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Abstract
The export of petrochemical products -as a type of non-oil export- plays a key role in the economic development of our country. This is of special importance in light of the structure of Iran's economy that is oil-based. Identifying the factors affecting the export of petrochemical products can improve their export. Using Johansen-Juselius co-integration method and the error correction model, the present study purports to investigate the effects of the real foreign exchange rate and the total value of petrochemical products on the export of these products in Iran. This research used data from 1989 to 2012. It was found that the real foreign exchange rate and the real value of total petrochemical products positively affect their export in the long run, and the effect of the former is greater than that of the latter. However, in the short run the effect of the foreign exchange rate on the export of petrochemical products is more significant.

Keywords: Real Exchange Rate, Non-Oil Exporting, Petrochemicals, Johansen-Juselius Method, ECM Model.
JEL: C22, C65, F14, F31.

1. Introduction

It has been acknowledged that reliance on industries that are based on raw materials (such as oil) cannot meet the expectations of the governments exporting these materials to became industrialized and diversify their products (Ju et al, 2014). Therefore, there is no doubt that countries whose economy is contingent upon a particular product such as oil are more vulnerable in economic changes and crises and receive more damage (Mukhamediyev, 2014). Hence, paying attention to non-oil exports can be very effective and helpful in these crises. Iran's reliance on oil income and continuing this approach in different economic programs has led to inconsistency in improving the economic indicators and fluctuation in economic growth (Delavari et al, 2015). The decline of oil prices has overshadowed many policies and plans in different economic programs. Regardless of the general aspects of oil revenues, the fact that these revenues have a major role in inflation is one of the most salient economic concerns in Iran. The country's economy great vulnerability to international changes and tensions also illustrates the importance of this issue (Komijani et al, 2013). Therefore, economists and policy makers should do their best to reduce the economy's reliance on oil revenues and diversify exports.

A large part of Iran's revenues relies on oil. Since the advent of oil in this country, the proportion of oil export to all other exports has been on the rise (Delavari et al, 2014). Moreover, oil export has experienced great fluctuations over the past decades, particularly after the Islamic Revolution, causing huge crises for Iran's economy. Crude oil is the most important revenue for OPEC countries; however, this trend is more vivid in Iran. Sixty percent of Iran's governmental revenues and ninety percent of export revenues come from oil and gas exports (Komijani et al, 2014). Hence, changes in the prices of these products cause great fluctuation in the economies of these countries including Iran (Mehrara & Mohaghegh, 2011). On the one hand, this lies in the fact that the price of oil is hugely sensitive to the world's economic, political, and cultural conditions. On the other hand, these changing prices exert a huge influence on macroeconomic variables (Mehrara, M., Oskoui, 2007). Therefore, Iran's economy is always vulnerable to fluctuations of oil prices. The long dependence of Iran's economy on oil revenues necessitates fundamental reconsideration of the economy (Farzanegan & Markwardt, 2009). Avoiding one-product export, diversifying products for export, providing foreign currencies for investment, and gaining a bigger share in international trade vividly

illustrate the importance of non-oil exports including petrochemical products (Delavari et al, 2013a).

A large part of Iran's non-oil export is related to petrochemical products. Moreover, the comparative advantage related to the export of petrochemical products can reduce the negative effects of oil shocks (Delavari et al, 2015). Therefore, the development of non-oil exports has been considered an important growth and development strategy for Iran's economy because the production and export of these products produces numerous job opportunities as well as huge revenues (Komijani et al, 2013).

Petrochemical industry and the related industries are among the strategic parts of the country's economy. Iran's priority to abandon one-product export and the ability to gain added value from oil and gas by this means has led all governments to attach great importance to the petrochemical industry (Delavari et al, 2015). Iran has access to huge sources of oil and gas and also enjoys relatively inexpensive expert human resources in this domain, putting the petrochemical industry in a salient position. This industry enables Iran to obtain more added values from oil and gas (Delavari et al, 2013c). Consequently, the attention to the export of petrochemical products has been intensified and the proportion of these products to Iran's total non-oil exports has been on the rise (Kazemi & Kazemikhasragh, 2013). Although petrochemical products originate from oil and gas, they produce more added values. The increase of the export of these products enables us to enjoy the wealth produced by oil and gas within Iran (Komijani et al, 2013). Therefore, Understanding the factors affecting the petrochemical industry and the role of variables influencing the export of petrochemical products can have a great contribution to the development of their export. Hence, the present study investigates the effects of real exchange rate and the aggregate value of petrochemical products on their export in Iran.

2. An overview of the complementary oil industry

Oil industry falls into two parts, namely the upper-hand part and the lower-hand part. The upper-hand oil industries include those related to oil discovery, extraction, and exploit (Masih et al, 2010a). Industries using petrochemical or refinery products are considered as lower-hand petrochemical industries. Petrochemistry is currently a vast industry enjoying complex technologies and produces thousands of products (Lissek

& Muller, 2012). The importance of this industry is vivid. Petrochemical products are used in agriculture, textile and construction industries, and also in the production of detergents and drugs. It is crystal clear that without petrochemical products human life would be disrupted (Masih et al, 2010b). Doing less activities, devoting less investment, gaining more added value, producing more diverse products, and facing less dangers are some advantages of the development of lower-hand petrochemistry industries. Petrochemical industries are considered as mother industries and foster the economic and industrial development of the country (Komijani et al, 2013).

Since seventy percent of the added value produced by the petrochemical industries is achieved by the complementary industries, we can obtain huge revenue in one year that can be equal to the total amount of Iran's oil revenues (Delavari et al, 2013b). Therefore, different countries make a huge investment in some aspects of petrochemistry such as producing basic and lower-hand materials with regard to their facilities and potentials such as access to technical knowledge, raw materials, and cheap oil and gas resources (Bachmeier & Grin, 2006). The developed countries have chosen to produce lower-hand materials having high added value due to their high management and technological computability ies, and have let the developing countries to produce basic, upper-hand materials having a low added value (Erbil, 2011). Although Iran enjoys comparative advantage in petrochemistry and its lower-hand industries, discrete chains are observed in this area. Hence, most materials produced in different parts of Iran's petrochemical industries are exported to countries such as Japan, China, and the European Union and after being converted to final products are again imported to Iran with exorbitant prices (Delavari et al, 2015). It should be that noted great attempts have been made to develop the upper-hand and middle-hand petrochemical industry over the recent years to complete the value cycle of this industry; nevertheless, selling raw materials is still the most important advantage of this industry in Iran. However, it has been demonstrated that seventy percent of the added valve of the petrochemistry industry is gained in complementary industries, which have not developed in line with lower-hand industries in Iran (Delavari et al, 2013a). Some of the most important problems of the petrochemistry industry in Iran are as follows:

1. Lack of modem plans and strategies for lower-hand industries.
2. Unfulfilled promises of the related organizations (such as Petrochemical

Industries National Company)
3. Various governmental and semi-governmental companies and centers involved in lower-hand petrochemical industries whose activities are not harmonious
4. Technological shortcomings of the lower-hand petrochemistry industries
5. Lack of centers responsible to create new technologies or acquire foreign ones related to lower-hand petrochemical industries

Due to the importance of this industry for the economic development of the country, recognizing the obstacles of the petrochemistry industries and devising comprehensive, purposeful strategies to overcome them are crucial. Research shows that most of the problems of this industry are due to production limitations. Therefore, one of the questions investigated in this study is to what extent the production level affects the degree of the development of the export of petrochemical products.

2.1. The future of foreign trade in petrochemical products

The rising trend of oil and gas prices in international markets and the neglectance of the probable break of the price record in mid-2008 (the average price of oil in that year was more than $100), and the continuous rise of oil prices in subsequent years have overshadowed most industries. This has negatively affected petrochemistry more than other industries. The reason is that other industries consider oil as an energy source that can be replaced with other sources, while for petrochemistry oil is a raw material for production. In Europe and North America, oil cannot be substituted with natural gas for petrochemistry. Moreover, in most countries petrochemistry cannot work without oil. Therefore, any increase in oil prices would raise the production costs of petrochemical products, reducing the economic profitability of petrochemistry units. Therefore, due to the considerable advantage of West Asia in producing raw materials for petrochemistry, it can be clearly predicted that this industry will significantly improve in West Asia in the next decade, which would be a continuous trend. Moreover, the remarkable advantage of this region with regard to reducing the total costs of production and the governments' tendency to diversify oil-based economies will foster this trend. About twenty years have passed since the start of investments in this region, and currently 10 percent of the total ethylene of the world is produced in West Asia.

Although dependence on West Asia is considered a threat for America and

Europe in the short run, but the technological dependence of this region on the West will benefit America and the Western Europe in the long run. Moreover, West Asia can be an appropriate and profitable investment target and a guaranteed market for petrochemistry-related technologies.
Although Iran is located in West Asia, but it does not limit itself to produce just raw materials, which has been defined for this region. This country has strategic plans to convert petrochemical products to final products with a high added value. Furthermore, Iran aims to reach the newest technologies by its own experts and even export them to other countries, which is the role defined for some Western countries. The important point is that producing high-value products, entrepreneurship, creating sustainable jobs, and gaining maximum added value from petrochemical Martials require comprehensive development of this industry and the harmony of upper-hand, lower-hand, middle-hand, and other related industries. If the necessary infrastructures are provided and enough investment is made, we can gain a huge achievement in this industry.

2.2. The importance and functions of the foreign exchange rate in the export of petrochemical products

One of the economic policies that may have a significant influence on non-oil exports, including petrochemical products, is the foreign exchange rate. Since previous studies have had conflicting results on the effect of the real foreign exchange rate on non-oil exports, and this effect has been different for various products, investigating the impact of this economic policy on export (Mtembu & Motlaleng, 2010). products is essential to help authorities improve the export of these products. The real foreign exchange rate refers to the proportion of foreign prices to domestic prices in terms of one currency (Kazerooni & Feshari, 2010). In other words, the real foreign exchange rate measures the country's computability in international trade. It should be noted that a government or a central bank can stabilize the value of its currency in the short run; however, the exchange rate between two countries is determined by the relative purchasing power of each of the two currencies if there are no structural barriers and the market forces are active (Prasanna, 2010). The relative purchasing power is measured in terms of the foreign exchange rate. In theory, the foreign exchange rate positively affects the amount of exports. The reason is that if the exporter determines the price, the rise of the foreign exchange rate reduces the price of the exported products. This will increase the demand for these products

and hence, their export (Fang et al, 2009). On the other hand, if the exporter receives the price, he will receive more money for the products exported (in terms of the domestic currency) which will encourage the exporter. The increase of the real foreign exchange rate indicates the relative increase of the price of foreign products in comparison with that of the domestic products (Oskouei & Ratha, 2008). In other words, foreign products become more expensive. If other conditions are constant, this means that consumers will prefer domestic goods. This phenomenon increases the compatibility of domestic products compared to that of foreign products. Conversely, the decrease of the foreign exchange rate causes the domestic products to be relatively more expensive and reduces their compatibility (Akhtar Hossain, 2008).

Based on economic theories, the export of non-oil products, including petrochemical products, is also directly influenced by the total level of production and is inversely affected by the general level of prices. Therefore, the changes of the foreign exchange rate directly and indirectly impact the export of non-oil products including petrochemical products. Econometric research has shown that the rise of the foreign exchange rate has a direct impact on the export of non-oil products; however, due to the particular characteristics of Iran's economy, the indirect effect of this rise on the export of petrochemical products have led to the decline of their export. On the other hand, since a large part of Iran's imported products have been capital and intermediate goods, the rise of the foreign exchange rate has made these goods more expensive, leading to the increase of production costs hampering production. This can augment the general level of prices of these products, hindering their export. This is another indirect negative impact of the rise of the foreign exchange rate on the export of non-oil products, including petrochemical products. Research has shown that the aggregate indirect effects of the rise of the foreign exchange rate exceed those of the direct effects, and increasing the foreign exchange rate is not an appropriate policy to improve the level of non-oil exports. Hence, before making any decision with regard to the foreign exchange rate we should take the volume of the exported and imported goods into careful consideration.

3. Introduction of the model and the method

Error correction model (ECM) was utilized in this study to investigate the degree of the effect of the real value of petrochemical products on the real

value of the export of these products in Iran. The general framework of this model examines how the system comes back to equilibrium when it deviates from it in the long run. Moreover, this model explores the causal relations among the variables.

When the variables of a regression model are inconstant and integrated, first we should investigate the long-term relationship between the variables in order to describe the model accurately, measure the coefficients of the variable accurately, and avoid spurious regression. Common econometric methods (OLS) would not yield correct estimates. Therefore, the common methods to investigate he long-term relationship between a set of variables are the two-step Engle-Granger method and Johansen-Juselius method. In the two-step Engle-Granger method, a regression equation between the inconstant, integrated variables is estimated. Then, the constancy of the residuals of the estimated model is tested. Therefore, if these residuals are constant, we can conclude that there exists a long-term relationship between these variables. However, this method has some limitations such as inability to estimate the side functions, being two-step, and estimating just one relationship between the variables (even if there is more than one long-term relationship). Hence, two economists − Johansen and Juselius − proposed a new model to overcome the shortcomings of the above-mentioned model. This method uses vectors to illustrate all the long-term relationships between the inconstant variables (Enders, 2004).

In line with the objectives of this study, the short- , mid-, and long-term relationships between the variables will be examined in this study. In economic modeling, we cannot limit ourselves just too long-term relations between variables. Investigating the short- and mid- term relations is also necessary. Consequently, this research utilizes the ECM model to analyze the data and interpret the relations between them. The following section elaborates on the ECM model.

3.1. The structure of ECM

This pattern investigates the balancing and long-term role of the variables to analyze short-term fluctuations. This means that the error correction model considers the changes of the dependent variable as a function of temporary deviation from the long-term equilibrium equation (determined by element of error correction) and demonstrates the changes of other explanatory variables. In the literature of the theory of integration, the equation $Y = \beta X + U$ is considered as the regression of the co-integration, β

is regarded as the co-integration parameter, and $[1-\beta]$ is known as the co-integration vector. After the long-term relationship between the variables was confirmed and the long-term coefficient of the model was estimated, the second step deals with estimating a dynamic short-term relationship which is the first order difference of the dependent variable on the first order difference of explanatory variables with the error term. These are the residuals of the regression of the first step with a delay period, known as the error correction term or ECT. The model estimated according to the second step is known as the error correction model (Pesaran and Pesaran, 1997). This model associates the long-term and short-term behavior of two variables, and is shown as follows:

(1) $$\Delta Y_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta Y_{t-i} + \sum_{i=1}^{n} \gamma_i \Delta X_{t-i} + \lambda \varepsilon_{t-1} + V_t \qquad -1 < \lambda < 0$$

In this equation, λ is the short-term equilibrium coefficient. It indicates that in any short-term period how much of the deviation from the long-term equilibrium is corrected (Gujarati & Porter, 2009).

4. Elucidation of the model

In line with Dolatti et al (2012) and Kazerooni & Feshari (2010), we used $RER = E.\frac{CPI_{us}}{CPI_{IR}}$ to describe the real foreign exchange rate, in which CPI_{us} is the American consumer price indicator in 2005, E is the foreign exchange rate in the informal market, and CPI_{IR} is the Iranian consumer price indicator in 2005. The following equation was used to investigate the effect of the real foreign exchange rate on the export of petrochemical products.

(2) $$LY_t = \beta_0 + \beta_1 LP_t + \beta_2 LRER_t + u_t$$

In equation 1, LY_t is the logarithm of the real value of total export of petrochemical products, [1] LP_t is the logarithm of the real value of total petrochemical products, and $LRER_t$ is the logarithm of the real foreign exchange rate. In order to make the value of production and the value of export, the American consumer price indicator has been used. The data used in this study are taken from the official sites of Iran's Central Bank, Iran's Statistics Center, The World Bank, and the annual reports of the

Iran's Petrochemical Industries National Company.

In models that are based on time series data, we should examine the constancy of the data first, measured by Philips-Pron index here. The results showed that all the variables of the study are inconstant and as Table 1 demonstrates they will become constant by one subtraction.

Table 1: *The Study Variables Stationary Tests*

Variables	***Accounting Value for Level***	***Accounting Value for Difference***	***Result***
dLY	*-1.82*	*-2.689*	*I(1)*
dLP	*-1.83*	*-2.688*	*I(1)*
dLRER	*-0.49*	*-2.207*	*I(1)*

Source: *The Finding of the Study*

Entering variables with numerous delays will make prediction erroneous, and variables with few delays will yield unusual results. We should pay attention to the fact that the effects of independent variables on dependent ones are not immediate in modeling. Particularly, a great deal of precision may be required in time series models to determine the consequences of an economic decision on a given variable. In these cases, finding the optimal delay is of prime importance. Therefore, in order to find the optimal delay for the VAR model, Akaike Information Criterion (AIC), Shoartz Information Criterion (SBC), Final Prediction Error (FPE), and Sequential Modified Likelihood Ratio Test Statistic (LR) have been used. These statistics are presented in the following table.

Table 2: *The Best Lag Tests*

Lag	***LogL***	***LR***	***FPE***	***AIC***	***SBC***
0	*41.74*	*NA*	*6.91e-6*	*-3.22*	*-3.33*
1	*95.57*	*88.94**	*1.42e-7**	*-7.27**	*-7.12**

**the stars show the best lag base on each measurement of tests*

Source: *The Finding of the Study*

After determining the optimal delay, the long-term relationship between variables was measured by Johansen-Juselius method. This method has features such as estimations with free functions, the ability to do hypothesis testing on long-term parameters, and identifying all long-term relationships. In this method, first Trace Test and Maximum Eigen value Test are used to determine the co-integration and the number of long-term relationships. Then, the normalized vector of the long-term relationship between the real value of the total export of petrochemical products, the

logarithm of the real value of total petrochemical production, and the logarithm of the real foreign exchange rate is estimated.

Table 3: *The Johansen-Juselius Co-integration test*

Null Hyp.	*Maximum Eigen value Test*			*Trace Test*		
	Stat.	*Critical value*	*P- value*	*Stat.*	*Critical Value*	*P-Value*
$r = 0$	*103.71*	*21.13*	*0.02*	*114.81*	*29.79*	*0.01*
$r \leq 1$	*10.598*	*14.26*	*0.29*	*11.102*	*15.49*	*0.22*
$r \leq 2$	*0.5045*	*3.84*	*0.16*	*0.5045*	*3.84*	*0.16*

Source: *The Finding of the Study*

The results shown in the above table indicates that with confidence level of 95 percent there is at least one long-term relationship between the inconstant variables of the study Therefore, we should estimate the normalized vector between these variables. The results are shown in the following table:

$$LY = -0.014 + 1.005\,LP + 0.25\,LRER \quad (3)$$

Since all the variables have been used in a logarithm mode, we can consider the coefficients as the long-term interaction of the dependent variable to all the independent variables Therefore, we can suggest that the relationship between the real value of the exports and the real foreign exchange rate is positive and significant. If in the long run the real foreign exchange rate increases by one percent, the real value of the exports rises by 0.25 percent. Moreover, if in the long run the real value of the total petrochemical products increases by one percent, there mill be 1.005 percent increase in the real value of exports. These results are in line with the previously mentioned theories. Therefore, it has been shown that the logarithm d the real value of total petrochemical products and the logarithm of the real foreign exchange rate have a significant impact on the logarithm of the real value at total export at petrochemical products.

After confirming and estimating the long-term relationship, the ECM model is estimated the most important reason why the error correction model is famous is that it relates the short-term fluctuations of the variables to their long-term equilibrium values. When two variables are co-integrated, there is long-term equilibrium relationship between them, although there may be short-term in-equilibrium between them. These models are a type of minor equilibrium models, in which we can measure the short-term forces and the speed of approach in the long-term equilibrium value by entering the constant residual from a long-term relationship. The results of the above-mentioned model are as follows:

(4)

$$DLY = -0.0154 + 0.85DLP + 0.12DLRER - 0.78ECM(-1)$$
$$t: \quad (-1.44) \quad (6.97) \quad (4.17) \quad (-3.92)$$

As it is observed, the ECT (-1) coefficient, which is the equilibrium coefficient toward the long-term equilibrium, in the dynamic models of the value of exports are significant and its value is between 0 and -1. This means that if a short-term shock disturbs the long-term equilibrium, it will come back to the equilibrium after 1.28 periods (one gear and 103 days). In addition, the positive and significant relationship between the real value of exports and the real value of production in the short run was confirmed. The short-term interaction between the real rates of the export of petrochemical products in proportion to the real value of their production is 0.85. Moreover, the association between the foreign exchange rate and the dependent variable is positive and significant. The short-term interaction between the dependent variable and the above-mentioned variable is 0.12.

5. Conclusion and implications

The petrochemical industry in Iran is passing its puberty. Many researchers and policy makers have devoted attention to this industry over the recent years to overcome its challenges Therefore, the main objective of this study is to examine the effect of the real foreign exchange rate and the real value of petrochemical products on the real value of the export at these products in Iran. Hence, the main model used in this research is Johansen-Juselius co-integration model (ECM model).

The results of this study shows that there exists positive and significant association between the real foreign exchange rate, the real value of petrochemical products, and the real value of the export of these products in the short run and in the long run. Moreover, in both short and long run, the real value of the export of petrochemical products is more affected by the real value of petrochemical products rather than the real foreign exchange rate The coefficients of the real value of petrochemical products in the short run and in the long run are 0.85 and 1.005 respectively, while this coefficient for the real value of foreign exchange rate is 0.12 and 0.25 respectively. The greater coefficient of the real value of petrochemical products in comparison with that of the real foreign exchange rate seems to be logical in terms of the theory and particular conditions of Iran's market. The reason is that a part of the increase of the real value of petrochemical

products is rooted in the rise of the real foreign exchange rate, leading to the increase of comparative advantage of the export of these products. Moreover, another part of the real value of petrochemical products affecting the amount of export of these products is the amount of their production Therefore, the greater coefficient of the real value of petrochemical products, which is due to the foreign exchange rate and the amount of their production, in comparison to that of the foreign exchange rate is logical.

This study also revealed that the relationship between the variables is dynamic. In other words, the long-term equilibrium of the variables of this study is constant because the ECTC(-l) in the ECM model is negative and significant. The value of this coefficient is -0.79, showing that the effect of short-term shocks disturbing the equilibrium will fade away after one year and 103 days and the equilibrium will return in the long run.

The positive relationship between production and export of petrochemical products is not unexpected in light of the policies related to the export at these products. Most of the previous studies have confirmed the positive relationship between export and the real foreign exchange rate. This is supported by the findings of this study. However, this study showed that the growth rate of export particularly the export of petrochemical products is even greater than that of other non-oil products. The increase of the growth rate of the export of petrochemical companies is due to changes in petrochemistry production and the global demand for these products. Nevertheless, we expect that in making subsidies purposeful the foreign exchange rate has had a significant impact on the export of petrochemical products. We can generalize the findings of this research to other times.

We should pay attention to the following points in plans to develop production in lower-hand petrochemistry industries:

1. Increasing production by rising the proportion of the operational capacity to the installed capacity
2. Increasing production by establishing new factories
3. Due to huge gas resources, the capacities of petrochemistry leads to a comparative advantage for this industry. Therefore, serious attempts should be made to complete petro chemistry units that have not been finished yet, so that Iran can outperform Saudi Arabia and be the greatest petrochemistry producer in the Middle East.
4. Most petrochemistry companies use natural gas. Therefore, the long-term price of gas should be determined based on the competition in the

region. This will not reduce the profitability of current projects and also constantly boosts non-oil exports including petrochemical exports.

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