



Original Article

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The Effect of Exchange Rate Volatility on Imports of Capital Goods in the Industry Sector of Iran During Sanctions

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ABSTRACT: This paper investigates the effect of Exchange Rate Volatility (ERV) on Imports of capital goods in Iran's Industry for the period of 1979-2012 In terms of sanctions. In the first stage, we consider a special case of GARCH family model to measure ERV. In the second stage, we employed the OLS approach for estimating the import demand function for Iran's industry sector, so that ERV has entered in the model as an explanatory variable. The other explanatory variables considered for multivariate estimation include the value of production of industrial goods and relative prices index of Imports of capital goods. The result of Engle-Granger Co-integration test shows a long term relationship between the imports of Iran's industrial goods, ERV and other variables. The findings suggest that ERV has negative impact on Imports of capital goods in Iran's Industry. In addition, the effect of relative prices index is negative, but the effect of production of industrial goods on the Imports of capital goods is positive.

KEYWORDS: Exchange Rate Volatility, Imports of Capital Goods, GARCH Model, Iran's Industry, Engle-Granger Co-Integration.

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1. INTRODUCTION

Empirical evidences show that the role of imports of industrial goods in economic growth of our country is very important in sanctions period. So, recognition of impact of various economic variables on the imports of industrial goods is necessary. Traditionally, economists believed that economic variables such as exchange rate, relative price and national income affect on the volume of imports industrial goods (Bahmani Oskooee et al., 2008). Since the breakdown of the Bretton-Woods system of fixed exchange rates collapsed in 1973, the relative prices of currencies began to fluctuate. After the adoption of the floating exchange rate system in the early 1970s, there has been an extensive argumentation about the impact of exchange rate volatility on international trade. This increased volatility of exchange rates is believed to have negative impact on an economy, especially for a developing country with underdeveloped capital market and lack of stable economic policies (Bahmani Oskooee et al., 2008). However, despite a large body of the literature, few papers have written about effect of exchange rate volatility on trade flows between countries especially volume of imported industrial goods. This effect can be positive or negative. Developing countries such as Iran need to new technologies in their industrial sector. For this purpose, they should imported capital goods from other countries, especially from industrialized countries. It's obvious that exchange rates plays a decisive role on international trade and its fluctuations is effective on the price of import capital goods (Wong Yi et al., 2012). So, the survey on the effect of exchange rate fluctuations on imports of capital goods in our country is very important. This paper focus on the effect of Exchange Rate Volatility (ERV) on Imports of capital goods in Iran's Industry for the period of 1979-2012 In terms of sanctions. In the first stage, we use a GARCH type model to generate the volatility of exchange rates and in the second stage, we estimate demand function of imports of capital goods in Iran's Industry using Ordinary Least Square (OLS) technique, by replacing the variable of unobserved volatility with the measured proxy. Since, all of used variables in our study are non-stationary, for avoidance of spurious regression among the variables of estimated model and determination of non-spurious long-run relationships among the variables; we use the Engle-Granger Co-integration test. For this mean, we used ADF criterion for testing null hypothesis of unit root for the residuals in estimated demand function of imports capital goods in Iran's Industry. Therefore, the main focus of present paper is to derive statistically valid estimates for demand function of imports capital goods in Industry sector of Iran in sanctions period with a generated variable for volatility of exchange rates, so that a GARCH type model is used to measure risk in exchange rates. The remainder of this paper is organized as follows: Section 2 explains literature review. Section 3 presents the foundation of theoretical. Section 4 contains the materials and methods. Section 5 reports the estimated results. Finally, section 6 concludes the findings.

2. LITERATURE REVIEW

Over the two past decades, issues related to exchange rate and international trade poses a number of questions and challenges. According to Moosa (2000), international trade is habitually affected by the exchange rate variability, which is known as exchange rate misalignment and volatility. Exchange rate volatility is commonly referred as a short-term exchange rate fluctuation measured by the conditional variance of the exchange rate, which believed may inhibits the growth of trade (naseem,2009). This has attracted debates among policymakers and researchers on how to deal with exchange rate volatility influence on the volume of trade specifically the import flows as there is little attention devoted to assessing the extent of such exchange rate volatility on import flow. Sercu and Vanhulle (1992) showed that increased exchange rate volatility will lead to a decline in the risk-adjusted anticipated profits from international trade, implying that traders are risk-averse, where hedging is expensive or impossible. Furthermore, some authors do find support for the benefiting effects of exchange-rate volatility on trade such as Giovannini (1988) and Baron (1976), which exchange rate volatility significantly hastened trade flows. With respect to the relationship between exchange



rate volatility and import flows, Kenen and Rodrik (1986) advocated that volatility of exchange rate appears to depress the volume of import flows. Cushman (1988) and McKenzie (1998) further corroborated that higher volatility of exchange rate deters import flows. Conversely, Mckenzie and Brooks (1997) provided evidence that exchange rate volatility has a positive effect on import flows, which implies that a rise in exchange rate volatility hastens import flows. Besides, Arize (1998) showed that an increase in exchange rate volatility may have mutually positive and negative insinuations on import flows, based on the products' and countries' cases. Indeed, these cannot be seen as definite conclusion because there are also studies that failed to establish significant relationship between exchange rate volatility and import flows (see for example, Medhora, 1990; Belangar et al. 1992 and Siregar and Rajan, 2004). A number of other researches about relationship between exchange rate volatility and import flows are as follows:

Bahmani Oskooee et al (2008) investigated the impact of exchange rate uncertainty on trade flows for commodity trade between the United States and the United Kingdom. They use disaggregated import and export data for 177 commodities traded between the United State and United Kingdom to investigate whether volatility of the real bilateral dollar-pound exchange rate has any detrimental effect on trade flows at the commodity level. In most trade flow models estimated, they found a negative effect of exchange rate volatility on commodity trade.

Byrn et al (2008) in a research considered the impact of exchange rate volatility on the volume of bilateral US trade (both exports and imports) using sectoral data and use of sectoral industrial price indices. They found evidence to suggest that exchange rate volatility has robust and significantly negative effect across sectors.

Naseem et al (2009) investigated the effect of real exchange rate misalignment and volatility on Malaysian import flows during 1991:Q1 to 2003:Q4. The volatility of real exchange rate is generated from the GARCH model. The empirical results also show that the exchange rate volatility has merely promoted the Malaysian imports during the crisis period. This suggests that the exchange rate misalignment and volatility are important determinants in inspiring Malaysian import flows, especially during the 1997 Asian financial crisis.

Wong Yi Siing et al (2012) studied on the impact of exchange rate volatility on import flows for the United States and Malaysia using annual American and Malaysian data for the period 1975/2009. The nonlinear causality test shows both Malaysia and the US have nonlinear causal relationships between exchange rate volatility and import flows.

Askari mansour (2008) investigated effect of exchange rate volatility on export flows for the industry of Iran. He used ISIC code (2 digits) for various industries during 1974-2006 period using VAR model. His findings show that exchange rate volatility has negatively effect on the export of Iran's industrial goods.

Boshraadi et al (2011) studied relation between of exchange rate fluctuations on price of import and export goods in Iran using VAR and VECM method for 1990 -2012 period. Findings indicate that exchange rate fluctuations affect on the price of import and export goods in Iran.

Galali and koochekzadeh (2014) studied the effect of uncertainty in the actual currency exchange rate on development of economic sectors in Iran using combined data over the period between 1991 and 2011 through panel method. The results obtained from this study indicate that uncertainty in the exchange rate has negative and significant effects on development of economic sectors. This effect was higher in industry, mining, agriculture, transportation and communication, hotels and restaurants, and construction sector with -0.51, -0.40, -0.35, -0.27, -0.24, and -0.23 respectively.

Given the limitations of empirical studies on area of imports effect of exchange rate volatility, especially in the industrial sector of Iran, this study is deemed to be timely in order to bridge the gap by empirically inspecting for investigating on relationship between exchange rate volatility and imported industrial goods in Iran.



3. THEORETICAL FRAMEWORK

3.1. Capital goods

All final goods (i.e., goods which are meant for final use) produced in the economy are of two kinds: consumption goods and capital (investment) goods.

Consumption goods: Goods which are consumed for their own sake to satisfy current wants of consumers directly are called consumption (or consumer) goods. For example, food, shirt, shoes, cigarettes, pen, TV set, and radio, etc. are all consumer goods because when used, they satisfy immediate needs of the consumers.

Consumption goods sustain the basic objective of an economy, i.e., to sustain the consumption of entire population of the economy. Human beings must consume in order to survive and work. It is consumption of basic necessities of life – food, clothing, shelter that make us function.

Consumer goods are further classified into durable and non-durable goods. Durable goods are those which can be used in consumption again and again over a considerable period of time, e.g., chair, car, fridge, shoes, TV set. Non-durable goods are like single use goods which are used up by consumers in a single act of consumption, e.g., milk, fruits, cigarettes, coal, etc.

Capital goods: Goods which are fixed assets of producers which are repeatedly used in production of other goods and services. Alternatively durable goods which are bought for producing other goods but not for meeting immediate needs of the consumer are called capital goods. These goods are of durable character, e.g., tools, implements, machinery, plants, tractors, buildings, transformers, etc. Such goods are used for generating income by production units. Here, the points to be noted are:

(a) While they make production of other goods possible, they themselves do not get transformed (or merged) in the production process,

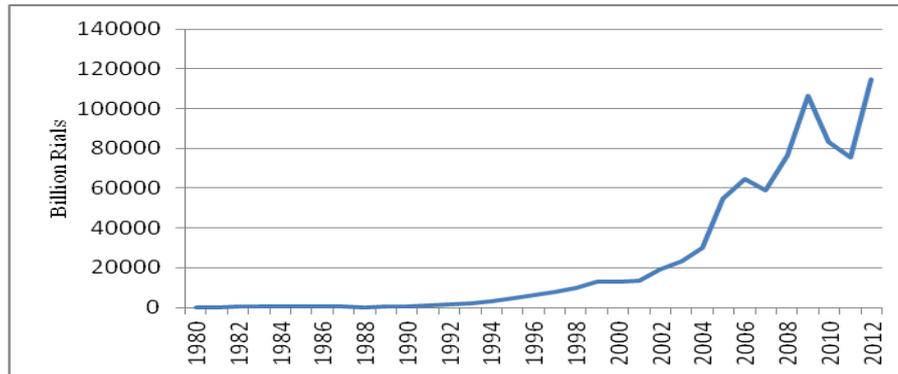
(b) Capital goods undergo wear and tear and need repairs or replacement over time.

(c) They are backbone of production processes as they aid and enable production to go on continuously capital goods are purchased by the business enterprises either for maintenance or addition to their capital stock so as to maintain or expand the flow of their production.

Clearly, there is a trade-off between consumer goods and capital goods. If an economy produces more of capital goods, it is producing less of consumer goods. But the more the capital goods are produced now, more will be the productive capacity of the economy in future. In return, a large volume of consumer goods can be produced in future (Singh, 2014). A capital good is a durable good (one that does not quickly wear out) that is used in the production of goods or services. Capital goods are one of the three types of producer inputs, the other two being land and labour, which are also known collectively as primary factors of production. This classification originated during the classical economic period and has remained the dominant method for classification. In terms of economics one can consider capital goods to be tangible. They are used to produce other goods or services during a certain period of time. Machinery, tools, buildings, computers, or other kind of equipment that is involved in production of other things for sale represent the term of a Capital good. The owners of the Capital good can be individuals, households, corporations or governments. Any material that is used in production of other goods also is considered to be capital good (wikipedia). In the theory of the international trade the causes and nature of trade of capital goods receive little attention. Trade in capital goods is a crucial part of the dynamic relationship between international trade and development. The production and trade of capital goods as well as consumer goods must be introduced to trade models, and the entire analysis integrated with domestic capital accumulation theory (Eaton and Kortum, 2001).

Manufacturing sector is one of the principle components in the Economic Development Plans of Iran. This sector needs to high amount of capital goods for production consumer goods and other commodities. Because of limitation resources and especially capital goods for manufacturing sector, government sector and private sector import appropriate capital goods from other countries. So, figure 1 shows the value of imported capital goods during 1980-2012, based on the latest available information in Iran Statistic Center.

Figure 1. Imported capital goods to Iran during 1980-2012



Source: Research findings & SCI

According to the figure 1, imported capital goods for industry sector of Iran indicates increasing trend during 1980-2012. In the next section, we describe the characteristics of Iran's industry sector in detail.

3.2. Industry sector of Iran

Nowadays industrial development is considered as one of the vital and fundamental subjects for sustainable development of countries. Iran now produces a wide range of manufactured commodities, such as telecommunications equipment, industrial machinery, paper, rubber products, steel, food products, wood and leather products, textiles, and pharmaceuticals. Steel, weaving, food processing, car, electrical and Electronics Industries are among the key industries in the country. The pharmaceuticals, paper, sugar, packaging, and textile segments have been identified as key growth areas of the industrial sector by the Industrial Development & Renovation Organization of Iran. Iran is rich not only in oil and gas, but in mineral deposits, as well. Iran has the world's largest zinc reserves and second-largest reserves of copper. It also has important reserves of iron. Uranium, lead, chromate, manganese, coal and gold, in addition to the major coal mines found in Khorasan Razavi, Kerman, Semnan, Mazandaran, and Guilan, a number of smaller mines are located north of Tehran and in Azarbayjan and Esfahan provinces (OIETAI, 2015).

A review of the economic reports of Statistical Centre of Iran (SCI, 21 March- 21 June 2015) reveals that employment share in manufacturing sector is %33 (7205841 workers), employment share in agriculture sector is %19 (4189558 workers) and employment share in services sector is %47.9 (10465707 workers).

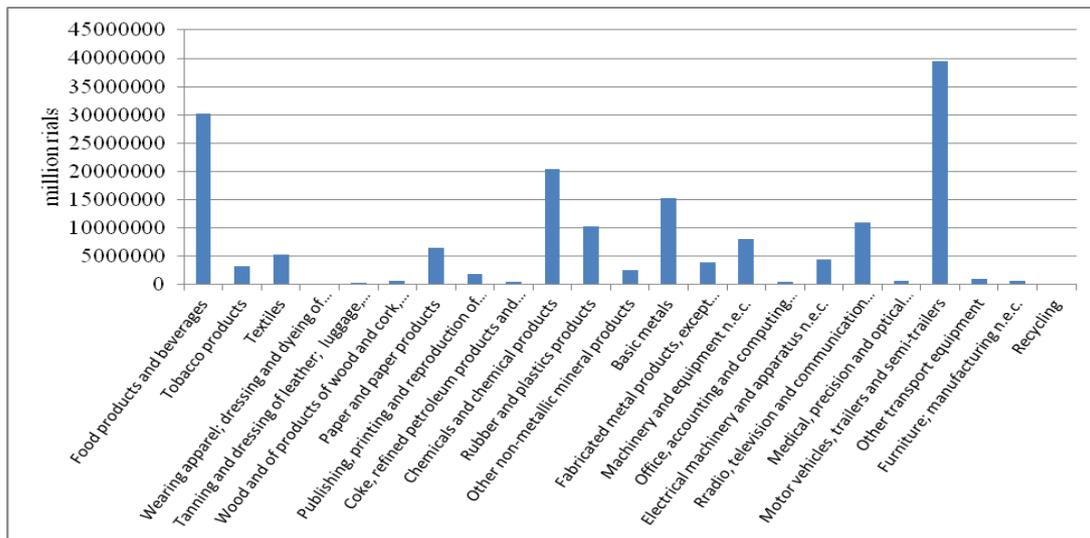
Given the importance of the industrial sector in our country, in the following described the features of this section by using of statistics. Using existing statistics helps us to evaluate the progress made within the objectives of industrial development. Based on Ministry of industry, mine and trade Iran, there are three groups of firms and enterprises in Iran: micro firms which have less than 10 full-time employees; small and medium firms which have 10-249 full-time employees; and large firms which have more than 250 full-time employees.

Statistics and information on manufacturing include specifications of manufacturing licenses issued by the Ministry of Industries and Mines and a selection of specifications and economic performance of manufacturing establishments and households with manufacturing activity related to the final results of the survey of Manufacturing Establishments implemented by the Statistical Centre of Iran in the year 1391. In the year 1391, there were 14,784 manufacturing establishments with 10 and more workers in the country, the number of which decreased about 1.2 percent compared with the year 1390. The private and public sectors own about 98.2 and 1.8 percent of the establishments, respectively. Also, total employed persons in the establishments were over one million and 204 thousand persons showing a 3.1 percent decrease compared with the year 1390. Among employed persons, 15.8 percent have been working in manufacturing of food products and beverages which have the highest number of the workers. Also, industries

like “manufacture of other non-metallic mineral products” and “manufacture of motor vehicles, trailers and semi-trailers” got the second and the third ranking with 14.5 and 10.8 percent, respectively following food industries in view of the number of the employed. In this year, value added of manufacturing activity of the manufacturing establishments with 10 and more workers was over 846 thousand billion Rials showing a 35.5 percent increase compared with the year 1390. In the year 1391, value added of manufacturing activity of the manufacturing establishments with 10 and more workers was 74 thousand and 783 billion Rials for the establishments with 10-49 workers, 51 thousand and 662 billion Rials for the establishments with 50-99 workers and 719 thousand and 562 billion Rials for the establishments with 100 and more workers. Also, the amount of investment in manufacturing establishments with 10 and more workers was about 93 thousand and 72 billion Rials increased about 39.1 percent compared with the year 1390. In the year 1391, manufacturing establishments' productivity (ratio of value added to the number of establishments) was 57 billion and 224 million Rials showing a 37.1 percent increase compared with the year 1390. In the year 1391, workforce productivity in manufacturing establishments (ratio of value added to the number of the employed) was 702.3 million Rials showing a 39.8 percent increase in comparison with the previous year. In the year 1391, production productivity in manufacturing establishments (ratio of value added to the output value) was 0.26 percent showing an 8.3 percent increase compared with the year 1390. Among the provinces, Khuzestan, Tehran and Esfahan with 143528, 113395 and 96812 billion Rials had the highest value added of manufacturing activity in the manufacturing establishments with 10 and more workers and the provinces of Bushehr, Khuzestan and Hormozgan with 941068, 393227 and 164276 million Rials had the highest manufacturing establishments' productivity in the manufacturing establishments with 10 workers and more, respectively (SCI, 2014).

Figure 2 shows of the value of foreign raw material for Iran’s industry sector using International Standard Industrial Classification of All Economic Activities (ISIC) during 2013.

Figure 2. Value of imported foreign raw material for Iran’s industry sector (base on ISIC two digit codes) during 2013



Source: Research findings & SCI

According to the figure 2, Manufacture of motor vehicles, trailers and semi-trailers, Manufacture of food products and beverages, Manufacture of chemicals and chemical products, and Manufacture of basic metals have had the highest value of foreign raw material during 2013, respectively. In the other hand, Recycling, Manufacture of wearing apparel; dressing and dyeing of fur, and Manufacture of Tanning and dressing of leather; luggage, handbags,

Saddlery, harness and footwear have had the highest value of foreign raw material during 2013, respectively.

3.3. Sanctions on Iran

Sanctions on Iran are not new; the country has lived with US sanctions in some shape or form since the 1979 takeover of the US embassy in Tehran when US diplomats were detained for 444 days. In recent years, however, and particularly since the first round of UN sanctions was imposed in 2006, sanctions have gained unprecedented momentum and visibility in the context of international efforts to halt or even reverse Iran's nuclear trajectory.

'Sanctions' is a term used to describe a range of punitive legislative provisions that are put in place with a view to altering political and/or military behaviour. A distinction can be made between 'targeted' or 'smart' sanctions and 'comprehensive' sanctions. Targeted sanctions are "directed at leaders, their core allies in the regime's hierarchy, and/or specific enterprises and agencies engaged in the proscribed behaviour" (Etel Solingen, 2012). "The aim here is to minimize unintended, undesirable, or indiscriminate consequences for the broader public. Comprehensive economic sanctions, however, target "both the macro-economy and macro-politics of states, so that punishments [...] are extended over wide segments of the population"(Ibid). The distinction here is important since sanctions on Iran have evolved in recent years from a targeted approach to what is now a wide-ranging, comprehensive sanctions regime. On one hand, "the U.S. has used its leverage over the international financial system to create the most comprehensive unilateral sanctions regime in history" (Khajepour, 2013).

A first round of sanctions was imposed on Iran by the UNSC in December 2006 under Resolution 1737. This was followed by the imposition of additional sanctions in 2007 (Resolution 1747), 2008 (Resolution 1803), and 2010 (Resolution 1929). UN sanctions are focused on technologies and entities directly associated with Iran's nuclear and missile programmes. The sanctions which have had the largest impact on the insurance industry are those put in place by US and EU legislation. In the case of the European Union, prominent members such as the UK, France and Germany have, for some time, lobbied for more punitive sanctions on Iran. These efforts played a significant role in the 2012 decision by the European Union to impose a phased oil embargo on Iran.

Table 1. Sanctions by sector and source

Sectors	U.S. (1995-)	E.U. (2007-)	U.N. (2006-)
Missile/arms industry	×	×	×
Revolutionary Guard Corps	×	×	×
Nuclear industry	×	×	×
Energy/petroleum industry	×	×	
Banking	×	×	×
Central bank	×	×	
Shipping industry	×	×	×
International trade	×	×	
Insurance	×	×	
Foreign firms dealing with Iran	×		

Source: Wikipedia

The European Union has imposed restrictions on cooperation with Iran in foreign trade, financial services, energy sectors and technologies, and banned the provision of insurance and reinsurance by insurers in member states to Iran and Iranian-owned companies (Akbar, 2012). On 23 January 2012, the EU agreed to an oil embargo on Iran, effective from July, and to freeze the assets of Iran's central bank (Nasseri, 2012). Sanctions have reduced Iran's access to products needed for the oil and energy sectors, have prompted many oil companies to withdraw from Iran, and have also caused a decline in oil production due to reduced access to technologies needed to improve their efficiency. As well as restricting export markets, the sanctions have reduced Iran's oil income by increasing the costs of repatriating revenues in



complicated ways that sidestep the sanctions. Table 2; show the major economic sanctions against Iran by U.S, EU and UN Security Council from 1979 to present.

Table 2. Major Economic sanctions against Iran by U.S, EU and UNSC, 1979-2015

U.S. Sanctions Actions		
Name	Date	Description of select elements
Executive Orders 12170, 12205, 12211	Nov. 1979–April 1980	<ul style="list-style-type: none"> Blocked Iranian property and prohibited some trade, including import of all goods from Iran.
Executive Order 12613	October 1987	<ul style="list-style-type: none"> Banned import of all goods from Iran, including oil.
Executive Orders 12957, 12959	March–May 1995	<ul style="list-style-type: none"> Prohibited all U.S. investment in Iran, including in oil sector. Banned export of American goods to Iran.
Iran and Libya Sanctions Act	August 1996	<ul style="list-style-type: none"> Sanctioned companies that invest more than \$20 million in Iranian oil sector.
Executive Order 13059	August 1997	<ul style="list-style-type: none"> Expanded ban on exports to Iran.
Executive Order 13382	June 2005	<ul style="list-style-type: none"> Blocked property of WMD proliferators.
Iran Freedom Support Act	September 2006	<ul style="list-style-type: none"> Codified U.S. trade ban.
Comprehensive Iran Sanctions, Accountability & Divestment Act	July 2010	<ul style="list-style-type: none"> Sanctioned sale to Iran of gasoline or supporting domestic gasoline industry.
Executive Order 13590	November 2011	<ul style="list-style-type: none"> Sanctioned contributing to maintenance or expansion of Iranian petroleum resources.
Section 1245, NDAA FY2012	December 2011	<ul style="list-style-type: none"> Restricted export of Iranian oil.
Executive Order 13599	February 2012	<ul style="list-style-type: none"> Blocked all Iranian government property under U.S. jurisdiction.
Executive Order 13622	July 2012	<ul style="list-style-type: none"> Sanctioned foreign financial institutions that facilitate petroleum sales.
Iran Threat Reduction and Syria Human Rights Act of 2012	August 2012	<ul style="list-style-type: none"> Sanctioned support of petroleum sector. Mandated that Iran’s oil revenue be “locked up” in special escrow accounts.
Iran Freedom and Counter-Proliferation Act of 2012	January 2013	<ul style="list-style-type: none"> Sanctioned involvement in Iranian energy, shipping or shipbuilding, or provision of insurance or reinsurance to shipping firms. Sanctioned provision of precious metals to Iran.
Executive Order 13645	June 2013	<ul style="list-style-type: none"> Sanctioned involvement in Iranian automotive industry. Blocked assets of banks doing business in rials, the currency of Iran.
UN Security Council Resolutions Against Iran		
1737	December 2006	<ul style="list-style-type: none"> Banned export to Iran of “all items, materials, equipment, goods and technology” related to nuclear activities or development of nuclear weapon delivery systems. Banned Iranian export of nuclear-related equipment and material. Froze assets of individuals and companies involved in nuclear and ballistic missile programs.
1747	March 2007	<ul style="list-style-type: none"> Banned export by Iran of “any arms or related materiel”. Expanded list of sanctioned individuals and companies.
1803	March 2008	<ul style="list-style-type: none"> Expanded prohibitions on trade in sensitive nuclear equipment and materials. Expanded list of sanctioned individuals and companies.
1929	June 2010	<ul style="list-style-type: none"> Prohibited Iranian investment in foreign nuclear activities. Called on states to inspect “all cargo to and from Iran” if suspected of transferring illicit materials. Called on states to prevent the provision of financial services that would facilitate Iranian sanctions evasion. Expanded list of sanctioned individuals and companies.



EU Sanctions Against Iran		
Council Common Position 2007/140/CFSP	February 2007	<ul style="list-style-type: none"> Prohibited financial and technical assistance related to nuclear or missile activities. Froze assets and denied travel of designated individuals and companies.
Council Decision 2010/413/CFSP	July 2010	<ul style="list-style-type: none"> Banned export to Iran of all arms and materiel. Banned export to Iran of “key equipment and technology” related to oil and natural gas industry. Prohibited provision of insurance or re-insurance to Iranian entities. Expanded list of designated individuals and companies.
Council Decision 2012/35/CFSP	January 2012	<ul style="list-style-type: none"> Banned “import, purchase or transport” of Iranian crude oil and petrochemical products. Prohibited provision of financing, insurance or reinsurance related to Iranian crude oil sale or transport. Prohibited export to Iran of equipment for petrochemical industry and provision of technical or financial assistance Prohibited sale of gold, precious metals and diamonds to Iran. Banned provision of financial messaging services to designated Iranian banks (i.e. denied access to SWIFT).
Council Decision 2012/152/CFSP	March 2012	<ul style="list-style-type: none"> Banned provision of financial messaging services to designated Iranian banks (i.e. denied access to SWIFT).
Council Decision 2012/635/CFSP	October 2012	<ul style="list-style-type: none"> Banned “purchase, import or transport” of natural gas from Iran. Banned export of shipbuilding technology.

Source: Present Research & Harvard Kennedy School (2015)

The most damaging sanctions against Iran have targeted its energy and financial sectors. While these sanctions are closely intertwined, they are presented here separately for simplicity.

Energy sanctions: Sanctions against Iran’s energy sector seek to degrade Iran’s ability to produce, sell, transport, and profit from its oil and gas - the nation’s most important natural resources. International efforts to date include: Embargo of Iranian oil, Restricting access to oil revenues, Limiting ability to transport oil and other goods, ban on trading in graphite and raw or semi-finished metals (e.g. iron, steel, copper etc.), ban on the sale, supply, transport or (re)insurance of Iranian crude oil, petroleum and petrochemical products, ban on trading in key equipment and technology used in Iran’s oil and gas sector, limiting ability to invest in oil production (American sanctions prohibit companies from selling to Iran equipment used in oil and gas production. They also prohibit foreign firms from making substantial investments in oil and gas fields, thereby limiting Iran’s ability to modernize its oil sector. EU sanctions similarly prohibit the provision of oil and gas technology and equipment. Japan and South Korea have implemented similar provisions).

Financial sanctions: Sanctions against Iran’s financial and banking sectors have almost entirely isolated Iranian banks - including the Central Bank of Iran—from the international financial system. The most serious actions taken against Iran include: Sanctioning Iran’s major banks, Disconnecting from SWIFT, asset freeze of listed persons/entities, prohibition on financial transactions with Iranian banks and financial institutions, Money laundering designation (In 2011, the U.S. designated Iran as a jurisdiction of “primary money laundering concern” under Section 311 of the USA PATRIOT Act. And the European Union froze the Central Bank’s assets), Blocking “U-turn” transactions (Harvard Kennedy School, 2015).

4. MATERIALS AND METHODS

4.1 Demand Function for Imports of Capital Goods in Iran’s Industry

A conventional demand function for imports of capital goods in Iran’s Industry could be simplified as:

$$M^d = M^d(Y, PM, PD, Evol) \quad (1)$$

Where M^d denotes demand for imports of industrial goods, Y is the value of industrial goods production, PM shows Price index of imported industrial goods, PD is price index of domestic industrial goods and $Evol$ denotes exchange rate volatility. We assume that such as Bahmani -skooee' study (2004), variables are in multiplication form. So, we employ the logarithm of industrial imports demand function as the following:

$$\ln M_t^d = \alpha + \beta_1 \ln Y_t + \beta_2 \ln(PM_t / PD_t) + \beta_3 \ln Evol \quad (2)$$

Where: PM_t / PD_t is relative prices index of imports industrial goods. It is expected that an increase in production of industrial goods has a positive effect on imports volume of industrial goods, but an increase in relative prices affects on imports of industrial goods negatively. In the other hand, the effect of exchange rate volatility on import industrial goods is unknown, depending on Iran's traders. If the traders are risk-neutral, uncertainty in exchange rates may be an additional opportunity to increase profits and thereby boosts overall import flows (Holly, 1995). On the contrary, if the traders are risk-averse, the risk due to exchange rate uncertainty is an additional cost, which will tend to depress industrial imports volume.

In equation (2) exchange rate volatility is not directly observed. Given that volatility in exchange rates is generally characterized as the clustering of large shocks to conditional variance. So, a GARCH model is formulated to capture non-constant time varying conditional variance, and then conditional variance is used as a proxy for exchange rate volatility. For this reason, we explained GARCH family models in the following.

4.2. The ARCH family models

The major assumption behind the least square regression is homoscedasticity i.e. constancy of variance. If this condition is violated, the estimates will still be unbiased but they will not be minimum variance estimates. The standard error and confidence intervals calculated in this case become too narrow, giving a false sense of precision. ARCH and related models handle this by modelling volatility itself in the model and thereby correcting the deficiencies of least squares model (AK Dhamija, 2010).

4.2.1. The ARCH Model

A simple strategy is to forecast the conditional variance by an AR (q) process:

$$\hat{\varepsilon}_t^2 = \alpha_0 + \alpha_1 \hat{\varepsilon}_{t-1}^2 + \alpha_2 \hat{\varepsilon}_{t-2}^2 + \dots + \alpha_q \hat{\varepsilon}_{t-q}^2 + \nu_t \quad (3)$$

Where ν_t is white noise term If the amounts of $\alpha_1, \alpha_2, \dots, \alpha_q$ are all zero, the estimated variance will be constant and equal to α_0 . Otherwise, the conditional variance exists. Hence, the following equation can be used to forecast the conditional variance at the time $t + 1$:

$$E\hat{\varepsilon}_{t+1}^2 = \alpha_0 + \alpha_1 \hat{\varepsilon}_t^2 + \alpha_2 \hat{\varepsilon}_{t-1}^2 + \dots + \alpha_q \hat{\varepsilon}_{t+1-q}^2 \quad (4)$$

Equation (3) is called ARCH model by Engel (1982).

4.2.2. The GARCH Model

Bollerslev (1986) developed the work of Engle in way that the conditional variance be a process of ARMA. Suppose the errors process to be as the following:

$$\varepsilon_t = \nu_t \sqrt{h_t}$$

In a way that $\sigma_v^2 = 1$ and

$$h_t = \alpha_0 + \sum_{i=1}^q \alpha_i \hat{\varepsilon}_{t-i}^2 + \sum_{j=1}^p \beta_j h_{t-j} \quad (5)$$

In this condition, one needs to make sure that $\alpha_0 > 0, \alpha_i \geq 0, \beta_j \geq 0$

and $1 - \sum_{i=1}^q \alpha_i + \sum_{j=1}^p \beta_j > 0$ to see the conditional variance positive. Since v_t is a white noise, the

key point here is that the conditional variance of ε_t is as the following:

$$E_{t-1} \varepsilon_t = h_t$$

So, the ε_t conditional variance complies with an ARMA process like the process (4). Such models are called GARCH (p, q) where q is the number of moving average (MA) terms and p is the number of autoregressive (AR) terms. GARCH model is known as a model of heterocedasticity which means not constant in variance. This model has been used widely in financial and business areas since the data of these areas tend to have variability or highly volatile throughout the time.

4.2.3. The Exponential GARCH (EGARCH) Model

A model which accepts the asymmetric effect of the news is the exponential GARCH model (EGARCH). A problem in using the standard model of GARCH is that all the estimated coefficients must be positive. To overcome this problem the exponential GARCH (EGARCH) Model, suggested by Nelson (1991) can be used in which there is no need to observe the condition of non-negativeness for the coefficients:

$$\ln(h_t) = \alpha_0 + \alpha_1 \left(\frac{\varepsilon_{t-1}}{h_{t-1}^{0.5}} \right) + \lambda_1 \left| \frac{\varepsilon_{t-1}}{h_{t-1}^{0.5}} \right| + \beta_1 \ln(h_{t-1}) \quad (6)$$

Three interesting characteristics of the EGARCH model are:

- (1) The conditional variance equation has a logarithmic-linear form. Despite the fact that $\ln(h_t)$ is large, the amount of h_t cannot be negative. Therefore the coefficients are allowed to be negative.
- (2) Instead of using the amount of ε_{t-1}^2 , this model uses the standardized amounts ε_{t-1} (ε_{t-1} divide on $h_{t-1}^{0.5}$). Nelson showed that this standardization enables better interpretation of the amount and persistence of the shocks.
- (3) The EGARCH receives leverage effect. If $\frac{\varepsilon_{t-1}}{h_{t-1}^{0.5}}$ is positive, the shock's effect on the conditional variance logarithm will be equal to $\alpha_1 + \lambda_1$. If $\frac{\varepsilon_{t-1}}{h_{t-1}^{0.5}}$ is negative, the shock's effect on the conditional variance logarithm will be equal to $-\alpha_1 + \lambda_1$.

4.3. Specification of Engle-Granger co-integration test

Consider two non-stationary time series variables that are integrated of the same order, say order 1, $I(1)$ variables. Following Engle and Granger (1987), two variables, say x and y are said to be co-integrated of order $CI(1,1)$ if there exists a long-run equilibrium relationship

between the two integrated variables such that the residuals of the estimated regression are stationary or integrated of order zero, $I(0)$.

The long-run equilibrium relationship is captured by the following regression models:

$$x_t = \beta_0 + \beta_1 y_t + u_t \quad (7)$$

Where x and y are $I(1)$ variables, β_0 and β_1 are cointegrating parameters, u_t are OLS residuals which capture divergences between the variables from an assumed equilibrium long-run relationship.

Testing for the presence of co-integration in the context of the bivariate Engle-Granger co-integration test is essentially equivalent to testing for the presence of a unit root in the estimated residual series $\{\hat{u}_t\}$ for the co-integrating regressions (7) where the Engle-Granger (EG) test (which are akin to the standard Dickey-Fuller tests) used for testing the stationarity of the residuals are specified as follows:

$$\Delta \hat{u}_t = \rho_1 \hat{u}_{t-1} + \varepsilon_t \quad (8)$$

The first difference of the residuals is regressed on the lagged level of the residuals without a constant, where ρ_1 is parameter of interest representing the slope of line, $\Delta \hat{u}_t$ are the first difference of the estimated residual series $\{\hat{u}_t\}$ and \hat{u}_{t-1} are the estimated lagged residuals, ε_t are error terms which are expected to be serially uncorrelated.

The EG test requires that error terms be serially uncorrelated. Due to the problem of serial correlation in standard EG test, it is a common practice to use the Augmented Engle-Granger (AEG) test which accommodates more lags of the first difference of the residuals to eliminate the serial correlation problem that is associated with standard EG test. The corresponding AEG test for (8) is specified as follows:

$$\Delta \hat{u}_t = \rho_1 \hat{u}_{t-1} + \sum_{i=0}^p \xi_i \Delta \hat{u}_{t-i} + \varepsilon_t \quad (9)$$

Where ρ_1 is parameter, ξ_i are coefficients of lagged difference of the estimated residuals, $\Delta \hat{u}_t$ are first difference of the estimated residual series $\{\hat{u}_t\}$ and \hat{u}_{t-i} are the estimated lagged residuals, ε_t are error terms, p is optimal truncation lag parameters to be determined to whiten the error terms. AEG test can be utilized to perform unit root test on the estimated coefficients ρ_1 to establish the existence or non-existence of long-run equilibrium relationship. Any unit root test involving ADF is sensitive to the choice of lag length which is the number of lagged differences with which the regression is augmented. Since AEG test is a modification of ADF test, it also inherits the lag selection problem that is commonly associated with ADF test due to its sensitivity to the choice of lag length (olukun, 2014).

5. MODEL ESTIMATION: RESULTS AND DISCUSSION

Since the main purpose of this study is to deliver statistically reliable evidence on the impact of exchange rate volatility on imports of industrial goods, we applied econometrics methods to determine effects of exchange rate volatility on Iran's imports of industrial goods. At the first, for extracting exchange rate volatility of Iran against the U.S. Dollar (IRR/USD), we use GARCH family model. Since the basis of GARCH models is the stationary of the series in

question, so we use of Augmented Dickey–Fuller (ADF) test and Phillips-Perron (PP) test on exchange rate data. Table (1) summarized the unit root tests for exchange rate series. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were used to test the null hypothesis of a unit root against the alternative hypothesis of stationarity. According to the Table (3) the results of ADF and PP tests show that the exchange rate series is stationary, because the statistic value for both ADF and PP tests are less than their corresponding critical values.

Table 3: Unit Root Tests for stationary of exchange rate Series

Variable	Variable name	ADF Test Statistic	Critical Value (5%)	PP Test Statistic	Critical Value (5%)
Log exchange rate	<i>E</i>	-3.417612	-2.957110	-3.417612	-2.95711

Source: Research Findings

In empirical study, we distinguished that the best ARCH-type model for Iran's exchange rate volatility is an EGARCH model based on an ARIMA (1, 1) of the first difference of the logarithm exchange rate (LnE). The estimated equation is:

Mean Equation:

$$Ln(E) = 9.065 + \varepsilon \quad (10)$$

(0.00)

Variance Equation:

$$LOG(Evol_t) = 0.187 + 0.508 \frac{\varepsilon_{t-1}}{\sqrt{Evol_{t-1}}} + 1.062 LOG(Evol_{t-1}) \quad (11)$$

(0.00) (0.00) (0.00)

Where, the values in parentheses represent standard errors. All the coefficients in equations (10) and (11) are statistically significant at the 1% significance levels. Overall, the estimated model seems to appropriately capture the underlying data generation process, and thus is used to generate exchange rate volatility in equations (1) and (2).

In next parts we apply *Evol* variable as exchange rate volatility in demand function for imports of capital goods in Iran's Industry.

In this stage, we check that used variables in equation (2) are stationary or non-stationary? For this mean, we use the augmented Dickey-Fuller (ADF) test because ADF test is used to test for the unit root of the series. The results of unit root test are presented in table (4) and table (5).

The results of unit root test are presented in table (4). The results for each variable indicate that null hypothesis of a unit root could not be rejected of any variables. That is, the implications of these tests indicate that all of the variables are non-stationary. Unit root test for the first differences for each variable rejected the presence of unit root according to the table (5).

Table 4: Unit Root Tests for stationary of Data Series

Variable	Variable name	ADF Test Statistic	Critical Value (5%)
exchange rate volatility	<i>Evol_t</i>	-1.62240	-3.562882
imports industrial goods	<i>M_t^d</i>	-2.367566	-3.557759
industrial goods production	<i>Y</i>	-2.205691	-3.557759
relative prices index of imports industrial goods	<i>PM_t / PD_t</i>	-2.085943	-3.568379

Source: Research Findings

Table 5: Unit Root Tests for stationary of First Difference of Data Series

Variable	Variable name	ADF Test Statistic	Critical Value (5%)
exchange rate volatility	$Evol_t$	-5.899653	-2.960411
imports industrial goods	M_t^d	-4.0464479	-2.963972
industrial goods production	Y	-4.475419	-2.967767
relative prices index of imports industrial goods	PM_t / PD_t	-4.583697	-2.967767

Source: Research Findings

The results of table (4) show that all the data series are non-stationary in the levels and table (5) indicates that they are integrated to order one. Now, for estimating coefficients of equation (2), we apply ordinary least square (OLS) method. We have the following representation of the results of estimation equation (2):

$$LnM_t^d = 0.92 + 0.83LnY_t - 0.92Ln(PM_t / PD_t) - .077\beta_3 \ln Evol + .02AR(1) - .44AR(3) - 0.99MA(1) \quad (12)$$

0.059
0.00
.057
.006
0.00
0.00

The results are showed that all of the coefficients are statistically significant at 94% level.

Engle-Granger co-integration test

For avoidance of spurious regression among the variables of estimated model and determination of non-spurious long-run relationships among the variables, we use the Engle-Granger Co-integration test. For this mean, we used ADF criterion for testing null hypothesis of unit root for the residuals in equation (12). Table (6) presents the result ADF test for residuals of estimated model:

Table 6: Engle-Granger co-integration test using ADF test for residuals of estimated model

Variable	Variable name	ADF Test Statistic	Critical Value (5%)
residuals of estimated model	u	-3.963177	-2.991878

Source: Research Findings

According to the Table (6), the null hypothesis of “no co-integration” is rejected. Because the statistic value for ADF test is less than the corresponding critical value and the result of ADF test shows that residuals of estimated model are stationary. Therefore, it is determined that the variables are co-integrated and there is a long run relationship between the imports of industrial goods, exchange rate volatility and other variables of model.

6. CONCLUSION AND RECOMMENDATIONS

In this paper, we investigated a possible effect of exchange rates volatility on demand function of industrial imports in Iran's economy over sanctions. To examine this issue, in the first stage we applied an Exponential Generalized Auto-Regressive Conditional Heteroscedastic variance (EGARCH) model for generating exchange rate volatility and made an effort to find statistically valid evidence by employing the Engle-Granger Co-integration test using ADF criterion for testing null hypothesis of unit root test for the residuals of OLS method in the estimated demand function of imports capital goods in Iran’s Industry. The result of Engle-Granger Co-integration test shows a long term relationship between the imports of Iran's industrial goods, volatility of exchange rate, industrial goods production and relative import price index. The empirical results



indicate that volatility in exchange rates affects on Iran's industrial imported capital goods negatively and this effect is statistically significant. This result is consistent with other previous studies that found the volatility of exchange rate has negatively relationship with imports (Mohammadi & et al., 2011) and (Jafari Samimi and Monfared, 2014). Moreover, our empirical findings show that the increasing the value of industrial goods production has a positive effect on the volume of imports industrial goods; so that a 1 percent increase in production of industrial goods causes a 0.83 percent increase in imports of industrial goods. Also, the increasing of relative imports prices index has a negative effect on imports volume of Iran's industrial goods; so that a 1 percent increase in relative imports prices index of industrial goods causes a 0.92 percent decrease in imports of Iran's industrial goods.

The findings obtained recommended several policy implications. First, Since the fluctuations in value of dollar has negative effect in imports of Iran's industrial goods and the most traders in Iran apply Rial-Dollar exchange rate, so, the government should support traders by special insurance against fluctuations in value of dollar. Second, Most of Iranian traders applied dollar in trade, so in order to the eliminate or decrease volatility effect of dollar on imported industrial goods volume, traders should use a mixed bundle of exchange rates consist of Dollar, Euro, Yen, and etc. Third, the increasing the value of industrial goods production has a positive impact on import volumes over the study periods, suggesting that strong production domestic industrial goods in Iran will induce higher demand for capital goods imports. If import growth outweighs export growth, it may worsen the balance of payment. Hence, policymakers should applied appropriate policy which improves the problems of balance of payment deficits.

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ETHICAL CONSIDERATION

Authenticity of the texts, honesty and fidelity has been observed.

AUTHOR CONTRIBUTIONS

Planning and writing of the manuscript was done solely by the author.

CONFLICT OF INTEREST

Author/s confirmed no conflict of interest.

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