel as well as gas consumption and its growing exports play increasing role in economic development. Share of oil exports in Iran's Gross Domestic Product is gradually diminishing and today does not exceed 10% (see Fig. 8).

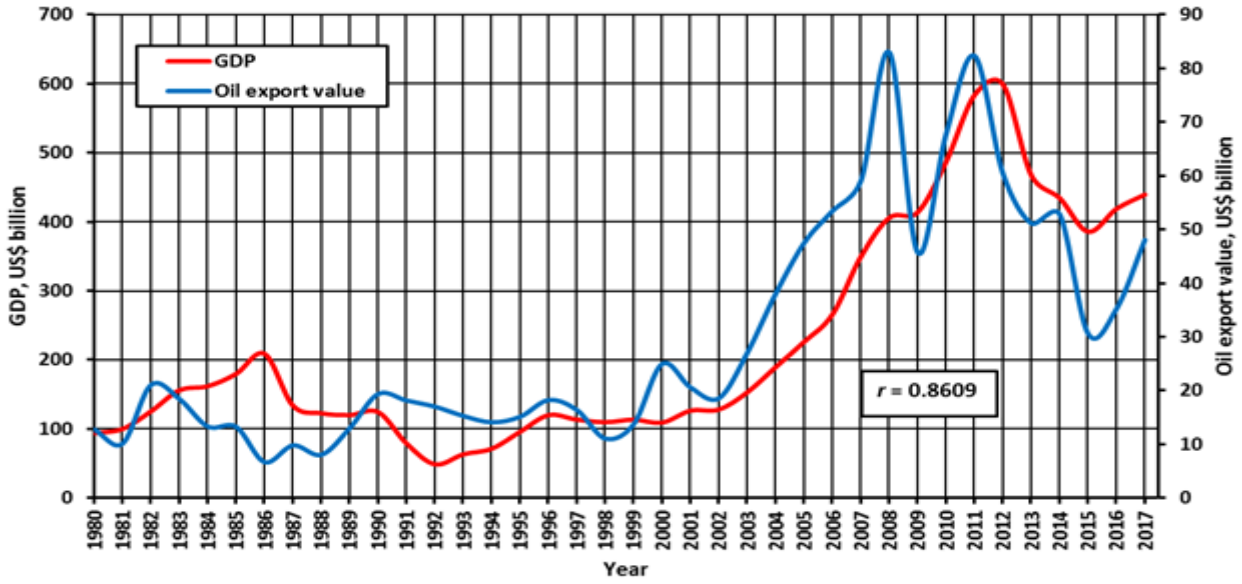

Figure 9. Interrelation Between Iran's GDP and Oil and Oil Export Value in 1980-2017.

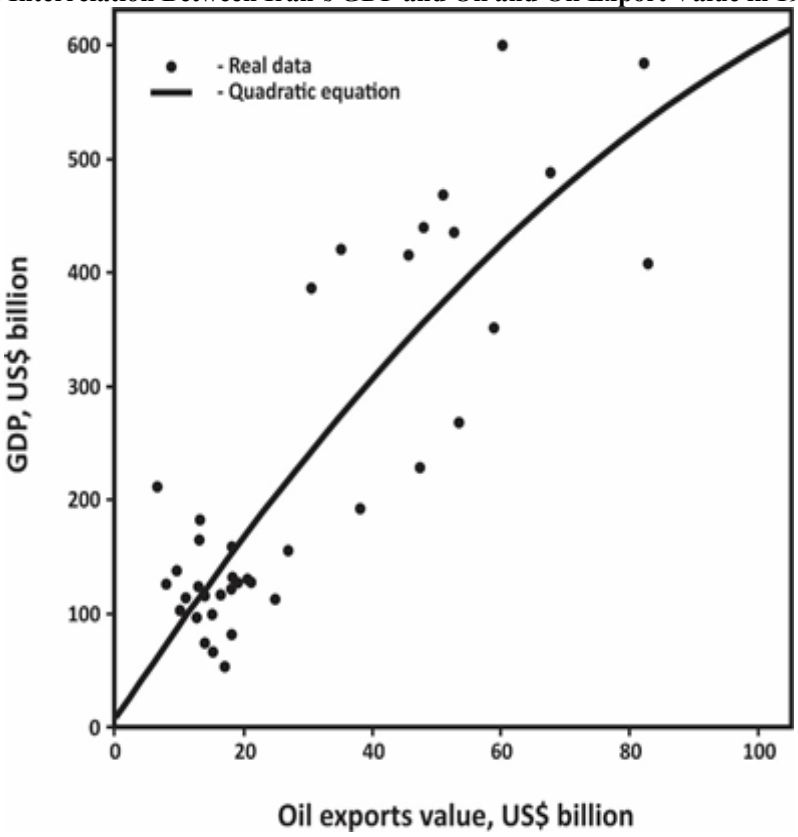

Figure 10. Model of Interdependence Between Iran's GDP and Oil Exports Value.

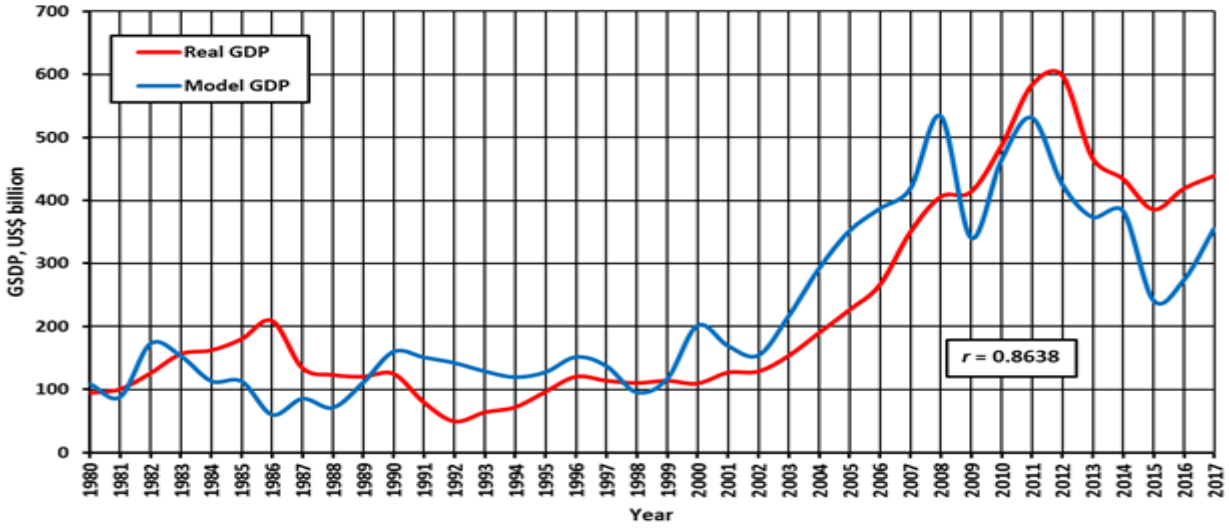

Figure 11. Comparison of Iran's Real GDP with the Model One Computed from Oil Exports Value.

Conclusions

Investigation results are important and may have huge geopolitical corollaries as follows:

1.In medium-term run President Trump's administration measures to cause serious economic obstacles for economic development of Iran will be unsuccessful.

2.USA has no means and geopolitical instruments to bring oil exports from Iran to zero.

3.Hence, even if it is done, these measures will cause difficult but not dramatic consequences for economic life of this Islamic country, which would create complications for development of civil society in Iran. Moreover, the desire of President Rouhani to modernize the Iranian society [35] will fail, and Islamic Revolutionary Guard Corps, weakened under the Rouhani's presidency, will regain momentum.

4.Thus, President Trump's measures will cause just the back effect than the target he wanted to reach.

5.The sole possibility to provoke democratic movements within the Iranian society is to imply the country into international energy projects, in which Rule of Law is governing partnership relations.

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